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Waste Utilization Potential of Oil Palm Industry in North Kalimantan Province, Indonesia

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Abstract: This research is aimed to identify the potential economic value of oil palm waste utilization and to construct an environmentally friendly business model based on oil palm waste utilization for the context of North Kalimantan Province. Method of research is descriptive using both quantitative and qualitative specifications. The results of research showed that plantation enterprises and farmers do not yet optimally utilize and manage oil palm waste into economically valuable products. The population around oil palm plantation perceive that oil palm waste from oil palm enterprises is safe and never bringing negative impact on environment. Economical value potential from oil palm waste utilization has been calculated and the number is positive and profitable. Other result indicated that the construction of a business model regarding oil palm waste management involves a collaboration between plantation enterprises, farmers and Village Enterprise (Bumdes-Badan Usaha Milik Desa) as the representative of community around the plantation. The expectation is that the utilization of oil palm waste will improve the welfare of farmers and community members, protect the environment and prevent social conflict concerning waste from happening.

Keywords: waste; environmentally friendly business; economic value; social conflict; waste negative impact.

JEL Classification: Q20; Q53; O30; R11.

Introduction

Oil palm plantation industry is one of strategic sectors in Indonesia. Total width of oil palm plantation area, comprising of state plantation, private plantation and people plantation (PIR – *perkebunan inti rakyat*), has been significantly increasing every year. In 2010, the area of oil palm plantation was totally 8,548,828 Ha and until 2017 (seven years), the number was increasing by almost 44% or becoming 12,298,450 Ha (BPS-Indonesia, 2017). Production and volume capacities for the exported crude palm oil (CPO) and the derivatives were increasing with the expansion of total plantation area. According to the report from the Association of Indonesian Oil Palm Industrialists (GAPKI-*Gabungan Pengusaha Kelapa Sawit Indonesia*), production capacity of palm oil was 41.98 millions tons in 2017, which is an increase by 18% compared to the 2016 production (35.57 millions tons). The

value of the exported palm oil in 2017 was quite promising, which is an increase by 23% or from 25.11 millions tons in 2016 to 31.05 millions tons in 2017.

The growth in total area width of oil palm plantation and also in production capacity of palm oil was relatively high which then surely gives positive impact on economic in the form of absorbing workforces and contributing foreign exchange. However, oil palm agroindustry affects the environment negatively. Pursuant to the opinion given by Syahza (2019), the expansion of oil palm plantation in Indonesia was not entirely followed by the proper environmental management system. Instead, the production from oil palm industry is potentially destructive to the surrounding environment. Converting forests into oil palm plantation has brought negative consequences such as changing ecosystem dramatically that may eliminate ecological function of soil; triggering greenhouse gas emission, deforestation, and forest fire; and potentially causing social conflict between plantation enterprises and community around the plantation.

Oil palm plantation enterprises, including those with and without palm oil processing mills, are indeed potentially causing environmental pollution through their production waste. The production of both palm oil and oil palm core only needs 25% of total weight of oil palm fresh bunch whereas the remaining of 75% weight becomes waste. Oil palm waste is differentiated into three forms, respectively solid, liquid and gas. Solid waste includes empty bunch, shell, and fiber. More specifically, one ton of oil palm can yield 230 kg empty bunch (23%), 65 kg shell waste (6.5%), and 130 kg fiber waste (13%) (Dirgantoro and Adawiya 2018). Palm oil processing leads to liquid waste which is commonly known as POME (*Palm Oil Mill Effluent*). In calculation, one ton of palm oil production can leave total waste for 550kg – 675kg, precisely 55%-67% of total production capacity (Maryadi 2006). Meanwhile, gas waste from oil palm industry usually takes two forms. First gas form is combustion gas from the burned shell and fiber, although the emission of this burning is used for electric generation system. Second gas form is methane and carbondioxide which go up in the air from liquid waste treatment ponds.

If these byproducts (waste) are not properly treated, this waste will be potentially pollutive to the environment. Solid waste from oil palm fiber contains nutrients, phosphor (P), calcium (Ca), magnesium (Mg), and carbon (C) that provides fertile ground for bacterial growth (Hariyanti *et al.* 2014, Pratiwi and Usman 2016). Moreover, the smell of this solid waste is quite unpleasant. Liquid waste from palm oil contains *Biochemical Oxygen Demand* (BOD), *Chemical Oxygen Demand* (COD), and highly suspended solids that can diminish water fertility (Chan *et al.* 2013). In addition, liquid waste of oil palm is extremely dangerous to the environment because the waste is toxic and initiating methane (CH_4) and carbondioxide (CO_2) that later cause greenhouse effect emission (Maryadi 2006, Silalahi and Supijatno2017, Loekito 2002). Gas waste from oil palm production can increase CO_2 level that may trigger air pollution.

Referring to the explanations above, the establishment of oil palm plantation helps increasing foreign exchange income and improving the welfare of oil palm farmers. Unfortunately, the management of oil palm industry does not follow environmental management system and sustainable agriculture system, which later engender a huge negative impact on environment and community. The expectation is that the establishment of oil palm plantation shall be integrated with environmental, economical and social aspects, or at least be complying with sustainable development concept that requires a harmony across environmental, economical and social dimensions (Syahza 2019).

Managing oil palm waste into useful products is an effort with positive impact, at least for the goal of creating harmony across environmental, economical and social dimensions. Oil palm waste can be utilized economically to create several related businesses that conform to the effort of reducing environmental pollution. The findings of previous studies showed that oil palm waste, especially solid waste and liquid waste, can be utilized and processed into new products with economic value. Solid waste can be processed into fertilizer, fuel, pulp, vapor for electric generator, charcoal, compost and livestock feed (Afifah *et al.* 2016b, Haryanti *et al.* 2014, Silalahi and Supijatno 2017, Dirgantoro and Adawiya 2018). Interestingly, liquid waste has been successfully utilized as raw material in the production of soap, cosmetics and organic fertilizer (Afifah *et al.* 2016b, Silalahi and Supijatno 2017, Maryadi 2006).

The current research sees a potential behind the utilization of oil palm waste and this potential provides business opportunity to the community around the industrial area of oil palm plantation in North Kalimantan Province. The 2016 data from BPS showed that the oil palm plantation (including state plantation, private plantation, and people plantation) in North Kalimantan Province has total area of 50,347 ha with CPO production reaching 167,668 tons. In 2017, total area of oil palm plantation has extended by 37% to 69,196 ha with CPO production increasing by 8% to 181,737 tons (BPS-Indonesia, 2017). Based on the 2017 data, CPO production in North Kalimantan Province has delivered solid waste for approximately 38,563 tons (23% of 181,737 tons). This

waste level is quite serious and surely requiring immediate treatment that corresponds to sustainable environmental and agricultural management system.

Concerning with matters above, the current research becomes an important early step for giving benefit to local, regional and national levels. Taking into consideration of those matters, this research sets several goals, respectively: (1) to find out the negative impact perceived by the community from oil palm waste, (2) to inquire the utilization of oil palm waste that has been conducted, (3) to estimate the potential economic value of the utilization of oil palm waste as business alternative, and (4) to construct the model of oil palm waste utilization that involves community and oil palm enterprises. The suggested business model is the activity of oil palm waste utilization that is directly managed by community and farmers with a collaborative relationship with oil palm industry (oil palm enterprises). Previously, the utilization of oil palm waste is only managed by the enterprises or industry and without involving the surrounding community. This business model is expected to be able to create mutual partnership between oil palm industry (enterprises), farmers and surrounding community in North Kalimantan Province. By applying this model, the expectation is that the environment can be kept away from the pollution of oil palm waste and also that the surrounding community can improve their income by utilizing oil palm waste in economic way. Else, oil palm enterprises can be enforced to ensure that their production activity is already environmentally friendly. Production viability is needed to ascertain that the products are good and in compliance with environmental management standard which make the products eligible for export and to be helpful for increasing national foreign exchange.

1. Literature Review

1.1. Oil Palm Waste

There are two products delivered by oil palm mills, respectively crude palm oil (CPO) and palm kernel oil (PKO). Many different products can be obtained from the processing of CPO, including biodiesel and processed palm oil for frying, baking and other cooking activities (Barthel *et al.* 2018). Meanwhile, PKO is the main raw material for the production of natural fatty alcoholic substance, which later is processed into shampoo and liquid detergent (Barthel *et al.* 2018).

Palm oil products can yield a huge amount of waste or residuals in the forms of shell, empty bunch and fiber (Abdullah and Sulaiman, 2013, Promraksa and Rakmak, 2020). Besides, main byproduct of CPO production is liquid mud waste known as palm oil mill effluent (POME) (Vairappan and Yen 2007). According to Haryanti *et al.* (2014), oil palm waste is the remnants from the treatment of oil palm plants which are not included in the processing of main products. But, oil palm waste can also be found after the processing of oil palm and the waste may take form as solid, liquid and gas. Therefore, oil palm waste can be associated not only with the residues of oil palm plants harvested from the plantation but also with the inclusive materials from the processing of palm oil.

So far, oil palm waste creates a problem related with waste management. Main principle of waste management is to minimize and recycle the waste, to recover the energy from the waste, and finally, to discard the waste (Gollakota *et al.* 2020). Before understanding the best waste management system, the detail about the byproducts of palm oil production needs to be investigated.

1.2. Types of Oil Palm Waste

The type of oil palm waste is varying and increasing in numbers with the expansion of production activity. In general, oil palm waste is differentiated into three, respectively solid waste, liquid waste and gas (pollutant) waste. All these waste can represent either the residues of harvested oil palm plants from the plantation or the inclusive materials from palm oil processing.

1.Solid Waste

Solid waste of oil palm consists of empty bunch, fiber, shell and wet solids. In average, one ton of oil palm fresh bunch can yield empty bunch waste for 220 kg (22%), fiber waste for 130 kg (13%), wet decanter solids [*lumpur sawit*] for 40 kg (4%), and shell waste for 60 kg (6%) (Afifah *et al.* 2016b, Haryanti *et al.* 2014).

2.Liquid Waste

Liquid waste is often associated with the residue of palm oil production. The appearance of this waste is like gelatins with blackish color. This waste is often known through a term of POME (*Palm Oil Mill Effluent*) (Dirgantoro and Adawiya 2018).

3.Gas (Pollutant) Waste

Gas waste from oil palm industry includes combustion gas from the burned shell and fiber and methane and carbondioxide from liquid waste treatment ponds.

1.3. Impact of Oil Palm Industry and Oil Palm Waste

Oil palm plantation has successfully improved the income of rural farmers compared to other livelihoods. Therefore, in the context of this research, oil palm plantation has a great contribution to the economic development of rural area and also of oil palm producer countries through their cooperative relationship. Converting the forest into oil palm plantation and oil palm industry without compliance with sustainable agriculture principle may give bad impact on environment and society (Barthel *et al.* 2018, Utomo *et al.* 2019). Environmental impact of this unwise land conversion comprises of: deforestation; loss of biological diversity (partially due to forest degradation); greenhouse gas emission from the change of land use and from the utilization of palm oil as raw material for biodiesel; the activity at oil palm plantation and at palm oil mills; the use of fire and the consequences; air pollution (including vapor fog); and water polution. Social impact of such ignorant land conversion consists of: forced use of land right; the emergence of smallholding farmers (with small livelihood, low income and improper welfare); forced laborer and child workers; and inhuman work conditions and requirements (regarding wage, health and safety).

Furthermore, the production of palm oil can release waste that is dangerous for the environment. As previously stated, fiber waste can have unpleasant smell and also be the source of bacterial growth (Haryanti *et al.* 2014). Liquid waste from palm oil production may contain *Biochemical Oxygen Demand* (BOD), *Chemical Oxygen Demand* (COD), and wet decanter solids that can reduce water fertility (Chan *et al.* 2013). Moreover, this liquid waste also initiates the emergence of methane (CH_4) and carbondioxide (CO_2) that cause greenhouse effect emission and endanger the environment (Maryadi 2006, Silalahi and Supijatno 2017, Loekito 2002). Else, oil palm waste contains a great sum of inorganic compounds, including heavy metals (copper, lead, silver, zinc, iron, nickel, etc), which have harmful effect on microorganism (Sugiharto 1987, Tsouko *et al.* 2019).

1.4. Utilization of Oil Palm Waste

Oil palm waste can be handled economically by utilizing this waste to be reprocessed into the useful product with economic value. Previous studies have examined the utilization of waste from palm oil production. The following table presents waste type, utilization of oil palm waste and the studies that examine these items.

Table 1. Various Utilization Types of Oil Palm Waste

Waste	Utilization	Reference
Solid waste; empty bunch	Empty bunch is used as raw material in the making of compost and charcoal. At final form, empty bunch is used as fertilizer.	(Afifah *et al.* 2016b, Haryanti *et al.* 2014)
Solid waste; oil palm leaf	Oil palm leaf is used as support material in the making of coffin, furniture, house roof, and souvenir products.	(Singh *et al.* 2010)
Solid waste; oil palm fiber	Oil palm fiber is used as the fuel material for boiler. The burning in the boiler produces vapor that will be used in electric generator.	(Afifah *et al.* 2016b, Haryanti *et al.* 2014, Silalahi and Supijatno 2017)
Solid waste; oil palm stem	Oil palm stem is used in the production of laminated veneer lumber (LVL). The stem of Indonesian oil palm has been recognized for flexibility and compressive strength, which make Indonesian-made LVL compatible to Malaysian LVL, which is usually made from Malaysian oak wood (or rubber wood), a wood species often used in the manufacturing of furniture in Malaysia. The Indonesian oil palm stem-based products are almost comparable to the Malaysian oak stem-based products in relation to solidity, flexibility and compressive strength.	(Nordin *et al.* 2004, Ghani *et al.* 2022)
Solid waste; shell	Shell waste is used as raw material in the making of active charcoal. Chemical contents in active charcoal (carbon compounds) can be used in water purification process.	(Afifah *et al.* 2016b, Haryanti *et al.* 2014)
Solid waste: fiber	Fiber waste is utilized as the material in the making of pulp (paper porridge)	(Haryanti *et al.* 2014)
Solid waste; wet decanter solids	Wet decanter solids are used as raw material in the making of compost.	(Afifah *et al.* 2016b)
Solid waste; empty fruit bunch	Empty fruit bunch of oil palm (TKKS- *tandan buah kosong kelapa sawit*) can be converted into pulp. This potential	(Abdullah and Sulaiman 2013)

Waste	Utilization	Reference
	has been confirmed by MPOB because TKKS is categorized as plant residue with high fiber constituents. Paper material from TKKS can be casted and formed easily.	
Solid waste; empty fruit bunch	Other utilization of TKKS includes fuel for electric generator, biomass, fertilizer and bioethanol.	(Haryanti *et al.* 2014)
Liquid waste; sludge oil	Sludge oil is liquid waste that resembles gelatin with blackish color. This waste is used as raw material of soap, cosmetics and others. Liquid waste from palm oil mills has a good nutrient level which is potential to be used as liquid organic fertilizer.	(Afifah *et al.* 2016b, Maryadi 2006)
Solid waste	Solid waste of oil palm has energy potential which can be utilized as fuel for electric generator, charcoal briquet, pulp material, livestock feed, and fertilizer.	(Dirgantoro and Adawiya 2018)
Solid waste; fiber	Fiber contents in empty bunch and empty shell can be utilized as material in the admixture used for the production of lightweight concrete brick that needs to be environmentally friendly.	(Fitriadi and Fatahillah 2017, Abrar and Abdillah 2019)
Solid waste; empty shell	Empty shell is a material in the admixture used for the production of lightweight concrete brick that needs to be more economic and environmentally friendly.	(Oktarina and Natalina 2013, Oktarina and Natalina 2018)

Source: Data collected in this research

Based on the contents in Table 1, solid waste and liquid waste of oil palm can be utilized to be processed as products with economic value that gives alternative income to the community. The utilization of these waste provides a new way toward entrepreneurship that involves farmers, community and oil palm enterprises (palm oil mills) in a collaborative relationship.

2. Methodology

Data type of this research is primary and secondary. Primary data were collected through survey, interview and questionnaire. Respondents include community members, farmers groups and Village Enterprise (Bumdes). The respondents must live in the vicinity of oil palm plantation in North Kalimantan Province. Secondary data were obtained from the institutions that release data concerning oil palm plantation. These institutions are Central Bureau of Statistics for North Kalimantan Province and government offices in North Kalimantan Province that handle oil palm-related activity.

Research type is descriptive with both quantitative and qualitative specifications. Descriptive research is usually aimed to produce description, illustration, or drawing in systemic, factual and accurate manners about events, characteristics and relationships across the targeted phenomena (Sugiyono 2012). Analytical instrument for quantitative specification is used to analyze the economic value of oil palm waste utilization. This economic value is associated with the income realized from selling the waste to free market or from utilizing waste into profitable products. Mathematic formula of this economic value is written as follows (Sunyoto 2013):

$$I = TR - TC \quad 2.1$$

Where, I = Income (IDR/month), TR = Total Revenue (IDR/month), and TC = Total Cost (IDR/month). Total economic value comprises of what so called direct use value and indirect use value.

Direct use value (N1). Direct use value is economic value of the waste that is directly sold. Such waste usually takes forms as liquid waste and solid waste. The formula for direct use value is written as follows:

$$N = (P\ x\ Q\ ) - TC \quad 2.2$$

Where, N = Value of liquid/solid waste (IDR/month). P = Price of liquid/solid waste (IDR/kg), Q = Production of waste (IDR/month), and TC = Total Cost (IDR/month)

Indirect use value (N2). Indirect use value is economic value of the waste that is utilized into another product (not for sale). The usual form of this utilized waste is liquid waste and solid waste. The formula for indirect use value is written as follows:

$$N = (\ Q\ x\ P) - TC \quad 2.3$$

Where, Q = Waste level (kg/month), P = Sale price (IDR/kg), TC = Total Cost (IDR/month). Taking into consideration of all equations above, total economic value can be calculated by the following formula:

$$NET = \sum Direct\ Use\ Value + \sum Indirect\ Use\ Value \quad (2.4)$$

3. Case Study: Oil Palm Industry in North Kalimantan Province

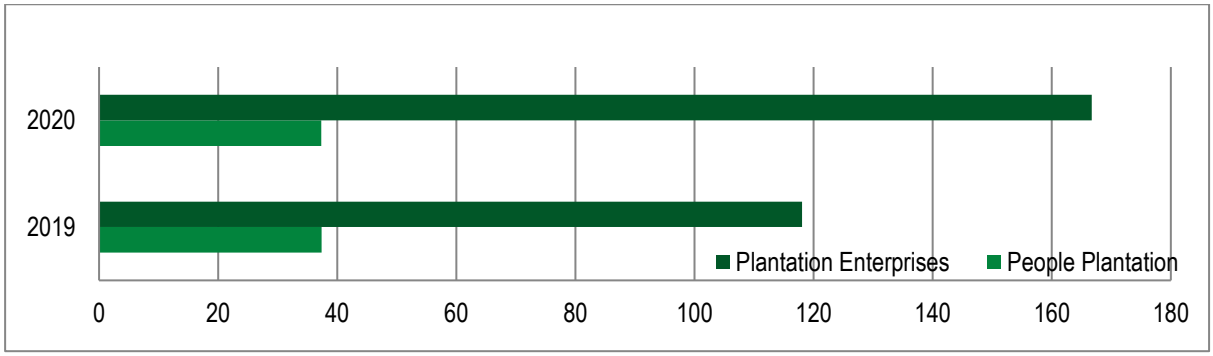
3.1 General Description of Oil Palm Industry in North Kalimantan Province

Oil palm commodity is one of leading sectors that support the economic of North Kalimantan Province. Oil palm is a plantation commodity that is available abundantly in this Province. In 2020, Plantation alone contributed by 3.26% to Gross Regional Domestic Product of North Kalimantan Province. In addition, plantation also contributed by 19.78% to the Sector of Agriculture, Forestry and Fishery of North Kalimantan Province (BPS-Kaltara 2020). Oil palm plays quite important role in economic activity of North Kalimantan Province and also Indonesia. The processing of oil palm can deliver vegetable oil and various processed products needed by industries. Having a wide area of oil palm plantation, North Kalimantan Province has a great potential to trade oil palm and oil palm core in the domestic and foreign markets.

The BPS data in 2017 indicated that the area width of oil palm plantation in Indonesia has reached 12.38 millions hectares. The width had expanded annually and became 14.59 millions hectares in 2020. One reason of this expansion is the increase of administrative area of oil palm plantation managed by oil palm enterprises. In North Kalimantan Province alone, total area width of oil palm plantation is around 204 thousands hectares dominated by plantation enterprises. Of this total width, people plantation has area width of 37.3 thousands hectares whereas plantation enterprises has area width of 166.7 thousands hectares (BPS-Kaltara 2020).

More specifically, the development of area width of oil palm plantation in North Kalimantan Province from 2019 to 2020 is depicted in Figure 1.

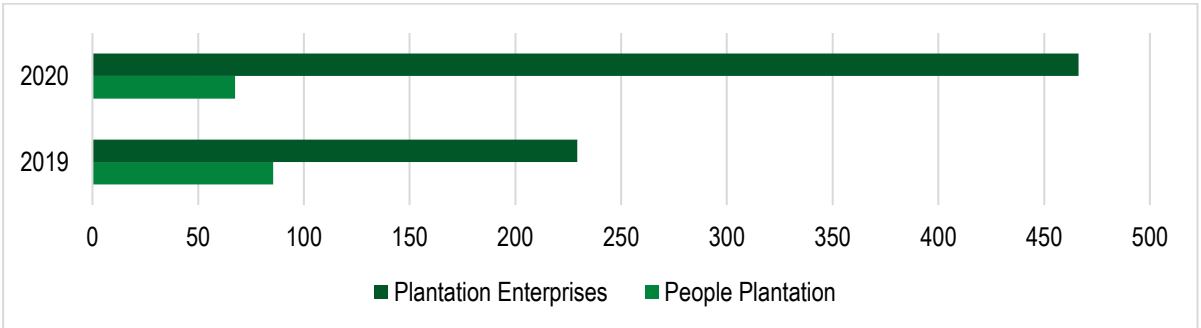
Figure 1. The Development of Area Width of Oil Palm Plantation in North Kalimantan Province, 2019-2020 (in thousand hectares)



Source: Secondary data are processed (2022)

Pursuant to the contents of Figure 1, the width of people plantation was a bit decreasing by 0.1% in 2019, precisely from 37.4 thousands hectares to 37.3 thousands hectares in 2020. Meanwhile, the area width of plantation enterprises has been increasing significantly by 41.23% from 118.06 thousands hectares in 2019 to 166.7 thousands hectares in 2020. Oil palm plantation enterprises play important role in the development of oil palm industry in North Kalimantan Province.

Figure 2. The Development of CPO Production in North Kalimantan Province, 2019-2020 (in thousand ton)



Source: Secondary data are processed (2022)

Oil palm industry processes oil palm into finished products and half-finished products which have higher economic value than their previous material. Among these products is Crude Palm Oil (CPO). The development of palm oil production in North Kalimantan Province from 2019 to 2020 is displayed in Figure 2.

Correspond to the content of Figure 2, CPO production of plantation enterprises increased significantly by 103.3% or 237 thousands tons from 229.2 thousands tons in 2019 to 466.2 thousands tons. Different from plantation enterprises, CPO production from people plantation decreased by 20.98% or 17.9 thousands tons from 85.4 thousands tons in 2019 to 67.5 thousands tons in 2020. This decrease is mainly caused by Covid-19 pandemic in 2020.

Following the data of plantation area width and CPO production, the potential of oil palm industry in North Kalimantan Province is quite promising but with the possible discharge of oil palm residues which include solid waste, liquid waste and gas (pollutant) waste. The elaboration regarding negative impact of oil palm waste on environment and society will be elaborated in the next sections.

3.2 Oil Palm Waste Management in North Kalimantan Province

Palm oil production leaves solid waste in the forms of empty bunch, fiber, shell and wet decanter solids. Liquid waste in the form of *sludge oil* has a characteristic resembling gelatin with blackish color. Gas waste is associated with methane, hydrogen and other air pollutant. Actually, in the context of North Kalimantan Province, oil palm waste has been managed to become other products with higher economic value. But the implementation of this processing is not yet optimally done by plantation enterprises and people plantation.

However, many plantation enterprises only utilize solid waste in small scale, or precisely only for the interest of themself. For instance, shell waste is used for hardening the access road to palm oil mills and very often used as the fuel of the boiler. Empty bunch is simply used as compost fertilizer for oil palm plantation. On the other hand, people plantation utilizes oil palm waste at household scale, which the products probably do not have high economic value as expected. Housewives of oil palm farmers groups in Tanjung Agung Village, Bulungan Regency, North Kalimantan Province have utilized the waste of oil palm leaf rib to make handicraft product named *Sa'ep* (Singal *et al.* 2021). Sa'ep is a term used by Dayak Kenyah Tribe in North Kalimantan Province to define plate or container made from plaited palm leaf rib. That is why the plate is called Rib Plate or *Piring Lidi*. Other enterprises related to oil palm plantation are not welcoming enough to the searching of information and data regarding their oil palm waste management. Therefore, in the current research, the information about management and utilization of oil palm waste are still limited.

3.3 Analyzing Negative Impact of Oil Palm Waste Perceived by Community

One of four goals that this research intends to attain is to find out the negative impact perceived by the community from oil palm waste. Following up this intention, sample was taken which the result is 50 respondents of dwellers who domicile at the vicinity of oil palm plantation enterprises. In majority, there are 94% respondents saying that oil palm waste from oil palm plantation enterprises is safe and not bringing negative impact on environment. Respondents who feel disturbed by oil palm waste are only 2%. Moreover, the negative impact of oil palm industry is also associated with the existence of garbage from production process.

There are three types of impact caused by oil palm waste, respectively water pollution, air polluton and soil pollution but the waste with the most prominent impact is air pollution, which is related with unpleasant smell. Respondents admitted that their health condition is interfered because their respiration system was disturbed by the smell. Air pollutant discharged by oil palm industry includes carbondioxide, carbonmonoxide, methane and other harmful gases (Anyaoha and Zhang 2021). Air pollutant (gas) is typically dust, smoke and gas emission from combustion process. Smoke usually emanates from boiler chimney, smoke stack of generator set and also as gas discharge from chemical reaction at the laboratory of oil palm plantation. Gas is air pollutant derived from the processing of frech fruit bunch (oil palm fruit after being removed from the bunch) into CPO (*Crude Palm Oil*) (Afifah *et al.* 2016a). Such disposed gas is very dangerous to the health of human or other living creatures.

3.4 Analyzing Economic Value Potential of Waste from Oil Palm Industry

Economic value of the waste from oil palm industry is the actual value of waste discharged by palm oil mills. The value of the marketed waste is called as direct use value while the value of the utilized waste is known as indirect use value. Before analyzing the economic value of the waste from oil palm industry, there is a notion that the utilized waste is dominated by:

a) Solid waste, which includes empty bunch, shell, fiber, and wet decanter solids.
b) Liquid waste, which refers to sludge oil.

As stated in previous section, every one ton of oil palm fresh bunch produces in average empty bunch waste for 220 kg (22%), fiber waste for 130 kg (13%), wet decanter solids [*lumpur sawit*] for 40 kg (4%), shell waste for 60 kg (6%), and sludge oil for 2 kg (0.2%) (Afifah *et al.* 2016b, Haryanti *et al.* 2014).

In pursuance of the 2020 data, CPO production in North Kalimantan Province was 528,700 tons. If this number is calculated from the amount of oil palm fresh bunch, then the involved bunch will be as much as 2,114,800 tons or 2,114,800,000 kg. The quantity of oil palm waste is presented in the following table.

Table 2. Quantity of Oil Palm Waste

Waste Type	Waste Proportion in Percentage	Waste Quantity per Year in Kg	Waste Quantity per Month in Kg
Shell	6	126,888,000	10,574,000
Sludge Oil	0.2	4,229,600	352,467
Empty Bunch	23	486,404,000	40,533,667
Fiber	13	274,924,000	22,910,333
Wet Decanter Solids	4	84,592,000	7,049,333

Source: Secondary data are processed (2022)

In accordance with the contents in Table 2, monthly revenue potential from marketed waste and non-marketed (utilized) waste is calculated. The result of this calculation is elaborated in the following table.

Table 3. Revenue Potential of Marketed and Utilized Oil Palm Waste

Revenue of Marketed Waste			
Waste Type	Price in IDR/kg	Waste Quantity (kg)	Revenue in IDR/month
Shell	500	10,574,000	5,287,000,000
Sludge oil	300	352,466,67	105,740,000
Total			5,392,740,000
Revenue of Non-Marketed (Utilized) Waste			
Waste Type	Price in IDR/kg	Waste Quantity (kg)	Revenue in IDR/month
Empty Bunch	50	40,533,667	2,026,683,333
Fiber	165	22,910,333	3,780,205,000
Wet Decanter Solids	25	7,049,333	176,233,333
Total			5,983,121,667
Total Revenue			11,375,861,667

Source: Secondary data are processed (2022)

According to the contents in Table 3, the total revenue potential of both marketed and utilized waste is IDR 11,375,861,667.00 per month. Revenue of marketed waste is higher than that of utilized waste because the marketed waste is affected by differences in sale price and waste volume. Price of shell and sludge oil is higher than price of empty bunch, wet solids and fiber. The difference in price seemingly affects the revenue level.

Net economic value of oil palm is estimated by calculating costs involved in the management and utilization of the waste. The costs consist of fixed cost and variable cost. Fixed cost comprises depreciation cost of waste production equipments, maintenance cost of waste production equipments, and workforce cost in waste handling. Variable cost is the cost that follows production volume. More detail about depreciation cost of waste production equipments is given in the following table.

Table 4. Depreciation Cost of Waste production Equipments

Waste Type	Equipment Type	Depreciation per Month
Empty Bunch	EFB Hopper	4,000,000
	EFB Conveyor	580,000
	Shredder	4,333,333
	Dumptruck	1,960,000
	Loader	1,764,333
Total		**12,637,666**
Fiber	Fiber shell conveyor	159,360
	Fuel Return Elevator	293,333
	Fuel Distibuting Conveyor	446,667
Total		**899,360**
Sludge Oil	Sludge collection pit	163,333
	Daily pond	216,667
	Cooling pond	200,000
Total		**580,000**
Shell	Fiber shell conveyor	6,640
	Loader	469,000
Total		**475,640**
Solid	Solid Bin	526,667
	Dumptruck	373,333
Total		**900,000**

Source: Secondary data are processed (2022)

Maintenance cost of dumptruck as a waste production equipment is shown in Table 5.

Table 5. Maintenance Cost of Dumptruck

Name of Equipment	Maintenance Cost	Cost of Empty Bunch	Cost of Wet Solids
Dumptruck	3,200,000.00	2,688,000.00	512,000.00

Source: Secondary data are processed (2022)

In conformity with the contents of Table 5, dumptruck maintenance cost is only incurred against empty bunch waste and wet solids because other waste does not use dumptruck. Workforce cost in waste management is explained in the following table.

Based on the contents of Table 6, total workforce needed for the management of oil palm waste is 1000 persons. The utilization of oil palm waste may need more than this number. Wage per day for this workforce is IDR 192,307.69 by assumption that the work day is 26 days in a month. Every worker will get monthly total income for IDR 5,000,000.00 (IDR 192,307.69 x 26 days). This wage level is much higher than minimum wage level in North Kalimantan Province. Correspond to the Decree of Governor of North Kalimantan Province No. 188.44/K.770/2021, minimum wage for North Kalimantan Province is IDR 3,016,738.00. Variable cost of oil palm waste production is presented in the following table.

Table 6. Workforce Cost of Waste Management

Waste Type	Number of Involved Workforce	Number of Work Day	Wage per Day (IDR)	Total Wage (IDR)
Empty Bunch	200	26	192,307.69	999,999,988.00
Fiber	200	26	192,307.69	999,999,988.00
Shell	200	26	192,307.69	999,999,988.00
Sludge Oil	200	26	192,307.69	999,999,988.00
Wet Decanter Solids	200	26	192,307.69	999,999,988.00
Total	1.000			4,999,999,940.00

Source: Secondary data are processed (2022)

Table 7. Variable Cost of Oil Palm Waste Production

Type of Cost Use	Variable Cost in IDR/Month	Cost of Empty Bunch (IDR/Month)	Cost of Shell (IDR/Month)	Cost of Wet Solids (IDR/Month)
Fuel for Loader	40,778,906.50	32,215,336.14	8,563,570.30	-
Lubricant for Loader	2,918,200.00	2,305,378.00	612,822.00	-
Fuel for Dumptruck	12,200,000.00	10,248,000.00	-	1,952,000.00
	Total	44,768,714.14	9,176,392.30	1,952,000.00

Source: Secondary data are processed (2022)

Pursuant to the contents of Table 7, the cost components of fuel for loader, lubricant for loader, and fuel for dumptruck are calculated when these equipments are used for handling empty bunch, shell and wet solids. By the costs determined for each waste, then economic value of processing and utilization of oil palm waste can be known. The acquisition of this economic value is elaborated in the following table.

Table 8. Economic Value of Oil Palm Waste Utilization

Direct Use Value					
Waste Type	Revenue	Total Cost	Profit/Loss Before Tax	Sale Tax (10%)	Economic Value
Cangkang	5,287,000,000	1,060,094,368.14	4,226,905,631.86	422,690,563.19	3,804,215,068.67
Sludge Oil	105,740,000	1,003,363,988.00	- 897,623,988.00	0	- 897,623,988.00
Total	5,392,740,000	2,063,458,356.14			2,906,591,080.67
Direct Use Value					
Empty Bunch	2,026,683.333	1,060,094,368.14	966,588,965.19	0	966,588,965.19
Fiber	3,780,205,000	1,000,899,348.00	2,779,305,652.00	0	2,779,305,652.00
Wet Solids	176,233,333	1,003,363,988.00	-827,130,654.67	0	- 827,130,654.67
Total	5,983,121,667	3,064,357,704.14	2,918,763,962.53		2,918,763,962.53
NET					5,825,355,043.20

Source: Secondary data are processed (2022)

In relation to the contents of Table 8, the economic value of oil palm waste utilization comprises direct use value and indirect use value. The former is the value of the waste that has been processed to be then sold in the market whereas the latter is the value of the waste that has been processed but not to be marketed or to be utilized for self-interest. Two waste have negative economic value, respectively sludge oil and wet solids. Total economic value of oil palm waste processing has positive value, which is described as profitable, as much as 5,825,355,043.20 per month.

Oil palm waste management in North Kalimantan Province will be potentially benefiting if the processing of oil palm waste is aimed for improving the living standard of workers, farmers and plantation enterprises. Waste management, either in the marketing or utilization, can absorb workforce, which therefore can reduce unemployment or help a lot of jobless individuals. Indeed, farmers groups and community members get wage in the waste-related jobs and use their income for improving their living standards.

3.5 Business Model for Utilization of Waste from Oil Palm Industry

Business model for oil palm waste utilization is constructed after conducting empirical review on previous studies. The result of this review indicates that there is an opportunity to create new entrepreneurs who will apply *green entrepreneur* concept (environmentally friendly entrepreneurship). Oil palm waste utilization can be done by farmers and community members through collaborative relationship with plantation enterprises. This collaboration is expected to produce a synergy across plantation entities in their efforts of improving the welfare of plantation farmers and community members, reducing environmental problem caused by plantation enterprises, minimizing negative impact of waste on environment, and anticipating the occurrence of social conflict due to waste issue.

The perception of farmers and community members concerning oil palm waste utilization is understood by conducting survey on 50 respondents (mostly village dwellers and farmers) who live nearby plantation enterprises, precisely in Ruhuy Rahayu Village, District of Tanjung Palas Tengah, Bulungan Regency, North Kalimantan Province. Respondents are required to give score to their perception based on the scale from 1 (very disagree) to 5 (very agree). The result of survey on oil palm waste utilization is displayed in the following table.

Table 9. Community Perception on Oil Palm Waste Utilization

Statement	Score Average
Oil palm waste must be processed before discharge in order to minimize the negative impact on environment.	4.73
Plantation enterprises must process their waste before discharge.	4.67
I am willing to cooperate with plantation enterprises in waste utilization efforts.	3.06
I am willing to self-dependently utilize waste produced by plantation enterprises.	2.88
I know how to utilize oil palm waste.	2.86
I am required to have specialized skill in waste processing.	4.16
The current generation must protect environment for the interest of the next generation.	4.80
Justness across generations must be the priority in policy making.	4.69
The impact of oil palm waste is already harmful to environment.	1.31

Source: Primary data are processed (2022)

In regard to the contents of Table 9, respondents who live nearby plantation enterprises have quite similar perceptions. Indeed, farmers and community members require plantation enterprises to manage their waste and control the waste processing to ensure that the waste products do not negatively affect environment and society. Besides, the respondents wish to have a cooperation with plantation enterprises in processing oil palm waste into other benefiting products. The problem is that farmers and community members lack of knowledge about how to process oil palm waste self-dependently. Therefore, the cooperation with plantation enterprises and the skill related to oil palm waste utilization are needed. Furthermore, the respondents also insist on protecting the environment in sustainable way for the interest of the next generation. Surprisingly, the respondents perceive that oil palm waste from oil palm enterprises is safe and never bringing negative impact on environment. This posture was confirmed by 94% respondents who said that oil palm waste from oil palm plantation enterprises do not give negative impact on environment and never disturb environment, particularly their dwellings.

The activity that has been carried out by farmers and community members concerning the management and utilization of oil palm waste, their readiness for this utilization and their cooperation with plantation enterprises, are shown in the following table.

As indicated by the contents of Table 10, farmers and community members do not quite understand about how to process oil palm waste and also do not have the required skills. On the other hand, farmers and

community members somehow realize that oil palm waste can be utilized. The problem is that farmers and community members do not yet take initiative to build cooperation with plantation enterprises or other institutions. In consequence, the economic potential of oil palm waste cannot be yet managed optimally.

Table 10. Condition and Readiness of Farmers/Community Members Toward Oil Palm Waste Management

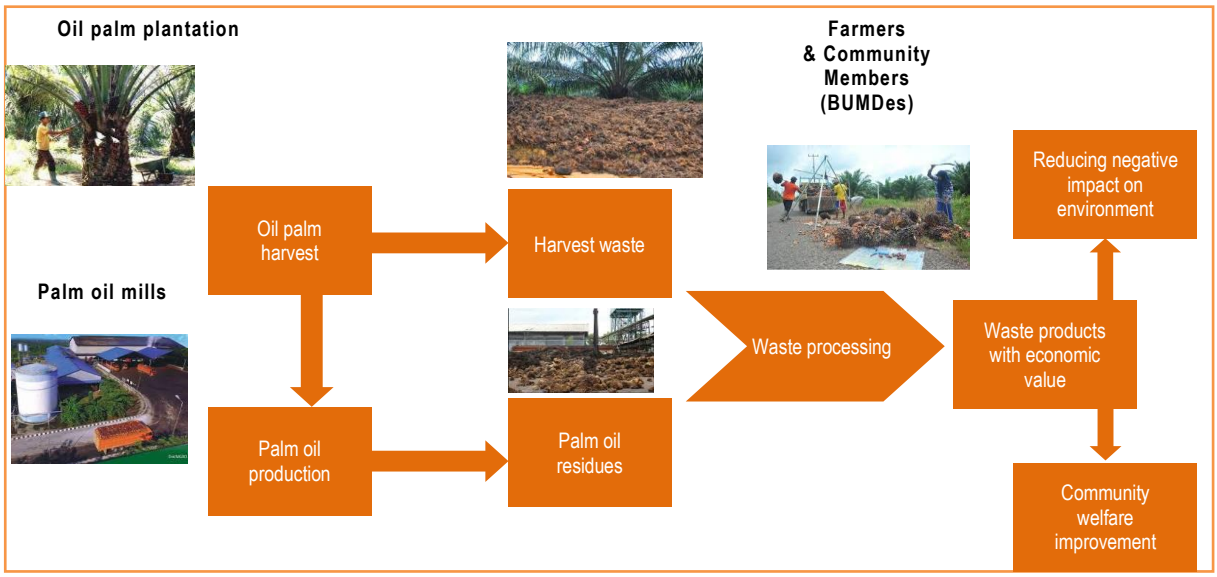
No	Statement Item	Actual Condition
1.	Type of waste that has been ever utilized	90% respondents said that there is no oil palm waste that needs to be processed. 10% respondents have processed waste, which the waste is in the form of empty bunch and wet decanter solids.
2.	Quantity of waste that has been ever produced	90% respondents never encounter the waste. 10% respondents ever processed waste in weight of ¼ to 1 ton.
3.	Technology used in waste processing	90% respondents never use any technologies. 10% respondents use manual and simple technologies.
4.	Product from oil palm waste	90% respondents reported that there is no products from the waste. 10% respondents admitted that the product is mostly in the form of compost fertilizer.
5.	Cooperative relationship with plantation enterprises	90% respondents informed that there is no cooperation with plantation enterprises. 10% respondents notified that there is relationship across the suppliers of fresh fruit bunch, employees of plantation enterprises, oil palm buyers and oil palm couriers.
6.	Training about oil palm waste management	96% respondents never attend the training. 4% respondents get the related training from seminar and in their higher education.
7.	Receiving helps for oil palm waste management	100% respondents never get such helps.
8.	Understandings about oil palm waste utilization	99% respondents feel quite informed about oil palm waste utilization but do not do the processing. 1% respondents do not know how to utilize oil palm waste.
9.	Skills needed for oil palm waste processing	88% respondents do not have relevant skills. 8% respondents have technical skills. 4% respondents have marketing skills.
10	Trusted party to mitigate the risk of oil palm waste	49% respondents refer to government or authorized party. 44% respondents believes in Village Enterprise (BUMDES). 7% respondents rely on farmers groups

Source: Primary data are processed (2022)

The initiative toward collaboration among farmers groups, community members, government, Village Enterprise (Bumdes), and plantation enterprises in oil palm waste utilization in North Kalimantan Province is truly needed. The result of analysis on economic value reveals that oil palm waste utilization has benefited plantation enterprises and also been helpful in absorbing workforce and improving the income of farmers and workers.

Referring to the opinion given by Utomo *et al.* (2021), the utilization of oil palm waste by plantation enterprises shall involve farmers and community members in order to create new entrepreneurs who are environmentally friendly and who are able to implement waste processing, to make the processing more efficient and to implement recycle system. Indeed, the collaboration between farmers, community members, and plantation enterprises in managing and utilizing waste into economically valuable products is then formulated in this research within a business model. This model is described in Figure 3.

Figure 3. Business Model of Oil Palm Waste Utilization



Source: Utomo *et al.* (2021)

As illustrated in Figure 3, oil palm waste emanates from 2 sources. **First** source is oil palm waste from harvest in oil palm plantation owned by state, private and local people. **Second** source is oil palm waste derived from palm oil residues (from palm oil mills). Both sources can be directly managed by farmers and community members into new processed products. Sometimes, palm oil mills and also oil palm enterprises hand over the residues (waste), which are not yet utilized, to farmers groups and community members to be further processed. By such generosity, palm oil mills get benefit in the form of reducing environmental cost of waste processing. On the other side, farmers groups and community members get benefit in the form of acquiring additional income from waste processing. Moreover, the environment becomes cleaner because oil palm waste has been well utilized through recycle or reprocessed into other products with economic value. Such arrangement can prevent social conflict in relation with waste. In the business model proposed by this research, farmers group and community members as the waste processor are represented by an institution called Village Enterprise (BUMDES-*Badan Usaha Milik Desa*). According to Law No. 6 of 2014 and Government Regulation No. 43 of 2014, BUMDES was founded by intention to implement economic empowerment program at village level. The creation of BUMDES will accommodate local economic potentials that can stimulate and improve village economic (Purnamasari 2015).

Conclusion

This research is aimed to identify the potential economic value of oil palm waste utilization and to construct a business model based on oil palm waste utilization for the context of North Kalimantan Province. Based on the data regarding area width and CPO production, the potentials of oil palm industry in North Kalimantan Province are quite promising but also producing residues in the forms of solid, liquid and gas (pollutant). Plantation enterprises, plantation farmers and community members do not yet optimally manage, utilize and change oil palm production waste into other products with economic value. Oil palm waste is simply used as compost fertilizer because this utilization does not need further processing. The majority dwellers who live in vicinity of plantation enterprises have perceived that oil palm waste from oil palm enterprises is safe and never bringing negative impact on environment. Only few dwellers feel disturbed by oil palm waste. Negative impact of oil palm waste is only related with the amount of garbage which increases quickly with the establishment of oil palm industry.

Economic value potential of oil palm industry leads to positive or profitable economic value. The management of oil palm waste in North Kalimantan Province can potentially benefit plantation enterprises, plantation farmers, and community members who live nearby plantation area. Waste management can also absorb workers which then reduces unemployment. Workers and community members can get additional income beyond their usual livelihood from main product of oil palm industry, which is Crude Palm Oil (CPO).

Concerning with the real condition of oil palm waste management, farmers and community members have realized that oil palm waste can be utilized but either farmers or community members do not yet take initiative to build cooperation with plantation enterprises or other institutions. This decision makes the economic potential of

oil palm waste become less optimally managed. Dealing with this issue, the initiative toward collaboration among farmers groups, community members, government, Village Enterprise (Bumdes), and plantation enterprises in oil palm waste utilization in North Kalimantan Province is necessary. Business model of oil palm waste management is then proposed and this model is involving farmers and community members who are represented by Village Enterprise (Bumdes). This involvement is in line with the intention to create new entrepreneurs who are environmentally friendly. The suggested business model benefits plantation enterprises through the reduction of environmental cost from waste processing whereas the farmers and community members benefit from the model through additional income acquired from waste processing. Clean environment is obtained by processing oil palm waste through recycle or by reprocessing the waste into other products with economic value. The utilization of oil palm waste can prevent social conflict concerning waste from happening.

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Credit Authorship Contribution Statement

Mohamad Nur Utomo: conceptualization, investigation, methodology, software, formal analysis, writing – original draft, supervision, data curation, validation, writing – review and editing, funding acquisition.
Ahmad Mubarak: conceptualization, supervision, visualization, validation
Sulistya Rini Pratiwi: conceptualization, investigation, methodology, project administration, writing – original draft, supervision, data curation, validation, writing – review and editing.
Najmudin Najmudin: conceptualization, investigation, supervision

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Legal Regulation of Civil Liability for Environmental Damage: How Appropriate are Civil Liability Provisions with the Privacy of Environmental Damage?

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Abstract: The study analyzes the nature of civil liability resulting from environmental damage, because the risk of environmental pollution is one of the dangers that cannot be counted or predicted. Therefore, it is difficult to determine the legal basis on which it is based in the field of pollution. Traditional wrong-based liability rules do not respond to the tort-based environmental policy objectives in order to avoid environmental damage and ensure effective protection for those affected. This made the provisions of civil liability in the Jordanian Civil Law no longer commensurate with the specificity of environmental damage, especially since the situation requires compensation for damage to the environment itself and to the health and property of individuals. In addition, it is not hidden that there are shortcomings in the provisions of the Jordanian Environment Protection Law No. (6) of 2017. Its provisions included preventive and remedial measures for environmental pollution without considering the issue of compensation for environmental damage in a manner consistent with the nature and specificity of this damage. This requires the development of these rules in a way that commensurate with the nature of environmental damage.

Keywords: pollution; environmental damage; civil liability; compensation; civil law.

JEL Classification: K32; K19; K10; Q53; R11.

Introduction

The country aims at applying the best international criteria to enable and reinforce the law and human rights and freedoms (Abdel Hafiz 2007). Not to forget the importance of reinforcing the concept of environmental justice and rights and the related issues, whether ecological or organizational. Framing the legal acts to protect the environment and their importance through effective instructions, laws and systems which aims at achieving the desired objectives (Mehani 2021).

The issue of environmental pollution occupies a great importance in practical life, after it has become one of the most complex problems facing the international community. Its multiple sources, forms, and damage often affect the environment, people, and the vital interests of states. The danger of environmental pollution increases in view of its pervasive nature that transcends the geographical borders of countries around the world, and its effects on the environment in the entire international scope. This is the case in the transfer of toxic waste and the dumping of factory waste in regional rivers and seas. This led to an increase in countries' concerns about the impact of this waste on human resources and nature. Therefore, it was necessary for many researchers to shed light on such studies in order to seek legal solutions that might help prevent or reduce the spread of this global scourge.

From this point of view, civil liability for environmental damage began to occupy a privileged position in the face of issues related to the areas of the environment and its protection from pollution and compensation for it. As a whole, it emphasizes that it is a form of harm to others, resulting from illegal practices and actions committed by some. These environmental damages have a specificity that differs in terms of their content and nature from the rest of the damages that arise from other causes. In addition, the establishment of responsibility for this damage requires the availability of its elements, which have known deep conflicts about the basis of this responsibility and the difficulty of estimating compensation. It is known that the general provisions of civil liability in legal systems have become stable and work with them is easy. However, this is not the case in the field of liability for damages and the existence of the principle of liability per se for this modern field. Accordingly, we will review the civil liability that actually takes place within the framework of general rules, which have not been decided in particular to compensate environmental damages, we will also stress the need to adapt the rules of civil liability, both tortious and contractual, to respond to the special nature of this type of damage that cannot be known in advance because it is in a state of permanent and continuous change. Compensation for it is still arbitrary or through compensation established by economic laws.

1. Research Background

Among the most serious and difficult issues confronting modern industrial civilization are effectively discouraging environmental degradation and sufficiently remedying environmental injury. The environmental liability regime is a common regulatory mechanism used to help with this endeavor (Zhai 2022).

In practice, due to a lack of regulation, certain instances involving environmental destruction can only be resolved in the context of a dispute over environmental contamination responsibility. As a result, in the framework of codification, it is studied whether the damages generated by the act destructing the ecological may be included in the current civil system and if civil laws governing tort can remedy the loss of public environmental interest (Xua and Khanb 2023).

The importance of this study lies in the fact that no environmental legal system can be considered an adequate and satisfactory legal system unless it includes provisions regulating civil liability for environmental damage, and the nature and limits of that liability. Then it is possible to claim compensation for environmental damages in accordance with the provisions of this responsibility. Humankind is exposed to various damages that affect people and their private property, as well as the environment itself through harming the general elements of the environment that belong to all. This study showed the possibility of applying the rules of civil liability in the field of environmental pollution, and the ability of those affected by such practices harmful to the environment to claim compensation. The Jordanian Environmental Protection Law came to deal with various environmental issues. It did not adopt a special system for this civil responsibility. This makes the environmentally harmed person compelled in this case to refer to the general rules related to civil liability for the harmful act in an attempt to obtain what he wants, which is compensation for this damage.

The problem of the study appears primarily in that environmental pollution is a new subject with complex specificity. This results in the difficulty of proving the existence of this pollution, the damage caused, and their attribution to a specific person or entity that can be responsible for compensating the resulting damages. It is often difficult to apply the general rules of civil liability contained in the Civil Code in full agreement to environmental damage. This requires working on developing these rules and provisions and adapting them to

make them commensurate with the nature of these harmful environmental practices and the damages arising from them.

This study seeks to answer the following questions: What is the legal concept of environmental pollution? What is the legal basis for civil liability for environmental damage? To what extent is it possible to adapt the general rules of civil liability in a manner commensurate with the nature of damages resulting from environmental pollution?

2. Methodology

This study adopted the descriptive, analytical and comparative approach. Through the descriptive approach, the position of the Jordanian legislation under study will be described by listing the different rules related to the conceptual framework of environmental pollution and explaining its characteristics and legal nature. As for the analytical approach, its purpose is to analyze those legal texts contained in the legislation related to the study to determine their effectiveness, and the extent of their shortcomings in clarifying the legal regulation of civil liability for environmental damage.

3. What is the Environment and Environmental Pollution?

To study the civil liability for environmental damage and its various aspects, it is necessary to define the legal meaning of the environment with the identification of its elements. It is also necessary to clarify what is meant by environmental pollution, which is the act that results in damage to the environment.

3.1 Definition of the Environment

The concept of the environment came within a broad concept and different connotations. Some of them look at the environment from a scientific point of view, while others look at it from a legal point of view. This made it difficult to put a comprehensive definition of it. The environment, in one of its definitions, is: “the biotic and abiotic factors that all actually affect the organism, directly and indirectly, at any period of its life history” (Hilal 2005; Al-Billeh and Abu Issa 2022). In another, more specific definition, the environment means "the framework in which a person lives, in which he obtains the necessities of his life such as food, clothing, medicine, and shelter, in which he practices his life with his fellow human beings" (Al-Mihanna 2018, Al-Billeh 2022a).

As for the legal efforts made in defining the term environment, many legal legislations have been keen to include a definition within the relevant laws. The Jordanian legislator defined it in Article (2) of Environment Law No. (6) of 2017 as: “the environment that includes living and non-living organisms, the materials they contain, and the surrounding air, water, soil, and interactions, any of them, and facilities established by man.” In this definition, it is noted that the Jordanian legislation combined the definition between the two terms natural environment and industrial environment when it used the phrase (the facilities established by man).

The Egyptian legislator defined it in Law No. (4) of 1994 regarding environmental protection as: “the biosphere that includes living organisms, the materials it contains, the air and water that surrounds it, and the facilities established by man.” It is noted in the previous text that the definition approved by the Jordanian legislature for the term environment has been in conformity with the text of the Egyptian legislator, as they agree on the definition of the environment completely and do not differ.

The Tunisian legislator also defined in Article (2) of the Environmental Protection Law No. (91) of 1998 the term environment as: “the physical world, including land, air, sea, ground and surface waters, valleys, lakes, marshes and the like, as well as natural spaces, landscapes and distinct sites.”, the various kinds of animals and plants, and in general everything that includes the national soil. It appears from the text of the Tunisian legislation that it has adopted the broad concept of the environment, as it made its scope include everything related to life, including nature and biological life, in addition to the smallest details related to humans.

By looking at the previous definitions, we find that they may differ according to the legal systems that define them, but they agree within the general framework of the concept of the environment. In light of this, we can define the environment as: "the material medium in which man lives, including air, water, soil, space, living organisms, as well as facilities established by man to fulfill his demands and needs".

3.2 Environment Elements

The elements of the environment generally consist of two basic types of elements, which are (Al-Nawaisa 2020):

Living elements: They are multiple and different elements, the most important of which are humans, animals and plants, as they live with each other within an integrated ecosystem. Each element of it affects and influences the other elements. Man affects all of these elements if fixed proportions are available among their

components, because any deficiency or imbalance in one of them may cause a collapse of the entire ecosystem. It should be noted here that the population problem and the increasing numbers of people around the world have become the most prominent role in contributing to environmental pollution and lack of natural resources, as a result of the spread of hunger, diseases, poverty and pollution of various environmental sources.

Non-living elements: The most prominent of these elements are air, water, soil, and all the elements that form an environment of its own. These elements are the center of life. The air is breathed by man, the soil is cultivated and eaten from its production, water is drunk, and food comes from all the elements that God has subjected to man. There are also other non-living elements called industrial elements, which are elements invented by man and harnessed to serve him over time, such as tools, constructions, and equipment, to benefit from them in meeting his needs and requirements (Fahmy 2020; Al-Billeh 2022b).

3.3 Nature of Environmental Pollution

Pollution is one of the oldest problems that the environment suffers from. The emergence of this problem has increased as a result of the increasing activity of man in various fields of life. This excessive activity has led to an imbalance in the environment, a threat to the existence of many living organisms, and an infringement of every person's right to a clean, pollution-free environment. This called for combating this pollution and standing up to its expansion and development, as it is the key to any environmental protection law, and the starting point for determining harmful work, and specifying means to combat it (Al-Billeh 2022c).

3.3.1 Definition of Environmental Pollution

Many legal legislations have been keen to provide a definition of the term environmental pollution. There have been many definitions that cannot be counted, so we will suffice to mention some of them. In Article (2) of the Jordanian Environment Law No. (6) of 2017, the Jordanian legislator defined it as: “Any negative change to any of the elements of the environment that goes beyond, directly or indirectly, the environmental standards and specifications approved by the Ministry, or causes this change, whether it occurs to a tangible or intangible degree, or leads to limiting the use of these elements, or reduces their economic value or aesthetic or social aspects, or lead to their partial or total elimination, or affect the practice of the natural life of living organisms, and everything that disturbs their natural balance”.

The French legislator also defined pollution in Article (3) of the French Environmental Law as: “the direct or indirect introduction of any polluting substance into the surrounding medium, whether it is biological, chemical or physical.”

The same applies to the Egyptian legislation, which defined the term environmental pollution under Article (7/1) of the Egyptian Environment Law No. (4) of 1994 as: “Every change in the characteristics of the environment that leads, directly or indirectly, to harm human health and affect the practice of his natural life, or to damage natural resources, living organisms, or biological biodiversity.” Article (1/8) therof also defines the term environmental degradation as: “The impact on the environment, which reduces its value, distorts its environmental nature, depletes its resources, or harms living organisms or antiquities.”

Accordingly, the researchers believe that pollution can be defined as every change in the environment or one of its elements, by the action of living organisms that leads to harmful effects that are negatively reflected on the general health of man, natural resources or his property.

3.3.2 Types of Environmental Pollution

Environmental pollution is divided into three main types as follows (Balmarat and Haddum 2021):

Biological pollution: This type of pollution means that every pollution results from the activity of microorganisms during the fermentation of organic matter. These organisms multiply rapidly, consume oxygen and turn the place into a suffocating medium, or they lose their immunity cells and become infected with viruses and germs. It also results from sediments resulting from industrial, agricultural, or household activities, or from waste resulting from industries that process organic materials. This type is considered one of the oldest forms of environmental pollution known to man. It arises as a result of the presence of living organisms, visible or invisible, plant or animal, in the environmental medium (water, air, soil), fungi and viruses that spread in the air, causing diseases, and others. These beings appear in the form of dissolved substances or substances composed of atoms, or in the form of living bodies that evolve from one form to another in a constantly renewed cycle.

Chemical pollution: It means the excessive use of industrial chemicals to the extent that causes an imbalance in the compounds of the elements of the environment, which are the cause of many chronic diseases that affect the health of living organisms such as humans.

Radioactive contamination: It is the moving energy emanating from a nucleus in a state of instability, which has the ability to penetrate objects that stand in its way, causing an imbalance in its natural components, thus disrupting the biological and chemical processes as a result of the penetration of nuclear radiation to these bodies. This type of pollution results in the emission of radioactive waves in some industrial places and in the vicinity of nuclear reactors in amounts sufficient to damage some living tissues, in addition to the pollution of one of the components of the environment such as water, soil and air (Al-Hiti 2011).

4. Legal Basis of Civil Liability for Environmental Damage

Civil liability is generally defined as the debtor's obligation to compensate for the damage that resulted from his breach of a contractual or legal obligation that falls on him. Therefore, the harmful act is the one that establishes the legal bond between the responsible and the injured. It is the one that imposes an obligation to compensate for the damage it causes to others (Qaid 2015; Al-Billeh 2022d).

It is known that the general provisions of civil liability in legal systems have become stable and easy to use. However, this is not the case in the field of liability for damages and the principle of liability per se for this modern field. Accordingly, we will review in this section civil liability, which takes place within the framework of general rules, which have not been decided to compensate environmental damages in a particular way.

In another sense, on the one hand, it is the rules of tort liability as determined by the general principles, whether for unlawful work, or for guarding things, and on the other hand, the rules of contractual liability when the injured and the responsible are linked to a contractual relationship and the damage occurs on the occasion of the breach of the implementation of the contract.

4.1 Civil Tort Liability Arising from Environmental Damage

Civil liability in its tortious aspect is based in various statutory laws and as required by the traditional theory on the harmful act (tort), which is the basis for tort liability. The claimant for compensation must prove the harmful act, and prove the damage incurred. He must also prove the link between the harm and the harmful act, *i.e.* prove the existence of a causal relationship between them (Al-Nawaisa 2020; Al-Billeh and Abu Issa 2023).

4.1.1 Harmful Act Element (Tort)

The act giving rise to civil tort for environmental damage is the core of traditional civil liability within the scope of environmental damage along with the other two elements, namely, damage and causation. The legislative systems have differed views on the basis of liability for the harmful personal act. Some legislations built it on the basis of tort, as did the Egyptian legislator. Article (163) of the Egyptian Civil Code stipulates that: “Every error that causes damage to others requires the person who committed it to pay compensation.” The same applies to the French legislator, as Article (1382) of the French Civil Code, which regulates civil liability for personal action, stipulates that: “Every act, whatever it may be, that causes damage to others, obliges the one through whose fault the damage occurred to compensate” (Al-Mathan and Al-Mahasnah 2006; AL-Hammouri *et al.* 2023). French jurisprudence estimates that Article (1382) of the Civil Code, in its generality, is applicable to environmental damage in general, and its role may even increase in the future (Martin 1992). It responds to the special provisions contained within new and numerous regulations that impose specific obligations with the aim of protecting the environment, such as those that fall on the shoulders of waste producers and holders. It also cites in this regard the strict expressions contained in Article 2 of Law No. (15-07) of 1975 related to the exclusion of waste. The law stipulates that: “Any person who produces or possesses waste, in conditions that may generate effects on the land, animals or plants, or lead to the deterioration of the site or farms or pollute the air or water, or generate noise or odors in a general way, causing damage to human health and the environment, is obligated, guaranteed or insured to exclude it in accordance with the provisions of the current law, in circumstances that would avoid such effects."

According to the aforementioned laws, whether Egyptian or French law, the harmful act that occurred to the environment must be described as tort. In order for compensation to be sought for damage to the environment, there must be some tort on the part of the polluter. The tort was not defined comprehensively and specifically in most of the legislations that adopted it as a basis for establishing civil liability. These legislations were reconciled by not mentioning a specific definition, because this term covers countless numbers of human behavior (Al-Rashidi 2012; Al-Khawajah *et al.* 2022).

The environmental tort is not different from the tort in general, as it is the behavior that emanates from the polluter, or his refusal to do an action, and the awareness of the perpetrator of the act harmful to the environment of the deviation he has committed. This deviant behavior of a person in the field of environmental damage is

represented by his actions that cause harm to others or damage the environment around him. For example, a person may place highly toxic substances in the water springs frequented by other people's animals with the intention of harming them, or a person may break the sewage streams to make the sewage run down the roads, forming puddles of water resulting in harassment of the population represented by the emission of unpleasant odors (Al-Rashidi 2012; Alkhseilat *et al.* 2022).

There is no importance here for the capacity of the person who committed the harmful act, as he may be a natural person or a legal person. Claims may be filed against the polluting companies and institutions that produce materials that have a direct impact on human health or the environment around. The harmful act may be issued by persons of public law (such as the state), whereby the state may carry out acts that harm another neighboring country (Abdelrahman 2014).

As for the Jordanian legislation, it did not establish liability for a harmful act on the basis of tort, but rather made the basis of civil liability the harmful act. Article (256) of the Jordanian Civil Code stipulates that: "Every damage to a third party obligates the perpetrator, even if he is not discerning, to be liable for it." This does not mean that the Jordanian legislator did not stipulate the description of tort in the act that causes the damage, because whenever a person acts unjustly, it is considered a fault. Also, whoever causes damage to others that is not permitted by law is considered at fault. Accordingly, whoever commits an harmful act that results in environmental damage is undoubtedly at fault (Al Shara'a 2014).

The tort occurs in two ways, either by direct or by causing. Article (257) of the Jordanian Civil Code stipulates that: "1- Damage is made directly or caused 2- If it is direct, the guarantee is necessary with no condition, and if it occurs by causing, then it is required that the act be infringement, or intentional, or that the act leads to damage." The Jordanian legislator made the liability of the direct based on merely causing damage to others or to the elements of the environment. Direct is the case in which the act of the polluter has caused the environmental damage directly. As for causing environmental damage, it means the case in which the polluter does an action that leads to environmental damage. The illegality of the act is not added except by adding another, which is intentional or transgression. Intentional is that the causer has caused damage to others with the intention behind this action to cause damage and harm to others, such as one of the factories deliberately discharging wastewater into the watercourse that flows into the river. As for transgression, it is doing something that is not permissible to do, such as one of the companies drilling for oil in the sea without taking the necessary precautions, during the exploration, part of the oil leaked into the sea water. This led to significant pollution and damage to this water (Al-Nasser 2010).

4.1.2 Tort Element

Environmental damage is the core of civil liability for environmental damage. This responsibility cannot be established if this element is absent, given that it is considered the first spark that emanates from thinking about holding those responsible accountable. The availability of the first pillar represented in the act that generates responsibility (tort) is not sufficient alone to claim recourse against the perpetrator for compensation. Rather, the harmful act must result in damage in order for civil liability to be established (Al-Mathan and Al-Mahasnah 2006).

Damage is generally defined as the harm that befalls a person as a result of a violation of one of his rights or a legitimate interest he has, whether that right or that interest relates to the safety of his body, affection, money, freedom, honor, status, and other things that require compensation (Al-Nasser 2010). This definition constitutes the general framework for the concept of damage. However, environmental damage remains of a special nature, as this specificity of environmental damage requires that its concept be explained in a more precise and detailed manner.

Despite the importance of the element of damage, which represents the essence of civil liability, there is no specific definition for it in the texts of civil law, as the matter was left to jurisprudence to take over this task (Al-Ta'i 2013). Some have defined it as: "Any impact on the living or non-living components of the environment and ecosystems, including damage to marine, terrestrial, or atmospheric life" (Al-Hasnawi 2012). Another definition was given as: "current or future damage to an element of the environment, the consequence of a person's activity, or the act of nature, which is represented in disturbing the environmental balance, whether it comes from within the polluted environment or comes to it" (Al-Asir 2014).

It is noted that most of the legislations did not include a definition that defines the concept of environmental damage, including the Jordanian legislation, which did not include a clear and explicit legal provision in which it explains what is meant by environmental damage in the Environmental Protection Law, although it has included some expressions that could be descriptions of environmental damage. It also included a definition of the term environmental degradation in its second article. It defined it as affecting the environment in a

way that reduces its value, distorts its nature, depletes its resources, or harms living organisms or antiquities (Al-Sarayrah 2015). According to the linguistic meaning of this definition, environmental degradation is less severe than environmental pollution itself, but it leads to it, because the latter does not occur suddenly, but requires a period of time for its occurrence.

The Logan Convention defines it as: “loss and harm resulting from environmental spoilage or degradation.” The modern European Directive of 2004 dealt with it in paragraph (1/2) of it as: "measurable adverse change in natural resources that may occur directly or indirectly."

It is worth noting that any definition introduced to define the concept of environmental damage must take into account that the environment is divided into two types of resources. The first is the general and shared resources that everyone benefits from, such as the air in the atmosphere, the waters of the seas and oceans, forests and public pastures, while the second is represented in the private resources of individuals such as agricultural lands, canal waters, animals and other private properties that are included in the concept of the environment. The environment in its artistic sense belongs to everyone and does not belong to a particular person. This damage is not personal, in other words it can be said that it is, at first sight, irreparable harm; on the pretext that it does not affect individuals directly, and that the condition of interest must be met by the one who files the lawsuit to claim compensation. However, there remains the possibility of compensation for this type of environmental damage that affects the environment itself, although there is some difficulty in this field. As for the environmental damage that befalls a person's private property, it is a harm that affects a private interest. It is only a personal damage, given that this harm has befallen the injured person, whether financially or physically, so he has a personal and direct interest in filing a lawsuit to claim compensation.

Accordingly, we can define environmental damage as: “the harm or negative impact on the environment, including its living or non-living elements, resulting from an illegal activity, or a legitimate activity that carries a danger to people and other living organisms.”

Environmental damage can be of two types, the first type: material environmental damage, and the second type: moral environmental damage. We will discuss both types as follows:

Physical environmental damage: It is generally meant as damage to a person’s body or money, or a loss of his financial rights or legitimate interest. As for the physical environmental damage in particular, it is the damage resulting from environmental pollution, which harms human health and the consequent treatment expenses incurred by the injured party, such as a person suffering from cancer as a result of inhaling toxic gases emitted from a factory, or it may cause damage to his property and land, leading to a decrease in its economic value, or a decrease in its agricultural product (Al-Sarayrah 2015).

Moral environmental damage: It means everything that hurts a person's feelings or emotions, causing him pain or sadness. Moral harm is unlike material harm. It is an intangible harm that does not encroach on a person’s financial integrity, while affecting a person’s right to his freedom, honor, reputation, social or financial status (Sultan 2015). This is what Article (267/1) of the Jordanian Civil Code addressed, saying: “The right of guarantee covers moral damage as well. Any trespass against a third party in his freedom, honor, honor, reputation, or social or financial status makes the trespasser liable for the guarantee.” The Jordanian Court of Cassation also decided in one of its decisions, "The jurisprudence established that the perpetrator of the crime is liable for the value of the damage inflicted on the victim, whether the damage is material or moral."

As for the moral damages in the field of harmful environmental activities, it may be represented in the deprivation of the joys of life. For example, it may be represented in the loss of the joys of the picturesque marine environment, as a result of the dumping of oil residues carried by a ship in the territorial waters, or in the loss of a person the joy of sitting in his garden because of the toxic waste left by a factory, which led to the destruction of that person’s garden, which was planted with flowers and fruit trees (Al-Nawaisa 2020).

It is worth noting that compensation for moral damages was the subject of controversy. Some have argued that this type of damage may be difficult to determine the moral damage that requires responsibility and compensation, as it differs from other damages in terms of its impact, time of occurrence and source, in addition to the things that are subject to moral harm, such as honor, reputation, and affection, do not have specific prices. How can it be compensated? However, there is another trend that considers the necessity of compensating for moral damages similar to material damages, because the intent is not to compensate for the damage, but rather it is a kind of condolence for the person as a result of what he has suffered. In addition, leaving the victim of sensory damage without compensation will cause him great injustice. The Jordanian legislator did well in the civil law when he required compensation for moral as well as material damage.

In applying the above to moral environmental damages, is it possible to envisage a claim for moral damage resulting from activities harmful to the environment? To answer this question, it is necessary to refer to

the judicial rulings issued by the Jordanian courts. They show that the Jordanian judiciary has recognized the principle of compensation for moral damage in general. However, it did not specifically address the issue of compensation for moral damage caused by environmental activism (Manasir 2020).

This is in contradiction to what has been established in Western jurisprudence and judiciary, which emphasized the comprehensiveness of compensation for environmental moral damages. In this we mention the example of the claims made by the United States of America against the German government to compensate for the damages that resulted from the sinking of the passenger ship "Lusitania" by a German submarine. The court affirmed that moral damages are real and certain rather than emotional and vague damages (Manaseer, 2020). In a recent ruling, the Salalah Court of First Instance ruled in its Decision No. (80/2014) issued Dec.23, 20214 to compensate the plaintiff for the material and moral damage incurred by the aggrieved party as a result of the death of his cows due to eating rotten fish that the factory owner threw behind his factories.

The question that arises is whether the damage is material or moral arising from harmful environmental practices. Are there specific descriptions and conditions for this environmental damage? This will be explained as follows:

For environmental damage to be compensable, certain conditions must be met. It does not differ from the terms of damage in general. Which we will explain in detail as follows:

Environmental damage to be assured: In order for the environmental damage to be compensable, it must be assured. The assured harm is the harm that occurred immediately. For example, the death of a person due to inhalation of toxic gases, or the harm that will occur in the future, such as a worker suffering an injury that is certain to lead to death or inability to work in whole or in part in the future. In fact, this issue raises a problem with regard to the nature of environmental damage, as it is possible that these damages may not appear as soon as they occur, but may take a long period of time, as is the case with air pollution from fumes, or marine pollution with oil derivatives such as petroleum (Othman 2008).

Environmental damage to be direct: It is required for the environmental damage to be a direct result of the harmful act committed by the polluter. For example, the leakage of toxic gases from a factory adjacent to a house led to the inhalation of these gases by one of the household members, this person suffered from shortness of breath or continuous vomiting, so this damage is considered immediate and direct. The injured person has nothing but to prove what he claims, because the tort is presumed on the part of the defendant. As for the indirect damages, we find that the Jordanian legislator required in Article (266) of the Jordanian Civil Code compensation for direct damage only. This is the general trend prevailing in the majority of legislations because of the interruption of the causal relationship between the alleged act and the indirect damage resulting from it (Othman 2008).

In the field of environmental damage, we did not find a provision in the Jordanian Environmental Protection Law requiring compensation for indirect environmental damage. Therefore, the researcher sees the implementation of general rules and sufficiency in compensation for direct damages only. This is sound because estimating indirect damage is not easy either in terms of identifying it or evaluating its effects on the affected person (Al-Rashidi 2012).

Environmental damage befalls an acquired right or a legitimate interest of the aggrieved: One of the conditions for the damage to be compensable is that it falls on a legally acquired right or a legitimate interest, *i.e.* an interest that is not contrary to public order and morals. The Jordanian Court of Cassation ruled in its Decision No. (1018) of 1990 that: “The assessment of compensation for damage to fruit trees based on the percentage of product decline due to dust covering the leaves of trees is a correct estimate. The award of compensation on this basis does not violate the law. The p has violated the acquired right of the respondent. The flying dust from the Jordan Cement Company led to a decrease in the production of the land owned by the respondent, which necessitated compensation.”

Environmental damage to be personal: This condition denotes that the claimant for compensation must be the injured person because it is in the nature of matters that a person demands his rights and not the rights of others from the injured. This is only an application of the rule (no lawsuit without interest). Only the aggrieved person is entitled to claim compensation for the damage, or his general successor (such as being his heir), or his representative (such as an agent). Otherwise, no one else can claim compensation and file a liability claims for him. As for the extent to which this condition applies to environmental damages, as it was previously shown that they may affect the general elements of the environment that belong to everyone and not to a specific individual, such as pollution of rivers and seas. Here, it may be difficult to claim compensation for these damages, on the pretext that whoever is claiming compensation does not have a personal and direct interest. Nor does he have the capacity to file a lawsuit and move the liability towards the polluter. This contrasts with the environmental

damage that affects individuals and their private property. There is no problem with this condition because it is considered personal damage that occurred to the aggrieved person in his money or body. The aggrieved party has the capacity to file a lawsuit and move the responsibility towards the polluter (Hashmawi 2021).

4.1.3 Causal Relationship

In order for civil liability to be established for the harmful act in general, the mere issuance of the tort (the harmful act) from the harmed person is not sufficient. Rather, it is required that there be a direct relationship between the harmful act and the damage that befell others. That is, the harmful act must be the direct cause of the damage, otherwise liability is not established. The causation must also be established and direct between the harmful act and the damage.

The causal relationship is the main axis on which the rules of civil liability are based. These rules require the injured person to prove the existence of a link between the harmful act and the damage he suffered. If the injured person is unable to prove this link, then it is impossible for him to obtain the required compensation (Muhammad 2020).

As for the causal link within the scope of civil liability for environmental damage, the element of causation is the existence of a direct link between the harmful act committed by the polluter and the environmental damage inflicted on others, so that proof of this element falls on the injured party according to the general rules of civil liability. However, proving this element is not without difficulty. Most of these damages are generated from several different sources and are described as resulting from frequent and gradual pollution, which may make it difficult to accurately identify the main source causing the pollution. For example, if a factory dumps toxic substances into a nearby river, this will harm everyone who uses or drinks from the river. The difficulty also arises in how to estimate the damage, whether it was before or after the dumping of toxic substances, especially if we know that the river has been previously polluted by someone else. Here we have several causes and sources of pollution, which one is the productive cause, and which one is the accidental cause? This is something that the researcher sees as not easy to know and appreciate (Al-Rashidi 2012; Alshible *et al.* 2023).

One of the difficulties that may face the issue of proving the causal relationship in the field of environmental damage is that the plaintiff is usually tasked with proving the damage and supporting his claim with accurate scientific evidence proving that. For example, if the plaintiff was harmed by toxic substances emitted by a factory adjacent to his home, he must prove that the percentage of emissions exceeded the specified standards for air quality and purity. The trial judge is known to have discretion in assessing the probative strength of evidence presented. However, in the field of environmental damages, this scope may become narrow, because the judge is not a scientific expert in these issues, and pollution issues have a purely scientific nature. When the judge considers a lawsuit filed against a large industrial establishment, he views it as the strong party and awards it compensation for the damages claimed by the plaintiff, despite these factories' compliance with environmental protection laws (Abdelrahman 2014).

4.2 Contractual Civil Liability for Environmental Damage

In addition to what is provided by the tort civil liability in terms of legal provisions and rules that those affected by environmental pollution can resort to, there is the possibility of resorting to the provisions of contractual liability. This is achieved when a contractual relationship is established between the affected party and the person liable for the damage.

Contractual liability is based on the availability of its basic pillars, which are tort, damage, and causal relationship. As for the damage, it must be direct, in the sense that it is the result of non-implementation or delay. If the debtor's obligation is to exercise care, then the creditor must prove the creditor's fault. But if his commitment is to achieve a result, then the tort is established once the commitment is breached. Finally, the causal relationship must be present.

However, in the field of environmental damage, although those affected by environmental pollution can file a contractual liability lawsuit, we acknowledge that such lawsuits are very few, because these disputes are still recent. In addition to the fact that most of these disputes are often settled through reconciliation between the parties, to the extent that they may be considered in many cases an economic burden for industrial projects rather than compensation for damages.

Contractual liability for environmental damage can be established by two main mechanisms. The first is the mechanism of guaranteeing the hidden defects of the thing sold. The provisions of the second mechanism, which is the obligation to inform and advise, can apply to it, which the French legislator adopted to confront this type of damage (Qaid 2015).

4.2.1 Hidden Defects Guarantee

A hidden defect is generally defined as any blemish on something that is unusual in its normal condition. By looking at the texts of the Jordanian Civil Code, we find that it stipulated the concept of a hidden defect indirectly when it stipulated the conditions for the old defect in Article (4/513) by saying: "The old defect is required to be hidden, the hidden is the one that is not known by seeing the appearance of the thing sold or it is not evident to the ordinary person, nor is it revealed by anyone other than an expert, or it does not appear except by experience."

The guarantee of hidden defects, according to the same law, also included the sale contract and every contract transferring ownership or usufruct. Because whoever transfers ownership to another person or a usufruct right must transfer beneficial possession that enables the buyer to benefit from the thing according to the purpose for which it was prepared (Yusifi and Al-Zein 2006; Almanasra *et al.* 2022). This is the same as stipulated by the French legislator in Article (1641) of the French Civil Code, stating that the seller is bound by the guarantee because of the hidden defects found in the thing sold, which would render it unfit for the use for which it was intended, or which greatly diminishes this use, so that the buyer would not have earned it or paid a lower price, had he known it.

On the basis that we are discussing the damages of environmental pollution, we can say that the aggrieved party has the right to justify his claim accordingly. The best example to mention in this regard is what the French judiciary went to in applying the text of Article (1641) civil to the case of harmful waste. The French judiciary tended to acknowledge that the waste producer cannot be ignorant of the hidden defects that the simple professional is supposed to be aware of. Thus, his contractual liability for all damages that befall the buyer to his person or money, or the consequences of his liability against third parties, is established. Concealment of the defect is achieved in this case if the waste was stored in a hidden manner or buried in the ground without a visible mark.

4.2.2 Commitment to Advice and Information

Modern legal jurisprudence has settled on the need for a commitment to inform and advise for the majority of agreements that involve dangerous things. This leads us to exposure to some agreements that lead to environmental damage and pollution. The agreements that relate to the treatment and transportation of waste are the responsibility of whoever entrusts another contractor with the treatment or transportation of these wastes. Contractual liability in this case occurs whenever the first contractor breaches this obligation, resulting in damages to the carrier or others. For example, the first contractor refrains from the obligation to inform and advise in order to draw the attention of the other contractor (the carrier) to the risks that may arise from the nature of the waste and the extent of its danger in order to take the necessary precautions to avoid the occurrence of damages. It is also his responsibility to advise due to his knowledge of ways to store and destroy these wastes in safe conditions (Yusefi and El-Zein 2006).

Conclusion

The study dealt with the legal system of civil liability for environmental damage, with the aim of establishing responsibility for everyone who caused damage to the environment and obligating them to pay compensation as a penalty for an act that violates the law. It is done either by the rules of liability for illegal action that are based on tort as an essential element of its existence or based on contractual liability for these environmental damages. This is when it is possible to attribute to one of the contracting parties a breach of the contractual obligation that was behind the occurrence of this damage.

In fact, it is necessary to reformulate and accommodate new rules commensurate with the magnitude of the devastating damage to the environment. The traditional legal rules of civil liability can no longer contain this type of damage. The reason for this is the difficulty of proving the elements of civil liability in the field of environmental pollution, whether from a harmful act or damage, or the causative relationship between them, in addition to the difficulty of determining who has the capacity to file a lawsuit for liability for damages of environmental pollution.

Therefore, the plaintiff, according to laws and regulations, is required to have an interest protected by law. He shall have this capacity when the environmental pollution harms his physical safety or his money and private property. As for the environment, it does not belong to a specific person. The issue becomes thorny as to who has the capacity to initiate a civil liability lawsuit against those who commit harmful environmental practices. It should also be noted that the issue of estimating compensation for environmental damage is not an easy matter, as most

of the environmental damage is indirect and appears over a long period of time. This confirms the inadequacy of applying the general rules of civil liability for environmental pollution.

The Jordanian legislator must address the issue of civil liability, in both its tort and contractual parts, for environmental damage within the Jordanian Environmental Protection Law, given the special nature of environmental pollution. In this regard, we also suggest the need to enact a legal text within the law that activates the role of compensation funds in the event that the person responsible for the pollution is not identified. These funds are directed to cover the environmental damages that affect public environmental elements that belong to everyone and that may not be covered by the insurance system in general, or the environmental damages resulting from sudden accidents or force majeure that cannot be attributed to any person. This is for the purpose of protecting the environment and providing effective protection for those affected by environmental damage.

Finally, the Jordanian legislator must develop the rules of civil liability to respond to the special nature of environmental damage without adherence to or being satisfied with the traditional rules of liability. We also hope to increase the role of the media in raising awareness of the dangers of pollution to the safety and health of humans and nature, and the right of individuals to live in a clean environment. This is considered the basic and essential block in building the concept of civil liability for environmental damage in Jordan.

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Credit Authorship Contribution Statement

All authors listed have significantly contributed to the development and the writing of this article.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Study the Nexus between Indicators of Surface Water Quality on the Small River for Better Basin Management

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Abstract: Purpose is determination of interdependencies between hydrochemical indicators of surface water quality in the example of a small river as a limiting factor of formation of aquatic ecosystem of territories. Correlation analyses of the studied indicators of water quality was conducted on an average value of each indicator (pH, phosphates, nitrates, BOD, COD, soluble oxygen). Found a significant increase in phosphates with time, with a coefficient of correlation R=0.71, indicating contamination of the water facility. This can be explained by the arrival of various surface-active substances and, to a lesser extent, the lack of quality sewage treatment facilities. Positive changes are founded in water object that is related to a decrease in the value of BOD. This is due to a decrease in the use of oxygen on oxidation of inorganic and organic substances. In general, the use of river runoff of the river above normal, and the overall environmental state of river basin is defined as "extremely poor".

Keywords: pollution; quality water indicators; small river; correlation analysis.

JEL Classification: Q53; R11.

Introduction

The problem of natural water pollution is especially important in terms of monitoring studies and studying the interdependencies between water quality indicators. It is especially true in regions with developed infrastructure and agriculture, where there is a significant source of pollutants in water systems. On the other hand, aquatic ecosystems consist of various elements, some of which are small rivers. Small rivers form the water resources of medium and large rivers, hydrochemical water quality and creating lands large areas. Environmental monitoring is one of the country's priorities for achieving the goals of sustainable development. The one is the goal of the

roadmap for the implementation of environmental policy in Ukraine, as a country that has set a course for European integration in terms of implementing programmes aimed at national security and sustainable development of society. Environmental issues outlined in the legislation and regulations of the European Union, namely: Millennium Development Goals (Millennium Development Goals, 2015); Objectives of 2050 of the Seventh Environment Action Programme (7th Environment Action Programme, 2013; Ishchenko *et al.* 2019), Water Framework Directive 2000/60/EC (Directive 2000/60/EC of the European Parliament and of the Council, 2000; Charis and Galanakis 2010); Industrial Pollution Directive 2010/75/EU (Directive 2010/75/EU of the European Parliament and of the Council, 2010); Water Code of Ukraine (Water Code of Ukraine,1995).

1. Research Background

The scientific works of scientists have acquired significant scientific significance in the study of environmental problems related to water resources management and anthropogenic impact on the state of water bodies. Staddon C. *et al.* study the socio-economic issues of water resources management, the structure of water consumption in different countries (Staddon 2016).

Meyer A.M., Klein C., Fünfrocken E., Kautenburger R., Beck H.P. *et al.* study the correlations between chemical components, as well as the patterns of distribution of pollutants in the aquatic environment, study the problems of pollution of small rivers (Meyer *et al.* 2019; Mitryasova and Pohrebennyk 2017; Mitryasova *et al.* 2020).

Obolewski K., Glinska-Lewczuk K., Szymanska M., Astel A., Lew S. study the issues of green chemistry of water bodies, search for patterns between the content of chemical components of the aquatic environment and its biological component (Obolewski *et al.* 2018).

Issues of assessing the impact of industrial enterprises on the water resources state present in the works Kapelewska J. *et al.* (2019). Schickele A. *et al.* (2020) investigate the influence of temperature on the morphological composition of water bodies.

The works of Snizhko S. *et al.* became especially important issue - multifactorial impact on surface water quality (Snizhko 2004); Grebin V. *et al.* - regional landscape-hydrological analysis of the modern water regime of the rivers of Ukraine (Grebin and Khilchevskyi 2016). Thus, the study of Grebin V. and Khilchevsky V., following the requirements of the Water Framework Directive developed a method of hydrographic zoning of rivers of Ukraine, assessment of aquatic ecosystems.

Vasenko O. *et al.* develop methods of comprehensive assessment of water bodies taking into account the factors of degradation processes, carry out scientific research to improve the methodology for establishing environmental standards of surface water quality, taking into account landscape and geographical features of aquatic ecosystems, ranking of observation points (Vasenko *et al.* 2016; Bezsonov *et al.* 2017; Pohrebennyk *et al.* 2019; Mitryasova and Pohrebennyk, 2020a).

However, a comprehensive analysis of water resources from the standpoint of assessing the state of small rivers for effective integrated management for sustainable development of the region and achieving proper environmental status of water bodies, under Ukrainian legislation and the Water Framework Directive, processes of adaptation to EU environmental policy.

Small rivers are an important component of the natural environment. Small rivers form the hydrochemical conditions of water resources and water quality of medium-sized and large rivers, creating landscapes large areas. An important feature of small rivers in the fact that they are the starting point of the river network, and any changes that occur in their mode, marked on the hydrological chain (Tanriverdi *et al.* 2010; Pohrebennyk *et al.* 2016; Zeinalzadeh and Rezaei, 2017; Zhang *et al.* 2018; Alifujiang *et al.* 2021; Thuy *et al.* 2021; Mitryasova *et al.* 2021b; McBean *et al.* 2022; Tha *et al.* 2022; Ward 2021). Water resources of small rivers are part of the shared water resources and are often the main and sometimes the only one source of local water. Small rivers have some features that need to be considered when developing environmental management measures (Petrov *et al.* 2020). The first is the dependence of water content, hydrological regime and water quality of small rivers on the state of the catchment. The second is climatic and weather factors (Mazlum *et al.* 1999; Mitryasova *et al.* 2021a; Arndt *et al.* 2022).

The object of the research is a small river Mertvovod in Mykolaiv region (Ukraine).

The length of the river is 114 km, the area of the drainage basin is 1820 km². The river valley is predominantly trapezoidal, width up to 3 km, depth up to 40-50 m. The floodplain is 200-300 m wide, up to 1-1,5 km below the ground. The generator is twisted; its average width in the lower reaches is up to 20 m. The slope of the river is 1,8 m/km (Southen Bug River Basin Management in Mykolaiv Region, 2021).

Monitoring studies are conducted by Southern Buh River Basin Management in Mykolaiv region at the point of monitoring near Voznesensk (Mykolaiv region, Ukraine) (fig. 1).

Figure 1. The sampling point location on the Mertvovod River

2. Methodology

The study methods used: observation; comparisons and analogies; analysis; synthesis; generalization. Also, we have used research: Google Maps, Microsoft Excel, Origin software. Calculations are made using the correlation formulas 1 and 2 (Buda and Jarynowski 2010; Kupalova 2008; Mitryasova *et al.* 2021):

$$r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2\sum(y-\bar{y})^2}} \quad 2.1$$

r = -1; +1

where x, y are the numeric values of the variables, which set the correlation connection; where $\bar{x}$, $\bar{y}$ are average arithmetic values.

$$R = \sqrt{1-(1-r_{yx1}^2)(1-r_{yx2/x1}^2)} \quad 2.2$$

r = 0; +1

where r_{yx1} – doubles correlation coefficient;

$r_{yx2/x1}$ – partial correlation coefficient.

To describe the magnitude of the correlation coefficient are the following, which are presented in table 1.

Table 1. Correlation coefficient interpretation

Value	The correlation coefficient interpretation
≤ 0,2	very weak
≤ 0,5	weak
≤ 0,7	average
≤ 0,9	high
≥ 0,9	very high

Correlation analysis was used to find quantitative relationships between natural water quality indicators (pH, phosphates, nitrates, COD, soluble oxygen). Trend analysis using the Shapiro-Wilk test in the Origin program allowed determining changes in the water body.

3. Case Studies

To study the relationship between the indicators of surface water quality on the small river example, three integrated indicators were selected, namely soluble oxygen, pH, COD, BOD as well as hydrochemical parameters that fall into the risk zone are: nitrates, phosphates and ammonium for the period from 2007 to 2021.

The value of pH characterizes the active acidity, its value is influenced by the following factors:

- the content of carbon dioxide and oxygen in the water;
- content of humic acids;

- the presence of heavy metal ions;
- temperature regime of the reservoir.

The content of hydrogen ions of natural reservoirs is determined by the quantitative ratio of carboxylic acid and its ions by chemical equation 3.1:

$$CO_2 + H_2O \leftrightarrow H_2CO_3 \leftrightarrow H^+ + HCO_3^- \leftrightarrow 2H^+ + CO_3^{2-} \quad 3.1$$

The formation of bicarbonates occurs due to the dissociation processes of equations 3.2 and 3.3:

$$Ca(HCO_3)_2 \leftrightarrow Ca^{2+} + 2HCO_3^- \quad 3.2$$

$$Mg(HCO_3)_2 \leftrightarrow Mg^{2+} + 2HCO_3^- \quad 3.3$$

Due to the hydrolysis of bicarbonates, the pH increases according to the chemical equation 3.4:

$$HCO_3^- + H_2O \leftrightarrow CO_2 + OH^- \quad 3.4$$

Surface waters with low carbon dioxide content have a slightly alkaline reaction medium; pH≤7 with large amounts of CO_2. pH values are closely related to the processes of photosynthesis due to the consumption of carbon dioxide by aquatic vegetation. The source of hydrogen ions is also humic acids, which are contained in soils.

During the hydrolysis of heavy metal salts, strongly acidic waters with pH≤3 are formed (chemical equation 3.5):

$$FeSO_4 + 2H_2O \leftrightarrow Fe(OH)_2 + 2H^+ + SO_4^{2-} \quad 3.5$$

Such waters are formed when significant amounts of iron, aluminum, copper and many other heavy metals ions enter the water. A similar process of oxidation of heavy metal sulfides occurs during the discharge of mine water by chemical equations 3.6 and 3.7:

$$2FeS_2 + 7O_2 \rightarrow 2FeSO_4 + 2H_2SO_4 \quad 3.6$$

$$4FeSO_4 + 2H_2SO_4 + O_2 \rightarrow Fe_2(SO_4)_3 + H_2O \quad 3.7$$

The sources of hydrogen ions are humic acids. Acidic, weakly acidic waters (pH = 3-6.5) are formed during the decomposition of organic compounds, as well as the influx of carbon dioxide and sulfonic acids. Therefore, the pH value of natural waters depends on the content of carbon dioxide, humic and other organic acids, as well as the content of cations of weak bases (ammonium ions, aluminum, iron, organic bases). In these cases, the pH is not below 4.5.

High values of COD and BOD in natural waters are due to some indicators, namely the high content of inorganic and organic pollutants, humic substances, hydrogen sulfide, sulfites, sulfides, nitrites, ammonium nitrogen.

The correlation nexus between COD, phosphates, and nitrates. Phosphates and nitrates, as the main forms of the most important nutrients of Phosphorus and Nitrogen, often limit the development of water productivity. Therefore, the inflow of excess phosphorus and nitrogen compounds from the catchment (in the form of mineral fertilizers with surface runoff from fields (for example, from a hectare of irrigated land is taken out 0 4-0.6 kg of phosphorus), with runoff from farms (0.01-0.05 kg/day per animal), with untreated or untreated domestic wastewater (0.003-0.006 kg/day per capita), as well as with some industrial waste leads to a sharp uncontrolled increase in plant biomass of the water body (This is especially true for stagnant and low-flowing reservoirs.) There is a so-called change in the trophic status of the reservoir, accompanied by the restructuring of the entire water community and most importantly to the predominance of putrefactive processes.

The presence of nitrates in natural waters is associated with: internal processes in the reservoir - nitrification of ammonium ions with the participation of oxygen under the action of nitrifying bacteria; atmospheric precipitation, which absorbs oxides of nitrogen formed during atmospheric electric discharges (the concentration of nitrates in precipitation reaches 0.9-1 mg; industrial and domestic wastewater, especially after biological treatment, when the concentration reaches 50 mg/dm^3; runoff from agricultural lands and runoff from irrigated fields where nitrogen fertilizers are applied.

The main processes aimed at reducing the concentration of nitrates are their consumption by denitrifying bacteria and phytoplankton, which in the absence of oxygen use nitrate oxygen to oxidize organic matter.

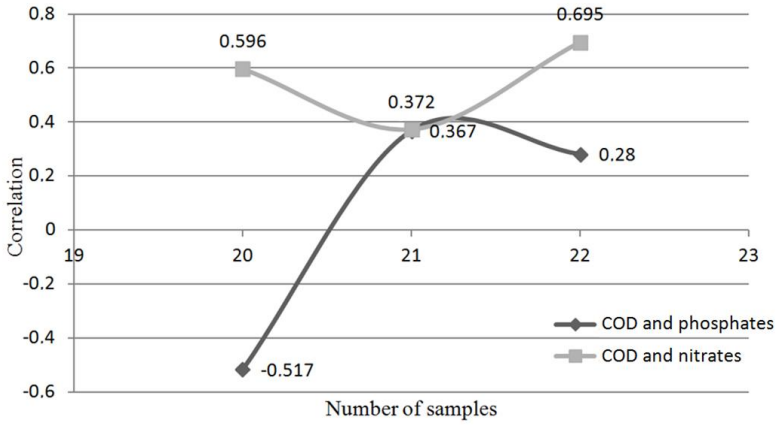
In surface waters, nitrates are in dissolved form. The concentration of nitrates in surface waters is subject to seasonal fluctuations: minimal in the growing season, it increases in autumn and reaches a maximum in winter,

when the minimum consumption of nitrogen is the decomposition of organic matter and the transition of nitrogen from organic to mineral forms. The amplitude of seasonal fluctuations can be one of the indicators of eutrophication of a water body.

The value of COD in all investigated samples exceeded the maximum permissible concentration, minimum value of – 15.24 mgO_2/dm^3 and maximum – 68,6 mgO_2/dm^3 (MPC < 15 mgO_2/dm^3).

Exceeding the maximum permissible concentrations by phosphates and nitrates were observed. Exceeding the maximum permissible concentration of COD is associated with oxidation of organic substances which fall into natural water from surface runoff and dumping sewage. There was a weak correlation between indicators (fig. 2).

Figure 2. The nexus between COD and phosphates, and nitrates



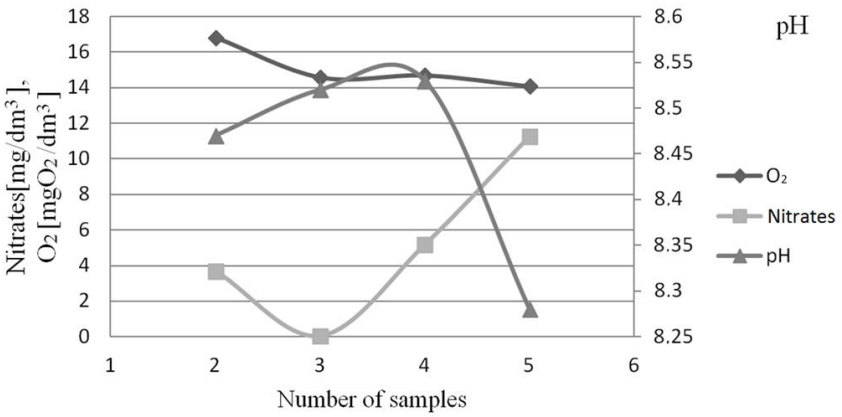
This confirms the fact that high COD values may be due to oxygen-free compounds of nitrogen and phosphorus, such as ammonium phosphide forms. So, with the increase of phosphates COD vice versa decreases, which is typical. The increase of phosphates is caused by deterioration of the river water quality due to the discharge of domestic sewage.

The correlation nexus between soluble oxygen, nitrates, and pH. The values of soluble oxygen in the water were in the norms and were > 4.00 mgO_2/dm^3. The values of nitrates were in the norms and not exceeded MPC. The value of pH was in the rules in not all the samples and was up 8.74 (MPC of pH = 6.5–8.5).

The smallest dependence observed between O_2, nitrates and pH (fig. 3.) Correlation coefficient equals about 0.36, that is, there is a weak dependence between parameters. In the period the soluble oxygen (O_2) decreases, and nitrates on the contrary increase that is typical of data indicators and associated with the maximum increase of COD in the given period that makes up 52.47 mgO_2/dm^3 (MPC < 15 mgO_2/dm^3).

Such excess allows the claim about water pollution by organic and inorganic substances. Oxidation-reduction process of conversion of nitrogen-containing compounds into nitrates occurs.

Figure 3. The nexus between by soluble oxygen, nitrates and pH

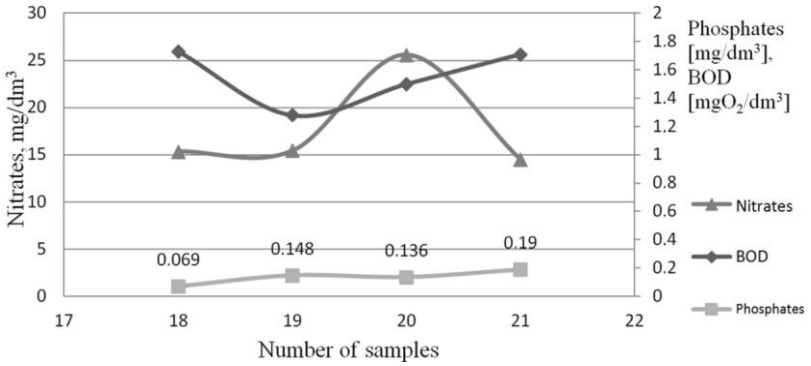


The correlation nexus between BOD, phosphates, and nitrates. In the studied period there was observed exceeding of MPC by BOD, the maximum value of which was 20.4 mgO_2/dm^3 (MPC < 3 mgO_2/dm^3). The correlation changes in most cases from 0.6 to 1.0 which indicates a close functional connection.

Excess value of BOD confirms receipt of the organic substances of plant and animal origin. With a high content of organic matter in the water, aerobic bacteria multiply rapidly, which require oxygen to function. This can lead to a decrease in the content of dissolved oxygen, create hypoxic conditions and the death of certain species of organisms that live permanently in the aquatic environment. The smallest correlation is observed between BOD, phosphates and nitrates (r = 0.31) that is a weak link between indicators. Also, this confirms the fact that high BOD values may be due to oxygen-free compounds of nitrogen and phosphorus, such as ammonium phosphide forms. So, with the increase of phosphates BOD vice versa decreases, which is typical also.

A sharp increase of nitrates is observed, which is 25.6 mg/dm^3 (with MPC=45 mg/dm^3) (fig. 4). The concentration of nitrates is subject to seasonal variations: the minimum is in the growing season, the maximum is in autumn, when the organic substances decay and nitrogen compounds transition from organic forms in the mineral. Nitrates come mainly from surface runoff, which contains residues of used nitrogen fertilizers.

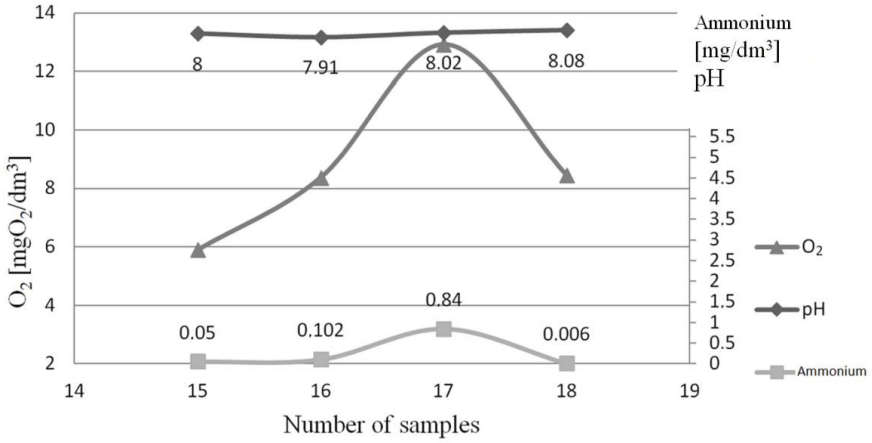
Figure 4. The nexus between BOD, phosphates and nitrates.



Another source of no-waste is groundwater, which can have fairly high concentrations (up to 100 mg/dm^3) and increase the content of nitrates in the areas of discharge into surface waters. Groundwater is the main source of nitrates in the limited period when the supply of surface water is mainly due to groundwater runoff. There are also a significant many other sources of nitrates in surface waters: surface runoff from landfills, urban areas, wastewater from animal complexes, urban wastewater. In the research period, the maximum concentration of nitrates was observed in autumn. The amplitude of seasonal fluctuations of the nitrates is an indicator of the eutrophication of the water object.

The correlation nexus between pH, ammonium, and soluble oxygen. There is excess of MPC on pH that is 8.74 (MPC = 6.5-8.5), exceeding by ammonium, which is 0.84 mg/dm^3 (MPC = 0.39 mg/dm^3), the value of dissolved oxygen is normal and is 4.00 > mgO_2/dm^3. The smallest dependence between parameters observed in the sample №15 and the coefficient of multiple correlation is weak 0.223 (fig. 5).

Figure 5. The nexus between pH, ammonium and soluble oxygen.



At the all-test period the highest concentration of ammonium is 0.84 mg/dm^3 (MPC = 0.39 mg/dm^3) and meets the sample №17. A sharp increase of ammonium is associated with agricultural ranges, growing downpours the day before sampling.

Conclusion

The status of the small river is an indicator of the water security of natural surface water. Correlation analysis of dependences between COD, phosphates, and nitrates; and also, soluble oxygen, nitrates and pH; BOD, phosphates and nitrates; pH, ammonium and dissolved oxygen show stable links between chemical components that are caused by chemical interconversions, the influence of external factors (weather conditions, the hydrological regime of the river, the anthropogenic factor).

As a result of the environmental analysis of the river Mertvovod identified periods of excess MPC by hydrochemical indicators of water quality. The sources of pollutants in the water are discovered and analyzed.

Using correlation analysis gave a clear idea about weak correlations between BOC, COD and nitrates, phosphates. These confirm the fact of increasing BOC and COD due to non-oxine-containing forms of phosphorus and nitrogen compounds. A significant increase in phosphates is detected, which is associated with the collection of cleansers with domestic waters and more with the lack of quality sewer facilities. A significant reduction of COD over the years is detected.

A further perspective is to study ways to reduce the supply of phosphates to the water body. It is also relevant to further study the dependencies between water quality indicators, as well as their interpretation.

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Credit Authorship Contribution Statement

Olena Mitryasova: Conceptualization, Methodology.
Andrii Mats: Software, Writing –review and editing.
Ivan Salamon: Validation, Supervision.
Viktor Smyrnov: Formal analysis.
Vadym Chvyr: Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Attracting Investment for Rural Development: Introduction of Organic Agriculture and ESG Principles in Kazakhstan

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Abstract: Today, the market for organic products is one of the most dynamic in the world. The prerequisites for this are the growing consumer demand for food that is environmentally friendly and safe for human health. In Kazakhstan, despite the existing problem, the development of organic production in the agro-food system appears promising and, if implemented in compliance with environmrntal, social and governance (ESG) principles, can be beneficial for the country, which determines the relevance of the study. The purpose of the study is to analyze the possibilities of investment incentives for organic agriculture for the sake of the development of Kazakhstan's rural areas and the implementation of ESG principles. The study employs the following general scientific methods: a) theoretical: analysis of scientific sources; b) empirical: the focused interview method (focus group), an online expert survey; c) mathematical and statistical methods of data analysis; triangulation method. The study concludes that Kazakhstan has considerable potential for the development of organic agriculture. The production of organic products in Kazakhstan is an extremely promising area that can promote the competitiveness of agricultural products, significantly improve the country's image on the world stage, and facilitate the development of market infrastructure and sustainable development of the country as a whole.

Keywords: sustainable development; ESG principles; landscaping; green spaces; green infrastructure.

JEL Classification: Q13; Q16; R58.

Introduction

Rural areas play a vital part in the development of the national economy. However, their development often requires investment programs with the involvement of the state and large businesses. The search for the forms, ways, and methods of organization of production, areas of economic activity, and production alternatives is a priority in developing the competitive strategy of agricultural enterprises to attract investment. Organic agricultural production is one of the most promising alternative methods of production that focuses on economic growth and is safe for the environment (Aher *et al.* 2012, 209). We believe that the implementation of organic agriculture (OA) can become a key to attracting investment and stimulating the growth of agricultural land. In this paper, we emphasize the potential benefits and issues of introducing OA in rural areas proceeding from the experience of Kazakhstan, as well as highlight the ways to attract investments for the development of rural territories.

We believe that there may be several main benefits of organic farming in rural areas.

1.Improved efficiency of agricultural production together with a reduction of anthropogenic pressure on the environment and natural resources can be achieved through the development of organic production as an alternative farming model (Lotter 2003, 59; Salkhozhayeva *et al.* 2022, 131). This leads to higher yields and improved crop quality.

2.Increased biodiversity: organic farming encourages the use of multiple crops, crop rotations, and intercropping systems, resulting in greater biodiversity and a healthier ecosystem.

3.Higher market demand: there is great demand for organic products, and the growth of this market has created many opportunities for rural farmers.

4.Improved development of rural areas: by promoting sustainable agriculture, organic farming can improve the living standards of the population (Polushkina *et al.* 2020, 1081). The social benefits of OA include the creation of additional jobs in rural areas and new prospects for small and medium-sized farms.

However, in the development of the territory through fostering OA, the state and business can face several problems.

Lack of access to markets. One of the biggest problems faced by rural farmers is the lack of access to markets. Therefore, for the successful functioning of the market for organic products, it is important not only to produce quality products but to carry out a set of measures for effective marketing. This complex involves the physical transportation and distribution of goods in the market space, delivering goods to the demands of consumers, and organizing the delivery of goods to the places of their consumption or use. All of this is part of the development of a marketing and sales strategy.

The primary goal of the sales strategy is the realization of the producer's economic interest (entrepreneurial profit) through satisfying the solvent demand of consumers.

In the choice of marketing channels for organic products in Kazakhstan, we can refer to the European experience. The main European marketing channels for organic products are retail (70%), direct sales from businesses and sales through markets, which provide about 15% of sales, and sales through specialized stores, such as bakeries, butchers, restaurants, and other catering facilities – up to 15% (Reganold and Wachter 2016).

Worldwide practice demonstrates that the main marketing channels for organic food sales are direct sales from the producer to the consumer through markets or stores owned by the producer (Pretty and Bharucha 2014, 1571).

Foreign experience in selling organic products in the retail trade suggests that the choice of marketing channels depends on the level of development of this market segment. In the case of newly emerging markets, most sales are made through specialized organic food stores. Later, as the market matures, the share of supermarkets in the total number of outlets grows and reaches 60% (Seufert *et al.* 2012, 229). Domestic organic producers who are interested in finding competent importers and business partners are also encouraged to participate in organic fairs, which display organic food and methods of production.

High initial costs. The transition to organic farming can be costly, and agribusinesses and farmers may need assistance in accessing financing and investment programs. The government can provide subsidies or low-interest loans to help farmers make the transition and offer various financial instruments that could support agribusinesses and farmers (Kashina *et al.* 2022, 2413).

Thus, we emphasize the need to develop and implement a mechanism for investment incentives for organic production by agricultural enterprises, which will consider global trends in the development of this direction of economic activity.

Aside from macro-level changes, the implementation of this mechanism allows for the development of public-private partnerships in OA, as well as for the training of highly qualified personnel, improvement of economic relations, and changes in the fiscal regulation of OA (Soni *et al.* 2022, 21).

Furthermore, this mechanism makes it possible to attract young people to rural areas and provide human capital and investment resources to the economy of specific enterprises; to create prerequisites for investment measures of socio-economic and environmental development, for improvement of the investment climate, ensuring the activation of agribusiness processes, and so on (Jouzi *et al.* 2017, 144).

Realization of the proposed measures in terms of investment incentives for organic production by agricultural enterprises will raise the interest of enterprises in the production of such products (Badgley *et al.* 2007, 86).

Lack of technical knowledge. Organic farming requires specialized knowledge and skills, which many rural farmers may not have access to. To solve this problem, training and information services can be provided to help farmers learn about organic methods and improve their technical skills. In addition, special programs and courses for training specialists and managers in organic farming can be introduced in specialized universities in Kazakhstan.

According to IFOAM (International Federation of Organic Agricultural Movements), the total turnover of organic products in the world has reached 60 billion dollars; the total area of land used for organic production has already reached almost 37 million ha and the total number of employed farmers – 1.8 million (de Ponti *et al.* 2012, 1). The number of countries engaged in organic production is 160, and those who have implemented organic standards – 84 (Migliorini and Wezel, 2017).

From this, we can conclude that the study of the prospects and conditions for the development of organic production to increase the investment attractiveness of rural areas of Kazakhstan is a topical issue for scientific research.

1. Literature Review

Unlike intensive methods of farming (Adilkhankyzy *et al.* 2022, 539), organic production relies on the use of resource-saving technologies (Tatibekova *et al.* 2022, 2002) and minimization of mechanical tillage (Nugmanov *et al.* 2022, 268) and excludes the use of synthetic substances (Gusev *et al.* 2022, 842; Reganold and Wachter 2016). A priority for OA is the use of materials and technologies that improve the ecological balance in natural systems (Seidakhmetova *et al.* 2022, 1993; Zhumatayeva *et al.* 2022, 492) and contribute to the creation of sustainable and balanced agroecological systems (Pretty and Bharucha 2014, 1571; Tsenina *et al.* 2022, 63). Organic production ensures that the organic farming system and agricultural products comply with certain standards, which provides an opportunity to label products accordingly and sell them as organic (Seufert *et al.* 2012, 229).

Analyzing Kazakh and world interpretations of the essence of OA and its components, we must note the lack of unity of scientific views, although there are many common features. Some scientists (Lee *et al.* 2015, 263; Santhoshkumar *et al.* 2017, 1277) believe that in the definition of OA, the emphasis is placed either on the technological aspect of such production (Nasiyev *et al.* 2022, 77) or on the process of its management. Thus, they use the idea of a systemic combination of the most important aspects of these characteristics.

Another group of researchers (Sandhu *et al.* 2010a, 1) argues that OA stands for the practical implementation of the main provisions of the concept of sustainable development.

According to the definition of IFOAM (International Federation of Organic Agricultural Movements), OA is a production system that supports the health of soils, ecosystems, and people. It rules out the use of chemically synthesized fertilizers and plant and animal protection products, the use of GMOs, preservatives, etc. All stages of cultivation, transportation, and processing provide for maximum environmental protection and the protection of workers' health and are subject to mandatory inspection and certification (de Ponti *et al.* 2012, 1).

From the perspective of balanced development the most successful is the interpretation of P. Migliorini and A. Wezel (2017), which presents OA as a holistic multifunctional model of management and production of organic products which provides a balanced dynamic equilibrium between the components of an integrated socio-economic system over a period of time to combine economic growth and higher living standards while improving the environment (Martirosyan *et al.* 2022).

Thus, the core idea is to use self-regulating mechanisms of agroecosystems, resources obtained locally and on the territory of the farm, and the management of biological processes and reactions. The use of external sources of energy, both chemical and organic, is limited as much as possible. Organic farming primarily relies on

the sustainable management of ecosystems rather than the mobilization of external resources (Connor and Mínguez 2012, 106).

The majority of existing studies suggest that the primary most efficient methods of agricultural production in OA include the organic (Crowder *et al.* 2010, 109), organic and biological (Norton *et al.* 2009, 221), biodynamic (Rundlof and Smith 2006, 1121), biological (environmental) (Meier *et al.* 2015, 193), and integrated (Inclan *et al.* 2015, 1102) methods.

Researchers believe that of particular importance in ensuring the development of OA (MacRae *et al.* 2007, 1037; Sandhu *et al.* 2010b, 302) is the introduction of ESG-principles (Environmental, Social, Governance) in the management of agricultural areas: environmental protection (environmental friendliness), creation of favorable social conditions (sociality), fair treatment of employees and customers, and good corporate governance (Khoruzhy *et al.* 2022). These principles are largely consistent with the OA principles established by the IFOAM, which are the principle of ecology (OA should follow the principles of natural ecological systems and cycles, operating within and maintaining them), fairness (OA has to be built on relationships that guarantee fairness with regard to the environment and life opportunities), care (OA management must be proactive and responsible to protect public health and welfare and the environment), and the principle of preserving health (OA must support and improve the condition of the soil (Hieu 2022, 1125), plants, animals (Baimukanov *et al.* 2022, 154), humans, and the planet as a single indivisible whole) (Woodward and Vogtmann 2004, 24).

The goal of the study is to analyze the possibilities of investment incentives for OA for the development of rural areas of Kazakhstan and the implementation of ESG principles.

Research objectives: 1. to analyze scientific literature on the problem of introducing ESG principles in Kazakhstan for the development of OA; 2. to identify the most efficient methods of agricultural production in the context of the implementation of OA in Kazakhstan; 3. to determine the main advantages of implementing ESG principles in the development of OA in Kazakhstan; 4. to analyze the primary directions for improving the efficiency of rural territory management in the development of OA based on ESG principles; 5. to establish problems in the development of OA market in Kazakhstan.

2. Methods

The established research objectives were addressed by means of the following general scientific research methods: a) theoretical: analysis of scientific sources on the research problem; b) empirical: the focused interview (focus group) method, an online expert survey; c) mathematical and statistical data processing methods; the triangulation method, which tested the consistency of the data obtained through the focused interview and the expert survey.

The study was conducted in three stages in August-September of 2022 based on the K. Zhubanov Aktobe Regional University, Toraigyrov University, and L.N. Gumilyov Eurasian National University.

In the first stage of the study, scientific and analytical sources dealing with the research problem were analyzed. The analysis of publications covering the outlined issues gave the opportunity to examine scientific approaches to the implementation of ESG principles for the development of OA and improvement of rural territory management.

The second stage consisted in the expert interview (focus groups). The interview results gave grounds to determine the most efficient methods of agricultural production with the introduction of OA in Kazakhstan, as well as the advantages of implementing ESG principles in this process, which would contribute to the efficiency of rural area management. The interview data were also used to establish problems in the development of the market for OA in the country. The focused interview included nine people, who were employees of enterprises in Kazakhstan's agro-industrial complex who dealt with the implementation of OA development projects. The audio-recorded group discussion lasted 1 hour and 15 minutes.

In the third stage of the study, after the results of the focused interviews were processed, an online expert survey was carried out. The criterion for the selection of experts was at least 5 years of experience in the field of organic farming and animal husbandry. E-mail letters were sent to 48 experts, asking them to rank the most effective methods of agricultural production in OA identified during the focus group and the benefits of implementing ESG principles in the development of OA in Kazakhstan that would contribute to better management of rural areas, as well as problems in the development of OA market in Kazakhstan.

All participants in the study were briefed about the purpose of the study and about the intention of its organizers to publish the results in a summarized form.

The consistency of expert opinions in the expert ranking was assessed using Kendall's concordance coefficient (W), which was calculated using the SPSS software product. The information obtained in the expert ranking was then processed to determine the weights of the expert opinions.

3. Results

The most efficient methods of agricultural production in OA in Kazakhstan determined by the results of the focus group and evaluated by the pool of experts are presented in Table 1.

Table 1. The most efficient methods of agricultural production in OA in Kazakhstan

No.	Method	Characteristic	Rank	Weight
1	Integrated	Combining the advantages of intensive and organic agricultural production, while avoiding their shortcomings through the rational use of natural conditions and achievements of scientific and technological progress	1	0.37
2	Biological (environmental)	Strict restrictions on the use of pesticides and a flexible attitude to mineral fertilizers, only organic and non-toxic preparations (essential oils, powders, infusions of algae, etc.) are allowed	2	0.31
3	Organic	Crops are cultivated without the use of synthetic fertilizers, pesticides, or growth stimulants, *i.e.* with a complete rejection of means of chemicalization; manure, compost, bone meal, and raw rocks (dolomite, glauconite sand, chalk, lime, feldspar) are used as fertilizers; pyrethrum, garlic, and tobacco dust are used for pest control	3	0.21
4	Organic and biological	Creating a living and healthy soil by maintaining and activating its microflora; only organic fertilizers (manure, green manure) and some slow-acting mineral fertilizers (Tomas slag, basalt powder) are used	4	0.11

Note: compiled from the expert survey; the concordance coefficient W = 0.77 ($p < 0.01$), indicating a strong consistency of expert opinions

The advantages of implementation of ESG principles to improve the efficiency of rural management in the development of OA in Kazakhstan, determined by the results of the focus group and evaluated by a pool of experts, are presented in Tables 2-4.

Table 2. Benefits of implementing the ESG principle of eco-friendliness (Environment) in the development of OA in Kazakhstan

No.	Benefits	Rank	Weight
1	Reduction of anthropogenic load on the environment due to agricultural activities	1	0.26
2	Preservation and restoration of agricultural soil fertility, improvement of soil structure	2	0.22
3	Prevention of land degradation and acidity and salinity of soils	3	0.15
4	Preservation of biodiversity, avoidance of monoculture dominance, natural conditions of animal husbandry	4	0.11
5	Reduced risk of erosion due to greater amounts of humus, physical stability, and ability to use water	5	0.09
6	Cleaning of the sources of drinking water from toxic chemicals	6	0.07
7	Harnessing the potential of symbiotic processes	7	0.05
8	Combination of the preservation of wildlife biodiversity and agricultural biodiversity and soil conservation	8	0.03
9	Promotion of a better mix of biotopes adjacent to agricultural land	9	0.02

Note: compiled from the expert survey; the concordance coefficient W = 0.74 ($p < 0.01$), indicating a strong consistency of expert opinions

Table 3. Benefits of implementing the ESG principle of social nature (Social) in the development of OA in Kazakhstan

No.	Benefits	Rank	Weight
1	Improved life expectancy and health of the population	1	0.27
2	Greater well-being of the population owing to the diversification of activities, higher employment rates, and the development of rural areas	2	0.22
3	Increased level of education of the rural population	3	0.17
4	Formation of the environmental image and rating of Kazakhstan	4	0.14
5	Providing the public with high-quality and environmentally friendly and safe certified organic food, as well as other goods	5	0.10
6	Preservation and support of small farms	6	0.05
7	Higher scientific and technological levels of the agricultural sector	7	0.03
8	Ensuring the food security of Kazakhstan	8	0.02

Note: compiled from the expert survey; the concordance coefficient W = 0.755 ($p < 0.01$), indicating a strong consistency of expert opinions

Table 4. Benefits of implementing the ESG principle of good corporate governance (Governance) in the development of OA in Kazakhstan

No.	Benefits	Rank	Weight
1	Introduction of resource-saving technologies and technical means, reduction of the energy intensity of agricultural production	1	0.32
2	Development of local markets for organic products through the establishment of small farms	2	0.23
3	Additional development of the processing sector for the produced organic products	3	0.17
4	Increased crop yield (with long-term application)	4	0.12
5	Higher quality and competitiveness of agricultural products of Kazakhstan on domestic and world markets	5	0.07
6	Significant reduction in production costs and dependence on external financing (with medium and long term application)	6	0.05
7	Greater use of renewable resources	7	0.04

Note: compiled from the expert survey; the concordance coefficient W = 0.81 ($p < 0.01$), indicating a strong consistency of expert opinions

Despite the above-mentioned benefits, the market for organic agricultural products in Kazakhstan remains at an early stage of development. The synthesis of expert opinions points to the following main problems in the development of the organic products market in Kazakhstan (Table 5).

Table 5. Problems of the development of the OA market in Kazakhstan

Group of problems	Problem	Rank	Weight
Institutional	Lack of state financial support	3	0.14
	Imperfect institutional and legal support	11-12	0.01
	Lack of national certification bodies	11-12	0.01
Organizational	Underdeveloped infrastructure of the domestic market for organic products	4	0.10
	Little awareness of the peculiarities of organic production, lack of specialized knowledge and skills	5	0.09
	The beginning stage of development of the system of processing, production, wholesale, and retail of organic products	8	0.04
	Imperfect commodity structure of organic raw materials, the predominance of grains	9-10	0.03

Group of problems	Problem	Rank	Weight
Economic	Lack of access to markets	1	0.24
	High initial costs, requiring significant investment in production	2	0.20
	Increase in the cost of production due to lower yields during the conversion period and in the case of low soil fertility, low natural productivity of animals and seeds	6	0.06
	Certification expenses	9-10	0.03
Social	The presence of a transition period, during which the income of agricultural producers may fall	7	0.05

Note: compiled from the expert survey; the concordance coefficient W = 0.80 ($p < 0.01$), indicating a strong consistency of expert opinions.

4. Discussion

OA can become a powerful tool for attracting investment and stimulating the growth of rural regions. However, there are problems to be addressed. Proper support and resources can make organic forming an effective way to improve the quality of life of rural farmers, increase biodiversity, and contribute to sustainable development. By prioritizing investment in OA in rural territories, the state and organizations can support the growth of rural communities and promote more sustainable development in Kazakhstan's rural regions (Migliorini and Wezel 2017; Sandhu *et al.* 2010a, 1).

Implementation of the social EGS principle provides such advantages as support for the livelihood of the rural population and stimulation of small farms, creation of jobs, preservation of traditional knowledge of farming in each region, and reduced migration of the rural population to megacities. K.S. Lee, Y.C. Choe, and S.H. Park demonstrate (2015) that agricultural production often prompts farmers to cooperate to reduce their certification, transportation, and processing expenses. In this sense, OA enables the self-determination of small farmers and makes them more self-confident. As suggested by D.J. Connor and M.I. Mínguez (2012), OA reduces the health risks of agricultural workers, as they are the most likely to be exposed to pesticides and other chemicals used in conventional production. Organic products are more beneficial to consumers due to the minimized health effects of toxic and persistent chemicals (Meier *et al.* 2015, 193).

Proceeding from the results of our study and previous research (Kashina *et al.* 2022, 2413; Nurgaliyeva *et al.* 2020, 149; Yashkin *et al.* 2022, 181), we propose the following measures to create favorable conditions for the development of the OA market:

- To develop national regulations for organic production based on international requirements and standards;
- To intensify the institutional and infrastructural support of the market for organic agricultural products;
- To resolve the issue of accreditation of authorized organic production certification bodies;
- To introduce special programs and courses to train specialists and managers in OA in specialized universities in Kazakhstan;
- To supplement the state statistical reporting in the agricultural sector with special forms to reflect the position of the production and turnover of organic agricultural products and foodstuffs;
- To develop and enforce the implementation of the program of state support for producers of organic products.

Given the above, it is worth considering the improvement of public policy to stimulate and develop the production of organic agricultural products by creating a system of state investment incentives. As indicated by research findings (Kaldiyarov *et al.* 2021, 56; Nardin and Nardina 2021, 1242), without state support the conduct of organic production is virtually impossible.

The main levers of economic stimulation of the production of organic agricultural products include:

- Direct support (in the form of budget subsidies for products, preferential loans for the period of conversion);
- Indirect support (measures aimed at assisting in passing certification, laboratory research (Temreshev *et al.* 2023, 1), measures to provide information and consulting services, insurance (Garnov *et al.* 2022)).

Concerning state support, for economic entities operating in the sphere of production and circulation of organic products (raw materials), it should be provided in accordance with the program of state support for producers of organic products. In the course of the implementation of this program, it is necessary to form an

investment and innovation model of agricultural development due to increased competition in the market of agricultural products.

The formation of this model should be facilitated by the creation of economic conditions for the development of OA. Among the priority measures are the following:

- Economic incentives for businesses in the production of organic agricultural products through appropriate tax, customs, pricing, and credit policy. Application of special anti-dumping and countervailing protection measures, including import quotas, special duties levied regardless of the import duty, anti-dumping, and countervailing duties;
- Establishing a state order for the production of organic agricultural products;
- Economic regulation of imports of organic food and exports of agricultural raw materials;
- Creating conditions for technical re-equipment of production facilities, including through the reduction of the tax base of enterprises by the amount of their funds allocated for technical re-equipment;
- Establishment of tax incentives for enterprises producing organic agricultural products and investment in the introduction of innovative technologies that support the production of organic products.

In connection with the above, there is a need to stimulate investment activity and ensure the growth of direct investment in fixed capital of enterprises at the expense of budgets of all levels (Panchenko *et al.* 2022, 2385).

One of the features of the production of organic agricultural products is increased costs compared to traditional agricultural production. The enterprise producing organic agricultural products needs additional funds. Scientists have outlined all additional sources of funding:

- own funds of the company to implement projects to switch from conventional to organic production;
- funds from the budgets of all levels to finance the restructuring of large enterprises toward the production of organic products;
- environmental funds that allocate funds for the implementation of projects related to the improvement of the environmental situation;
- bank loans in the aspect of preferential loans to enterprises producing organic products;
- non-repayable grants – allocation of funds for organic production projects.

Although today's Kazakhstan has no proven incentive mechanisms for producers of environmentally safe products, the country is still beginning to form a new market segment – the market for organic agricultural products. However, the product supply in this sector in the short term will be much smaller than in Western countries, and organic products themselves will be only a small niche in the grocery market.

This way, a consistent state policy for the development of organic agricultural production provides for the formation of a legislative framework, budget priorities, the implementation of several regulatory measures, and, accordingly, the organization of a regulated market for organic food. For the creation of this market, the necessary prerequisites must be created, including regulatory support, the formation of market structures and the appropriate economic mechanisms, and state support for the producers of organic agricultural products. The effectiveness of state support can be achieved only if the first two positions are realized and special state and regional programs on this issue are developed.

Conclusion

It can be argued that OA is a method of intensive agriculture, which is based on the effective use of the entire complex of local conditions and resources. This form of farming can be exceptionally favorable for sustainable socio-economic and ecological development since it is characterized by high economic efficiency. The market for OA products is very promising but underdeveloped, so it opens up broad prospects for producers and exporters. Production of organic products in Kazakhstan is an extremely perspective direction, which can increase the level of competitiveness of agricultural products, significantly improve the country's image on the world stage, and contribute to the development of market infrastructure and sustainable development of the country as a whole.

Kazakhstan has considerable potential for the development of OA and has already achieved certain results in the production of its organic agricultural products, their export, and consumption in the domestic market. Given the above, it is necessary to further study the status and trends of development of the consumer market for organic products in Kazakhstan and beyond. This can be a determining factor in the effective operation of national food enterprises in the current market conditions and will allow forming possible ways of promotion and sales of these products in the national agro-food market.

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Credit Authorship Contribution Statement

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Aidos Akpanov: Conceptualization, Methodology, Project administration, Supervision, Data curation, Validation, Writing – review and editing.
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Declaration of Competing Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Forty-Seven Years of Environmental Management Accounting Research: A Bibliometric Analysis

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Abstract: Environmental sustainability is considered as responsible engagement with the environment in order to prevent the depletion or degradation of natural resources and ensure long-term environmental quality. Environmental management accounting (EMA) is a tool that aids in enhancing environmental performance and environmental information management. EMA is a growing topic, but there hasn't been a complete analysis to pull everything together and make sense of it all. By adopting bibliometric review, through performance analysis, and science mapping, our research fills in this research gap. Biblioshiny in R and VOS viewer is used for conducting data analysis. Through an extensive study of 1,075 documents, this study discloses the publication and citation trend, top influential authors, journals, publications, and top productive institutions and countries. The study also identifies topic trends through temporal analysis. Different thematic clusters are identified through bibliographic coupling and Co-occurrence of the author's keywords (*i.e.* Social and environmental accounting, Environmental management accounting, Environmental performance, Carbon accounting, Sustainability, and sustainable development, Eco-system services, Environmental disclosure, and corporate social responsibility). Centrality measures are presented to show the impact of the author and keywords. The study concludes with suggestions for future study, and ways forward focusing on Circular economy, green accounting, material flow cost accounting, carbon accounting, sustainability, etc. The study is wholly dependent on the Scopus database, further studies can explore other databases like Web of science, google scholar, and others.

Keywords: environmental management; bibliometric; performance analysis; science mapping; temporal analysis.

JEL Classification: Q56; M41; M49; M10; M19.

Introduction

Humanity needs sustainable development, which has become a growing trend. Enterprises, particularly industrial firms, are indeed faced with the issue of acting in an environmentally sustainable and socially responsible manner while continuing everyday operations and enhancing economic performance (Wang, Ismail, and Abas 2022). Countries all across the world face difficulties related to environmental pollution and climate change. These issues threaten global sustainable development and lower people's quality of life. Therefore, many nations place a premium on green growth and environmental safeguards as they work towards sustainable economic and social progress (Nguyen 2022). Across the globe, in both developed and developing nations, it has been noticed that regulatory policies promoting ecologically friendly economic activity have typically centered on the manufacturing industry's largest companies (Javed *et al.* 2022). There is a need for any application or technique which caters to the need of organizations in both environmental and economic performance.

Management accounting (MA) is a blend of accounting, finance, and management consisting of several cutting-edge procedures that are essential to the efficient operation of a corporation (Collins *et al.* 2011). Since their inception, MAPs have undergone steady improvement to help better firms adapt to the ever-evolving demands of the environment (Scapens 1994). The field of environmental accounting, and environmental

management accounting (EMA) in particular, has received increasing interest in recent years from academics, non-governmental organizations (NGOs), professional accountants, and businesses (Schaltegger, Gibassier and Zvezdov 2013). EMA and other MAP-related advanced accounting techniques have been used as information producers and mediators to provide information for decision-making, planning, and control purposes, all with the end goal of maximizing economic benefits while reducing negative social and environmental impacts (Dasanayaka, Murphy, Nagirikandalage, and Abeykoon 2021). Accordingly, several researchers (López and Hiebl 2015) have asserted that using MAPs is one of the viable approaches for any kind of firm to continually revitalize itself to accomplish sustainability goals in a fast-changing environment.

Much research has been conducted to better our understanding and use of environmental management accounting due to its widespread applicability and significance in advancing the sustainability agenda. Previous research has focused on a narrow subset of EMA rather than the field as a whole. The extant literature is summarizing in Table 1 and 2. In this study, we aim to present an up-to-date overview of Environmental management accounting, considering all relevant elements and publications. As opposed to prior studies, the scope of this study encompasses the entirety of EMA, rather than focusing on a specific facet of the idea.

1. Literature Review

This literature review addresses some of the available previous literature analysis on Environmental management accounting in various databases like Scopus, EBSCO, Emerald, etc. Nine review studies from 2011 to 2021 are examined. There are few studies existing on Environmental management accounting published before 2011. In his research, the author (Schaltegger, Gibassier, and Zvezdov 2013), summarized major review studies on Environmental management accounting published between 1997 and 2011. And literature review of their research states that, although a few writers have carried out several qualitative review studies, there has not yet been a thorough quantitative analysis of EMA.

The study of Debnath, Bose, and Dhalla (2011) put importance on the methodological developments of EMA and reveals a lack of in-depth methodological development on EMA. Yet, there is more scope in the future research perspective to make approaches and processes understandable for decision-makers. Another research by Derchi, Burkert, and Oyon (2013) reveals unstudied areas that require research to complete the body of knowledge and suggests researchers may focus on the idea of environmental performance and the use of various EMA models inside of organizations.

The findings of Guenther, Endrikat, and Guenther (2013) review study suggest integrating Environmental control systems with EMA. (Soderstrom, Soderstrom, and Stewart 2012) His literature review found a significant focus on integrating sustainability with management accounting; most research is case studies and surveys. The analysis of Johnstone (2018) examined how social controls as elements of environmental management control systems have been presented. Another review on EMA (Johnstone 2020), from a management accounting and control perspective, thoroughly examines the motivations, implementation procedures, and performance results of environmental management systems in small to medium-sized firms.

The study (Dasanayaka *et al.* 2021) evaluates the existing literature on the use of management accounting procedures to promote the sustainability of family businesses and suggests potential directions for further research. The recent literature review (Nyakuwanika, van der Poll, and van der Poll 2021) on mining operations have discussed how environmental management accounting practices may be included in a conceptual framework to solve ecological issues. The research of Schaltegger, Gibassier, and Zvezdov (2013) is the only bibliometric analysis among the review publication identified in the present study. Their research revealed tendencies that indicate the EMA has grown as a discipline but still has a ways to go before it is more widely accepted in mainstream accounting and management research. The identified review publications are summarized in Table 1.

Table 1. Extant literature reviews on EMA

Author and Year	Type of paper	Focus	Published journal
Debnath *et al.* 2011	Literature review	Methodological aspects of EMA	International Journal of Business Insights and Transformation
Derchi *et al.* 2013	Literature review	The existing body of knowledge on EMA and to highlight the need for additional study.	Studies in Managerial and Financial Accounting
Stefan Schaltegger *et al.* 2013	Bibliometric analysis	To know whether EMA is developed as a discipline.	Meditari Accountancy Research

Author and Year	Type of paper	Focus	Published journal
Guenther *et al.* 2016	Literature review	How businesses may help our planet by contributing to its needs.	Journal of Cleaner Production
Soderstrom *et al.* 2017	Literature review	Recent EMA publications on corporate responsibility or sustainability in specific journals.	Advances in Management Accounting
Johnstone, 2018	Literature review	Systems of environmental management and control that include social mechanisms	Social and Environmental Accountability Journal
Johnstone, 2020	Literature review	Understanding management accounting controls in SMEs.	Journal of Cleaner Production
Dasanayaka *et al.* 2021	Literature review	Family business management accounting practices	Cleaner Environmental Systems
Nyakuwanika *et al.* 2021	Literature review	Material flow cost accounting, Life cycle costing, and Activity-based costing	Sustainability (Switzerland)

Furthermore, literature studies and bibliometric analysis were identified on EMA, concentrating on one specific EMA tool or technique. The summary of these reviews is presented in the following Table 2.

Table 2. Past reviews on specific EMA tools or techniques

Author and Year	Type of paper	Focus	Published journal
Kristin Stechemesser and Guenther, 2012	Literature review	Carbon Accounting	Journal of Cleaner Production
Stefan Schaltegger and Zvezdov, 2015	Literature review	Material flow cost accounting	Journal of Cleaner Production
Geng *et al.* 2017	Bibliometric analysis	Life cycle assessment	Renewable and Sustainable Energy Reviews
Miah *et al.* 2017	Literature review	Environmental life cycle assessment and life cycle costing	Journal of Cleaner Production
Hasan *et al.* 2019	Literature review	Green business value chain	Sustainable Production and Consumption
Manewa *et al.* 2021	Bibliometric analysis	Life cycle costing in construction	World Construction Symposium
Zheng *et al.* 2022	Bibliometric analysis	Carbon accounting	Environmental Science and Pollution Research
Luo *et al.* 2022	Bibliometric and content analysis	Low-carbon supply chain	Frontiers in Environmental Science
Kurniawan *et al.* 2022	Bibliometric analysis	Carbon accounting	International Journal of Energy Economics and Policy
Yin *et al.* 2022	Bibliometric analysis	Carbon accounting	Urban Climate
Gulotta *et al.* 2022	Literature review	Life cycle costing and life cycle assessment	Environmental Impact Assessment Review
Kokubu *et al.* 2023	Literature review	Material flow cost accounting contribution to SDGs	Journal of material cycles and waste management.

Existing reviews of the extant literature on EMA research reveal diverse perspectives on EMA. Still, their scope is limited, and the significance of the evaluation is qualitative (*e.g.*, systematic literature review and content analysis). This issue can be resolved by using a bibliometric study, which can handle a large corpus and combines quantitative and qualitative techniques to offer a holistic and notified overview of the field (Chandra *et al.* 2022).

In the existing bibliometric analysis, all the publications focused on specific EMA tools or techniques (*e.g.* Carbon accounting, life cycle costing, etc.) except one study concentrating on the broader picture of EMA (Schaltegger, Gibassier, and Zvezdov 2013). It focused only on performance analysis of EMA publications (*e.g.*, Journals with most publications, Authorship, Publications by countries, Most cited publications).

In the absence of an extensive review analyzing EMA in its entirety based on the literature review presented in table 1 and 2. Considering EMA practices plays a crucial role in cleaner production. The following research questions remained unanswered and, as a result, are the primary subject of investigation in this review:

RQ1. What is the publication and citation productivity of Environmental management accounting research?

RQ2. Which are the most productive authors, journals, and publications in environmental management accounting?

RQ3. Which are the most contributing institutions and countries in environmental management accounting?

RQ4. What are the leading topics and themes in environmental management accounting?

RQ5. What are the future research opportunities for environmental management accounting?

Based on the research questions presented, the research objectives and the mode of achieving are presented in the below Table 3.

Table 3. Objectives and analysis methods

Objective	Type of Bibliometric analysis	Unit of analysis	Software used
To analyze the success of environmental management accounting studies in terms of publication and citation.	Performance analysis	No. of documents and citations	Biblioshiny in R
To rank the most productive researchers, journals, and publications in environmental management accounting.	Performance analysis, Co-authorship with centrality measures	Authors, Journals and Documents	Biblioshiny in R and VOS Viewer
To identify the top contributing institutions and countries in environmental management accounting.	Performance analysis, Country collaboration	Institutions, Countries	Biblioshiny in R and VOS Viewer
To examine the fundamental themes raised by the literature on environmental management accounting.	Science mapping (Temporal analysis, Keyword Co-occurrence, Bibliographic coupling)	Author keywords, Documents	Biblioshiny in R and VOS Viewer
To suggest avenues for further study in the field of environmental management accounting.	Science mapping (Thematic strategic diagram)	Author keywords	Biblioshiny in R

The present study contributes in a variety of practical ways. As a first step, both novice and seasoned researchers in EMA can get a bird's eye view of the subject's current and historical publishing trends. Second, aspiring writers can track relevant sources (articles, journals) and possible collaborations (authors, institutions, countries). Third, this overview's uncovered themes and subjects might help aspiring authors set themselves apart from the current EMA research landscape by highlighting the uniqueness of their contributions. Finally, this curated list of study areas provides potential authors with a starting point for doing original and fruitful research in the field of EMA.

The remaining parts of the research are structured as follows. The section 2 describes the conceptual background of EMA. Followed by methodology of the study in the section 3. The detailed data analysis containing performance analysis in section 4 and science mapping in section 5. Way forward of EMA research is presented in section 6 through strategic diagram. Finally, research presents conclusion and limitations in section 7.

2. Conceptual Background

EMA is defined as "the creation, analysis, and utilisation of financial and non-financial information to enhance corporate environmental and economic performance and achieve sustainable business" (Johnstone 2018).

On an institutional level, for instance, the United Nations Division of Sustainable Development has encouraged EMA systems by furnishing government agencies, industry executives, accounting professionals, and others with specific application guidelines and frameworks (UNDSD 2001). This research (Gurarda 2014; UNDSD 2001) defines EMA as the design and implementation of accounting systems that identify and measure the whole range of physical and monetary, environment-related information to assist day-to-day business

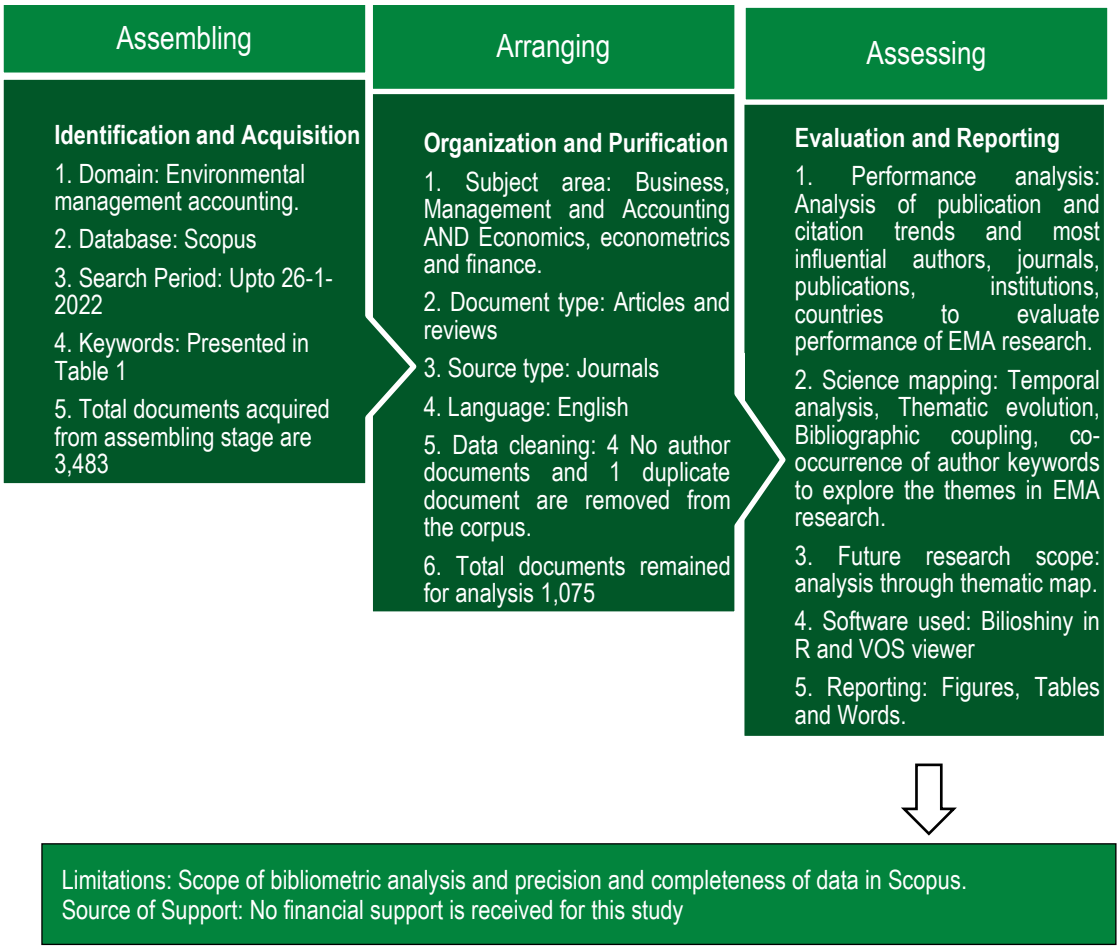
choices. The 'EMA' assists company managers in making capital budgeting decisions, costing judgments, process/product design approach, performance evaluations, and a variety of other future-oriented business decisions. Consequently, EMA serves an internal company role and is not a tool for reporting environmental expenses to external stakeholders. It is not constrained by rigorous rules, unlike financial accounting, and allows for consideration of the company's unique situations and requirements (UNDSD 2001).

If the corporate strategy for environmental sustainability is valid, organisations will be more inclined to create EMA systems to quantify the costs and benefits of proactive green management to support day-to-day business choices (Derchi, Burkert, and Oyon 2013). It makes reasonable that other countries and organisations would adapt EMA's general concepts, terminology, and methods to their own objectives. Due to the fact that EMA is a relatively developing field in comparison to traditional management accounting, experimentation and variety are also to be anticipated.

3. Methodology

This research uses a bibliometric method to examine the literature on Environmental management accounting. The bibliometric method is a quantitative way of assessing the efficacy and credibility of published works on a specific topic (Donthu *et al.* 2021). When compared to subjective methods (such as qualitative thematic analysis), this one stands out as the most objective (Donthu *et al.* 2021). Bibliometric reviews, a subset of systematic literature reviews, are held to the same standard and must establish, implement, and report on a comprehensive and open review process (Paul *et al.* 2021). In this respect, the Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR-4-SLR) protocol directs the choices and actions in data collecting, filtering, and analytic technique (Paul *et al.* 2021). Figure 1 summarises the SPAR4SLR protocol's three key stages: assembly, arrangement, and evaluation; these processes are further explained below.

Figure 1. Bibliometric review process adopted in the present study using SPAR-4-SLR protocol.



3.1 Assembling

In this section, you will read about the procedure followed to locate and acquire the necessary papers for evaluation.

The extant literature for review are identified in the Environmental management accounting domain published in journals and indexed in Scopus. The concentration on material published in journals is justifiable since they often undergo a higher level of peer-review scrutiny than alternative sources including books, book chapters, and conference proceedings. The use of Scopus is strategic because Scopus journals have met strict indexation standards (Paul *et al.* 2021). Scopus covers a lot of scientific papers and makes it easy to obtain and study bibliometric data and full texts (Donthu *et al.* 2021).

The bibliometric information of the publications are retrieved from scopus by using the keywords selected from the previous literature study (Schaltegger, Gibassier and Zvezdov 2013). The keywords are presented in Table 4. In total 3,483 documents are obtained from the assembling stage.

Table 4. Keywords used for the search of EMA publications

Keywords
Carbon Accounting
Environmental accounting
Environmental management accounting
Environmental management accounting practices
Ecological accounting
Green accounting
Material flow cost accounting
Total cost assessment
Water management accounting
Environmental life cycle costing

3.2 Arranging

In the arranging stage, organization and data cleaning of documents for review is conducted. The organization of documents relied on the refine results option available in the Scopus (*e.g.* Language, document type, source type and subject area). The first filter used to refine the results is subject area, Business, management and accounting and Economics, econometrics and finance. 1,394 documents are retrieved from this filter. Whereas, in the opinion of the writers, other academic fields are not included since they are not relevant to EMA research. Document type are limited to articles and review and retrieved 1,139 documents. Since editorials and notes are not subject to rigorous peer review they were left out (Chandra *et al.* 2022). Only journals are included in the source type and retrieved 1,113 documents. The documents were restricted English language and retrieved 1,080 documents. The inadequate quality of peer review was also a factor in the decision to exclude non-journal documents, conference papers (Chandra *et al.* 2022). In the data cleaning process four documents are removed because of insufficient author information and one duplicate document is removed. In total, 1,075 documents are finalized for the review. Figure 2 represents the search string of the final review documents.

Figure 2. Search string of documents retrieved for Bibliometric analysis

TITLE-ABS-KEY ("carbon accounting" OR "environmental accounting" OR "environmental management accounting" OR "environmental management accounting practices" OR "ecological accounting" OR "green accounting" OR "material flow cost accounting" OR "total cost assessment" OR "water management accounting" OR "environmental life cycle costing") AND (LIMIT-TO (SUBJAREA , "busi") OR LIMIT-TO (SUBJAREA , "econ")) AND (LIMIT-TO (DOCTYPE , "ar") OR LIMIT-TO (DOCTYPE , "re")) AND (LIMIT-TO (SRCTYPE , "j")) AND (LIMIT-TO (LANGUAGE , "english"))

3.3 Assessing

In the assessing stage, documents retrieved are analysed and reported. In order to evaluate the 1075 documents on EMA that were kept for examination, this study used a variety of bibliometric analysis techniques. The performance analysis used in this study is specifically used to define the metrics describing publication and citation trends (RQ1), as well as the most influential authors, journals, and publications (RQ2) in EMA research and the most productive institutions and countries (RQ3). In addition, Science mapping analysis is undertaken in this paper. A bibliographic coupling, which groups papers with comparable references (Donthu *et al.* 2021) (RQ4). Temporal analysis of the documents is conducted to identify the themes in different time periods (Kumar *et al.* 2022). The fundamental themes characterising the underlying logic of EMA research were decomposed using co-word analysis, which clusters documents based on the co-occurrence of author's keywords (RQ4). Different centrality measures (network metrics) (Donthu *et al.* 2021) are used and interpreted to enhance the information of co-occurrence results. Importantly, network measures are frequently used to expand upon the discussion of study domains in bibliometric studies, and as such, they constitute a valid way for enhancing bibliometric evaluations (Kumar *et al.* 2022). The future research directions are analysed through thematic map (RQ5). The analysis is conducted using Biblioshiny in R and VOS Viewer software (Donthu *et al.* 2021).

This study uses a mix of tables, figures, and text to convey the results of the bibliometric studies conducted using Biblioshiny and VOS viewer. At the end of this paper, I discuss the review's limitations and make suggestions for future studies in the field of Environmental management accounting.

4. Performance of EMA Research

4.1 Publication and Citation Trend of EMA Research

The overview of performance for EMA research is presented in Table 5. Data from the table shows that there have been a total of 1075 publications (TP) on EMA, spread throughout 255 sources; of them, 1014 are articles (both conceptual and empirical) and 61 are reviews (*e.g.* Systematic literature review, bibliometric review, and meta-analysis). 967 articles (89.53% of the total) from EMA research have been cited by other researchers. Although the area was launched in 1976, it did not see its first publication until 1989, making its whole lifespan as a research field 34 years. Annual production is 10.25%. There are a total of 55822 references in the published literature. In terms of citation counts, EMA studies have amassed 41,240 in total (TC). An average of 38.36 citations per paper has been found. In terms of metrics for co-authorship, there are a total of 2118 authors involved, 216 of them are sole authors. Publications feature, on average, 2.64 authors. There are a total of 2,393 author keywords on file.

Table 5. Publication, Citation and Co-authorship Metrics

	Statistic
Publication Metrics	
Total Publications (TP)	1075
Total cited Publications (TCP)	967
Article	1013
Review	62
Number of Active Years (NAY)	34
Productivity per active year (PAY)	10.25%
Total References	55822
Citation metrics	
Total citations (TC)	41,240
Average citations per publication (TC/TP)	38.36
Coauthorship metrics	
Number of contributing authors (NCA)	2118
Authors of single-authored publications (ASA)	216
Co-Authors per Document	2.64
Author keywords	2393

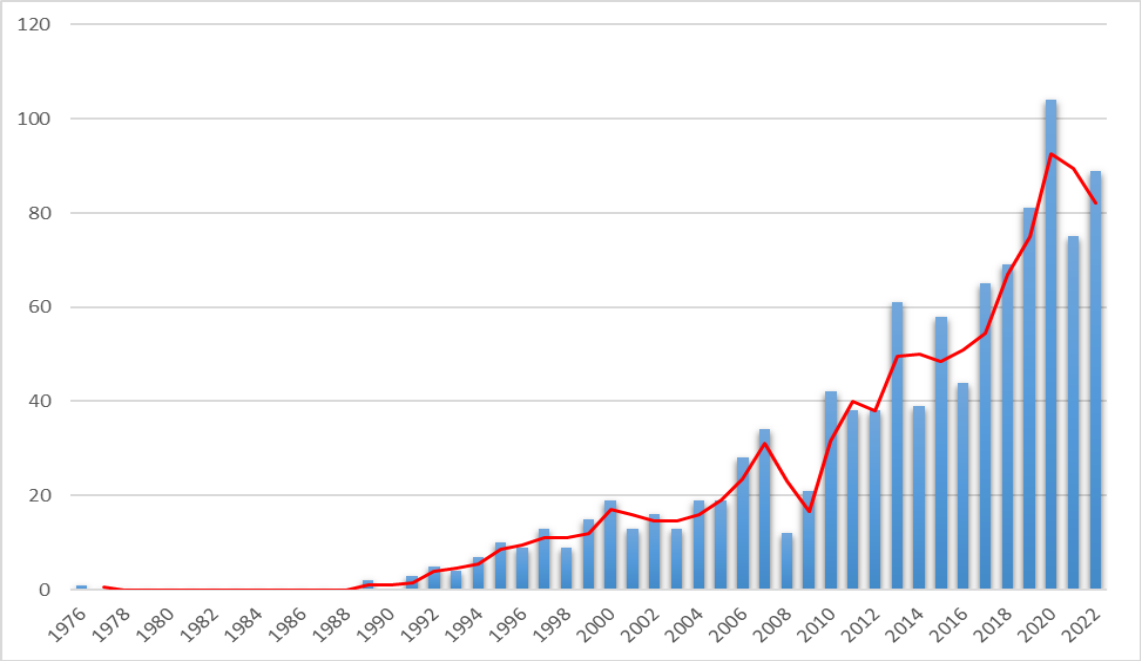
Table 6 shows the general upward trajectory of EMA research publications. The table shows that while the first publication on EMA emerged in 1976 (*i.e.*, one document), academic interest in the topic did not start up until 1989, growing significantly from 2 papers in 1989 to 104 and 89 documents in 2020 and 2022. A rising tendency can also be seen in the overall number of articles that are cited each year. Additionally, the overall number of citations has climbed from 43 in 1976 to 2789 in 2002, 4242 in 2007, 3457 in 2010, 2220 in 2013, and 2041 in 2018. The years 2002 (174.31), 2003 (102.23), and 2007 saw the highest average number of citations per document (124.76). The most significant number of citations was in 2007, however there is declining trend in citations till 2022. Since citations are time dependent, the fact that older publications often contain more citations than younger publications helps to explain the current trend of declining average citation counts (Chandra *et al.* 2022). The increasing number of publications in the EMA field indicates the sustained interest of academics and publishers in this area. The publication trend with moving average line is shown in figure 3.

Table 6. Publication and Citation trends

Year	TP	Avg. Citation Per article	TC	TCP
1976	1	43.00	43	1
1977 to 1988	0	0.00	0	0
1989	2	17.50	35	2
1990	0	0.00	0	0
1991	3	9.67	29	3
1992	5	35.60	178	4
1993	4	4.75	19	3
1994	7	68.86	482	7
1995	10	38.20	382	9
1996	9	49.22	443	9
1997	13	71.23	926	12
1998	9	13.89	125	8
1999	15	29.60	444	14
2000	19	35.89	682	19
2001	13	47.46	617	11
2002	16	174.31	2789	16
2003	13	102.23	1329	13
2004	19	94.74	1800	19
2005	19	89.95	1709	19
2006	28	72.32	2025	27
2007	34	124.76	4242	33
2008	12	73.17	878	12
2009	21	66.43	1395	20
2010	42	82.31	3457	41
2011	38	43.37	1648	34

Year	TP	Avg. Citation Per article	TC	TCP
2012	38	52.13	1981	34
2013	61	36.39	2220	59
2014	39	33.85	1320	38
2015	58	37.47	2173	56
2016	44	27.80	1223	43
2017	65	24.20	1573	61
2018	69	29.58	2041	67
2019	81	17.31	1402	79
2020	104	10.10	1050	97
2021	75	5.72	429	58
2022	89	1.70	151	39

Figure 3. Publication trend of EMA research



4.2 Most Influential Authors for EMA Research

The top twenty influential authors based on h-index for EMA research are presented in Table 7. From the data in the table, we can deduce that Burritt RL is the most cited author, having produced 18 works and receiving 1,241 citations (an h-index of 13 and a g-index of 18). It wasn't until 1995 that the author began publishing. One of his co-authored publication Environmental management accounting: the significance of contingent variables for adoption is one of the most influential publications published in 2013. With 11 papers to his name that have been cited 518 times and an h-index of 10 and a g-index of 11, Almeida CMVB has quickly risen to second place on the list of most prolific authors working in his field since 2006. At number three, Bebbington J. and Giannetti BF have produced 13 works with an 10 h-index, and 13 g-index. In contrast to Giannetti BF's 522 citations, Bebbington J's work has been cited 1,683 times. With ten works each, Brown J. and Patten DM. tie for fourth place. They share the same g-index of 10 and h-index of 9 respectively. In contrast to Brown J (1,148), Patten DM (1,547) has more citations. Followed by Schaltegger S and Cairns RD, who both have 9 publications but only 768 and 120 citations, respectively. Overall, Schaltegger S has been cited more times than Cairns RD, making him the more influential of the two. The h-index and the G-index are additional proofs of this. At number ten on the list, we find the writer

Gray R., who has produced 12 articles more than Almeida but whose h-index is only 9 and whose total citations amount to 1,290. Based on the total citaions the top influential author is Bebbington J, who started publishing from the year 1994.

Table 7. Most influential authors based on h-index

Authors	Articles (TP)	TC	h_index	g_index	PY_start
BURRITT RL	18	1241	13	18	1995
ALMEIDA CMVB	11	518	10	11	2006
BEBBINGTON J	13	1683	10	13	1994
GIANNETTI BF	13	522	10	13	2006
BROWN J	10	1148	9	10	2006
PATTEN DM	10	1547	9	10	2007
SCHALTEGGER S	9	768	9	9	2010
CAIRNS RD	9	120	8	9	2000
CHRIST KL	8	323	8	8	2013
GRAY R	12	1290	8	12	1994
LEHMAN G	9	450	8	9	1995
THOMSON I	10	629	8	10	1994
CHO CH	9	1409	7	9	2007
DILLARD J	8	555	7	8	2012
WANG X	8	123	7	8	2014
ROBERTS RW	6	607	6	6	2010
ULGIATI S	6	529	6	6	2002
BONILLA SH	5	256	5	5	2010
FREEDMAN M	5	486	5	5	2005
GUENTHER E	5	317	5	5	2012

This review does not just focus on the most influential researchers in the field; it also analyses the authors' co-authorship to see how often and with whom they collaborate Collaborations, according to previous study, are a great way to share expertise and produce ground-breaking new findings; also, the synergy that develops among researchers working together increases the prospect of having their work published in prestigious academic publications (Khanra *et al.* 2021). Networks of authors working together on at least three documents each were created using the VOS Viewer programme. Minimum 3 documents per author was the criteria fixed. Only 140 out of 2118 authors were chosen. There were gaps in the connections between some of the network's 140 authors. 66 authors form the largest possible network of authors that have worked together. The co-authorship or collaboration network of EMA researchers is depicted in Figure 4.

Ten groups of authors worked together frequently, according to the examination of their collaboration. Ten authors, including Burritt RL, Lehman G, Schaltegger S, Christ KL, Burritt R, Qian W, and others, make up the first important cluster (shown in red in fig 3). Brown J, Cho C.H, Dillard J, Roberts RW, Patten DM, Michelon G, and others constitute the second important cluster (shown in green in fig. 3). Ulgiati S, Geng Y, Wang Y, Brown MT, Chen X, Liu J, and others compensate the next major cluster (shown in blue in fig. 3). Larrinaga C, Correa C, Moneva JM, Scarpellini S, Garcia-toria N, Portillo-Tarragona P, and Aranda Uson A make up one group of seven authors (shown in yellow in fig. 3).

Figure 4. Co-Authorship network of authors of EMA research

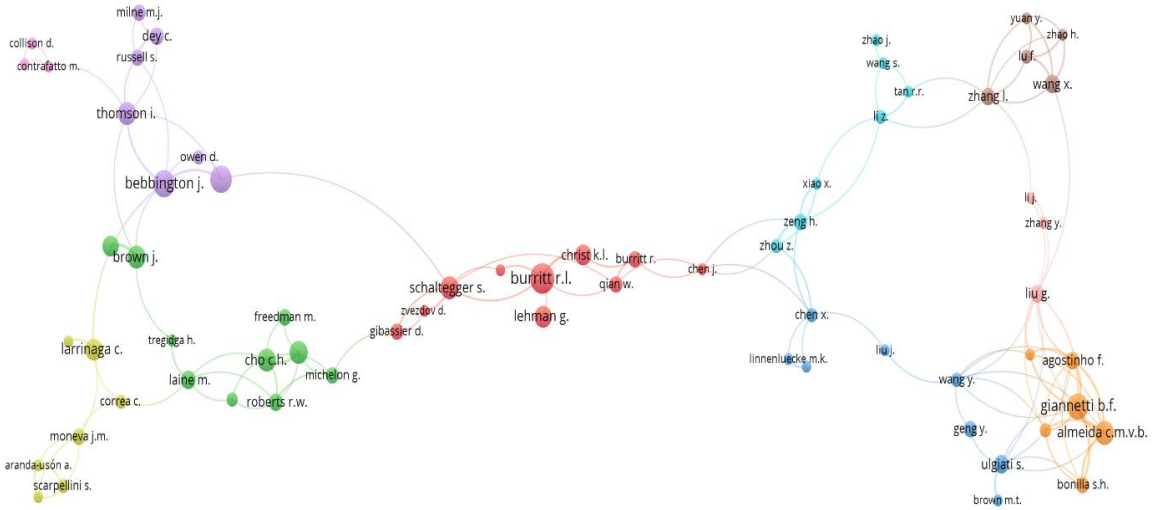


Table 8. Top influential authors based on centrality measures from different clusters

Author	Cluster	BC	CC	PR
Burritt RL		42.56	0.01250	0.04161
Schaltegger S		206.00	0.01538	0.02813
Gibassier D	1	114.00	0.01299	0.01555
Qian W		78.33	0.01282	0.02500
Chen J		46.00	0.01042	0.02343
Brown J		24.00	0.00990	0.02988
Cho CH		20.00	0.00917	0.04291
Patten DM	2	10.83	0.00909	0.03432
Roberts RW		14.17	0.00909	0.02718
Michelon G		100.00	0.01099	0.02306
Ulgiati S	3	7.17	0.09091	0.01790
Liu G		12.00	0.09091	0.01943
Larrinaga C	4	24.00	0.00971	0.01813
Bebbington J		95.41	0.01235	0.04527
Gray R		144.00	0.01408	0.02506
Thomson I	5	43.09	0.01220	0.03220
Dey C		3.26	0.00971	0.02298
Russell S		21.24	0.01000	0.03051
Wang X	8	7.00	0.06250	0.01761

BC=Betweenness centrality, CC=Closeness centrality, PR=Pagerank

Seven authors - Gray R, Bebbington J, Thomson I, Owen D, Russell S, Dey C, and Milne MJ - make up the fifth cluster (shown in purple in fig 3). Seven writers, including Zeng H, Wang S, Zhao J, Tan R R, Li Z, Xiao X, and Zhou Z, constitute the sixth cluster (shown in light blue in fig. 3). More nodes are concentrated in the seventh cluster, but just six authors (Giannetti BF, Almeida CMVB, Bonilla SH, Agostinho F, Huisingh d, and Sevegnani F) are represented. Three other groups of authors consist of 5, 3, and 3 writers, respectively. The most influential authors from the co-authorship analysis with different centrality measures are presented in Table 8.

More authors, including Schaltegger S (206), Gray R (144), Gibassier D (114), and Michelon G (100), have a high betweenness centrality. Then came Bebbington (95.41), Qian (78.33), Chen (46.00), Thomson (43.19), Burritt RL (42.56), and others. Who has the greater ability to create a link between the disconnected nodes (*i.e.* authors). The closeness centrality for the author Ulgiati S (0.09091), Liu G (0.09091), Wang X (0.06250), Schaltegger S (0.01538), Gibassier D(0.01299), and Qian W(0.01282) are greater than other authors in the network. These authors have strong ties to the network of co-authors. Authors Bebbington J (0.04527), Cho CH (0.4291), Burritt RL (0.04161), Patten DM (0.03432), Russell S (0.03051), and others in the table are deemed to be the most influential and prominent authors based on their page rank from the co-authorship network analysis.

In terms of citations, h-index, Clusters, Betweenness centrality, closeness centrality, and page rank, Burritt RL, Schaltegger S, Gray R, Bebbington J, and Patten DM are the most frequently cited authors. It is reasonable to call these writers the "leading lights" of EMA study.

4.3 Most Influential Journals for EMA Research

The most influential journals for EMA research in terms of productivity is presented in table 9. Based on the data in the table, the *Journal of cleaner production* is the most productive journal in the EMA research domain, having published 158 documents with the greatest h-index (46) and g-index (72) among EMA journals. The next most prolific journal is *Accounting, Auditing, and Accountability journal* (71 total articles, 44 h-index, 71 g-index). But, this publication is classified A* in ABDC and has more citations (6,993) than the Journal of cleaner production (6694). The *Social and Environmental Accountability Journal* is B-ranked in ABDC and has an h-index of 12 and a g-index of 23 from its 67 published journals. *Ecological economics* (60) and *Critical perspectives on accounting* (41) are the next most productive journals ranked A by ABDC. In addition, the table includes three A* journals that were placed lower in the ranking due to low output. *Journal of Environmental Economics and Management* (7), *Accounting, Organizations and Society* (12), and the *British Accounting Review (9)*. The other A ranked journals in the list are *Business strategy and the environment* (23), *Environmental and resource economics* (17), *Journal of business ethics* (12), and *Accounting education* (9). In addition to the aforementioned publications, the table also highlights six B-ranked publications, one C-ranked publication, and two that are not included in ABDC.

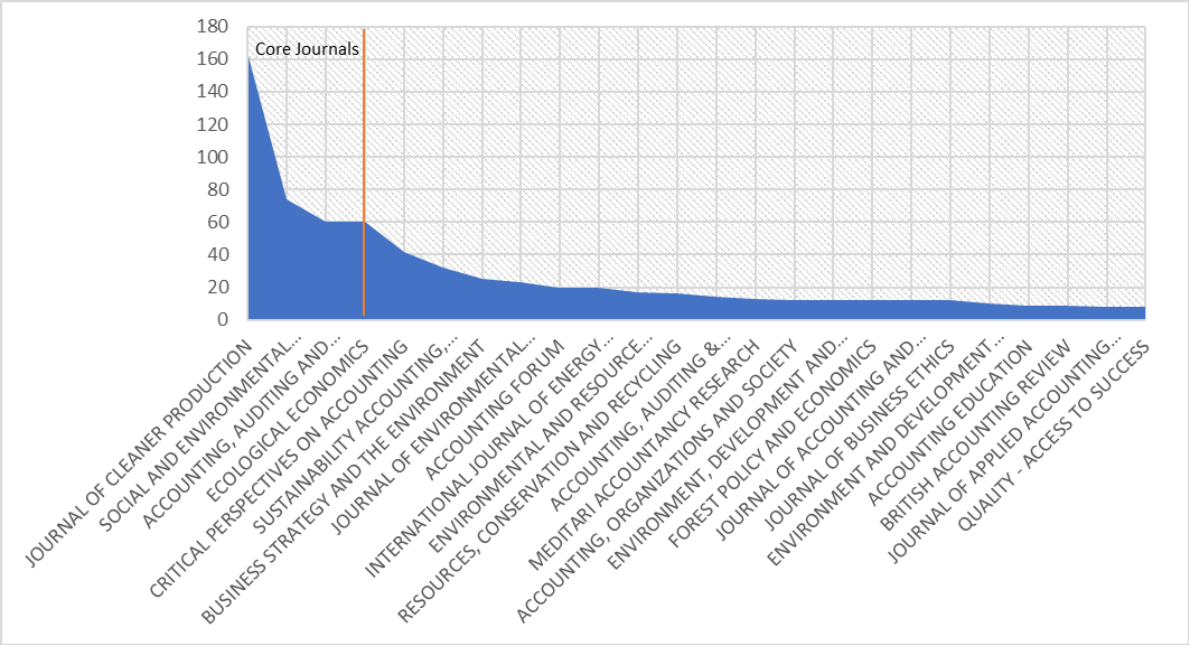
Table 9. Top 20 Journals based on Productivity

Sources	Articles (TP)	TC	ABDC Rank	h_index	g_index
Journal of Cleaner Production	158	6694	A	46	72
Accounting, Auditing and Accountability Journal	71	6993	A*	44	71
Social And Environmental Accountability Journal	67	718	B	12	23
Ecological Economics	60	3872	A	29	60
Critical Perspectives on Accounting	41	2655	A	28	41
Sustainability Accounting, Management and Policy Journal	30	559	B	14	23
Business Strategy and The Environment	23	1444	A	17	23
Accounting Forum	19	1113	B	13	19
Journal of Environmental Accounting and Management	18	190	Not Found	7	13
Environmental and Resource Economics	17	405	A	11	17
International Journal of Energy Economics and Policy	15	176	C	7	13

Sources	Articles (TP)	TC	ABDC Rank	h_index	g_index
Resources, Conservation and Recycling	13	478	Not Found	10	13
Accounting, Organizations and Society	12	2953	A*	12	12
Journal of Business Ethics	12	1450	A	9	12
Journal of Accounting and Organizational Change	11	250	B	9	11
Forest Policy and Economics	11	180	B	7	11
Environment and Development Economics	10	294	B	9	10
Accounting Education	9	277	A	8	9
British Accounting Review	9	455	A*	7	9
Journal of Environmental Economics and Management	7	425	A*	7	7

According to Bradford's Law, the simple geometric series 1:ns:n2s:n3s is formed by successive zones of journals holding the same number of articles on the subject, if the journals are placed in descending order of the number of articles they contained on the subject. Bradford identified a distinct area, the "first zone," where a cluster of publications focused solely on the topic existed. Figure 5 represents journals based on Bradford's law.

Figure 5. Core Journals based on Bradford's law



The zone one journals based on Bradford's law are Journal of cleaner production, Social and Environmental accountability journal, Accounting, Auditing and Accountability journal, and Ecological economics.

4.4 Most Influential Publications on EMA

Table 10 displays the top cited works on EMA according to Global citations. According to the table, Criagn Deegan's (2002) article on the theoretical foundations of legitimising effect of social and environmental disclosures has received the most citations worldwide, with a grand total of 1697; this is followed by the articles by James *et al.* (2007), which discuss eco systems and the need for standardised environmental accounting systems, and by Charles *et al.* (2007), which discuss environmental disclosures with a total of 1350 and 959 citations, respectively. The article by William (2003) entitled "Social accountability and corporate greenwashing" was cited 636 times, placing it in the top five most cited articles of all time. Compared to William's work, which has an average citation rate of 31.80, the article by Robgray (2010) on sustainability accounting, organization's

narratives investigation has been cited 631 times around the world with average citation per year of 48.54. Among these works, the most recent article Ralf Buckley's (2012) paper on sustainable tourism published in the journal Annals of tourist research has received the most citations (558) and the highest average citations per year (50.73). The credibility of environmental disclosures is the subject of the top first and third most-cited publications. Environmental and social responsibility are the topics of the fourth and eighth publications.

Table 10. Top influential publications based on Global citations

Title	Authors	Journal	TC	TC per Year
Introduction: The legitimising effect of social and environmental disclosures – a theoretical foundation	Deegan 2002	Accounting, Auditing and Accountability Journal	1697	80.81
What are ecosystem services? The need for standardized environmental accounting units☆	Boyd and Banzhaf 2007	Ecological Economics	1350	84.38
The role of environmental disclosures as tools of legitimacy: A research note	Cho and Patten 2007	Accounting, Organizations and Society	959	59.94
Social Accountability and Corporate Greenwashing	Laufer 2003	Journal of Business Ethics	636	31.8
Is accounting for sustainability actually accounting for sustainability…and how would we know? An exploration of narratives of organisations and the planet	Gray 2010	Accounting, Organizations and Society	631	48.54
Using content analysis as a research method to inquire into intellectual capital reporting	Guthrie, Petty, Yongvanich, and Ricceri 2004	Journal of Intellectual Capital	624	32.84
Sustainable tourism: Research and reality	Buckley 2012	Annals of Tourism Research	558	50.73
Social and environmental accountability research: A view from the commentary box	Parker 2005	Accounting, Auditing and Accountability Journal	454	25.22
Corporate Responses in an Emerging Climate Regime: The Institutionalization and Commensuration of Carbon Disclosure	Kolk, Levy, and Pinkse 2008	European Accounting Review	428	28.53
Twenty-five years of social and environmental accounting research: Is there a silver jubilee to celebrate?	Mathews 1997	Accounting, Auditing and Accountability Journal	400	15.38

4.5 Most Prolific Institutions

In table 11 we see the most prominent centres for EMA study. According to the data, Macquarie University in Sydney, Australia, has produced more research than any other institution. The University of South Australia came in second, with 28 publications published. On top of that, New Zealand's Victoria University of Wellington produced 24 articles. The University of St. Andrews in Scotland is ranked 4th among top universities for the number of articles it has produced (21 total). Furthermore, the fifth-ranked Parthenope University of Naples, Italy, and the sixth-ranked Universidade Paulista, Brazil, both produced 20 papers apiece. There are four Australian institutions and four Chinese institutions among the top 20. There are two major contributors to the number of papers in EMA research from the countries of New Zealand, Italy, Brazil, Scotland, and Spain. There are 15 publications from the institutions not reported.

Table 11. Top 20 Institutions for EMA Research

Institutions	Country	TP
Macquarie University	Australia	29
University of South Australia	Australia	28

Victoria University of Wellington	New Zealand	24
University of St Andrews	Scotland	21
Parthenope University of Naples	Italy	20
Universidade Paulista	Brazil	20
Beijing Normal University	China	19
University of Turin	Italy	19
Chinese Academy of Sciences	China	18
Rmit University	Australia	17
Shanghai Jiao Tong University	China	17
Central South University	China	15
Notreported		15
University of Zaragoza	Spain	15
Paulista University	Brazil	14
Universidad de Burgos	Spain	13
University of Bologna	Italy	13
University of Dundee	Scotland	13
Griffith University	Australia	12
University of Canterbury	New Zealand	12

4.6 Most Prolific Countries

The top contributing countries for EMA research are presented in the table 12. The table indicates that most prolific country is Australia with 298 documents, followed by United Kingdom, USA and China with 281, 263, and 244 articles respectively. With 6,642 and 6,698 citations, respectively, Australia and the United Kingdom emerge as the top two influential countries, and the United States follows closely behind as the third most influential country with 5,662 citations. However, with an average of 141.50 citations per publication, for 38 articles Netherlands contribution to the area had the highest average citation impact. Several nations have made substantial contributions to the EMA research field, including Italy (194), Spain (112), Germany (101) and Malasyia (100). New Zealand has been cited 2,557 times while contributing little articles. South Africa and India, which respectively contributed 60 and 59 publications, have received fewer citations.

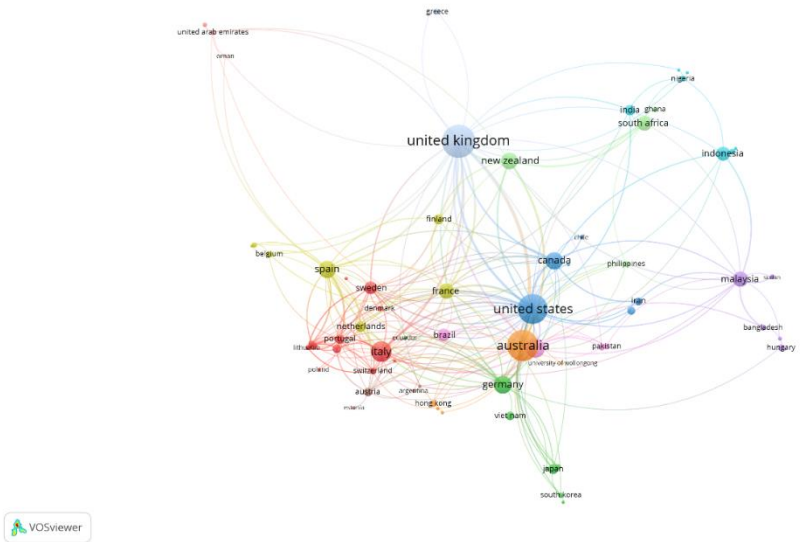
Table 12. Top countries contributing for EMA research

Countries	TP	TC	Avg. Article citation
Australia	298	6642	56.77
United Kingdom	281	6698	59.27
Usa	263	5662	60.23
China	244	1258	23.30
Italy	194	1566	28.47
Spain	112	1061	42.44
Germany	101	1424	44.50

Countries	TP	TC	Avg. Article citation
Malaysia	100	286	13.00
Indonesia	98	448	24.89
Brazil	91	879	35.16
Canada	79	1775	63.39
New Zealand	68	2557	88.17
France	62	506	28.11
South Africa	60	251	10.04
India	59	189	14.54
Finland	42	439	29.27
Sweden	41	393	20.68
Netherlands	38	1698	141.50
Portugal	36	410	31.54
Japan	29	276	21.23
Austria	23	312	52.00

This review does more than just rank the countries that produce the most research in a given field; it also conducts a co-authorship analysis of countries to highlight the nature and depth of collaboration between nations. Out of 102 nations included in the corpus, only 74 are connected when using the VOS Viewer programme to depict a collaboration network of leading countries with the parameter of one document published per country. This analysis identified a total of 12 groups of networks. Figure 6 shows that the United Kingdom has the most partnerships, as indicated by the largest node size, with countries like the United States, China, Australia, Germany, Italy, Spain, and Malaysia, and fewer partnerships with countries like Greece, the United Arab Emirates, Nigeria, Austria, Ireland, and others.

Figure 6. Co-Authorship collaboration network of countries



Australia comes in second with its extensive network of international partnerships that includes countries such as Italy, Spain, the Netherlands, Indonesia, the United Kingdom, New Zealand, Germany, Japan, and many more. The United States has a network of its own and is the world's second largest collaborator with the United

Kingdom, Australia, Italy, Sweden, France, Brazil, India, South Africa, and other countries. With the United Kingdom, the United States, and Australia as its primary network partners, Germany is well connected. In addition to these countries, Germany has ties to Japan, Italy, the Netherlands, Portugal, Canada, France, and the Philippines. In addition, Italy is linked to every major network partner. India's international network of partners in this area is extremely limited; the country has only worked with the United Kingdom, United States, South Africa, Sweden, and Nigeria. Many nations work closely together, including Malaysia, China, Canada, Italy, Indonesia, France, Spain, and South Africa.

5. Science Mapping of EMA Research

5.1 Temporal analysis

Articles covering EMA studies were divided into four-time intervals: 1976–1995, 1996–2005, 2006–2015, and 2016–2022. Word clouds in Figures 7, 8, 9, and 10 show the most important subjects throughout the different time periods that were uncovered by the chronological analysis. Tables 13, 14, 15 and 16 provide a summary of EMA research conducted during each time period.

Only 32 documents by 42 writers appeared between 1976 and 1995. Because there weren't enough author keywords for the analysis, titles were substituted in the word cloud field for the year 1976-1995. For this reason, the terms "sustainable development" (Steer and Lutz 1993) and "accounting issues" (Vanoli 1995) are more common than "environmental accounting" in the context of EMA studies. Every other word in the cloud is given the same importance. See Table 13 for a summary and see Figure 6 for a visualisation of the word cloud from 1976–1995.

Figure 7. EMA between 1976 to 1995

Table 13. EMA research overview 1976 to 1995

Time Span	1976:1995
Sources	19
Total Documents	32
Articles	29
Review	3
Annual growth rate %	12.88
Average Citation per doc	36.5
References	1008
Authors	47
Author's Keywords	2
Single authored docs	18
Co-authors per doc	1.72

Continued expansion of the term "sustainability" (Milne 1996) is shown from 1996 to 2005 in Figure 8. Research in the area of "social accounting" (Cooper, Taylor, Smith, and Catchpowle 2005) is accorded the same level of importance. The emphasis here is on "green accounting," (Jahamani 2003) which has considerable bearing on the matter. The fields of "disclosure," "environmental audit," "depletion," "forests," "material flow analysis," "national accounts," "national resources," and "social and environmental accounting" are among the new research areas investigated. There was a total of 145 publications, 124 articles and 21 reviews. There are now 197 people involved in EMA studies, and on average, each paper has 1.67 authors. Table 14 represents EMA research overview between 1996 to 2005.

Figure 8. EMA research between 1996 to 2005

Table 14. EMA research between 1996 to 2005

Time Span	1996:2005
Sources	59
Total Documents	145
Articles	124
Review	21
Annual growth rate %	8.66
Average Citation per doc	74.92
References	5135
Authors	197
Author's Keywords	263
Single authored docs	82
Co-authors per doc	1.67

Figure 9 depicts the sustained expansion of the term "sustainability" (Stasiškienė and Šliogerienė 2009) from 2006-2015, including the notable multiplication of research on topics like "green accounting," (Gray and Laughlin 2012) "social accounting" (Fraser 2012) "social and environmental accounting," and "sustainable development" that began in the previous decade. During this time, studies on "carbon accounting" (Ascui 2014) began to receive increased attention. Climate change, materials flow cost accounting, CSR, ecosystem services, environmental costs, management accounting, environmental reporting, sustainability accounting, cleaner production, financial reporting, legitimacy theory, carbon sequestration, and many more are among the emerging topics of study. There were 371 works published throughout this time, including 354 articles and 16 review papers. The number of authors who have made significant contributions has risen dramatically, up to 695. There

was a rise to an average of 2.37 authors per paper. Table 15 represents EMA research overview between 2006 to 2015.

Figure 9. EMA research between 2006 to 2015

Table 15. EMA research overview 2006 to 2015

Time Span	2006:2015
Sources	110
Total Documents	371
Articles	355
Review	16
Annual growth rate %	8.43
Average Citation per doc	57.52
References	18570
Authors	695
Author's Keywords	967
Single authored docs	95
Co-authors per doc	2.37

Figure 10. EMA research between 2016 to 2022

Figure 10 shows that with the launch of SDGs in 2015, "carbon accounting," "sustainability," "green accounting," "environmental performance," (Appiah *et al.* 2020) "sustainable development," "climate change," (Wu and Han

2020) "life cycle assessment," (De Menna *et al.* 2020) and "material flow cost accounting" (Sahu *et al.* 2021) all became major topics of discussion. Notable studies conducted and presented by EMA researchers over the past seven years include those on "ecosystem services," "sustainability accounting," "the circular economy," "corporate governance," "carbon footprint," "ecological accounting," "integrated reporting," "contingency theory," "carbon performance," "environmental costs," and "financial performance," among many others. A total of 527 works were published during this time, comprising 505 original works and 22 reviews. There are now 1335 authors' total. Overall, there are now 3.14 authors on average per paper. Table 16 represents EMA research overview between 2016 to 2022.

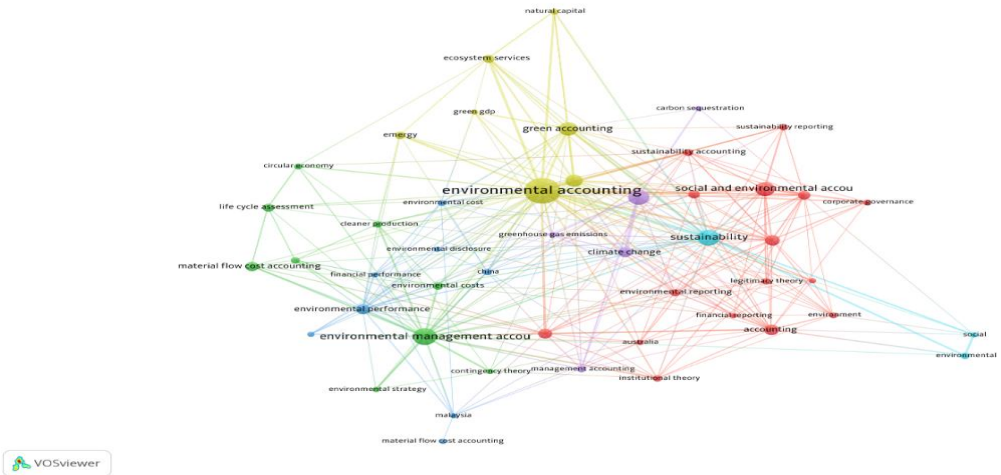
Table 16. EMA research overview 2016 to 2022

Time Span	2016:2022
Sources	170
Total Documents	527
Articles	505
Review	22
Annual growth rate %	12.46
Average Citation per doc	14.93
References	32466
Authors	1335
Author's Keywords	1525
Single authored docs	76
Co-authors per doc	3.14

5.2 Network Analysis through Co-Occurrence of Keywords in EMA Research

The network analysis uses across-the-board keyword co-occurrence to deconstruct the main ideas that have defined EMA research from its beginning in 1976 through 2022 (Kumar *et al.* 2022). As such, the major themes in the field of EMA can be better understood by the network analysis employing keyword co-occurences. There are a total of 48 keywords with a minimum of nine occurrences each, as determined by a co-occurrence analysis of the keywords authors identify in their works. Through VOS viewer, a network with 308 nodes, 6 clusters, and 718 link strengths was constructed. Figure 11 depicts the major themes discovered from the co-occurrences of keywords in the network analysis of the full corpus, while table 17 provides descriptive context.

Figure 11. Network of Author keywords Co-occurrences



Seven indicators, including, are reported to further enhance the findings of the co-occurrence study. The APY measures how recently a certain keyword was published on average. Average citation (AC), which shows how often a certain word is referenced in other documents; Indicative of how often a keyword appears in the corpus, occurrence (OC) The keyword's degree of centrality (DC), which reflects the amount of connections it has within the network; There are three measures of a keyword's significance within a cluster: its closeness centrality (CC), which shows how well it is connected to its neighbours, its betweenness centrality (BC), which shows how well it can spread information within the cluster, and its page rank (PR), which shows how important it is within the cluster based on the quality and quantity of links pointing towards it.

The next section employs sensemaking, in which keywords are arranged in a logical fashion to express the study substance of each issue, to analyse the six themes that emerged from the co-occurrence analysis and show the underlying conceptual structure of EMA research.

Table 17. Keyword co-occurrence clusters on EMA

Keyword	OC	DC	BC	CC	PR	AC	APY
Cluster 1: Social and Environmental Accounting (RED)							
accountability	21	10	0.7364	0.0101	0.0146	37.29	2018
accounting	36	23	16.8660	0.0110	0.0214	50.47	2013
Australia	10	12	3.5134	0.0093	0.0109	52.50	2013
corporate governance	12	8	0.2611	0.0096	0.0092	44.83	2016
corporate social responsibility	25	20	12.8419	0.0109	0.0253	47.08	2016
disclosure	9	11	0.0000	0.0092	0.0045	122.78	2010
environment	12	12	0.1198	0.0081	0.0080	85.00	2011
environmental management	31	17	32.4220	0.0114	0.0294	52.68	2013
environmental reporting	16	16	4.6637	0.0098	0.0099	51.75	2014
financial reporting	10	10	0.0000	0.0092	0.0051	20.50	2013
institutional theory	13	11	1.8355	0.0111	0.0152	37.69	2016
legitimacy theory	13	10	0.1958	0.0097	0.0080	70.15	2015
social accounting	35	18	23.3135	0.0112	0.0318	118.09	2011
social and environmental accounting	63	15	19.2108	0.0098	0.0337	32.56	2016
sustainability accounting	16	16	5.7784	0.0112	0.0186	27.19	2016
sustainability reporting	13	8	0.3264	0.0098	0.0115	48.77	2017
Cluster 2: Environmental Management Accounting (Green)							
circular economy	12	6	0.6774	0.0101	0.0104	38.00	2020
cleaner production	13	12	2.1762	0.0085	0.0127	40.85	2014
contingency theory	10	8	0.0000	0.0081	0.0092	24.20	2018
eco-efficiency	13	9	3.2444	0.0089	0.0138	47.08	2013
environmental costs	19	13	2.7282	0.0103	0.0138	21.32	2013
environmental management accounting	90	29	239.9392	0.0130	0.0797	29.61	2016
environmental strategy	9	5	0.0000	0.0081	0.0085	40.00	2018

Keyword	OC	DC	BC	CC	PR	AC	APY
life cycle assessment	22	7	3.7250	0.0097	0.0119	34.09	2018
material flow cost accounting	28	8	3.5182	0.0088	0.0145	22.54	2017
Cluster 3: Environmental Performance (Blue)							
china	13	14	0.0000	0.0106	0.0073	13.31	2016
energy efficiency	10	5	0.1500	0.0093	0.0099	12.60	2019
environmental cost	11	10	2.7282	0.0103	0.0138	19.27	2015
environmental disclosure	10	6	0.0000	0.0097	0.0081	54.60	2018
environmental performance	33	20	40.8136	0.0116	0.0287	16.85	2019
financial performance	10	10	1.2005	0.0083	0.0094	3.40	2020
malaysia	9	9	0.0000	0.0083	0.0078	12.78	2015
material flow cost accounting (mfca)	9	1	0.0000	0.0066	0.0070	28.00	2017
Cluster 4: Environmental Accounting (Yellow)							
ecosystem services	21	10	0.3153	0.0105	0.0226	105.81	2014
emergy	18	7	8.0668	0.0103	0.0149	27.22	2016
environmental accounting	206	41	537.9709	0.0159	0.1355	42.27	2013
green accounting	57	19	44.5277	0.0110	0.0405	15.35	2013
green gdp	9	6	0.0000	0.0095	0.0108	24.56	2011
natural capital	12	5	0.0509	0.0103	0.0183	25.42	2015
sustainable development	46	28	42.4540	0.0122	0.0357	44.17	2014
Cluster 5: Carbon Accounting (Purple)							
carbon accounting	75	14	56.9727	0.0098	0.0379	23.81	2017
carbon sequestration	9	3	0.0000	0.0068	0.0062	33.44	2012
climate change	33	17	8.5838	0.0104	0.0270	38.30	2016
greenhouse gas emissions	10	12	1.1469	0.0096	0.0111	62.10	2014
management accounting	13	11	13.1703	0.0112	0.0157	79.46	2012
Cluster 6: Sustainability (Sky Blue)							
environmental	13	4	0.9048	0.0087	0.0161	26.54	2016
social	10	6	0.0000	0.0084	0.0130	101.80	2013
sustainability	78	30	174.1356	0.0135	0.0721	45.59	2014

OC=Occurrence, DC=Degree of centrality, BC=Betweenness centrality, CC=Closeness centrality, PR=PageRank, AC=Average citations, APY=Average publication year.

Keyword cluster 1: Social and Environmental Accounting (Red Network)

Social and environmental accounting in environmental management make up the first cluster of related terms. The cluster's most popular terms include "social and environmental accounting" (OC=63), "accounting" (OC=36), "social accounting" (OC=35), "corporate social responsibility" (OC=25), and "accountability" (OC=21). Then comes environmental reporting (OC=16) and sustainability accounting (OC=16). Also highly ranked in the cluster

are the keywords (topics) social and environmental accounting (PR=0.0337), accounting (PR=0.0214), corporate social responsibility (PR=0.0253), and social accounting (PR=0.318), all of which point to the significance of these terms in EMA research. The keyword with the lowest average publication year is disclosure (APY=2010) and social accounting (APY=2011), showing that it is one of the old and well-researched topics in the cluster, and hence has the greatest average citation (AC=122.78) and social accounting (AC=118.09) counts. Accountability (APY=2018) and sustainability reporting (APY=2017) have lately received greater study interest than the other subjects in the cluster, as indicated by their higher APYs.

Keyword cluster 2: Environmental Management Accounting (Green network)

Among the nine keywords that make up the second cluster, material flow cost accounting (OC=28), life cycle assessment (OC=22), and environmental costs (OC=19) have the highest occurrence counts, with cleaner production (OC=13), eco-efficiency (OC=13), and the circular economy (OC=12) coming in at a distant fourth. According to PageRank, the most important areas of study in EMA are material flow cost accounting (PR=0.0145), eco-efficiency and environmental costs (PR=0.138), and cleaner production (PR=0.127). Eco-efficiency (AC=47.08), cleaner production (AC=40.85), and environmental strategy (AC=40.00) have all received a large number of citations, demonstrating their significance in EMA studies. Since average publication year 2020, the circular economy has been the hottest of much EMA investigation. Life cycle costing (CC=0.0097, BC=3.7250) plays a major role in EMA studies of the circular economy.

Keyword cluster 3: Environmental performance (Blue network)

Eight keywords that capture the essence of Environmental management accounting's focus on environmental performance make up the third cluster. The keywords "environmental performance" (OC=33, BC=40.8136, DC=20, CC=0.0116, PR=0.0287) "environmental cost" (OC=11, BC=2.7282, DC=10, CC=0.0103, PR=0.0138) and "financial performance" (OC=10, BC=1.2005, DC=10, CC=0.0083, PR=0.0094) have the highest degree of centrality, closeness centrality, betweenness centrality, and pagerank in the cluster, respectively Environment disclosure (AC=54.60), material flow cost accounting (mfca) (AC=28.00), and environmental cost (AC=19.27) are the most frequently cited terms in this cluster, whereas financial performance (APY=2020) is the most recently cited term in this group.

Keyword cluster 4: Environmental accounting (Yellow network)

Seven terms related to environmentally friendly accounting form the fourth group. Green accounting has the greatest OC (57), BC (44.5277), and PR (0.0405) in the cluster, followed by sustainable development (OC = 46, BC = 42.4540, PR = 0.0357). When looking at the average number of citations, studies on EMA find that eco-system services (AC=105.81) have the most influence. Emergy (APY=2016) is the most recent topic in the cluster. The cluster's APY=2013 average publication year also shows that green accounting is a popular area of study.

Keyword cluster 5: Carbon accounting (Purple network)

The fifth set of keywords deals specifically with carbon and gas emissions in EMA studies. The cluster's newest (APY=2017) research focus is on carbon accounting. It has the highest pagerank (PR=0.379), the most occurrences (OC=75), the highest betweenness centrality (BC=56.9727), the second most linkages between other terms (DC=14), and is the main centre of the cluster. Research into EMA is significantly impacted by climate change (OC=33, DC=17, BC=8.5838, CC=0.0104, PR=0.0270, AC=38.30) and greenhouse gas emissions (OC=10, DC=12, BC=1.1469, CC=0.0096, PR=0.0111, AC=62.10).

Keyword cluster 6: Sustainability (Sky blue)

Sixth, and final cluster deals specifically with sustainability in literature. The cluster first focused on social research (APY=2013), then moved on to sustainability (APY=2014) and is now focusing on environmental research (APY=2016). Sustainability in EMA research is currently the most prominent (OC=78, DC=30, BC=174.1356, CC=0.0135, PR=0.721, AC=45.59), although social publications have the highest average citation count (AC=101.80).

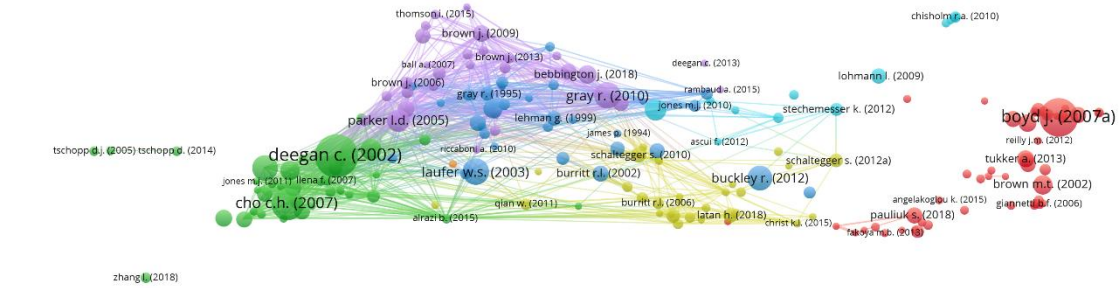
5.3 Bibliographic Coupling

When two or more documents share bibliographical references, they are considered bibliographically coupled. If both document A and document B cite document C, then documents A and B are bibliographically coupled, also known as retrospective coupling (Hjørland 2013). Bibliographic coupling identifies the semantic relationship between publications in order to unearth hidden research themes that will drive future research orientations (Chandra *et al.* 2022). Bibliographic coupling strengths are counts of the number of references a set of documents share, and it is assumed that a high coupling strength indicates a high degree of subject matter

similarity (Hjørland 2013). The thickness and intensity of the edges indicate the degree to which these publications are alike (Verma and Yadav 2021).

The use of bibliographic coupling to the review corpus resulted in the establishment of seven clusters that are sufficiently substantial to represent 208 documents in the review corpus significantly. For the bibliographic coupling analysis, Documents are used as unit of analysis. The bibliographic coupling map presenting different clusters are presented in the Figure 16. Seven separate bibliographic (thematic) clusters containing a total of 189 out of 1085 documents are revealed by the bibliographic coupling. The analysis is based on a minimum of 50 citations of a document that is being considered for coupling. The study and network only include 189 of the 208 documents that met the requirements. The network found 7 clusters, 4698 connections, and a total of 14,479 strength in the interconnections. Table 18 displays the most frequently cited publications for each bibliographic clusters.

Figure 17. Network representing bibliographic coupling of documents



VOSviewer

Bibliographic cluster 1: Eco-system services (Red)

The first cluster, consisting of 49 publications out of 1075, has a primary focus on eco-system services and circular economy. That have received an average of 534.40 citations per document (Total citations/Total publication) for a total of 26,186 citations. The earliest of these publications dates back to 1996, while the most recent is set to come out in 2020. Analysis of the most widely-cited papers in this domain reveals that they mostly address on eco-system services (Boyd and Banzhaf 2007; Howarth and Farber 2002), emergy evaluations (Brown and Ulgiati 2002), measuring the air pollution (Muller and Mendelsohn 2007) and environmental accounting for pollution (Muller, Mendelsohn and Nordhaus 2011) and environmental impacts of mega sporting events (Collins, Jones, and Munday 2009). The most cited publication in the present cluster is on eco-system services concentrating on the need for standardized environmental accounting units (Boyd and S. Banzhaf 2007).

Bibliographic cluster 2: Environmental disclosure (Green)

The second cluster capture research on environmental disclosure through 37 documents out of 1075. That have received an average of 699.33 per document (Total citations/Total publications) for a total of 27,274 citations. The first publication in this cluster published in 1999, while the most recent set to come in 2019. The most cited publications in the present cluster sheds light on the Environmental disclosures (Deegan 2002; Cho and D. M. Patten 2007; de Villiers and van Staden 2006; Monteiro and Aibar-Guzmán 2010; Freedman and Jaggi 2005; Huang and Kung 2010), Social and environmental accounting research (Chen and Roberts 2010), environmental capital expenditure (Clarkson, Li, and Richardson 2004), sustainability assurance (Kolk and Perego 2010) and intellectual capital reporting (Guthrie, Petty, Yongvanich, and Ricceri 2004). The highest cited publication in the present cluster is on environmental disclosures (Deegan 2002).

Bibliographic cluster 3: Social accounting (Blue)

The third cluster focuses on the research of social accounting through 31 publications that have amassed a total of 25,767 citations and average 831.19 citations per document (Total citations/Total publications). In the present cluster the publications was started from the year 1994, the latest publication came out in 2018. Around sixteen publications in this cluster are published during 2000 to 2006. In this cluster most cited publications concentrate on Social accountability and corporate greenwashing (Laufer 2003), sustainable tourism (Buckley 2012; Becken and Patterson 2006), corporate unsustainability (Moneva, Archel and Correa 2004), environmental management accounting in organizational change, comprehensive framework, institutional appropriation and future potential

(Gray, Walters, Bebbington, and Thompson 1995; Burritt, Hahn, and Schaltegger 2002; Larrinaga-Gonzalez and Bebbington 2001; Bartolomeo, *et al.* 2000). The highest citations in this cluster is for the paper by Laufer (2003) on social accounting.

Bibliographic cluster 4: Environmental management accounting (Yellow)

The fourth cluster concentrates on environmental management accounting with eco-efficiency, waste management, green and pleasant land and others through 29 documents with total citations of 20,126 and with 694 average citations per document. The first paper published in this cluster is in 2001 and the latest was published in 2018. The highly cited articles in this cluster sheds light on sustainability accounting (Schaltegger and Burritt 2010), environmental strategy and uncertainty (Latan *et al.* 2018), carbon accounting (Schaltegger and M. Csutora 2012), eco-efficiency (Burritt and Saka 2006), waste management (Qian, Burritt and Monroe 2018), significance of contingent variables on adoption of environmental management accounting (Christ and Burritt 2013) and environmental motivations into performance (Lisi 2015). The research on sustainability accounting of Schaltegger and Burritt (2010) has received highest citations of 226. Compared to other bibliographic clusters cluster 4 top cited publication has received less citations.

Bibliographic cluster 5: Sustainability and sustainable development (Purple)

The fifth cluster in bibliographic analysis concentrates on sustainability and sustainable development through environmental management accounting tools. 29 documents are identified in the present cluster. The cluster got 25,686 total citations with an average of 885.72 citations per document. The first document published in this cluster is 2004 and the latest publication came out in 2019. The most cited publication in the cluster sheds ligh on the accounting for sustainability (Gray 2010; Brown 2009), social and environmental accountability (Parker 2005) social and environmental accounting (Brown and Fraser 2006; Owen 2008), sustainable development goals (Bebbington and Unerman 2018), sustainable development (Bebbington and Larrinaga 2014). The highly cited publication in the present cluster is accounting for sustainability (Gray 2010).

Bibliographic cluster 6: Carbon accounting (Sky blue)

The sixth cluster in the analysis focuses on the research of carbon accounting through 13 documents with 1,582 total citations and average of 121.69 citations per document. The first document in the cluster was published in 2002 and the latest publication came out in 2012. 8 among 13 documents are published during 2010 to 2012. The most cited publication in the cluster concentrates on carbon disclosure (Kolk, Levy and Pinkse 2008), carbon in dio-diversity hotspot (Chisholm 2010), carbon accounting (Ascui and Lovell 2011; Cacho, Hean and Wise 2003; Bowen and Wittneben 2011), greenhouse gases (Latta, Adams, and McCarl 2010) and eco-system services (Chisholm 2010). The most cited publication is on carbon disclosure (Kolk, Levy, and Pinkse 2008).

Bibliographic cluster 7: Corporate social responsibility (Orange)

The bibliographic analysis identified only one document in the seventh cluster, the research is on corporate social responsibility and accountability regulation in care if business (Unerman and O'Dwyer 2007). The publication is cited 66 times. And it is published in the year 2007.

Table 18. Top ten highly cited articles based on bibliographic clusters

Publication	Author and year	Citations	Links	Total link strength
Cluster 1: Eco-system Services				
What are ecosystem services? The need for standardized environmental accounting units	Boyd and Banzhaf 2007	1350	12	26
Emergy evaluations and environmental loading of electricity production systems	M. T. Brown and Ulgiati 2002	340	7	8
Environmental accounting for pollution in the United States economy	Muller *et al.* 2011	281	7	11
EXIOPOL - DEVELOPMENT AND ILLUSTRATIVE ANALYSES OF A DETAILED GLOBAL MR EE SUT/IOT	Tukker *et al.* 2013	277	5	24
Critical appraisal of the circular economy standard BS 8001:2017 and a dashboard of quantitative system indicators for its implementation in organizations	Pauliuk 2018	253	8	27
Measuring the damages of air pollution in the United States	Muller and Mendelsohn 2007	251	7	10
Weak and strong sustainability in the SEEA: Concepts and measurement	Dietz and Neumayer 2007	244	20	49

Publication	Author and year	Citations	Links	Total link strength
Assessing the environmental impacts of mega sporting events: Two options?	A. Collins *et al.* 2009	222	4	8
Towards a global multi-regional environmentally extended input-output database	Tukker *et al.* 2009	208	7	25
Accounting for the value of ecosystem services	Howarth and Farber 2002	181	19	31
Cluster 2: Environmental disclosure				
Introduction: The legitimising effect of social and environmental disclosures – a theoretical foundation	Deegan 2002	1697	102	646
The role of environmental disclosures as tools of legitimacy: A research note	Cho and Patten 2007	959	58	169
Using content analysis as a research method to inquire into intellectual capital reporting	Guthrie *et al.* 2004	624	63	182
Determinants of the adoption of sustainability assurance statements: An international investigation	Kolk and Perego 2010	394	73	196
Can less environmental disclosure have a legitimising effect? Evidence from Africa	de Villiers and van Staden 2006	346	83	366
The market valuation of environmental capital expenditures by pulp and paper companies	Clarkson *et al.* 2004	266	2	2
Determinants of environmental disclosure in the annual reports of large companies operating in Portugal	Monteiro and Aibar-Guzmán 2010	249	86	441
Toward a More Coherent Understanding of the Organization-Society Relationship: A Theoretical Consideration for Social and Environmental Accounting Research	Chen and Roberts 2010	234	79	320
Global warming, commitment to the Kyoto protocol, and accounting disclosures by the largest global public firms from polluting industries	Freedman and Jaggi 2005	232	58	181
Drivers of Environmental Disclosure and Stakeholder Expectation: Evidence from Taiwan	Huang and Kung 2010	224	70	330
Cluster 3: Social accounting				
Social Accountability and Corporate Greenwashing	Laufer 2003	636	65	136
Sustainable tourism: Research and reality	Buckley 2012	558	8	8
GRI and the camouflaging of corporate unsustainability	Moneva *et al.* 2006	337	84	223
Towards a comprehensive framework for environmental management accounting - Links between business actors and environmental management accounting tools	Burritt *et al.* 2002	247	62	101
Bringing the environment into bank lending: Implication for environmental reporting	Thompson and Cowton 2004	232	71	133
Measuring national carbon dioxide emissions from tourism as a key step towards achieving sustainable tourism	Becken and Patterson 2006	221	25	25
Disclosing new worlds: A role for social and environmental accounting and auditing	Lehman 1999	189	89	265
Accounting change or institutional appropriation? - A case study of the implementation of environmental accounting	Larrinaga-Gonzalez and Bebbington 2001	188	44	66
The greening of enterprise: An exploration of the (NON) role of environmental accounting and environmental accountants in organizational change	Gray *et al.* 1995	167	83	297
Environmental management accounting in Europe: current practice and future potential	Bartolomeo *et al.* 2000	156	68	123
Cluster 4: Environmental management accounting				
Sustainability accounting for companies: Catchphrase or decision support for business leaders?	S Schaltegger and Burritt 2010	226	108	302
Effects of environmental strategy, environmental	Latan *et al.* 2018	193	51	141

Publication	Author and year	Citations	Links	Total link strength
uncertainty and top management's commitment on corporate environmental performance: The role of environmental management accounting				
Carbon accounting for sustainability and management. Status quo and challenges	S Schaltegger and Csutora 2012	172	57	145
Environmental management accounting and innovation: An exploratory analysis	Ferreira *et al.* 2010	170	63	159
Environmental management accounting applications and eco-efficiency: case studies from Japan	Burritt and Saka 2006	126	69	132
Environmental management accounting in local government: A case of waste management	Qian *et al.* 2018	122	91	274
Environmental management accounting: Roadblocks on the way to the green and pleasant land	Burritt 2004	116	70	166
Environmental management accounting: The significance of contingent variables for adoption	Christ and Burritt 2013	111	81	268
Environmental management systems as an embedding mechanism: A research note	Pérez *et al.* 2007	107	87	229
Translating environmental motivations into performance: The role of environmental performance measurement systems	Lisi 2015	105	64	148
Cluster 5: Sustainability and sustainable development				
Is accounting for sustainability actually accounting for sustainability...and how would we know? An exploration of narratives of organisations and the planet	Gray 2010	631	99	411
Social and environmental accountability research: A view from the commentary box	Parker 2005	454	95	441
Achieving the United Nations Sustainable Development Goals: An enabling role for accounting research	Bebbington and Unerman 2018	328	66	201
Chronicles of wasted time?: A personal reflection on the current state of, and future prospects for, social and environmental accounting research	Owen 2008	278	108	683
Democracy, sustainability and dialogic accounting technologies: Taking pluralism seriously	J. Brown 2009	261	80	479
Accounting and sustainable development: An exploration	Bebbington and Larrinaga 2014	241	116	473
Theorizing engagement: The potential of a critical dialogic approach	Bebbington *et al.* 2007	233	83	374
Integrated reporting: On the need for broadening out and opening up	J. Brown and Dillard 2014	223	56	158
Approaches and perspectives in social and environmental accounting: An overview of the conceptual landscape	J. Brown and Fraser 2006	165	88	341
A discussion of the political potential of Social Accounting	Cooper *et al.* 2005	149	55	135
Cluster 6: Carbon Accounting				
Corporate responses in an emerging climate regime: The institutionalization and commensuration of carbon disclosure	Kolk *et al.* 2008	428	20	26
Toward a different debate in environmental accounting: The cases of carbon and cost-benefit	Lohmann 2009	216	22	33
Carbon accounting: A systematic literature review	K Stechemesser and Guenther 2012	165	59	139
Trade-offs between ecosystem services: Water and carbon in a biodiversity hotspot	Chisholm 2010	120	3	3
As frames collide: Making sense of carbon accounting	Ascui and Lovell 2011	105	95	219

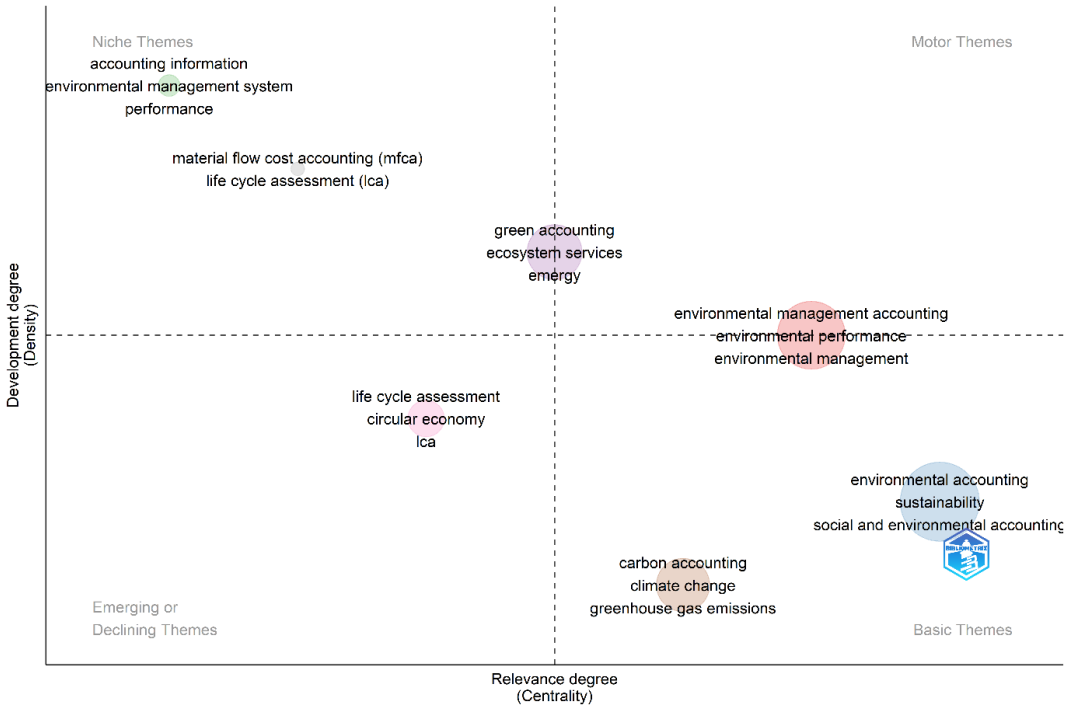
Publication	Author and year	Citations	Links	Total link strength
The costs of public involvement: Everyday devices of carbon accounting and the materialization of participation	Marres 2011	83	9	11
Climate change accounting research: keeping it interesting and different	Milne and Grubnic 2011	78	45	123
Carbon-accounting methods and reforestation incentives	Cacho *et al.* 2003	78	3	4
Carbon accounting: Negotiating accuracy, consistency and certainty across organisational fields	Bowen and Wittneben 2011	67	21	40
Mitigating greenhouse gases: The importance of land base interactions between forests, agriculture, and residential development in the face of changes in bioenergy and carbon prices	Alig *et al.* 2010	66	2	2
Cluster 7: Corporate Social responsibility				
The business case for regulation of corporate social responsibility and accountability	Unerman and O'Dwyer 2007	66	55	83

5.6 Way Forward for Environmental Management Accounting Research

The thematic clusters from the co-occurrence of the author's keywords and bibliographic coupling convergence between the clusters by indicating the major themes and clusters are similar to each other irrespective of the cluster number. It proves the credibility and veracity of essential ideas.

This study uses author keywords as inputs to construct a strategic diagram with impact and centrality as its y-axis and x-axis (Liu, Cobo, Herrera-Viedma, and Herrera 2013) using the simple center algorithm in Biblioshiny in R to acquire a better picture of the future of EMA research. Centrality reflects the significance of topics, whereas impact indicates their growth and influence in the field. Using the typology outlined in Figure 5 given by Cahlik (2000) (Chandra *et al.* 2022), the graphic depiction of the strategic diagram is divided into four quadrants.

Figure 17. Strategic diagram of Environmental management accounting



The keywords represented in the upper-right quadrant are regarded as high-centrality, high-impact motor subjects. The keyword in this quadrant is "environmental management accounting". The keywords "Green accounting", "Ecosystem services" and "emergy" are the part of motor themes. These keywords are well-developed and provide essential insights for the study of Environmental management accounting. These keywords also represent the thematic cluster four in co-occurrence of author keywords. Therefore, future

research on Environmental management accounting should always consider the effects of any proposed solutions for green accounting, emergy, and eco-system services on the EMA.

These keywords are known as transversal themes with high centrality but low impact. The keywords in this quadrant are “environmental management”, “environmental accounting”, “sustainability”, “social and environmental accounting”, “carbon accounting”, “climate change” and “greenhouse gas emissions”. The topics in this quadrant have low impact but high centrality on EMA research. Therefore, future research is more likely to benefit from utilising the concepts represented by these keywords to enable new research across the thematic clusters highlighted in this evaluation. The research on these topics will empower and enhance the existing knowledge of EMA research. These keywords represent the thematic cluster 5 of co-occurrence of keywords.

The keywords in the upper left quadrant are considered to be niche themes with high impact but with low centrality. The keywords in this quadrant are “accounting information”, “environmental management system”, “performance”, “material flow cost accounting (mfca)” and “life cycle assessment (lca)”. The keywords “Green accounting”, “Ecosystem services” and “emergy” partly represent the quadrant. These topics represent issues that are well-developed and have a significant impact on the area, despite remaining specialised topics. Future research in these areas is likely to be fruitful because they have the potential to make a significant contribution to the field, and they are likely to be sought after by both mainstream and specialty (*e.g.*, Journal of cleaner production, Sustainability) journals that welcome niche insights on EMA.

Due to their low centrality and minimal influence, the terms in the lower left quadrant are classified as emerging or declining themes. The keywords in this quadrant are “life cycle assessment”, “circular economy”, and “lca”. The research on these topics indicate possible study areas that would benefit from innovative and original ideas. In recent times as noted by the researchers, research on circular economy is gaining more importance.

Conclusion and Limitations

This study utilises bibliometric analysis and a systematic literature evaluation to shed light on the performance and science of Environmental management accounting. This study contributes in a novel way by leveraging the power of big data analytics through machine learning — and increasing visibility to it in the process — to identify the most influential articles and top contributing journals, authors, institutions, and countries, as well as by revealing the temporal evolution of topics and the major themes underlying the intellectual structure of Environmental management accounting research. The study also underpins the way forward the future scope of Environmental management accounting. In order to accomplish this, we provide a summary important insight and their corresponding consequences from this state-of-the-art assessment of 1075 works on Environmental management accounting published over the past four decades (1976-2022).

First, the performance analysis indicates the growth of publication and citation trend in the field of the EMA research. There is a annual growth rate of 10.25% in the publication, in the year publications are at its peak by 104 documents. There is also a growing trend in the citations of the publications. In addition, performance analysis indicates Burritt RL is the top author based on h-index and he also collaborates more with other authors. Furthermore, Journal of cleaner production is the most productive journal with 158 publications in the corpus and second influential author based on citations. Where, Accounting, Auditing and accountability journal is the first influential with highest citations. Performance analysis also revealed most influential publication by Craig Deegan globally, and publication by Lee D. Parker in the local file. Macquarie University from Australia and the country Australia are the most productive in EMA research.

Second, science mapping of EMA research has conducted. To begin with, Temporal analysis revealed the significant themes concentrated in different four time periods. With the overview of EMA research in that period. Sustainable development and accounting issues in 1976-1995 to Carbon accounting in 2016-2022. In addition, Co-occurrence of author keywords and bibliographic coupling underpinned the intellectual structure of EMA research through different thematic clusters. Noteworthily, all the clusters in the co-occurrence network and bibliographic coupling triangulate and presented almost same results irrespective of cluster number. Most influential publications based on bibliographic clusters are also presented in the analysis.

Third, future scope of EMA research is also identified with the help of strategic diagram. Which provides directions for the potential researchers in the field of environmental management accounting. It is identified that, research on material flow cost accounting, life cycle assessment, accounting information are the niche topics and have high scope for future research. Circular economy is a emerging theme which may contribute significantly on EMA. Life cycle costing is also present in declining or emerging theme, it can be considered as declining as there are few papers published in recent times. Green accounting, ecosystem services and emergy are the part of niche themes and also motor themes which are very much significant to the field of study. Carbon accounting,

social and environmental accounting, green house gas emissions and other are more transversal, and will empower the future study.

Finally, this study, despite its merits, has significant limitations which may lead to further research should be considered when interpreting its findings. We limited our inclusion to works found in the Scopus database. It is advised that future studies compare these findings to those found in other databases like Web of Science and google scholar. Our co-word metrics were developed using author keywords. We advise scholars to reproduce our strategic diagrams using alternative indexing techniques, such as keyword plus, to evaluate the validity of our findings. Such evaluations are valuable because they will either produce fresh insights into the scientific framework of EMA research or confirm the veracity of our conclusions. Finally, bibliometric software programmes and algorithms are continually improving. Researchers with an interest in this area can test the reproducibility of the strategic diagrams presented in this paper using other software tools, such as SciMAT, or they can assess the state-of-the-art in research on EMA from different perspectives using other units of analysis in bibliometric coupling (*e.g.*, sources, organisations, countries).

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Credit Authorship Contribution Statement

Chetanraj D.B: investigation, software, formal analysis, writing – original draft, data curation, validation, visualization.
Senthil Kumar J.P: conceptualization, methodology, project administration, supervision, writing – review and editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Accumulation of Heavy Metals in the Needles of Scots Pine of the Semipalatinsk Pre-Irtysh Region and Burabay National Park

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Abstract: Relict bogs in the northeastern area of the Republic of Kazakhstan are located in close proximity to sources of heavy metal pollution – non-ferrous metal ore mining and processing facilities, and highways. Monitoring of heavy metal transport in the air by means of a bioindicator such as Scots pine (*Pinus sylvestris* L.) is relevant for preventing the damaging effects of heavy metals on the population living in this region. The purpose of this article is to study pine needles (*Pinus sylvestris* L.) on the territory of the Semipalatinsk Irtysh region and the Burabay National Park to identify the features of the accumulation of heavy metals carried by atmospheric air flows, depending on the age of its formation. To determine the content of chemical elements in needles of the first, second and third year of formation from six experimental plots mass spectrometry method ISO 17294-2:2003 was used. Its results made it possible to conduct a primary analysis of the accumulation of heavy metals in the needles of Scots pine (*Pinus sylvestris* L.) depending on the year of its formation. General scientific methods were also used in the analytical selection of the scientific literature to formulate the objectives of the experiments and to compare the results obtained with those of other authors. Experimental studies revealed a direct correlation between the increase in concentrations of individual metals and the age of the needles. Furthermore, an increase in concentrations of individual chemical elements has been detected in the conifers of the second year of formation. The findings can be used for further scientific research on the use of pine needles (*Pinus sylvestris* L.) as a bioindicator, the impact of the heavy metal composition of the north-east of Kazakhstan on plant organisms, but also used in practice to monitor the state of the environment and the management of forests.

Keywords: heavy metal pollution; bioindicators; bioaccumulation; biomonitoring; air pollution; anthropogenic pollution.

JEL Classification: Q53; L65; R11.

Introduction

This article is devoted to the study of the accumulation of heavy metals in the needles of Scots pine (*Pinus sylvestris* L.) to monitor air pollution in the East Kazakhstan and Akmola regions of the Republic of Kazakhstan with heavy metals. This makes it possible to identify the role of the anthropogenic factor in the accumulation of heavy metals transported by air in living organisms. This is especially important since there are proven deposits of gold, molybdenum, uranium, lead, copper, titanium, zinc, nickel, magnesium, and iron in these areas, their extraction and processing is carried out. Furthermore, the six-lane Astana-Shchuchinsk autobahn leads to the Burabay National Park. The study of the transport of heavy metal particles by air shows the degree of accumulation of heavy metals released into the atmosphere as a result of human activity in living organisms (plants) and allows it to be separated from the accumulation obtained through root nutrition in the territories of heavy metal ores. Such a study makes it possible to reveal the features of the combination of heavy metals in the atmosphere of a given region as a result of human activity, which also affects the change in the general state of the atmosphere of the entire planet.

Such research helps to determine the most effective approach to combat air pollution, which adversely affects the health of mankind on all planets. The dangers of air pollution are highlighted by H. Cometen *et al.* (2019) and M. Cetin *et al.* (2021). As they point out, 30 million people die each year from causes related to air pollution, and according to the World Health Organisation, 92% of the world's population lives in regions with polluted air. The main sources of heavy metal pollution are non-ferrous and ferrous metallurgy, quarries and mines for polymetallic ores, road transport, oil, and waste incineration. Thus, 94-97% of lead accumulated by woody vegetation, 84-89% of cadmium, 56-87% of copper, 66-75% of nickel, 58% of mercury are of technogenic origin. The remaining part is extracted by plants from natural sources, notes N.M. Baiseitova (2014). The level of contamination with heavy metals can be determined by direct methods using special equipment or indirectly using bioindicators. According to Juranovic Cindric *et al.* (2018), the use of bioindicators to detect air pollution gives more reliable results on changes in heavy metal concentrations. The sophisticated equipment used to measure air pollution requires special laboratories to maintain and analyse the results and does not always capture the nuances of the effects of heavy metals on living organisms at different levels of accumulation. Bioindicators, according to V. Voronin and S. Soboleva (2019), is a simpler, more accessible method that allows measuring the accumulation of heavy metals even in the field. Furthermore, bioindicators are often more sensitive to changes in heavy metal concentrations than devices.

All studies of plants as bioindicators conducted by scientists from various countries focus on various factors affecting their accumulation of heavy metals. Thus, objects of investigation include the accumulation of heavy metals in different plant parts, dependence of heavy metal concentration in plants on distance from pollution sources, emission intensity, the age of plants or plant parts (*e.g.*, wood, needles), on wind direction in the studied areas, on the combination of heavy metals in these areas. These studies always give characteristics of the accumulation of heavy metals by bioindicator plants in a specific area on a specific site. Nevertheless, they also allowed for the identification of certain regularities between the accumulation of heavy metals by plants and the distance from the pollution source, the age of the plant or its parts, the integration of heavy metals in the phytocoenosis process, and the tracing of a pattern of heavy metal accumulation in homogeneous plant parts (from the most accumulating heavy metals to the least accumulating ones).

The study found that the content of Al, Mn, Sr, Zn in the needles of Scots pine (Pinus sylvestris L.) increases with age, *i.e.*, the process of bio-accumulation. Accumulation of heavy metals in pine needles has a definite pattern: Mn, Fe, Zn, Sr, Cu, Cr, Co, which are biogenic trace elements, accumulate in higher amounts than highly toxic elements – Tl, Cd, As. The elemental composition of Scots pine needles is significantly impacted by the place of growth, which is reflected in the intensity of the biogeochemical metal cycle.

1. Materials and Methods

To study the degree of heavy metal pollution in the Semipalatinsk Pre-Irtysh area and the Burabay National Park, the Scots pine (*Pinus sylvestris* L.) was selected as a bioindicator, as it is a widely distributed species of woody vegetation, very sensitive to changes in the chemical background of growing conditions (Parzych *et al.* 2017). Pine is actively studied and used in various countries as a bioindicator and bio-accumulator of heavy metals. To study the degree of atmospheric air pollution by heavy metals in Semipalatinsk Pre-Irtysh and Burabay National Park, the needles of Scots pine (*Pinus sylvestris* L.) of the first, second and third years of formation were examined. This investigation also included a comparative analysis of the content of heavy metals in coniferous needles collected from two trial plots (six test plots), including control plots. The first trial site included areas of pine forests located in the Semipalatinsk Pre-Irtysh:

1. Pilot site No. 1 was located within the city of Semey (pilot site – Semey, Silicate Plant district; 50.468442, 80.212024). This site is considered the most polluted.

2. Pilot plot No. 2 (control plot) is established at a distance of 16 km to the north of Semey (control plot – Semey, Staraya Krepost village; 50.498466, 80.090461).

3. Test site No. 3 (control area) is established 18 km eastward from Semey along Semey – Borodulikha highway (control area – Semey, Novopokrovka village; 50.571381, 80.345089).

The second test site included the territories of pine forests of the Burabay National Park:

1. Pilot site No. 4 was located within the Borovoye village, 1.5 km from its center along the main highway (pilot site – Borovoye, along the highway; 53.074672, 70.276040).

2. Pilot site No.5 (control site) is established on a mountaintop near the Abylaykhan stone throne (pilot site – Borovoye, mountain top; 53.088812, 70.233952).

3. Pilot plot No.6 (control plot) is located 120 km from the village of Borovoye, near the village of Zerenda (pilot plot – Borovoye, Zerenda; 52.887228, 69.142328).

Trees 25-30 years old, 6-9 meters in height and 24-36 cm in diameter were selected for the study. Samples of needles were sorted by age fractions (1-3 years). Chemical elements were determined by inductively coupled plasma mass spectrometry using an iCAP Q quadrupole mass spectrometer from “Thermo Scientific”. The multi-element standard solutions listed in the State system for ensuring the uniformity of measurements of the Republic of Kazakhstan under KZ.03.02.00901-2010 and KZ.03.02.00902-2010 were used to construct the calibration curves. The quality of the measurements was monitored by measuring the calibration solution every 10 samples. If the calibration chart deviated by 8-10% (unsatisfactory calibration result), the instrument was recalibrated with the new background parameters. The analysis was carried out according to ISO 17294-2:2003 “Water Quality. Application of inductively coupled plasma mass spectrometry (ICP-MS). Part 2: Determination of 62 elements” (ISO 17294-2:2003) (state registration number 022/10505 of 27.12.2005).

Dry samples of plant raw materials for suitability for analysis for the content of heavy metals were previously subjected to autoclave decomposition. A 0.4±0.0001 g sample dry weight of the plant material was placed in a fluoroplastic autoclave liner and 6 cm³ of concentrate was added. HNO_3 and 2 cm³ 30% N_2O_2. After 40 minutes, the PTFE liner was closed with a lid and inserted into the “BERGHOF” Speedwave Xpert microwave sample decomposition system, clamping it tightly to ensure sealing. The cover of the external casing of the autoclave was clamped with a screw. The system was heated to 190±5°C at 80% capacity and sustained. The total heating and exposure time was 50 minutes. Upon completion of the process, the cooled sample was transferred to a measuring tube and diluted with a 1% solution of nitric acid to a volume of 15 cm^3. This solution was diluted at a ratio of 1:10 and analysed for the content of the elements of interest.

The article presents comparative data on the composition of heavy metals (Cu, Ni, Cd, Pb, Fe, Zn, Mn) in Scots pine needles in each experimental plot and on the accumulation of heavy metals in needles of different ages of their formation.

The research carried out using the above methodology and its results are to a large extent unique, as the chemical background of the tree growth areas under study is unique, being influenced both by their geographical location, the wind direction, and the specifics of anthropogenic activity. At the same time, the results of the primary analysis of pine needles (*Pinus sylvestris* L.) samples allow for comparison with the similar unique results obtained from the primary analysis by other authors. To compare the results, the authors made a brief analytical review of the scientific literature on the results of studies of pine needles (*Pinus sylvestris* L.) carried out by scientists from different countries. Particular attention was paid to studies carried out under similar conditions - in national parks and natural forests in mountainous areas, near highways and near non-ferrous metallurgical plants. Such a comparison makes it possible to identify certain trends and features of accumulation of heavy metals transported by atmospheric masses, *e.g.*, correlation with distance from pollution sources (highways, industrial plants).

2. Results

Pine trees are very sensitive to pollution. It is particularly sensitive to aerial pollution of atmospheric air by both toxic gases and chemical elements of the heavy metal group (Alaqouri 2020; Wegiel, Bielini and Polowy 2018). It is therefore used as a bioindicator in environmental pollution assessments. The experimental data indicate that there is a definite pattern of redistribution of elements in the coniferous pine needles as the plants grow. Moreover, the accumulation of some elements occurs in close correlation with each other, as previously noted by other authors *(*Figas, Siwik-Ziomek and Kobierski 2021; Liu, Wang, Zou and Jiang 2006; Zhang *et al.* 2010). Indicators of the content of heavy metals in the coniferous pine (*Pinus sylvestris* L.) of different years of formation,

obtained during the experimental study at six sites of Semipalatinsk Pre-Irtysh and the Burabay National Park, are shown in Table 1, 2.

Table 1. The content of heavy metals (Fe, Be, Al, Cr, Mn, Ni, Cu, Zn, Sr, As) in pine needles (*Pinus sylvestris* L.)

No.	Age of needles, year	Elements content, mg/kg									
		Fe	Be	Al	Cr	Mn	Ni	Cu	Zn	Sr	As
Semey, Silicate Plant district (50.468442, 80.212024)											
1	3	92±8	<0.0004	110±1	2.3±0.1	130±1	3.6±0.02	1.3±0.1	27±1	11±0.1	<0.0015
2	2	55±4	<0.0004	76±1	1.8±0.1	120±1	1.6±0.03	1.5±0.1	25±1	9.7±0.1	<0.0015
3	1	110±8	<0.0004	140±1	1.8±0.1	150±1	5.5±0.1	1.9±0.1	29±1	13±0.1	<0.0015
Semey, Staraya Krepost village (50.498466, 80.090461)											
4	3	78±4	<0.0004	100±1	2.2±0.1	140±1	0.83±0.06	1.3±0.1	22±1	10±0.2	<0.0015
5	2	47±4	<0.0004	71±1	1.2±0.1	100±1	0.34±0.04	1.2±0.1	20±1	9.1±0.1	<0.0015
6	1	53±6	<0.0004	72±1	1.2±0.1	84±1	0.7±0.06	1.2±0.1	19±1	9.1±0.1	<0.0015
Semey, Novopokrovka village (50.571381, 80.345089)											
7	3	100±15	<0.0004	350±1	2.4±0.1	750±1	0.96±0.03	2.4±0.1	63±1	27±0.2	<0.0015
8	2	76±3	<0.0004	180±1	1.3±0.1	330±1	1.2±0.04	1.5±0.1	37±1	12±0.1	<0.0015
9	1	65±6	<0.0004	160±1	1.5±0.1	330±1	0.48±0.02	1.4±0.1	31±1	11±0.1	<0.0015
Borovoye, along the highway (53.074672, 70.276040)											
10	3	190±4	<0.0004	220±1	0.9±0.1	410±1	0.59±0.01	1.7±0.1	45±1	12±0.1	<0.0015
11	2	160±8	<0.0004	230±1	0.9±0.1	380±1	0.66±0.02	2.2±0.1	43±1	12±0.1	<0.0015
12	1	190±11	<0.0004	210±1	0.6±0.1	200±1	1±0.02	2.4±0.1	39±1	9.1±0.1	<0.0015
Borovoye, mountain top (53.088812, 70.233952)											
13	3	69±4	<0.0004	450±1	1.6±0.1	590±1	0.5±0.07	1.7±0.1	42±1	21±0.1	<0.0015
14	2	59±3	<0.0004	370±1	0.6±0.1	350±1	0.17±0.01	1.2±0.1	27±1	15±0.3	<0.0015
15	1	59±3	<0.0004	260±1	1±0.1	280±1	0.22±0.03	1.8±0.1	30±1	11±0.1	<0.0015
Borovoye, Zerenda (52.887228, 69.142328)											
16	3	74±3	<0.0004	86±1	1.7±0.1	150±1	0.74±0.04	3.5±0.1	39±1	13±0.1	<0.0015
17	2	65±9	<0.0004	63±1	1±0.1	110±1	0.57±0.05	2.8±0.1	32±1	8.5±0.1	<0.0015
18	1	54±4	<0.0004	44±1	0.7±0.1	95±1	0.95±0.01	2.7±0.1	31±1	6.7±0.1	<0.0015

Table 2. The content of heavy metals (Cd, Cs, Ba, Tl, Pb, U, Co) in the needles of Scots pine (*Pinus sylvestris* L.)

No.	Age of needles, year	Elements content, mg/kg						
		Cd	Cs	Ba	Tl	Pb	U	Co
Semey, Silicate Plant district (50.468442, 80.212024)								
1	3	<0.003	0.028±0.003	5.8±0.2	0.015±0.003	3.1±0.01	0.021±0.002	0.056±0.003
2	2	<0.003	0.018±0.001	5±0.1	0.009±0.002	2±0.01	0.028±0.002	0.041±0.003
3	1	0.051±0.009	0.034±0.004	6.6±0.2	0.01±0.001	3.1±0.04	0.022±0.002	0.1±0.004
Semey, Staraya Krepost village (50.498466, 80.090461)								
4	3	0.058±0.009	0.045±0.004	4.5±0.1	0.02±0.003	3.2±0.08	0.014±0.002	0.071±0.005
5	2	0.037±0.004	0.026±0.002	4.3±0.1	0.01±0.001	1.9±0.02	0.013±0.002	0.045±0.002
6	1	<0.003	0.022±0.002	4.8±0.1	<0.0004	1.6±0.04	0.013±0.002	0.053±0.002
Semey, Novopokrovka village (50.571381, 80.345089)								
7	3	0.066±0.013	0.027±0.001	17±0.1	0.013±0.003	1.7±0.03	0.034±0.005	0.086±0.004
8	2	0.045±0.003	0.011±0.001	8.5±0.1	0.01±0.001	0.9±0.02	0.011±0.002	0.042±0.002
9	1	0.038±0.007	0.013±0.002	7.7±0.1	<0.0004	0.94±0.03	0.015±0.001	0.044±0.008
Borovoye, along the highway (53.074672, 70.276040)								
10	3	0.033±0.005	0.023±0.002	5.2±0.1	0.01±0.002	0.99±0.03	0.019±0.002	0.075±0.002
11	2	<0.003	0.021±0.003	5.2±0.1	0.01±0.002	1.2±0.02	0.02±0.004	0.07±0.005
12	1	<0.003	0.037±0.004	6±0.1	0.009±0.001	0.63±0.01	0.033±0.002	0.082±0.006
Borovoye, mountain top (53.088812, 70.233952)								
13	3	0.1±0.028	0.014±0.003	6.3±0.1	0.025±0.004	0.52±0.01	0.015±0.001	0.094±0.01
14	2	0.071±0.012	0.017±0.004	4±0.1	0.012±0.001	0.63±0.03	0.011±0.001	0.11±0.007
15	1	0.19±0.027	0.015±0.003	3.5±0.2	0.01±0.002	0.32±0.02	0.013±0.001	0.043±0.001
Borovoye, Zerenda (52.887228, 69.142328)								
16	3	0.04±0.008	0.012±0.002	6.5±0.1	0.011±0.002	0.73±0.01	0.013±0.001	0.05±0.007
17	2	0.041±0.003	0.008±0.001	4.5±0.1	0.008±0.002	0.62±0.01	0.014±0.002	0.042±0.004
18	1	0.035±0.009	0.008±0.002	3.8±0.1	<0.0004	0.46±0.01	0.008±0.002	0.052±0.006

Summarised results of the study on the accumulation of heavy metals in the needles of Scots pine (*Pinus sylvestris* L.) at the six experimental plots are shown in Figures 1-6. The figures contain data on the composition of heavy metals in Scots pine needles at each trial site and on the accumulation of heavy metals in the needles of different ages of their formation. The figures represent the results of an initial analysis and synthesis of the data obtained from the study of the needle samples at each of the sites. The identified features of the accumulation of heavy metals in Scots pine needles can be a starting point for further research, both empirical and scientific analysis, and for the comprehensive compilation of the primary results obtained. The results of analyses of Scots pine needles across the Semipalatinsk Pre-Irtysh are presented below (Figure 1-3).

Figure 1. Accumulation of heavy metals in pine needles by years of their formation at experimental plot No.1 (Semey, Silicate Plant district; 50.468442, 80.212024)

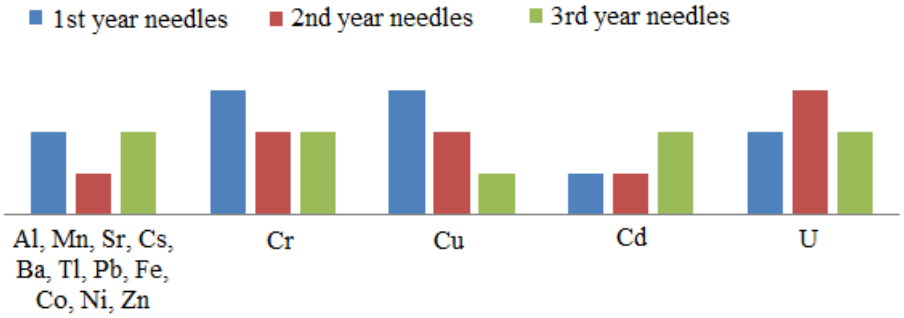


Figure 2. Accumulation of heavy metals in pine needles by years of their formation at experimental plot No.2 (Semey, Staraya Krepost village; 50.498466, 80.090461)

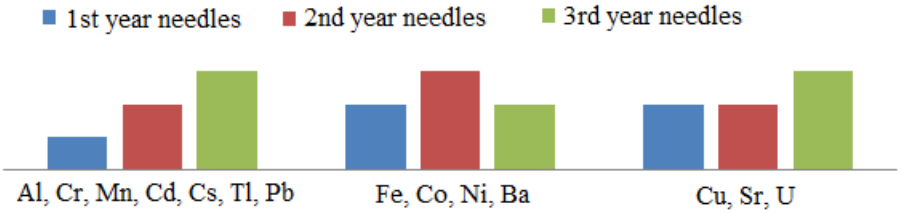
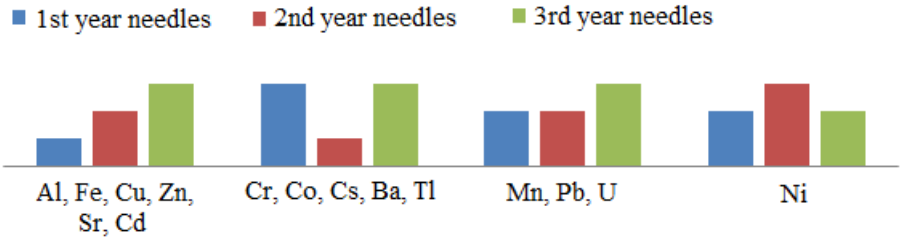


Figure 3. Accumulation of heavy metals in pine needles by years of their formation at experimental plot No.3 (Semey, Novopokrovka village; 50.571381, 80.345089)



Regarding the Burabay National Nature Park, the results of analyses of pine needles were as follows (Figure 4-6).

Figure 4. Accumulation of heavy metals in pine needles by years of their formation at experimental site No. 4 (Borovoye, along the highway; 53.074672, 70.276040)

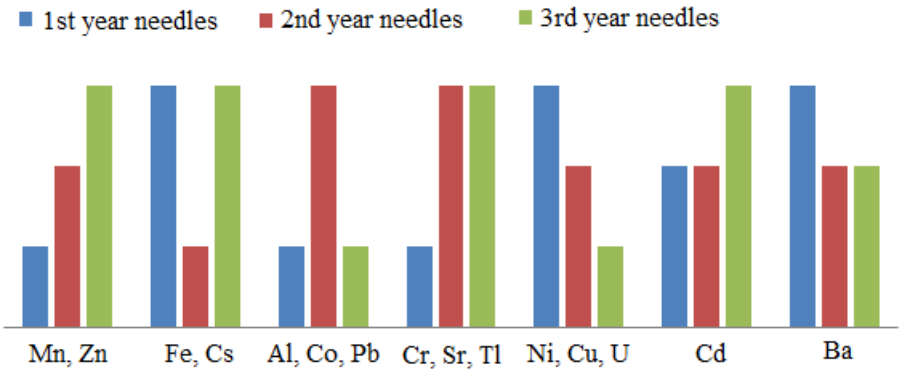


Figure 5. Accumulation of heavy metals in pine needles by years of their formation at experimental site No. 5 (Borovoye, mountain top; 53.088812, 70.233952)

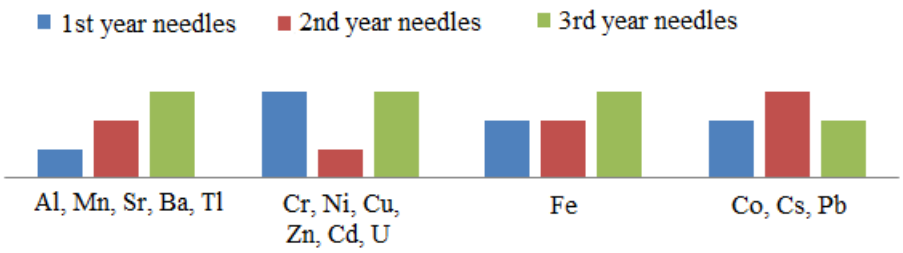
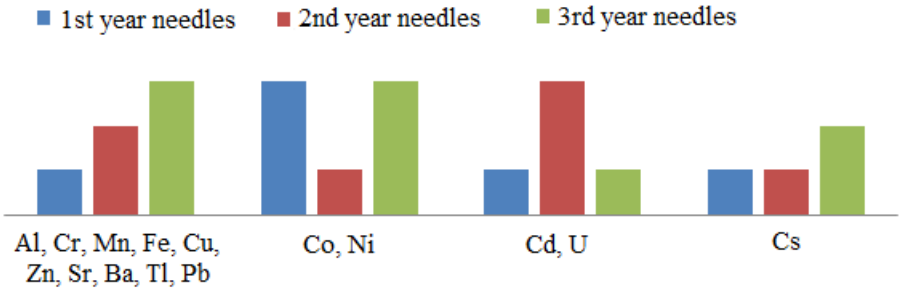


Figure 6. Accumulation of heavy metals in pine needles by years of their formation at experimental site No.6 (Borovoye, Zerenda; 52.887228, 69.142328)



The trees in the control and experimental plots exhibited a direct correlation between the increase in concentrations of individual metals and the age of the needles. The study found that in the needles of Scots pine (*Pinus sylvestris* L.), regardless of the environmental conditions of the study area, the accumulation of metals such as Al, Mn, Fe, Cr, Zn increases with age. Mn, Cr, Fe and Zn are biogenic trace elements, while aluminium is one of the elements likely to have some effect on plant metabolism, but the role of this element (along with Ba, Cu, U, Cs) in plants and its biogenic significance require further study.

It has also been determined that the needles in the second year of formation exhibit an increase in the concentration of certain chemical elements, and then either the needles die off or the concentration decreases. This pattern can be explained by the leaching of these elements as the cuticle of the needles breaks down. Such variations in the deviations of values indicate the adaptability of pine to pollution. It is also possible that under the influence of environmental factors or the protective mechanisms of the plant itself, little-studied mechanisms of blocking the toxic effect of absorbed metals are activated. When studying the content of heavy metals in Scots pine needles (*Pinus sylvestris* L.) in the territory of Semipalatinsk Pre-Irtysh and Burabay State National Nature Park, the following pattern in their accumulation (bioaccumulation) was noted, which can be represented by the following series of elements:

Mn>Al>Fe>Zn>Sr>Ba>Ni≥Pb≥Cu≥Cr>Co>Cs=U>Tl>Cd>As>Be 2.1

The heavy metal accumulation series obtained in this study consists of more chemical elements (17) than the accumulation series presented in the scientific literature by other authors. This may be indicative of the wide variety of minerals that are extracted and processed in the region by human industrial activity. The established pattern (1) agrees well with the data of various authors on the physiological role of individual elements. Thus, Mn, Fe, Zn, Sr, which are at the beginning of this row, are biogenic trace elements, without which the organism cannot grow, develop, and complete its natural life cycle. The same applies to elements such as Cu, Cr, Co. The elements Al and Ba in this series are very close to the biogenic elements, but their biogenic value has not been proven. The final elements in this series are Tl, Cd, As, which are highly toxic (Hassan and Aarts, 2011). The degree of toxicity of heavy metals can be represented by the following sequence:

Cu>Ni>Cd>Zn> Pb>Hg>Fe>Mo>Mn 2.2

Studies of various plant species with different ability to accumulate heavy metals have allowed heavy metals to be divided into four groups depending on the degree of bioaccumulation: elements of intensive absorption (Cd, Cs, Rb), elements of medium absorption (Zn, Mo, Cu, Pb, As), elements of weak absorption (Mn, Ni) and elements that are difficult for plants to access (Se, Fe, Va). It was found that in Scots pine (*Pinus sylvestris* L.) elements of intensive absorption (*e.g.*, Cd, Cs) are less accumulated in the needles, and those

difficult to access for plants (Fe, Ba) and elements of low absorption (Mn, Ni) have a high degree of accumulation in this organ.

Other researchers describe a similar but slightly different composition of these groups: elements of intense absorption (Cd, Cs, Rb); elements of medium absorption (Zn, Mo, Cu, Pb, Co, As); elements of low absorption (Mn, Ni, Cr); elements difficult for plants to access (Se, Fe, Ba, Te). One of the indicators of heavy metal pollution in the atmosphere is the age of the needles, as the accumulation of heavy metals in them, exceeding the critical limit, leads to diseases and the complete dying off of the needles. This critical limit for the concentration of base metals is 50-100 times higher than the reference value. As evidenced by I. Juranovic Cindric *et al.* (2018), the average age of the needles of the Scots pine (*Pinus sylvestris* L.) in the background areas is usually 5-9 years. Studies conducted at six trial plots in the Semipalatinsk Pre-Irtysh and the Burabay National Nature Park did not find pine plants with needles older than five years. This indicates significant cross-border transport of air pollutants and their dispersion over large areas.

3. Discussion

Scots pine (*Pinus sylvestris* L.) has proved to be a good indicator of airborne pollution, with high sensitivity, and is used in many countries for biomonitoring of atmospheric air pollution. An example is more than half a century of biomonitoring of changes in air and forest soil chemistry in two mature stands of Scots pine (*Pinus sylvestris* L.) as described by J. Pritzel *et al.* (2020), which allowed conclusions to be drawn about the dependence of forest ecosystem condition on changes in the chemical composition of anthropogenic emissions. However, the mechanisms of heavy metal uptake and accumulation through the surface of the needles are still largely understudied.

It is worthwhile to make a brief review of studies on the accumulation of heavy metals in the needles of Scots pine (*Pinus sylvestris* L.), made by other authors in conditions similar to those of Semipalatinsk Pre-Irtysh and the Burabay National Park in order to direct further comparative analysis of the obtained research results presented in this article. The main sources of heavy metal pollution are mining and their industrial processing, as well as highways. All of these sources are in the vicinity of the sites investigated by the authors and polluted by their emissions. Therefore, when analysing such investigations, attention was paid to the distance of pine forests from the source of pollution, the combination of heavy metals depending on the dominant sources, and the accumulation of heavy metals in the needles depending on the age of their formation. The authors investigating the accumulation of heavy metals in the needles of Scots pine (*Pinus sylvestris* L.), depending on the proximity to non-ferrous metallurgy enterprises, state that, in general, their accumulation decreases along the distance from the source of pollution. Although there are deviations for individual metals. There is also a difference in the degree of absorption between different types of trees, even of the same species.

Atmospheric emissions from ferrous and non-ferrous metallurgy plants consist mainly of sulphur dioxide and heavy metal particles (Cu, Pb, Cd, Zn, Fe, Ni, Co, etc.). Thus, H.A.A. Alaqouri *et al.* (2020) investigated the features of the accumulation of heavy metals in pine needles near the magnesium plant, focusing on the change in their concentrations depending on the age of the needles and the distance from the plant. A study of samples of scots pine needles (*Pinus sylvestris* L.) shows its efficiency as a bioindicator for monitoring the concentration of heavy metals in the air, in particular magnesium. A decrease in magnesium concentrations was noticeable with increasing distance from the pollution source. No such correlation was observed for Al, Fe, Mn and Ca. The direct correlation between the accumulation of heavy metals in conifers and the distance to industrial plants is also confirmed by the study of V. Popovic *et al.* (2022).

The second main source of heavy metal pollution is highways. This is important in the context of this study, as the Astana-Schuchinsk Autobahn is located near Burabay National Park, and the study areas of the Semipalatinsk Pre-Irtysh are close to large cities and industrial centres with intensive road infrastructure. Lead and cadmium are the main heavy metals in road emissions, and both are highly toxic. There is an inverse relation between lead and cadmium content and tree distance from the road, with roadside plants having lead concentrations 10-100 times higher than roadside plants, and cadmium concentrations 11-17 times higher than roadside plants. Also, heavy metal concentrations can increase by up to 60% in the lowlands and upwind compared to the flat landscape. This is evidenced in a study by N.M. Baiseitova (2014). Monitoring lead and cadmium in the air is very important because of the high toxicity of these metals and their long elimination period from the body. Thus, the half-life of cadmium from the human body is about 10 years. The use of Scots pine as a bioindicator is more effective than deciduous trees, as the needles have a large absorption area and waxy surface to trap metal particles. Scots pine (*Pinus sylvestris* L.) is also a good bioindicator for Mo and Ag and a bioaccumulator for K and Na.

The study by R. Kozlowski and M. Strzyz (2021) in the Świętokrzyskie National Park (Poland), where roads of different traffic levels are the main close sources of pollution, is of interest in the context of this investigation. The study confirmed the direct dependence of the concentration of Zn, Pb on the distance to the highways, as well as on the intensity of traffic. The lead content in the exhaust gases has decreased slightly due to its partial replacement in petrol by zinc. The authors note that the highest concentrations of these metals, along with Cu, Cd and Ni, were observed in the uplands, as the Świętokrzyskie Mountains, where the park is located, are elevated above the surrounding terrain. As such, strontium was detected in addition to the heavy metals' characteristic of automotive emissions. Cu, Cd, Sr, and Ni may be emissions from enterprises in the Upper Silesian industrial area, trapped by pine forests growing in the mountainous area of Świętokrzyskie National Park.

Research conducted by S. Ayan *et al.* (2021) in Kerey and Dzhanibek Khan Park in Astana, the capital of Kazakhstan, aimed to trace the dependence of heavy metal accumulation in five tree species, including Scots pine (*Pinus sylvestris* L.) on traffic density on the roads close to the park. Heavy metal pollution near highways is caused by exhaust fumes (Pb, Cd and Zn, used as fuel additives), abrasion of car tyres (Cd and Zn), and brake pads (Cu and Ni). The study confirmed that concentrations of Pb, Cd and Zn increase with higher traffic densities and decrease with greater distance from the road. There is also an increased level of concentration of these metals on curved sections of the road. In addition to the above-mentioned metals, elevated contents of Ni, Cr, Li, Co, Fe were detected in areas close to the roads. Comparison of the heavy metal accumulation capacity of different tree species makes it possible to assess the efficiency of their use as bioindicators, depending on the potential combination of chemical elements in the air at different sites, as well as to prioritise their use for the purposes of extraction, accumulation, and purification of air from toxic impurities. The ability of different tree species to accumulate heavy metals and the nature of their accumulation has been studied by authors such as J. Jonczak *et al.* (2021), in national parks, arboretums, respectively in Lisicine (Croatia) and Mlynany (Slovakia), and in nature reserves.

Some authors, such as A. Wegiel *et al.* (2018), take another step in the study of the properties of Scots pine (*Pinus sylvestris* L.) not only as a bioindicator of heavy metals in atmospheric air and soils, but also as their bioaccumulator for cleaning air and soils from elements harmful to living organisms. They investigated the dependence of accumulation levels of metals such as cadmium (Cd), nickel (Ni), chromium (Cr) and lead (Pb) on plantation density. A significant direct correlation was established between the density and mass of the stands of Scots pine (*Pinus sylvestris* L.) and the accumulation of Cd and Cr. Phytoextraction uses plants that are able to accumulate heavy metals without their toxic effects. The properties of Scots pine for phytoextraction are not widely investigated, but due to its unpretentious growth conditions and large distribution range, it can be considered as an effective phytoextractor. Research into the relationship between heavy metal accumulation and plantation density is important not only scientifically, but also practically for forest management. The purpose of the plantation as a phyto-extractor determines the decision to conduct felling. In this case, instead of thinning, the site is clear-cut and the mass of trees is disposed of, based on the nature of the contamination, which is removed by phytoextraction.

Plants that collect heavy metals from the air can thereby purify the air from heavy metals. Heavy metals accumulate in different parts of plants in different ways. Different plants also tend to have varying degrees of heavy metal accumulation, as evidenced in a study by R. Gamrat (2022). Therefore, depending on the combination of heavy metals in a particular area, it is important to choose as bioindicators the plants that are most sensitive to it or the plants that accumulate heavy metals the most for air purification. Depending on the performance of the desired function, the most effective plant species are determined. In the current study, Scots pine (*Pinus sylvestris* L.) was chosen to measure the accumulation of heavy metals. The needles of Scots pine (*Pinus sylvestris* L.) of the first, second and third years of formation were examined. Conifers, which include Scots pine, are used to measure the accumulation of heavy metals from the atmosphere, as the needles stay on the tree for several years and are covered with a layer of a waxy substance that traps the heavy metal particles. Pine forests of the Republic of Kazakhstan cover an area of 832 thousand ha, of which ribbon forests of Pre-Irtysh make up 58%, or 545 thousand ha (Belgibaev 2009). It should be noted that western, north-western, and south-western wind directions prevail in the territory of Semipalatinsk Pre-Irtysh and Burabay National Park, bringing particles of heavy metals from industrial mining and processing areas, as well as from the Astana-Shchuchinsk autobahn (Burabay National Park).

Conclusions

Pinus sylvestris L. is used as a bioindicator of heavy metals in the air in many countries because of its sensitivity to heavy metals, the nature of its needle surface and its life cycle of several years before it dies off. However, the

features of the accumulation of heavy metals in various organs of pine, in conifers of different ages of formation, and the tendency to greater or lesser accumulation of various heavy metals still require extensive research. Pine needles can be used as bio-indicators for continuous monitoring of air pollution, and for extracting heavy metals from the air and neutralising them. This study is devoted to the features of accumulation of heavy metals by Scots pine needles of 1-3 years of formation in the Semipalatinsk Pre-Irtysh and the Burabay National Park, located at a relatively short distance from the main sources of pollution – iron and steel enterprises and highways, and requiring constant monitoring of air and its purification by bio-extraction. The identification of a special combination of pollutant elements will also determine the main industrial or transport pollutants. Accordingly, the Environmental Inspectorate will be able to exercise targeted control over emission reductions from one or another source of pollution.

The study found that the content of Al, Mn, Sr, Zn in the needles of Scots pine (*Pinus sylvestris* L.) increases with age, *i.e.*, the process of bio-accumulation. Accumulation of heavy metals in pine needles has a definite pattern: Mn, Fe, Zn, Sr, Cu, Cr, Co, which are biogenic trace elements, accumulate in higher amounts than highly toxic elements – Tl, Cd, As. The elemental composition of Scots pine needles is significantly impacted by the place of growth, which is reflected in the intensity of the biogeochemical metal cycle. The results of the primary analysis of pine needles (*Pinus sylvestris* L.) samples allow comparison with similar unique results obtained from primary analysis by other authors. Such a comparison makes it possible to confirm certain patterns in the accumulation of heavy metals and the specificity of their combination for a given area, which reflects the specifics of anthropogenic pressure on the ecosystem. A comparison of the series of heavy metal accumulations in the needles of Scots pine (*Pinus sylvestris* L.) requires further in-depth study. The accumulation of an array of findings from such studies will make it possible to further advance to higher levels of generalisation. This will provide a scientific basis for the management of woodlands through the use of Scots pine as a bioindicator of heavy metals, as their bioaccumulator, which purifies the air, the degree of involvement of heavy metals in the plant phytocoenosis and their neutralisation, and subsequently the degree of toxicity of the wood.

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Credit Authorship Contribution Statement

The authors contributed equally to this work.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Identifying Karst Aquifer Recharge Area Using Environmental Stable Isotopes and Hydrochemical Data: A Case Study in Nusa Penida Island

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Abstract: Identifying the recharge area of karst aquifers is scientifically challenging due to the complexity of karst groundwater flow characteristics. It is essential to identify the recharge zones to conserve the groundwater resources contained within these aquifers. This paper proposes a combined methods for identifying recharge area of karst aquifers on Nusa Penida Island using stable isotopes (18O and 2H) and a hydrogeochemical approach. Based on the analysis of δ18O and δ2H values and their spatial distribution, it is possible to retrace karst aquifer recharge areas using average isotope elevations. In the meantime, groundwater facies will be determined in the karst region of Nusa Penida using the hydrogeochemical approach with the Piper diagram. According to the calculation of water stable isotope results, the average elevation of the groundwater recharge area at the study site is between 62 - 450 meters. If applied to the location of the study, the recharge area is almost entirely distributed across Nusa Penida. In addition, based on the hydrogeochemical analysis, the groundwater type at the study site can be divided into three categories: Na-Cl, mixed, and Mg-HCO3. The water types indicate that the groundwater in Nusa Penida comes from a combination of old water stored from its internal geological formations and mix with modern rainwater.

Keywords: recharge; karst; isotopes; hydrogeochemical; aquifer; facies.
JEL Classification: Q25; L65; Q57; R11.

Introduction

Nusa Penida is a district in Klungkung Regency, Bali Province, which has an area of 202.84 km^2 with a population of 63,468 people (Harmayani, *et al.* 2017). The sub-district includes three island groups, namely Nusa Penida (191.462 km^2), Nusa Lembongan (8.6875 km^2), and Nusa Ceningan (2.6875 km^2). Nusa Penida is a dry area with a hilly topography dominated by karst rocks in almost all parts of the island with slopes between 15% and 45% and consists of dry valleys filled with water during the rainy season only (Sudipa, *et al.* 2020). The Bali-Penida River Basin consists of 391 watersheds with an area of 5,617.04 km^2, making the potential for surface water on Nusa Penida Island quite large on Nusa Ceningan and Nusa Lembongan Islands there is no surface water potential. Nusa Penida has a negative karst morphology (valleys between the protrusions of hills), forming a river flow pattern that parallels the direction of direct flow to the open sea. In addition, the condition of the riverbed is composed of limestone formations with very high permeability (porous), causing water to seep directly and be wasted (Harmayani, Konsukartha, and Arsana 2017). In addition to surface water sources, Nusa Penida also has nine springs that can be utilized as raw water, including Penida (Sakti) Spring, Guyangan Spring, Seganing Spring, Tembeling Spring, Tabuanan Spring, Antapan Spring, Wates Spring, Angkel Spring, and Toya Pakeh Spring. Of these nine springs, two are already managed by the government in the form of a Drinking Water Supply System (SPAM), namely Penida Spring (200 lt/s) and Guyangan Spring (178 lt/s). The calculation of the water carrying capacity in Nusa Penida shows that the status of the water holding capacity in Nusa Penida is surplus (Harmayani, Konsukartha and Arsana 2017). This means that the potential water resources are sufficient for drinking water needs on Nusa Penida Island, but the problem of water scarcity also occurs on this island.

Karst is a special type of landscape that is formed by the dissolution of soluble rocks, including limestone and dolomite. Karst regions contain aquifers that are capable of providing large supplies of water. Karst aquifers commonly occur in limestone, and rarely in dolomite. Regarding porosity and hydraulic permeability, they are highly heterogeneous and often characterized by rapid groundwater flow. Karst aquifers are significant freshwater resources in many world regions. Their management demands a quantitative understanding of their hydrologic functioning to preserve water supplies, assess contaminants, and establish management strategies. In light of future climate change-related precipitation patterns, which will affect the transport of water and solutes through karst hydrogeological systems and strongly influence water availability for different uses, this is becoming increasingly important. Water scarcity is a growing issue in many karst areas (Chen, *et al.* 2018; Hartmann, *et al.* 2014). As the primary drinking water supply in many nations, these aquifers are incredibly susceptible to anthropogenic influences and the effects of climate change, necessitating a very specialized preservation strategy. The biggest issue for tiny islands, particularly karst islands, is water scarcity. Well-developed karst aquifers, with sluggish infiltration through the rock matrix and quick flow through conduits and fractures, are productive groundwater systems with high heterogeneity and anisotropy (Iacurto, at al, 2020). Consequently, identifying recharge areas and karst aquifer hydrogeological properties related to the significant type of groundwater discharge is crucial for sustainable groundwater management because karst aquifers are a substantial source of fresh water for humans (Sappa, *et al.* 2018; Shi *et al.* 2019).

In the study of karst aquifers, the use of environmental tracers can be viewed as an efficient strategy that permits an integrated inquiry in order to carry out suitable water resource management (Liebundgut, *et al.* 2009). Since the 1950s, the isotope tracer approach has been applied to hydrology; however, it is limited to the study of isotope tracing. Late in the 1960s, hydrological studies used isotopes considerably (Carucci, *et al.* 2012; Ma, *et al.* 2009; Ma, *et al.* 2003; Qian, *et al.* 2013). Hydrogen and oxygen stable isotopes are essential to comprehending hydrological processes (Zhang and Wang 2016; Ala-aho *et al.* 2018; Wang *et al.* 2016; Zhang and Wang 2016; Gat and Gonfiantini 1981). In recent years, technological advancements in hydrogen and oxygen isotope testing and a drop in testing costs have made extensive isotope application viable. Isotopes offer particular advantages in the study of groundwater production and supply mechanisms. Hydrogen and oxygen isotopes are exploited in international groundwater research (Abdalla, *et al.* 2018; Babaye *et al.* 2018; Boronina, *et al.* 2005; Hofmann, *et al.* 2020; Khaska *et al.* 2013; Love *et al.* 1994; Majumder *et al.* 2011; Mohammadzadeh *et al.* 2020; Pu *et al.* 2013; Richards *et al.* 2018; Sprenger, *et al.* 2014; Wei *et al.* 2014). The ^{18}O and ^{2}H data from groundwater are commonly utilized to gather information about the operation of the karst systems (Sappa, Vitale, and Ferranti 2018), to designate critical recharge regions of these aquifers, and to define the protection zones for the main springs (Zuppi and Sacchi 2004). The isotopic compositions of oxygen and hydrogen in water that meteoric processes have altered are valuable tracers for detecting the origin and migration of groundwater

because they are largely unaffected by rock–water interactions at low temperatures (Sidle 1998). Hence, oxygen and hydrogen isotopes (^{18}O and ^{2}H) can be utilized to determine the source and course of groundwater and surface water. Similar systematic isotopic fractionation occurs in stable hydrogen and oxygen due to their similar behavior in the hydrologic cycle (González-Trinidad, *et al.* 2017). This widespread behavior results in covariation between stable hydrogen and oxygen isotope contents (González-Trinidad *et al.* 2017), which Craig (1961) refers to as the Global Meteoric Water Line (GMWL) connection. Residence periods and water flow pathways of oxygen-18 and deuterium have been widely used in catchment studies (Adomako *et al.* 2010; Ardana *et al.* 2022) to determine groundwater recharge. In addition to hydro isotopes, many researchers have focused on understanding the karst hydrogeology mechanisms using various tools, including hydrochemistry, analysis of geomorphological structures, hydrological dynamics of karst flow, and estimation of the mean rate and spatial distribution of recharge areas (Andreo *et al.* 2008).

Identifying the various sources and areas of recharge, flowpaths, and surface–ground water interactions in karst systems is important for proper water resource management. Furthermore, spring conservation must be planned, implemented, and supervised to prevent a drop in discharge and water quality. The spring, where groundwater leaves and the recharge, or catchment, region are conserved. Conservation at the spring exit protects water from contamination. In contrast, protection at the recharge area reintroduces as much surface water flow as possible into the ground to create a groundwater reserve. Since Nusa Penida Island is a geologically protected karst ecosystem, Penida Spring and Guyangan Spring must be conserved. Based on the problem that has been described, the primary goal of this study is to identify the hydrogeological processes in the Nusa Penida Island, in order to understand possible origins and mechanisms of groundwater and spring hydrochemical and sources of recharge (recharge area). These processes have been determined through the use of the stable isotopes ^{18}O and ^{2}H and determinations of major ions concentrations.

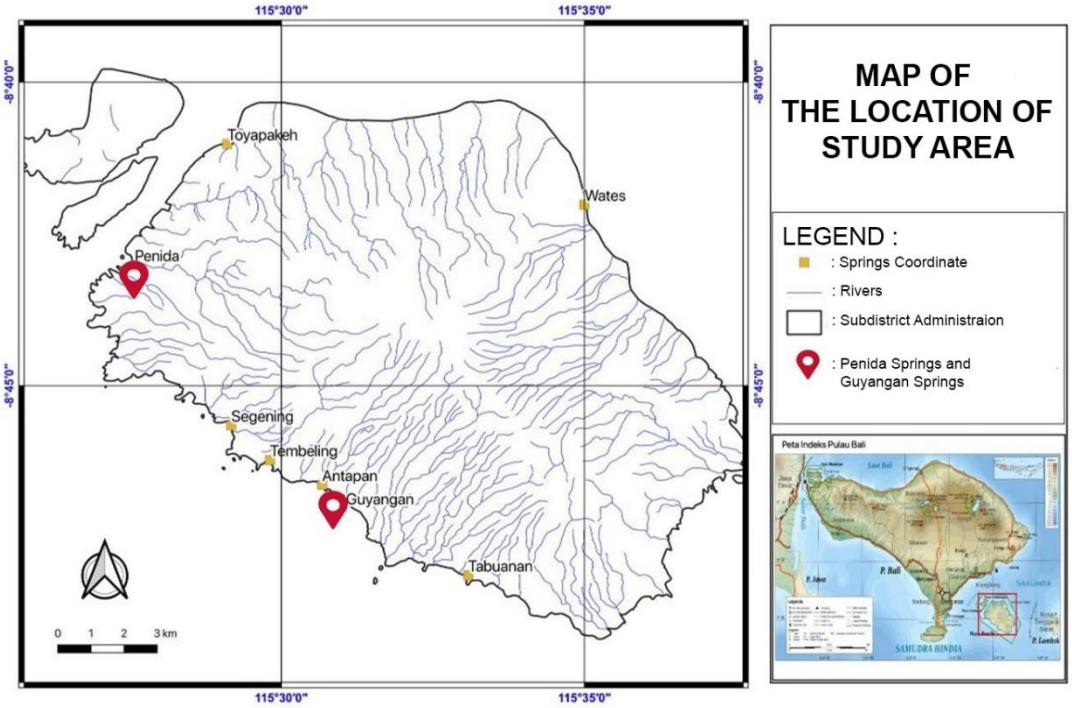
1 Material and Methods

This research is a quantitative descriptive method conducted with observation methods and measurements. Tests in the field and laboratory to obtain measured data or phenomena related to aquifer characteristics and groundwater recharge areas in karst areas on Nusa Penida Island. Primary data was collected in the form of an inventory of 10 spring points which are found in the region of Nusa Penida to measure hydrochemical and isotopes ratio. In addition, secondary data collection was also carried out in hydrogeological maps, geological maps, administrative maps of Nusa Penida, watershed maps, spring location maps, and annual rainfall data. Samples for stable isotopes analysis were collected in a polyethylene bottle of 100ml. The stable isotopes analyses were carried out using laser spectrometry Picarro L2130-i in the Hydrogeology and Hydrogeochemistry Laboratory Faculty of Mining and Petroleum Engineering, Bandung Institute of Technology (ITB). This study's primary element data collection was carried out using the ion chromatography (IC) testing method, which was analyzed using the Metrohm 930 Compact IC Flex instrument. Furthermore, the main element analysis results were plotted into a Piper Diagram. This Piper diagram is a conventional analysis method to determine the type/facies of water.

2. Study Area

The research was conducted on Nusa Penida Island, which is geographically located at coordinates 08°40'18,9"-08°50'10,8" sl and 115°26'47.6" -115°37'41.8" el. The area of Nusa Penida is two-thirds of the size of Klungkung Regency. Nusa Penida sub-district, with an area of 202,84 km^2, is bordered by the Badung Strait to the north and west, the Lombok Strait to the east, and the Indonesian Ocean to the south. Nusa Penida has a karst topography (undulating hills with rocks consisting of limestone). The land slope in Nusa Penida exceeds 40%, where this area is hilly. While land with a slope of 0 - 2% covers only 106,775 ha (18.94%), and a slope of 2 - 15% covers 124,051 ha (22.01%) (Badan Pusat Statistik Kabupaten Klungkung 2021) respectively, shown in Figure 1. The climate type in the Nusa Penida Island area is tropical, characterized by high temperature, humidity, and seasonal rainfall. Based on the Schmidt and Fergusson climate classification, the study area belongs to climate type F, indicated by an average of 4 wet months with rainfall of 1376 mm/year and an average dry month of 55 days/year. Such climatic conditions affect land use, which is more utilized for plantation land compared to rice fields. The average air temperature on Nusa Penida Island is around 26°C with an air humidity of 82%, fluctuating between the rainy and dry seasons (Sedana 2016).

Figure 1 The location of study area



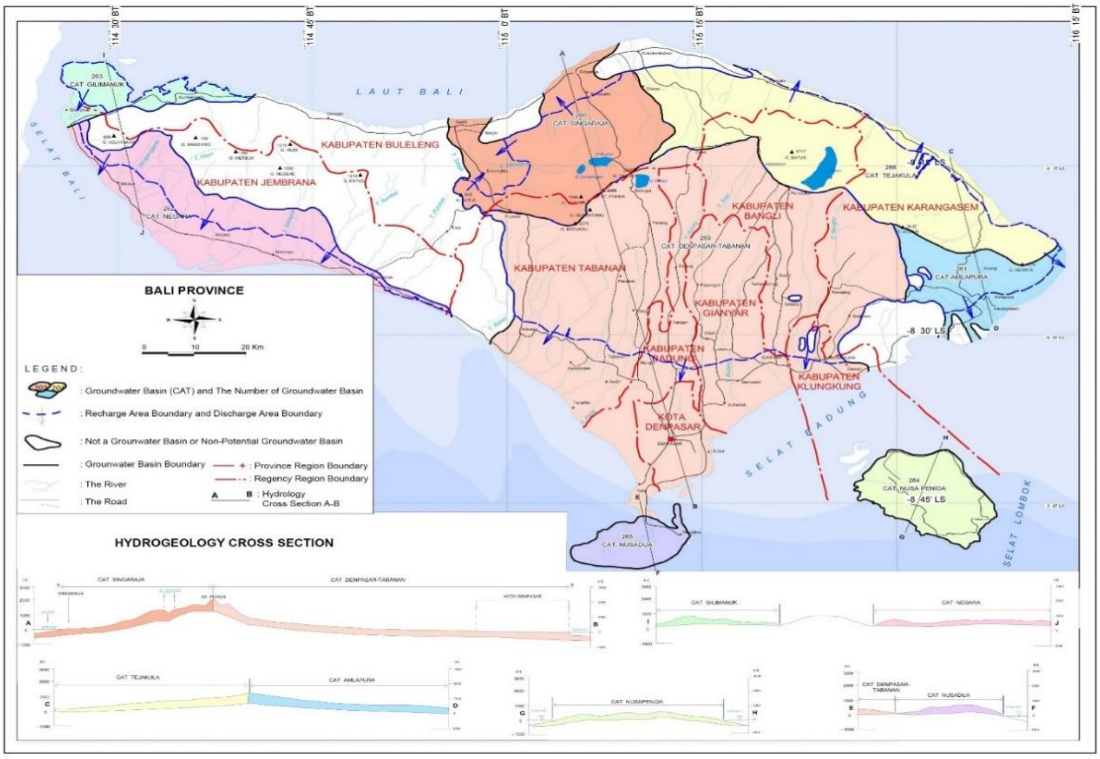
3. Geological and Hydrogeological Setting

The study area is located on Nusa Penida Island. Nusa Penida is located in the Nusa Penida groundwater basin. The Nusa Penida groundwater basin (CAT) is located in the southeast of Bali Province (Figure 2), located in Klungkung Regency, with an area of approximately 202,84 Km^2. This basin only has shallow groundwater potential in unconfined aquifers of roughly 79 million m^3/year. The topographic elevation of this basin is between 0 - 500 m.a.s.l, with a trellis river flow pattern, which is in the direction of the slope (Figure 3), thus forming morphological units of plains and undulating hills. Based on the lithological composition of rocks and their permeabilities, Nusa Penida Island consists of folded strata (Figure 4). This basin has a primary lithology (Figure 5) that functions as an aquifer in the form of mainly reef limestone from the South Formation, with medium-high graduation. With this geological condition, CAT Nusa Penida only has 1 (one) type of aquifer (Figure 5), namely aquifers with flow through faults, fractures and channels, with locally productive aquifer productivity, with groundwater flow limited to the zone of faults, fractures and dissolution channels, the groundwater table or piezometric height is generally deep. Nusa Penida has nine springs (Figure 6) that can be utilized as raw water, of these nine springs, two are already managed by the government in the form of a Drinking Water Supply System (SPAM), namely Penida Spring (200 lt/s) and Guyangan Spring (178 lt/s).

4. Research Method

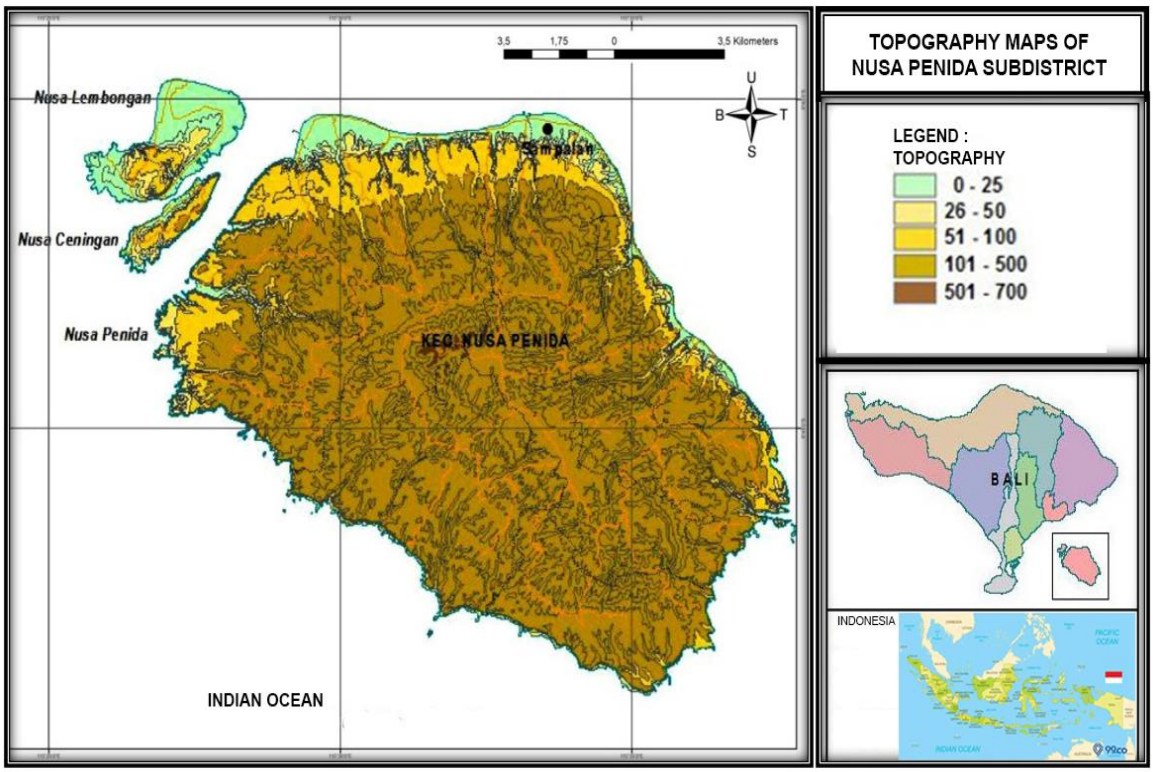
Determination of recharge areas in karst areas in Nusa Penida is based on hydrogeochemical and hydro isotope analysis. Based on the results of hydro isotope analysis, the ^{2}H and ^{18}O ratio values of groundwater, springs, and rainwater are obtained, and the Local Meteoric Water Line (LMWL) equation will be obtained. LMWL is an equation that describes the relationship between isotopic compositions of precipitation and altitude. LMWL is very useful in determining groundwater genesis and a function of elevation to determine the origin or location of groundwater and groundwater recharge areas. Meanwhile, based on the results of hydro isotope analysis, the major ion composition of groundwater will be obtained to determine the groundwater facies group.

Figure 2. Nusa Penida groundwater basin



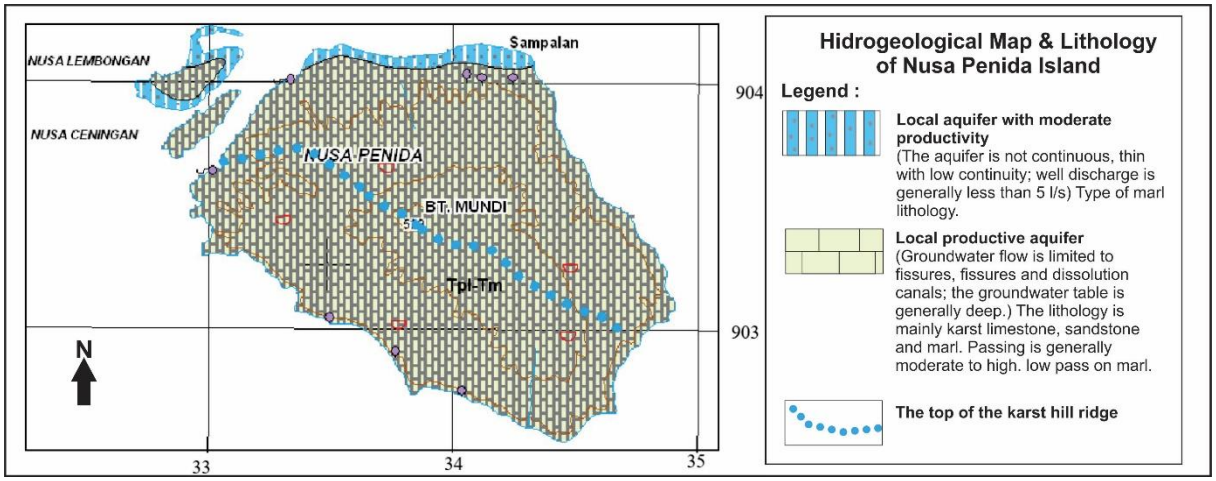
Source: Mudiana and Setiadi 2008

Figure 3. Topography and river flow patern on Nusa Penida groundwater basin



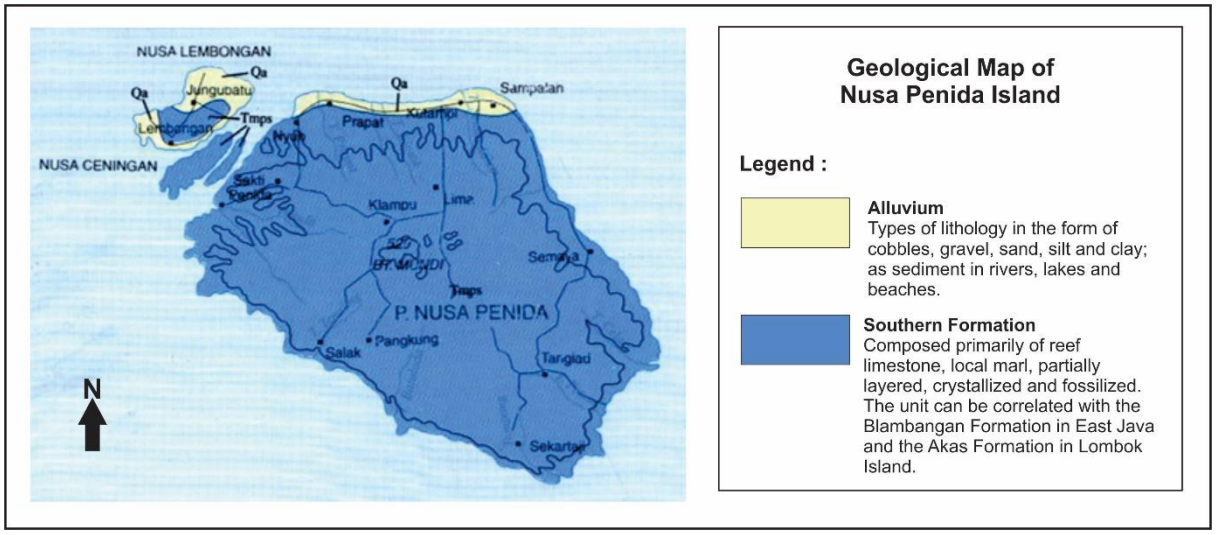
Source: Sudipa, 2020

Figure 4. Lithological composition on Nusa Penida groundwater basin



Source: Purbo-Hadiwidjojo, *et al.* 1998

Figure 5. Hydrogeological map on Nusa Penida groundwater basin



Source: Sudadi *et al.* 1986

5. Hydrogeochemical

Hydrogeochemical analysis was obtained based on data from direct measurements in the field, including measurements of water's physicochemical properties in the form of temperature, color, turbidity, acidity (pH), electrical conductivity (DHL), ion content (HCO_3^-, NO_3^-, and NO_2). In addition, groundwater sampling was also conducted for hydrochemical analysis of major ions (Setiawan, *et al.* 2018). According to Ford and Williams (1992), karst areas can be viewed as a system consisting of two integrated components, namely the hydrogeological sub-system and the hydrochemical sub-system, so that certain hydrochemical characteristics will reflect certain groundwater flow characteristics or mechanisms. According to Matthes (1981) in (Suganda, 2021), the chemical composition of groundwater (hydrogeochemistry) in an area is highly dependent on the interaction between air (CO_2), water (H_2O), and rock (in this case, limestone or $CaCO_3$). In karstification, water acts as a dissolving agent for carbonate rocks through reactions (Kehew 2001):

$$CaCO_{3(S)} + CO_{2(g)} + H_2O_{(l)} = Ca^{2+}{}_{(l)} + 2HCO_3^-{}_{(l)} \quad 5.1$$

According to Ford and Williams (1992), to determine the level of interaction between water and CO_2 it is important to know the amount of CO_2 (Pco2) which can theoretically be calculated from the hydrochemical analysis of water samples through the equation:

$$Pco_2 = \frac{(HCO_3^-)\,(H^+)}{K_1\, K_{CO_2}} \quad 5.2$$

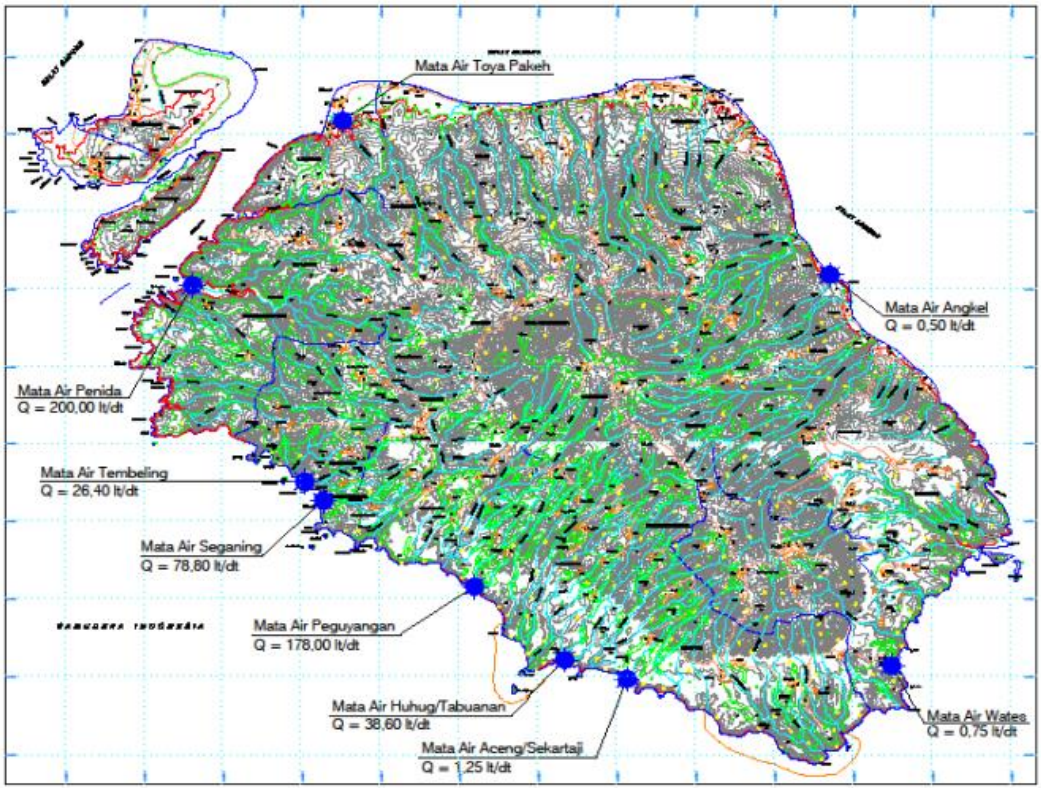
$$\text{Log } Pco_2 = \log (HCO_3^-) - pH + pKCO_2 + pK_1 \quad 5.3$$

The chemical reaction between water and carbonate rock ($CaCO_3$) is a reversible partial equilibrium reaction between dissolution and precipitation. To determine the level of water saturation in dissolving $CaCO_3$ the saturation index parameter for $CaCO_3$ minerals $CaCO_3$ ($SI_{calcite}$) is used, which is formulated as follows (Domenico, 1990 in Setiawan *et al.* 2018):

$$SI_{kalsit}=Log\ \frac{\left(Ca^{2+}\right)(HCO_3^{-})K_2}{(H^{+})\ K_{CaCO_3}} \qquad 5.4$$

A solution is in equilibrium concerning $CaCO_3$ if the $SI_{calcite}$ = 0, which means that the dissolution process of $CaCO_3$ has stopped. A negative calcite value indicates that the solution is undersaturated concerning $CaCO_3$, so water can still dissolve $CaCO_3$. A positive calcite value means that the solution is supersaturated concerning $CaCO_3$, so that $CaCO_3$ will be precipitated. According to Ford and Williams (1992), due to the difficulty of measurement in the field, the $SI_{calcite}$ value generally has an error rate of ± 0.1 - 0.2. According to Kehew (2001), the nature of groundwater flow in karst areas is divided into diffusion flow (slow flow) through pore media or dense fracture networks and flow through cavity networks (fast flow). Groundwater flowing through the cavity network is more difficult to reach saturated conditions for calcite.

Figure 6. Distribution map of springs in Nusa Penida Island



Source: Harmayani, Konsukartha, and Arsana 2017

6. Hydro Isotopes

The hydro isotope method is used as a comparison to the review of groundwater dynamics from a hydrogeological aspect, especially about the origin of groundwater. Natural isotopes are isotopes of chemical elements that occur naturally in nature. The most important natural isotopes in hydrology are isotopes of the atoms that form the water molecule itself, namely isotopes of hydrogen atoms: ^{1}H; ^{2}H (deuterium, D); ^{3}H (tritium, T), and isotopes of oxygen atoms (^{16}O, ^{17}O, ^{18}O). The abundance of hydrogen isotopes in nature is about ^{1}H = 99,985%, ^{2}H (D) = 0,015%, and ^{3}H (T) (radioactive) < 0,001%. Whereas the abundance of oxygen isotopes is: ^{16}O= 99,63%, ^{17}O = 0,0375%, and ^{18}O = 0,1995% (International Atomic Energy Agency 1981). From the abundance of these isotopes, it can be seen that the most dominant water molecules are: $H_2{}^{16}O$ (mass-18), $HD^{16}O$ (mass-19), and $H_2{}^{18}O$ (mass-20). In applications, the abundance of these molecules in water is not measured absolutely, but the relative abundance to a standard is measured.

The relative abundance of $HD^{16}O$ molecules is called the relative abundance of deuterium (δD), and the relative abundance of $H_2{}^{18}O$ is called the relative abundance of oxygen-18 (^{18}O). The deuterium relative

abundance and oxygen-18 relative abundance in water are measured relative to an international standard Standard Mean Ocean Water (SMOW), with the following formula (Eriksson 1983):

The relative abundance of deuterium is written as δD, with the formula:

$$\delta_D = \left(\frac{R_{D(sample)}}{R_{D(standard)}} - 1\right) x\ 1000\% \quad 6.1$$

The relative abundance of oxygen-18 is written as ^{18}O, with the formula:

$$^{18}O = \left(\frac{R_{O\text{-}18(sample)}}{R_{O\text{-}18(standard)}} - 1\right) x\ 1000\% \quad 6.2$$

Rainwater that falls and seeps into the soil, as long as it does not evaporate, the isotopic composition of ^{2}H and ^{18}O does not change. In the hydrological cycle, the degree of change in the composition of ^{2}H and ^{18}O isotopes in fractionation is influenced by the air temperature where the fractionation occurs. In nature, differences in air temperature can occur due to differences in geographical parameters such as altitude, latitude, and distance from the coast. The ^{2}H and ^{18}O composition of precipitation occurring at different locations will have different isotopic compositions. When plotted on the coordinates $\delta^{2}H$ against $\delta^{18}O$, these varying isotope compositions lie on a straight line called the Local Meteoric Water Line (LMWL). The relationship between the abundance of deuterium (δD) and oxygen-18 ($\delta^{18}O$) of a water sample has been proven by experts to be linear and written with the equation; $\delta D = A\ \delta^{18}O + B$. The relationship is obtained as an example for rainwater obtained from 91 earth stations worldwide: $\delta D = 8\ \delta^{18}O + 10$ and is called the Global Meteoric Water Line (GMWL) (Craig 1961).

Validation of hydro isotope data analysis

a.For LMWL based on rainwater isotopes, the higher the elevation, the ratio of O and H isotopes will be depleted (poor) with a greater value and vice versa low elevation isotope ratio values are enriched (rich), the value is getting smaller. If it is appropriate, it is said to be valid.

b.Groundwater flow direction (gravity concept). The recharge area has the highest position or level, meaning groundwater will flow from the highest to the lowest. Hence, it is necessary to describe the groundwater flow pattern.

c.Position of spring isotope values. If it is on the LMWL, then the spring comes from rainwater, and if it is outside the LMWL line (above or below it), then it is estimated that there is a source of the spring that is in a higher place than the spring. Furthermore, it is necessary to examine the approximate recharge location and, if the source location is found, test the water in the hypothetical recharge location again to equate the O and H isotope variations with the O and H isotopes of the spring as well as hydrochemical testing.

7. Result and Discussion

7.1. Hydrogeochemical Analysis (Major Ions)

Water found in nature contains a certain number of dissolved elements, including major, rare, and trace elements. These elements are present in the form of ions and dissolved metals that make up the chemical composition of water. This study's primary element data was collected using the ion chromatography (IC) testing method in the Hydrogeology and Hydrogeochemistry Laboratory Faculty of Mining and Petroleum Engineering, Bandung Institute of Technology (ITB). Water samples from the field were prepared using cellulose membrane filter paper measuring 0.2 μm and 25 mm in diameter. The filtered samples were then put into a small bottle (vial) of approximately 10 ml and then analyzed using the Metrohm 930 Compact IC Flex instrument. The main element analysis results of groundwater and surface water samples are shown in Table 1.

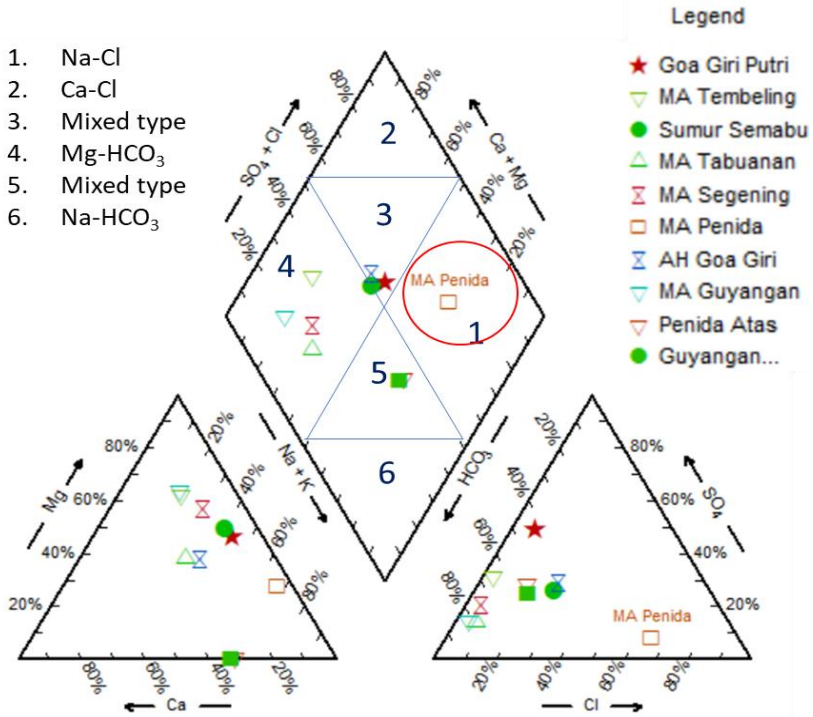
The main element analysis results obtained from the ion chromatography test were further analyzed using a piper diagram plot. Piper diagram is a conventional analytical method to determine the type/facies of water. Based on the diagram (Figure 8), the groundwater type at the study site can generally be divided into three types: Na-Cl, mixed type, and Mg-HCO_3. The mixed type water, which consists of rainwater samples from Goa Giri, Goa Giri Putri spring, and water from Semabu Hotel boring well, shows no ions (cations or anions) that dominate the chemical composition of the water. Rainwater samples around Penida spring and Guyangan spring also offer a mixed type. The samples from Tembeling spring, Segening spring, Guyangan Spring, and Tabuanan Spring are Mg-HCO_3 type water. The magnesium and bicarbonate content in these water samples is thought to come from the dissolution of the limestone from which the springs flow. The water sample from Penida spring (Sakti) differs

from the other springs, namely the Na-Cl type. Na-Cl-type water is generally found in quite old water or located close to the sea. Penida spring, as it is known, is located on the coast of Crystal Bay. The water from this spring is collected in an area resembling a dam so that the water from this dam does not flow freely like other springs in Nusa Penida. This is why Penida spring water has a Na-Cl type that characterizes the interaction with seawater.

Table 1. Chromatography Ion Analysis Results (main ions)

No	Sample ID	Na^+ (ppm)	K^+ (ppm)	Ca^{2+} (ppm)	Mg^{2+} (ppm)	Cl^- (ppm)	SO_4^{2-} (ppm)	HCO_3^- (ppm)
1	Goa Giri Putri	37.56	9.08	7.92	23.51	15.85	133.5	149.4
2	MA Tembeling	12.11	6.33	11.6	25.11	10.06	97.88	262.9
3	Semabu well	59.07	11.52	14.81	42.46	78.32	109.1	257.3
4	MA Tabuanan	13.02	8.03	12.71	10.57	11.27	29.59	212.6
5	MA Segening	16.31	14.95	10.01	25.37	9.28	45.99	211.4
6	MA Penida	265.4	16.5	16.01	59.63	400.3	64.16	289.4
7	AH Goa Giri	3.877	1.78	2.69	2.55	6.26	9.51	19.52
8	MA Guyangan	10.58	6.70	11.64	25.43	8.56	33.76	252.3
9	Penida Atas (precipitation water)	0.258	0.35	0.18		3.33	7.76	19.52
10	Guyangan Atas (precipitation water)	1.234	0.39	0.63		4.14	7.83	23.18

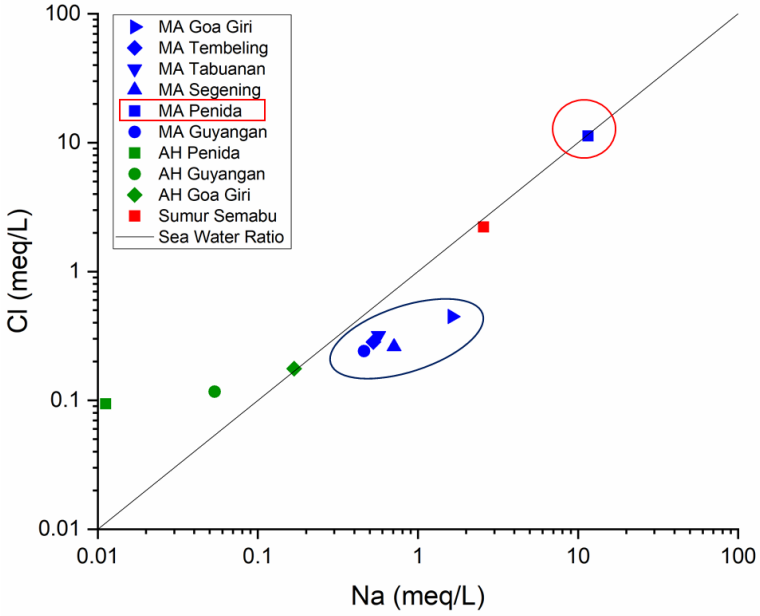
Figure 7. Piper Diagram Analysis of Major Ion Data



Further analysis of the Penida spring samples was conducted using a bivariate plot of sodium (Na+) against chloride (Cl-). This cross-plot was used to see the tendency of the chemical composition of the water toward possible interaction with seawater. It is known that seawater is composed of predominantly sodium and chloride ions. The bivariate plot of spring and rainwater samples in Nusa Penida is shown in Figure 9. The black line in the figure is the seawater ratio based on a 1:1 ratio between sodium and chloride composition. Based on the diagram, it can be seen that the spring water samples from Penida/Crystal Bay fall right on the seawater ratio

line. Samples that fall precisely on the sequence indicate a seawater influence on the water sample. The other spring samples tended not to fall on the seawater ratio line, indicating a difference with the Penida spring.

Figure 8. Bivariat Na-Cl Diagram



7.2. Water Stable Isotope Analysis ($\delta^{18}O$ and $\delta^{2}H$)

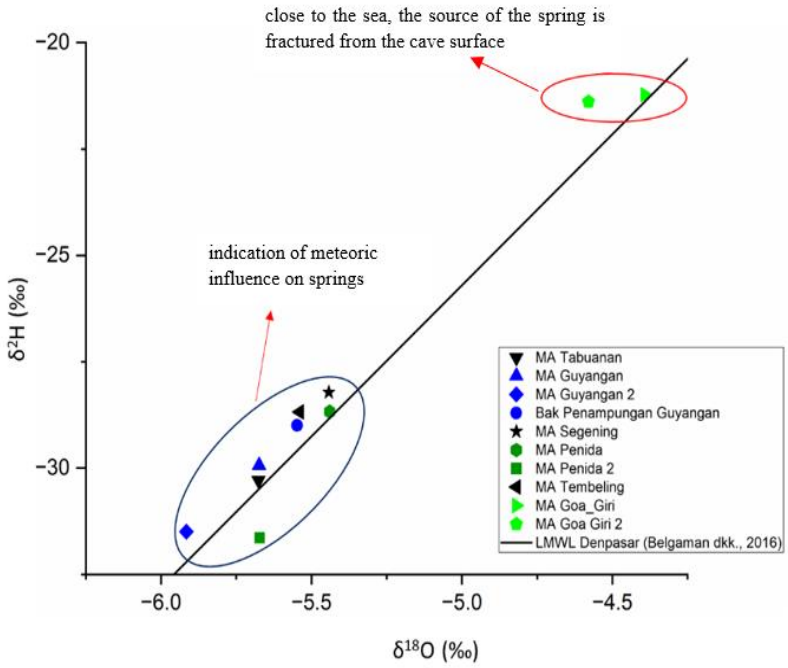
The stable isotopes present in water with the greatest abundance are $\delta^{18}O$ (oxygen-18) and $\delta^{2}H$ (deuterium). These two types of isotopes are the main constituent components of water composition in nature. Oxygen-18 and deuterium in this study were analyzed using the Picarro L2130-i Analyzer instrument with the Cavity Ring Down Spectrometer (CRDS) method in testing method in the Hydrogeology and Hydrogeochemistry Laboratory Faculty of Mining and Petroleum Engineering, Bandung Institute of Technology (ITB).

The sample required for stable isotope water analysis is 1.9 ml with prior filtration using a 0.2 µm membrane filter. The basic principle of isotope analysis is the fractionation of heavy and light isotopes, which are then sent to the vaporizer to produce steam from the water sample at 110°C. The steam produced from the evaporation process in the vaporizer then flows into the analyzer for further fractionation of $\delta^{18}O$ (oxygen-18) and $\delta^{2}H$ (deuterium) isotopes.

Table 2. Water Stable Isotope Analysis Result

Sample	$\delta^{18}O$ (‰)	$\delta^{2}H$ (‰)
MA Tabuanan	-5.676	-30.285
MA Guyangan	-5.674	-29.933
MA Segening	-5.442	-28.220
MA Penida	-5.439	-28.672
MA Tembeling	-5.539	-28.679
MA Goa Giri	-4.393	-21.223
Reservoir Guyangan	-5.548	-28.997
MA Guyangan 2	-5.916	-31.491
MA Penida 2	-5.672	-31.635
MA Goa Giri 2	-4.579	-21.386

Figure 9. Bivariat plot of water stable isotope



The laboratory analysis data for water-stable isotope parameters can be seen in Table 2. Water stable isotope analysis was conducted using a bivariate plot of oxygen-18 against deuterium (Figure 11). The black line on the diagram is the Denpasar local meteoric water line based on Belgaman, *et al.* 2016. This line determines the process in water samples relative to rainwater conditions. Based on the plot, it can be seen that all samples are relatively around the meteoric water line. This indicates the influence of meteoric/rainwater on the water composition of the spring samples. The water samples from Goa Giri spring have heavier oxygen-18 and deuterium isotope ratios than the other spring samples. This may occur because Goa Giri spring is located close to the sea. The spring at Goa Giri is a fracture whose source is thought to come from the surface interacting directly with rainwater. In addition, the location of Goa Giri spring, which is very close to the sea, causes the fractionation of heavier isotope ratios to fall first compared to lighter isotope ratios.

7.3. Recharge Area Analysis

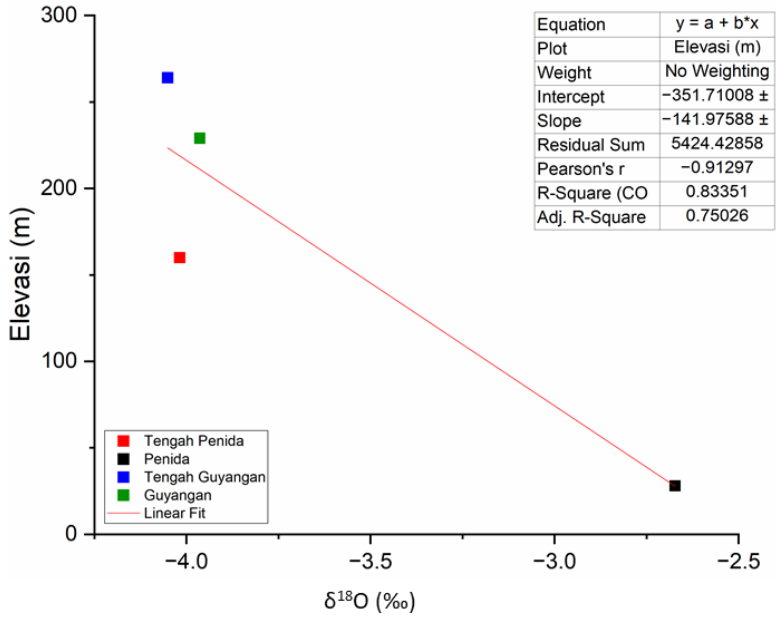
The water stable isotope approach ($\delta^{18}O$ and $\delta^{2}H$) was used in determining the recharge area in the Nusa Penida region. Water-stable isotopes will provide information on the processes that have taken place during water transportation to a location. Water-stable isotopes can also provide information about the water catchment area at that location. The results of laboratory analysis for rainwater stable isotope parameters around Penida and Guyangan springs and sampling elevations are shown in Table 3. The elevation of the catchment area can be determined based on the relationship between the ratio of oxygen-18 and deuterium isotopes to sampling elevation. A linear equation between the two values was determined based on this elevation and isotope data.

Table 3. Rainwater Stable Isotope Data and Sampling Elevation

Point of Rainfall	$\delta^{18}O$ (‰)	$\delta^{2}H$ (‰)	Elevation (m)
Midle of Penida	-4.018	-15.259	160
Penida	-2.673	-1.882	28
Midle of Guyangan	-4.051	-15.732	264
Guyangan	-3.964	-14.86	229

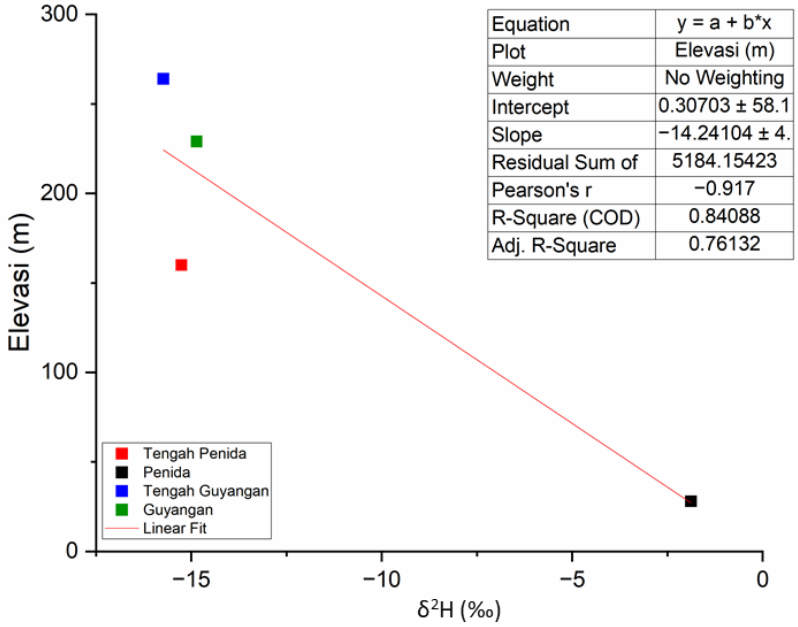
The cross plot between rainwater oxygen-18 isotopes and elevation is shown in Figure 12 with the linear equation E ($\delta^{18}O$) =-141.976 $\delta^{18}O$ - 351.71008.

Figure 10. Oxygen-18 correlation with elevation



In contrast, the plot between deuterium isotopes and elevation is shown in Figure 13 with the equation E (δ^2H) = -14.241 δ^2H + 0.307.

Figure 11. Deuterium correlation with elevation



These two equations will be used to calculate the recharge area elevation of the springs at the study site. The calculation table of the Nusa Penida catchment elevation for the Guyangan and Penida spring samples is shown in Table 4.

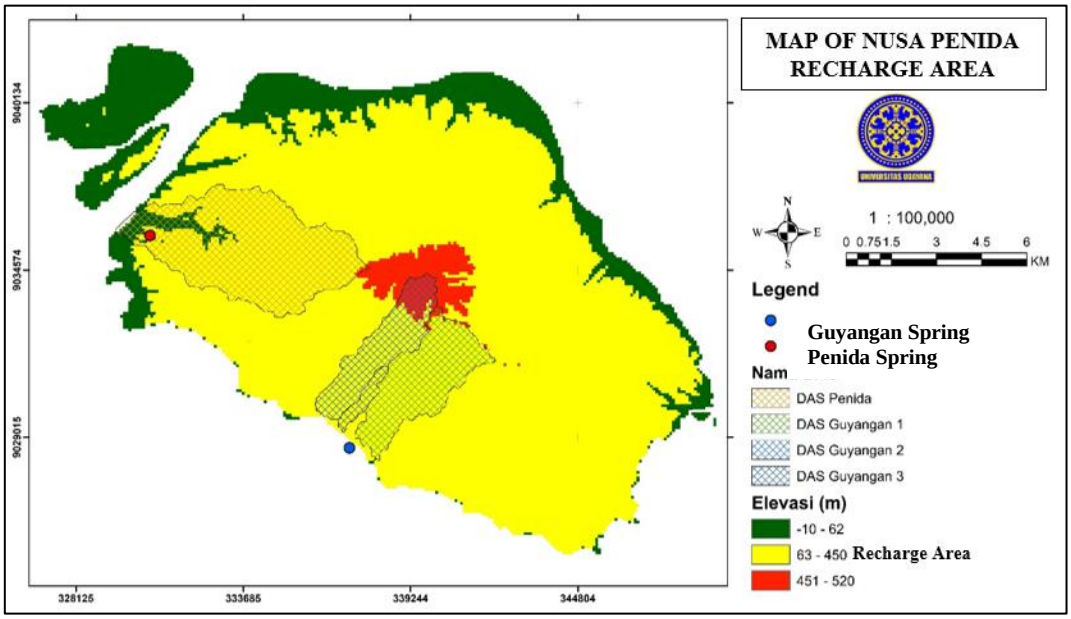
Based on the calculation results, it is known that, generally, the elevation of the recharge area for groundwater at the study site ranges between 62 m - 450 m. If applied to the research location, the recharge area is almost throughout Nusa Penida Island, with a relatively broad distribution. The recharge area can be seen on the elevation distribution map of this recharge area in Figure 14.

Table 4. Penida and Guyangan Springs Infiltration Area Elevation Calculation Table

Sample	Deuterium	Oxyigen	Gradient	D intercept	O intercept	Correlation Factor of Topography	Elevation D	Elevation O
			6	-27.87	-5.44	3.96	397.21	420.55
			6.1	-27.78	-5.29	4.51	395.86	399.70
			6.2	-27.66	-5.28	5.05	394.21	397.39
			6.3	-27.52	-5.26	5.60	392.15	394.49
			6.4	-27.33	-5.23	6.14	389.50	390.77
			6.5	-27.08	-5.19	6.68	385.96	385.80
			6.6	-26.73	-5.15	7.23	381.01	378.85
			6.7	-26.21	-5.07	7.77	373.59	368.42
			6.8	-25.34	-4.95	8.32	361.21	351.05
			6.9	-23.60	-4.70	8.86	336.46	316.29
			7	-18.39	-3.97	9.40	262.22	212.03
MA Penida	-28.672	-5.439	7.1	-28.67	-5.44	9.95	408.62	420.55
			7.2	-39.25	-6.91	10.49	559.21	629.07
			7.3	-34.03	-6.17	11.03	484.96	524.81
			7.4	-32.29	-5.93	11.58	460.21	490.06
			7.5	-31.43	-5.81	12.12	447.84	472.68
			7.6	-30.90	-5.73	12.67	440.41	462.26
			7.7	-30.56	-5.68	13.21	435.46	455.31
			7.8	-30.31	-5.65	13.75	431.93	450.34
			7.9	-30.12	-5.62	14.30	429.28	446.62
			8	-29.98	-5.60	14.84	427.21	443.72
			average	-28.72	-5.43	max	409.26	419.56
						min	262.22	212.03
			6	-26.92	-5.67	4.11	383.71	453.87
			6.1	-26.57	-5.12	4.68	378.64	375.52
			6.2	-26.13	-5.06	5.25	372.44	366.81
			6.3	-25.59	-4.98	5.81	364.69	355.93
MA Guyangan	-29.9	-5.674	6.4	-24.89	-4.89	6.38	354.73	341.94
			6.5	-23.95	-4.75	6.95	341.44	323.28
			6.6	-22.65	-4.57	7.51	322.84	297.17
			6.7	-20.69	-4.29	8.08	294.94	257.99
			6.8	-17.42	-3.83	8.65	248.45	192.70

Sample	Deuterium	Oxyigen	Gradient	D intercept	O intercept	Correlation Factor of Topography	Elevation D	Elevation O
			6.9	-10.89	-2.91	9.22	155.45	62.11
			7	8.70	-0.16	9.78		
			7.1	-29.93	-5.67	10.35	426.58	453.87
			7.2	-69.67	-11.19	10.92	992.41	1237.37
			7.3	-50.07	-8.43	11.49	713.42	845.62
			7.4	-43.54	-7.51	12.05	620.43	715.04
			7.5	-40.28	-7.05	12.62	573.93	649.74
			7.6	-38.32	-6.78	13.19	546.03	610.57
			7.7	-37.01	-6.59	13.76	527.43	584.45
			7.8	-36.08	-6.46	14.32	514.15	565.80
			7.9	-35.38	-6.36	14.89	504.18	551.81
			8	-34.84	-6.29	15.46	496.43	540.92
			average	-30.10	-5.65	max	428.99	450.14
						min	155.45	62.11

Figure 12. Nusa Penida Recharge Area



Based on the watershed analysis and hydrogeological analysis above, it is indicated that it is not possible for relatively large springs, such as Guyangan Spring and Penida Spring, to rely on water inputs from the catchment area alone. Although based on isotope analysis, it is known that the catchment area in Nusa Penida is spread over almost the entire area of Nusa Penida Island, the reliable discharge obtained is still much smaller to provide a relatively large discharge for Penida Spring and Guyangan Spring in particular. Considering the results of this analysis, it is reasonable to assume that the water source for these two springs is a mixture of rainwater and water from the subsurface stored in the limestone reservoirs/aquifers of Nusa Penida. There is also a

possibility of groundwater flow in the aquifer beneath the Nusa Penida limestone formation from the southeastern part of Bali Island, which belongs to the Ulakan Formation.

Conclusion

This paper identifies aquifer recharge areas in a karst basin on Nusa Penida Island using the stable isotope ratios of hydrogen and oxygen combined with a hydrogeochemical approach. Based on the hydrogeochemical analysis, the groundwater type at the study site can generally be divided into three types: Na-Cl, mixed type, and Mg-HCO_3. Mixed-type water comprises rainwater samples from Goa Giri, Putri, Semabu Hotel boring well, and Penida spring. Furthermore, Tembeling spring, Segening spring, Guyangan Spring, and Tabuanan Spring are magnesium and bicarbonate (Mg-HCO_3) type water, which content in these water samples are thought to come from the dissolution of the limestone from which the springs flow. Na-Cl-type water is found in old water or near the sea at the Penida Spring. According to the calculation of water stable isotope results, it is known that, generally, the elevation of the recharge area for groundwater at the study site ranges between 62 m - 450 m. If applied to the research location, the recharge area is almost throughout Nusa Penida, with a relatively broad distribution. But it can be distinguished genesis of the Guyangan Spring and Penida Spring. The water source for Guyangan Spring and Penida Spring is likely a mixture of modern rainwater and water from the older groundwater that stored in the limestone reservoirs/aquifers of Nusa Penida, or it could be there is connection groundwater flow from the southeastern part of Bali Island with groundwater in Nusa Penida.

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Credit Authorship Contribution Statement

I Ketut Ariantana: Conceptualization, Investigation, Methodology, Project Administration, Formal Analysis, Writing – Original Draft, Funding Acquisition.
Made Sudiana Mahendra: Supervision.
I Wayan Nuarsa: Supervision.
I Wayan Sandi Adnyana: Supervision.
Lambok Hutasoit: Supervision.
Irwan Iskandar: Investigation and Supervision.
Mustiatin: Formal Analysis.
Putu Doddy Heka Ardana: Formal Analysis, Supervision, Validation, Writing - Review and Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Regulatory and Legal Support for the Development of Digital Infrastructure in Rural Areas as a Factor in Improving the Level of Sustainable Development and Quality of Life of the Rural Population

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Abstract: Widespread problems of rural development have been the subject of scientific analysis and discussions for many years. The current debate is the result of reflections on improving the effectiveness of rural development policy and the search for new approaches to their development at the local level. They are also the result of the need not only to implement the Sustainable Development Goals more effectively but also to reduce the social and economic inequality between the village and the city, which is possible through the development of the digital infrastructure of rural areas. The purpose of the article is to identify priority areas and institutional and legal barriers to the development of digital infrastructure, the tools necessary to overcome them, and regulatory and legal support for the development of digital infrastructure in rural areas. The article identifies the advantages of digital infrastructure for the socio-economic development of rural areas, the priority level of the introduction of digital infrastructure and technologies for various sectors in the life of the rural population, institutional and legal barriers to the development of digital infrastructure of rural areas, as well as tools of regulatory support for the development of digital infrastructure of rural areas. It is concluded that the creation of the necessary regulatory framework that would stimulate the formation of digital infrastructure while protecting the interests of rural residents is the most significant of the problems of rural areas.

Keywords: sustainable development; rural areas; digital infrastructure; institutional and legal barriers; regulatory support.

JEL Classification: Q01; R11.

Introduction

The problem of transition to the information society has come to the fore (Ilkevich *et al.* 2022) among the emerging problems in the last decade. The changes taking place depend on global technological and digital development (Nakisbaev and Dugalich 2022, 132). The importance of digital infrastructure has been reinforced by the consequences of the COVID-19 pandemic, which has moved part of its activities to the virtual sphere (Borodina *et al.* 2021, 68). Equipping rural residents with digital communication skills makes it possible to reduce the distance and, thus, increase the availability of goods and services, especially public (Galizina *et al.* 2021, 420; Sovetova 2021, 105). In this context, ICT is considered an opportunity to overcome the difficulties of sustainable rural development (Chen and Wang 2020, 2). However, its use depends on the availability of digital infrastructure, the absence or poor development of which deprives rural areas of chances for development based on digital technologies or initiatives (Stovba 2020, 69; Yesmagulova *et al.* 2023, 179).

Not only digital technologies are becoming important in the local dimension, but also actions aimed at improving the general living conditions of rural residents, including at the micro level (Dubois and Sielker 2022, 1). In this context, it is necessary to provide adequate regulatory and legal support for the development of rural areas, in the presence of which it is easier for local development leaders to consider the needs and capabilities of their residents.

The need to substantiate the regulatory support for the development of the digital infrastructure of rural areas as a factor in increasing the level of sustainable development and the quality of life of the rural population determines the relevance of the topic under consideration.

1. Literature Review

The desire to have an efficient infrastructure associated with the growth of ICT has led to the emergence of the digital infrastructure concept (Khoruzhy *et al.* 2023), in which digital technologies are integrated with physical infrastructure for real-time monitoring, effective decision-making, and accelerated and improved service delivery (Yang *et al.* 2022, 178).

The term "digital infrastructure" is used in various contexts to describe socio-economic and technical conditions. Uniform, generally accepted definitions of digital infrastructure have not yet been developed at the international level. There are no specific norms and standards for its design and construction. This creates dualism and weak interpretation and slows down the development of such infrastructure (Ogie *et al.* 2017, 8). The lack of uniform standards has an ambiguous effect on the implementation of digital infrastructure projects, since the expectations of asset owners or operators of technological implementation of digital solutions may not be justified (Henningsson and Henriksen 2011, 355).

Digital infrastructure can be defined at the basic level as an interconnected network that provides digital information about the state of the system in real-time (Del Carpio *et al.* 2022, 1). This definition focuses on the ability to self-monitor a system through a combination of physical assets and digital technologies. Digital technologies are used to obtain data in this context, which is then processed, stored, and transmitted as reliable information to assist infrastructure service providers in making informed decisions regarding the management of their infrastructure assets (Fan *et al.* 2022).

K. Salemink *et al.* (2017) defines digital infrastructure as the result of combining physical infrastructure with ICT, due to which high-quality information is generated for making effective and quick decisions at a minimal cost.

Research on the development of digital infrastructure in rural areas is carried out at various territorial levels, covering entire continents (Stojanova *et al.* 2022), individual countries (Ashmore *et al.* 2017, 408), or small administrative units (Ding 2020, 33). The problems considered in them are very diverse. Thus, studies from Asia, Africa, and Latin America are most often related to energy systems, climate (Hieu and Toan 2023, 237), and sustainable agriculture (Chen 2020, 42; Li 2020, 13), while European studies address this topic mainly in the context of revitalizing local communities through improved public services and the use of new technologies (Konečny 2019, 1; Rundel *et al.* 2020, 21).

Scientific works to date indicate a great potential for the development of digital infrastructure in rural areas in many areas, for example, in mitigating the negative consequences of rural depopulation (Cowie *et al.* 2020, 169), as a factor of rural sustainability (Roberts *et al.* 2017, 355), or a tool for activating local communities (Randall *et al.* 2020, 1). Researchers (Stojanova *et al.* 2021) expect very broad social and economic effects from the development of digital infrastructure in rural areas and consider this development as a strategy that can improve the quality of life and give young generations good reasons to stay in rural areas, rather than migrate and look for their place in the city.

In our opinion, the issue of regulatory support for the development of digital infrastructure of rural areas in the scientific literature remains poorly researched despite a fairly wide range of studies devoted to the development of digital infrastructure of rural areas in general.

In this connection, the purpose of the article is to identify priority areas and institutional and legal barriers to the development of digital infrastructure, the tools necessary to overcome them, and regulatory and legal support for the development of digital infrastructure in rural areas.

2. Methods

A qualitative and quantitative approach to the study was chosen to achieve the purpose of the study.

In the course of a desk study (based on H.A. Yasavi International Kazakh-Turkish University, Higher School of Law, M. Narikbayev KAZGUU University), an analysis of scientific sources on the development of digital infrastructure in rural areas was carried out, which showed that the effectiveness of providing digital infrastructure in rural areas depends to a lesser extent from the general conditions of economic growth and development of the country and to a greater extent – on the institutional and legal environment. Therefore, institutional and legal changes can lead to improved performance.

Further, the analysis of the Internet resources of the district Akimats of the North Kazakhstan region was carried out following the purpose of the study, based on which the selection of representatives of Akimats responsible for the digitalization of rural areas was carried out.

At the first stage of the study, the study sample consisted of 68 people who were sent e-mails indicating the purpose and program of the study. Of the respondents to whom the letters were sent, 53 people agreed to participate in the study. The survey of representatives of district Akimats was carried out from September 25 to November 25, 2022. The questionnaires were sent by e-mail and included the following questions:

1. How important is each of the listed advantages of digital infrastructure for the socio-economic development of rural areas?

2. What is the priority level of digital infrastructure implementation in your area for each of the listed sectors?

3. Which of the aforementioned digital infrastructure technologies are planned to be developed as a priority over the next 2-3 years?

4. To what extent is each of the listed institutional and legal factors a barrier to the development of digital infrastructure in your area?

At the second stage, an expert survey was conducted in the form of in-depth interviews with experts from among those who took part in the first stage of the study (18 people) selected according to criteria such as work experience in local government (at least 5 years), higher legal education, participation in projects on digitalization of rural areas. The necessary tools of regulatory support for the development of digital infrastructure in rural areas were identified during in-depth interviews, followed by their ranking and determining the weight of the tool proposed by experts.

3. Results

The results of the survey of representatives of district Akimats are presented in Tables 1-4.

Table 1. How important is each of the listed advantages of digital infrastructure for the socio-economic development of rural areas? (% of the surveyed representatives of Akimats)

Sector	Important	Not important	Find it difficult to answer
Expansion of services for residents (in the field of healthcare, social security, education, transport, housing, and utilities)	98.1	1.9	-
Efficiency of the provision of administrative services	96.2	3.8	-
Economic development	94.4	5.7	1.8
Environmental sustainability	92.5	7.5	-
Improving the efficiency of the funds used	90.6	9.4	-
Improving social justice	86.8	9.4	3.8
Ensuring public safety	73.6	15.6	10.8

Table 2. The priority level of digital infrastructure implementation in the area for each of the sectors (% of the surveyed representatives of Akimats)

Sector	Priority*	Not a priority**	Find it difficult to answer
Public services	98.1	1.9	-
Healthcare	92.4	3.8	3.8
Education	90.5	5.7	3.8
Agro-industrial production	88.7	11.3	-
Ecology	83.0	13.2	3.8
Tourism and recreation	83.0	15.1	1.9
Waste management	81.1	17.0	1.9
Banking sector, finance	77.3	17.0	7.3
Housing and communal services	77.3	22.7	-
Transport	73.6	20.8	5.6
Energetics	73.6	24.5	1.9
Trading	62.3	30.2	7.5
Public safety	49.1	45.3	5.6

Note: *the sum of the answer options "main priority" and "significant priority"; **the sum of the answer options "minor priority" and "not a priority".

Table 3. Which of the aforementioned digital infrastructure technologies are planned to be developed as a priority over the next 2-3 years?* (% of the surveyed representatives of Akimats)

Technologies of the digital infrastructure of rural territories	%
Provision of public services (optimized mobile interface)	73.6
Healthcare (online medicine, personalization of treatment methods)	58.5
Education (online training, consulting, and courses)	58.5
Registration procedures (optimized mobile interface)	50.9
Ecology (monitoring of air and water quality)	49.1
Transport (mobile applications designed for various types of public transport)	47.2
Banking sector (online payment for services)	47.2
Housing and utility sector (implementation of energy-efficient measures)	39.6
Waste management (sensors for waste containers)	30.2
Trading (mobile apps)	28.3
Public safety (CCTV cameras)	11.3

Note: *It was suggested to mark all acceptable answers.

Table 4. To what extent is each of the aforementioned institutional and legal factors a barrier to the development of digital infrastructure in your area? (% of local government representatives surveyed)

	Significant barrier	Moderate barrier	Minor barrier	Not a barrier	Find it difficult to answer
Lack of a holistic policy for the introduction of digital infrastructure at the national level	56.6	30.2	9.4	3.8	0.0
Lack of investment policy stimulating the development of digital technologies	50.9	30.2	17.0	1.9	0.0
Lack of uniform (adopted at the legislative level) standards for the introduction of digital technologies (for technological expertise)	47.2	28.3	17.0	3.8	3.8
Lack of necessary legislation and Digital Infrastructure Development Strategy	43.4	37.7	11.3	7.5	0.0
Legal non-regulation of several issues related to digital technologies and their impact on the rights of citizens	41.5	34.0	17.0	3.8	3.8
Lack of assistance institutions at the State level and the level of rural areas	37.7	35.8	22.6	3.8	0.0
Lack of political will on the ground	17.0	11.3	28.3	37.7	5.7

The results of in-depth interviews to determine the tools of regulatory support for the development of digital infrastructure in rural areas are presented in Table 5.

Table 5. Tools of regulatory support for the development of digital infrastructure in rural areas

No.	Tools	Rank	Weight
1	Development and adoption of a national digital strategy	1	0.31
2	Adoption of the national plan for broadband Internet access	2	0.24
3	Development and adoption of a Digital Infrastructure Development Strategy at the level of the Akimat of the rural territory	3	0.19
4	Development of accompanying policies for the development of digital infrastructure in rural areas	4	0.13
5	Development of data management regulations	5	0.09
6	Developing and adopting a Digital Privacy and Security Strategy	6	0.04

Note: compiled by the authors based on the expert survey

4. Discussion

Other researchers have written that the issues of ensuring the continuity of the provision of vital services in the field of healthcare, social security, education, transport, housing, and utilities are becoming increasingly dependent on digital technologies (Rundel *et al.* 2020, 21). Projects to introduce digital infrastructure in rural areas should focus on their benefits for current and future generations with the potential to make rural areas more sustainable (Kashina *et al.* 2022, 2413), slow down migration outflows from rural areas (Seidakhmetova *et al.* 2022, 1993), improve the quality of life of villagers (Kornilova *et al.* 2022, 2248), and stimulate growth not only within the rural economy but also countries as a whole (Rundel *et al.* 2020, 21). Therefore, the main advantages from the standpoint of socio-economic development of rural areas, which have been identified as important and motivate local authorities to expand infrastructure digitalization initiatives, are the expansion of various services for residents, including administrative services, resource efficiency, economic development of rural areas, and achieving environmental sustainability (Table 1). The expansion of services for city residents in the field of health, education, social security, transport, and housing is the most important for 98% of the respondents.

Digitalization of the physical infrastructure of rural areas is also seen as an opportunity to accelerate economic development (Syahidun and Nawangsari 2022, 154), expand the production base (Seidakhmetova *et al.* 2022, 1993), and increase export potential (Khoruzhy *et al.* 2022, 742). In our study, 96% focused on this. The conclusions obtained by K. Salemink *et al.* (2017) were confirmed, in particular, enterprises using digital technologies to optimize work with agricultural products and their supply chains offer a wide range of opportunities to increase efficiency (Nugmanov *et al.* 2022, 268), reduce costs, and improve quality throughout the manufacturing sector.

The respondents also highly appreciated such an advantage as the efficiency of providing administrative services (94.4%). Electronic management as an element of digital infrastructure in Kazakhstan is gaining popularity and provides for the introduction of remote decision support systems, analysis, and forecasting,

provision of state and municipal services in electronic form, including through a single access point, and access to open data and various digital platforms through which citizens can participate in the management of rural areas remotely (Timoshenko *et al.* 2022).

According to the representatives of Akimats, digital solutions for improving social justice are characterized by lesser advantages for the socio-economic development of rural areas (87%). This refers to digital inclusion, improving the level of education and medical care among people with special needs.

The relevance of introducing digital solutions into everyday life can be easily understood since they provide specific opportunities, maximizing their positive impact on the population. Thus, the respondents identified the public services sector as the highest priority for the use of digital technologies – 98.1% (Table 2). In particular, the expert Dastan (9 years of experience in government agencies) assesses the situation as follows: "The provision of public services in the Republic of Kazakhstan provides for the provision of various ICT-based services due to the intensive development of digital infrastructure in the country".

The respondents identified other sectors in which digital technologies were identified as a top priority as follows: the healthcare sector – 92.5%, education – 90.6%, agro-industrial production – 88.7%, ecology, tourism, and recreation – 83% each. This choice is conditioned by many practical examples (Berdibekova *et al.* 2022, 2222). As far as the healthcare industry is concerned, telemedicine can have various types of impacts: from saving time to getting to a medical facility to reducing the overall waiting time for patients to turn up. This can both save a considerable amount of money for rural residents and improve their overall health through accelerated access to medical care.

As for the near-term perspective (Table 3), the provision of public services is one of the priority areas where digital technologies will be introduced (73.6%). The health and education sectors received the favor of 58.5% of the respondents among other areas. The top five areas where the most modern technological changes are planned include the simplification of registration procedures and the field of ecology. Less commitment to the expansion of digital technologies in the digital infrastructure of rural areas is allocated to technologies in transport, banking, housing, utilities, waste management, trade, and public safety.

The respondents identified the following among the most significant barriers to institutional and legal support: the lack of a coherent policy for the implementation of digital infrastructure at the national level (56.6% of respondents), the lack of an investment policy stimulating the development of smart technologies (50.9%), and the lack of unified standards for the implementation of smart- technologies (to conduct technological expertise) (47.2%).

43.4% of respondents paid attention to the lack of necessary legislation for the introduction of digital infrastructure. Since digital projects may contain elements that, according to the authorities, are risky, the project may face an unexpected obstacle of changing laws or regulations during its implementation, which may delay the timing of its commissioning.

Concerning the tools of regulatory support for the development of digital infrastructure in rural areas (Table 5), we consider highlighting several important theses for discussion.

The need to develop and adopt a national digital strategy is since a nationwide approach to digitalization is extremely important (Kirillova *et al.* 2022, 35). Given the strategy, rural areas will be able to respond to the demand and supply generated by the digital economy, combining various policy areas that should be aimed at expanding the ICT sector, strengthening trust in e-government, improving digital skills and education, and overcoming challenges such as data flow management. An important place in the Strategy should belong to the management of digital security risks, ensuring confidentiality and data protection. The strategy should be focused on creating positive socio-economic conditions for development and be based on strategic and tactical goals for the deployment of digital infrastructure and the introduction of digital technologies throughout the country. Its development and implementation should be based on a vision shared by both society and economic agents (reflecting public priorities). The document should be developed through broad consultations and considering the world's practical experience. Covering a wide range of issues, the strategy should form a single holistic system, including goals and tools for their implementation and monitoring their achievement.

The adoption of the National Broadband Internet Access Plan is due to the fact that an effectively formed and successfully implemented broadband policy focused on the development of social inclusion and productivity improvement can become a catalyst for expanding the digital dividends of broadband access for the economy and society. The plan should contain measures that can eliminate key barriers to the deployment of high-speed networks, as well as have the goal of overcoming the challenges associated with ensuring competition in this market and attracting investment. The National Broadband Plan is an important tool for creating a legal environment favorable for the deployment and development of digital infrastructure in rural areas. It sets the

proposed speed, the scope of service, and the scope of coverage. The Plan should contain maps of broadband coverage, including rural areas, which is important to identify current gaps and measure progress in achieving universal Internet access. It is desirable to determine the sources of investment in infrastructure projects for the development of broadband in rural areas. The following are among the first steps to the implementation of broadband access:

- reduction of administrative barriers to the deployment of digital infrastructure in rural areas by simplifying the issuance of licenses and facilitating access to physical infrastructure;
- ensuring unhindered access to the housing and communal infrastructure of rural areas;
- approval of financial support schemes: grants, loans, guarantees, fiscal incentives;
- leveling of regulatory barriers in terms of attracting investments at the initial stages of project implementation.

The development and adoption of a Digital Infrastructure Development Strategy at the level of rural Akimat will allow it to focus on its goals and resources (intellectual and financial), due to which it is possible to achieve these goals not only in the short term but also over time. This Strategy should consider the tools and mechanisms to achieve the goal, the potential of the technologies to be used, a detailed analysis of all the pros and cons, and monitoring of the market of existing business solutions in Kazakhstan on digital technologies. The strategy should be flexible and be able to adapt to changing internal or external changes, based on a clearly defined consensus vision of the future path of socio-economic development of a particular rural area. The strategy should focus on residents, since they are taxpayers, due to which the rural area is developing. It is important to define orientations: focus on specific areas of rural life support, such as education, public safety, healthcare, etc.

Digital technologies in rural areas should be inclusive and not leave a single resident out of their positive influence. In particular, the Strategy should consider the needs of vulnerable groups of the population, such as the elderly and people with special needs. The need to reach such groups is especially noticeable given their lack of skills in using such technologies.

Development of accompanying policies for the development of digital infrastructure within rural areas, for example, policies on social inclusion, education (advanced training) (Ybyraimzhanov *et al.* 2022, 507), and public procurement (introduction of mandatory independent evaluation of parameters, such as innovation, environmental friendliness, and sociality). We need modern rules – and the possibility of their application in such areas as data security, privacy, consumer protection, and cultural values. Investment-related policies (for example, taxation and trade) are important for the development of digital infrastructure in rural areas, and a link with social policy is also necessary to reduce the potential negative social and economic consequences of digital transformation.

The development of regulations on data management with the aim of non-interference in the privacy of rural residents is due to the fact that the organization of effective data collection requires the local administration to build partnerships with key organizations that generate such information. It is important to control the flow of confidential data that contains personal information, where specific pieces of data are or may be associated with personal identification information.

The development and adoption of a Digital Privacy and Security Strategy are closely related to the previous tool since the spread of digital technologies is accompanied by a change in the scale of digital security risks, which can have a significant impact on social and economic activities (Burova *et al.* 2021, 629). It is necessary to develop a reliable set of tools for responding to digital hazard incidents and managing digital risks.

Conclusion

Maximizing the potential of the digital infrastructure of rural areas will occur only given the trust of the population in combination with business and local authorities, which give priority to sustainability issues. A prerequisite for the successful implementation of digital projects in rural areas is strong political support on the ground. Local authorities should be the initiator of the implementation of such projects and lobby the interests of rural areas at different levels to participate in regional programs of state financing for the development of the digital economy.

The survey results provide an understanding of the readiness of Akimats to implement digital solutions, the obstacles standing in the way of the development of digital infrastructure in rural areas, as well as regulatory and legal measures necessary to overcome them. Therefore, it is extremely important to have progressive and effective regulatory support, with the help of which local authorities can most effectively solve the problems of rural areas, the most significant of which is the formation of digital infrastructure while protecting the interests of rural residents.

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Credit Authorship Contribution Statement

Serikbai Ydyrys: Conceptualization, Methodology, Validation, Supervision, Writing – Review and Editing. **Nazgul Ibrayeva**: Investigation, Formal Analysis, Writing – Original Draft. **Fariza Abugaliyeva**: Investigation, Formal Analysis, Writing – Review and Editing. **Mira Zhaskairat**: Project Administration, Methodology, Formal Analysis, Writing – Original Draft. **Aiman Uvaliyeva**: Data Curation, Investigation, Validation, Writing – Review and Editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Do Environmentally Responsible Practices in Accommodation Establishments Matter?

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Abstract: Environmentally responsible practices (ERPs) in accommodation establishments are identified as the implementation and or execution of certain principles in such a way that it lowers the production of waste, preserve energy, and encourages environmental health. The main purpose of this study is to identify whether or not environmentally responsible practices in accommodation establishments matters. A descriptive survey design was used. The study utilised a quantitative research approach with questionnaires as a data collection instrument. The data were analysed using Statistic Package for the Social Science (SPSS), software version 23, to enable the generation of descriptive and bivariate statistics for the interpretation of the results. The following themes emerged from the study; namely, guests' preferences of ERPs, influence of return patronage and the effect knowledge have on ERPs. Most participants were not bothered by the re-use of linen and towels, yet establishments still need to invest more time in educating the guests in this regard. Guests indicated that they would return to an accommodation establishment that practices linen reuse programs, water conservation and waste management procedures. This study provides insights on ways guests view ERPs and their preferences. It provides accommodation establishments a scope on what their guests are comfortable in participating on.

Keywords: environmentally responsible practices; linen reuse; accommodation establishments; guests; return patronage.

JEL Classification: M14; Q56; Q53; R11.

Introduction

As the world becomes increasingly cognisant of the negative impacts our modernised and automated lives have on the atmosphere that supports our livelihoods - it is crucial that every country, sector and person be well educated about and take a hands-on approach in mitigating those impacts for the sake of our very own sustenance. South Africa, as does many other countries, has seen a drastic turn in the climatic conditions over the past few years. We have seen extreme weather conditions – from extensive drought and recurring heat waves, to floods that periodically wreck-havoc in our communities. It would not be a waste of resources to start investigating extensively, the contribution every sector and industry has on the global crisis of environmental degradation caused by our ignorance and reckless operations, and ways to mitigate such contributions.

This study seeks to determine if environmentally responsible practices (ERPs) in accommodation establishments matters for guests, as well as the knowledge and the perception the guests have about whether or not these establishments do indeed implement these eco-friendly practices. The study was conducted at the Dinokeng Game Reserve, in the north of Pretoria, which houses several accommodation establishments and is home to the

'big five' and other animals. The Dinokeng Game Reserves prides itself on conserving nature and for adhering to eco-tourism.

In order to reach the main aim of the study the following objectives need to be addressed, that is; guests' preferences of ERPs, influence of return patronage, the effect knowledge and education have on ERPs.

2. Literature Review

Accommodation establishments now recognise the need to preserve and safeguard the natural environment and are implementing ERPs in their everyday business (Sucheran and Moodley 2019, 2). The government has instructed accommodation establishments to follow prescribed standards of caring for the environment (Oh 2022). The most common practices of ERPs in accommodation establishments are the use of energy-saving light bulbs, and linen and towel re-use, which reduces operational costs (Kim, Kim and Nguyen 2021). ERPs are adopted for financial gain (Abdou *et al*. 2022) and to improve the image of the company (Moise, Gil-Saura and Molina 2021,3508).

2.1 Guests' Preference of Environmentally Responsible Practices

Most guests prefer their comfort and select their accommodation mainly based on costs and the quality of the establishment (Tasci 2017, 380). This is still true even when guests have sufficient knowledge regarding ERPs. Many individuals are not willing to make sacrifices for something they cannot see, for example, the effect of recycling on climate change. Although some guests have a positive attitude towards ERPs, they lack action, based on limited awareness, confusion or scepticism about the actions taken by the establishment. This could be rectified by educating the guests on the implemented initiatives and the effect on the environment. A better understanding of the positive and negative impact on the immediate environment and wildlife may motivate guests to become more responsible and to participate more in these practises (Lee, Jan and Chen 2023,1233; Tasci 2017, 380).

Linen reuse

The implementation of linen and towel reuse programmes not only reduce immediate service costs, but also extend the lifespan of these items. A very important feature of these programmes is the saving of water and energy and reducing waste, which is good for the environment (Scholz, Linderova and Konecna 2020).

Energy efficiency

The excessive use of energy is common around the world (Yang 2017, 52). The excessive use of energy and perishable products in an accommodation establishment may result in 21% of CO2 emissions into the atmosphere (Sucheran and Moodley 2019, 2). Guests are prepared to spend more on accommodation that uses sustainable energy systems to mitigate the environmental impact (Chung 2020,722). Guests often participate in energy saving when at home but are not willing to do so when in an accommodation establishment. This reckless behaviour of guests confirms the need for educating employees as well as guests on energy and water saving initiatives (Achmad and Yulianah 2022). Most guests indicated that they would rather stay in an establishment that has energy conservation measures in store, when the cost of the establishment matches the quality of their sustainable practices (Hall *et al*. 2016, 7).

Water conservation

Accommodation establishments use about 3 423 litre per room per day, including drinking water, bathroom and toilet routines, swimming pools, and making food. Implementing policies that enforces the reduction of water consumption is challenging since it is almost impossible to monitor the guests' consumption (Yang 2017, 7).

Guests also pay a fixed fee per day regardless of the amount of water and energy they used. The establishment then benefits from guests using resources more sparingly which results in a financial saving for them (Joo, Lee and Park 2018, 1789). Accommodation establishments need to remind guests to save water in a creative manner, such as notes in the rooms. This might motivate guests to take part in the initiatives (Achmad and Yulianah 2022). Water saving techniques must be implemented to prevent serious measures such as water rationalising in affected areas.

Waste management

South Africa is faced with serious problems caused by waste disposal in accommodation establishments (Mbasera 2015, 8). There is also a huge increase in waste produced by accommodation establishments, yet the level of waste management is declining. The fast rate at which accommodation establishments are developing, poses a threat to the environment as guests largely contribute to the waste generated by accommodation establishments. It is estimated that approximately 1 kg of waste is generated per room daily. Some of the waste is excreted to water, causing harm to the environment (Mensah 2020). Accommodation establishments' failure to

educate their guests about the waste management ERPs implemented in their respective premises and the benefits thereof, may result in guests not participating in the said ERPs (Amasuomo and Baird 2016,92).

2.2. Return Patronage

Return patronage of guests is determined by their experiences and feelings of participating in something great for the environment. Therefore, their attitudes towards an accommodation establishments' green practices influences their future intentions such as the intention to stay at an environmentally responsible accommodation establishment, spreading positive word of mouth and the willingness to pay extra for ER accommodation establishments (Tan, Aziz and Ngah 2020; Patwari *et al*. 2022,4653).

Trust has been identified as an important factor influencing behavior intention (Garcia de Leaniz *et al*. 2019, 212). Guests' values, needs, and interests are highlighted as determining factors for participation in ERPs. In other words, guests participate in initiatives that they see as valuable and important in their lives (Moise, Saura and Molina 2021). Guests value ERPs and it affects guests return patronage intention. The knowledge of guests increases awareness and acceptance of green establishments and influences their behavioural decision to participate (Nimri, Patiar and Jin 2020,535).

2.3. The Effect of Knowledge and Education on Environmentally Responsible Practices

Guests might develop different attitudes towards the environment depending on whether they are directly or indirectly affected by the changing environment. Therefore, a person with perceived benefits from ERPs tends to care more and is more willing to support ERPs (Keles *et al*. 2023). Social media platforms can be used to educate guests about the importance of these practises which might better their attitudes and consequently their behavior (Olya, Bagheri and Tumer 2019,18).

If guests are enlightened about environmental matters, they might be encouraged to act in a responsible way. It has been identified that 27% of hotels were distributing brochures to their guests to educate them on environmental matters and to encourage support of the establishment's ERPs. Through education, guests' behaviour might be changed, and an environmentally responsible nation might be developed. Guests with more knowledge were more inclined to participate in environmentally responsible behaviour (Mensah 2020,33).

Environmental awareness is an important contributor to a positive attitude, responsible behaviour, and a sense of obligation to support environmentally responsible intentions (Han, Lee and Kim 2018,1304). Khatter *et al.* (2021,1351) opined that accommodation establishments were not doing enough in educating their guests on their ERPs. This caused guests to be sceptical about these practises.

Clear communication between accommodation establishment management and guests about their practices shows that they educate their employees. This could also provide guests an opportunity to educate themselves with regards to ERPs (Jaykumar 2021,1). Through education comes understanding which can enhance the willingness to support and take part in these initiatives.

3. Methodology

In order to collect the desired data, a descriptive survey, in the form of a questionnaire, was conducted at all the accommodation establishments that form part of the Dinokeng Game Reserve, whereby the guests voluntarily filled the questionnaires in. The data were analysed to give a holistic view of the perception guests have about the ERPs of the accommodation establishments. Ethical consideration was given when choosing data and distributing questionnaires. Permission from the university as well as from Dinokeng management were obtained before the commencement of the study.

A non-probability sampling technique in the form of convenient sampling were used to select the individual participants. 34 accommodation establishments were selected based on the qualification criteria. Out of 250 questionnaires sent out, only 118 questionnaires (47.2%) were received back fully completed and were successfully analysed.

In this study the questionnaire is used to determine demographic information of participants (age, gender, nationality), guests' preference of ERPs, influence of return patronage and the effect knowledge and education have on ERPs. A pilot study has been conducted in order to evaluate the questionnaires' validity and reliability.

The data were analysed using Statistic Package for Social Science (SPSS), software version 23, to enable the generation of descriptive and bivariate statistics for the interpretation of the results.

4. Results and Discussion

From the data, specific themes and sub-themes were identified. The first theme was Guests' preference of ERP's. Guests indicate that water conservation, energy efficiency, linen reuse and waste recycling procedures as very important ERPs when considering visiting an accommodation establishment (Sub-themes) (Table 1).

Table 1. The themes and sub-themes

Themes	Sub-Themes
Guests' preferences of ERPs,	Water coservation, Energy efficiency, Linen reuse Waste recycling procedures
Influence of return patronage,	Water conservation, Linen reuse Waste management
Effect of knowledge and education on ERPs	Knowledge improves ERP participation

Table 1 shows that the sub themes which influence return patronage are water conservation, linen reuse and waste management. These factors proof to be the reasons why guests return to the establishments. Guests are willing to learn about ERPs if only accommodation establishments' management can give themselves time and find ways to educate them. Guests with knowledge are more inclined to participate on ERPs in accommodation establishments compared to guests without knowledge. This then might mean that their perception depends on the level of knowledge they have on the practices.

4.1 Guests' Preferences of Environmentally Responsible Practices

Objective one of this study was based on the first identified theme to determine guests' preferences regarding the accommodation establishment's offering in terms of ERPs.

Table 2. Guests' preferences with regards to ERPs

Guests' preferences with regards to ERP	Mean	Median	Rank
Refillable glass bottled water for drinking water.	3.97	4.0	
Non- refillable plastic water bottles for drinking water.	3.00	3.0	
Provide re-usable amenities, not disposable ones	3.61	4.0	
Eco friendly air conditioning, which operates according to a timer (that switch itself off after few hours of operation).	4.15	4.0	1
Low flow showerheads with reducing valve.	3.75	4.0	
Room offering a bathtub.	3.30	4.0	
Linen and towels should be changed upon guests' request only (when sleeping for more than one night).	4.09	4.0	3
Provide organic food.	3.39	3.0	
Cross flow ventilation (small ceiling fan).	3.70	4.0	
Install photosensitive light switches on outdoor lights (sensor lights in the parking area, garden).	3.81	4.0	
Dimming lights (incandescent lighting).	3.59	4.0	
Separate waste bins in guest rooms.	3.80	4.0	
A half flush/ full flush toilet system should be installed.	4.02	4.0	5
Accommodation establishments should provide information about the green practices they engage in.	4.05	4.0	4
Energy Light-emitting diode (LED) light bulbs in rooms	4.09	4.0	3
Guests should be educated about water conservation.	4.10	4.0	2
An occupancy sensor that automatically controls lighting and air conditioning should be installed.	3.72	4.0	
I prefer to stay at a green establishment that cares about the environment.	3.87	4.0	
Friedman = 518.1875 Kendall = 0.3018 $p <$ 0.001			

Mean and median ranking analysis was conducted to determine the guests' preferences as shown in Table 2. The results in Table 2 indicate that the ERP-items listed in order of preference were as follows:

- Eco-friendly air conditioning.
- Education about water conservation.

- Led light bulbs in rooms and linen and towel re-use programmes.
- Provide guests with information about ERPs the establishment is engaged in.
- The installation of the half flush/full flush toilet systems.

Most guests indicated that they would prefer staying in an accommodation establishment that has energy conservation measures in place, provided that the cost of these establishments matches the quality of their sustainable practices. This statement corresponds with literature which indicates that most guests prefer their comfort and select their accommodation mainly on costs and the quality of the establishment (Tasci 2017, 380). It is concluded that the participants were willing to participate in ERPs if it did not require effort from them, for example, having to separate waste for recycling. Garcia de Leaniz, Crespo and Gomez-Lopez (2019, 213) concurred that guests' intention to participate in ERPs are based on values, needs, and interest. It was further concluded that the participants were willing to be educated about the ERPs of the establishment. This can be done on the website or through communication in the reception area or in the rooms. This may motivate guests to participate in the practices. Therefore, accommodation establishments need to put more effort in trying to educate guests to embrace ERPs. Guests also indicated waste recycling procedures as very important, followed by water conservation. It was found that guests were aware of these practices and would visit an establishment simply because they were following ERPs.

Guests participate when they feel whatever they are about to take part in corresponds with what is important in their lives and valuable to them. The Friedman test was conducted to determine if there is a statistically significant difference between these groups of variables of ERPs. The results indicated a statistically significant difference (Friedman = 518.2, $p < 0.001$), meaning that these ERPs are statistically significant.

4.2 Influence of Environmentally Responsible Practices on Return Patronage

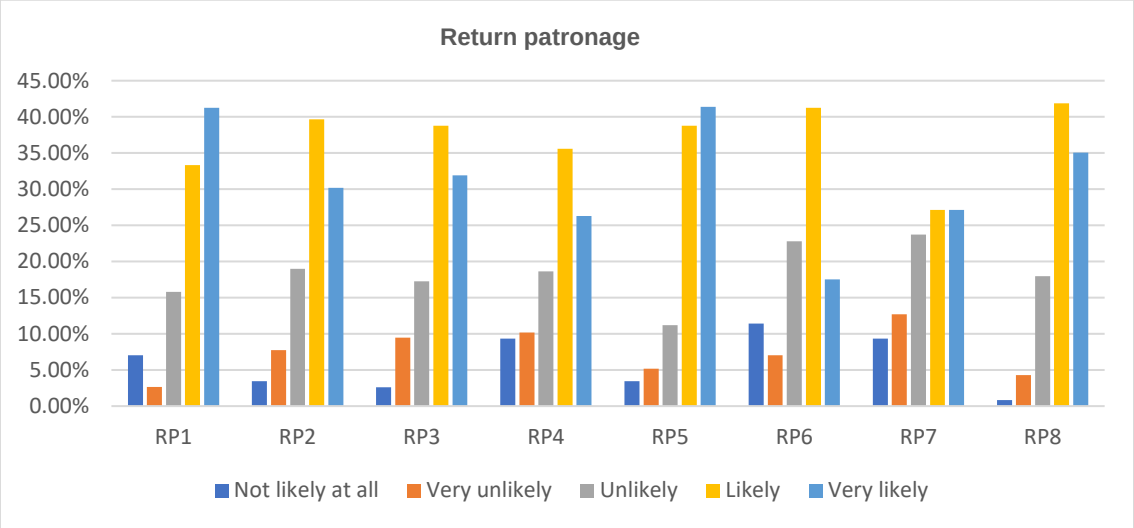
Theme two of the study determined if ERPs influence return patronage. Correlation and regression analysis were done to investigate this aspect. This section of the questionnaire presented eight statements to determine how likely it was that the participants would return to the accommodation establishment. The statements can be seen in Table 3 and the results are presented in Figure 1.

Table 3. Return patronage on the accommodation establishment

Return patronage	
RP1	Returning to stay in accommodation where you stayed in previously.
RP2	To stay in an accommodation establishment where there is technology for saving electricity.
RP3	To stay in accommodation establishment where there is technology for saving water.
RP4	To stay in an accommodation establishment where bed linen and towels are changed daily.
RP5	To stay in an accommodation establishment where bed linen and towels are changed at guests' request.
RP6	To stay in an accommodation establishment that serves organic food is served.
RP7	To stay in an accommodation establishment that has its own vegetable garden.
RP8	To stay in an accommodation establishment where waste recycling procedures are used.

The responses were guided by a 5-point Likert scale between not likely to highly likely, as presented in Figure 1. The participants were mostly likely or very likely to return to accommodation establishment offering the ERPs presented in the questionnaire. Most of the participants were likely and very likely to return to an accommodation establishment where they stayed before at 74.5% (Figure 1). The most influential factor was the issue of changing linen on the guests request with a total of 80.17% indicating likely and very likely. This was followed by the presence of waste recycling procedures being in place with a total of 76.92%. Saving water technology was also recognised as a significant factor with 31.9% indicating very likely and 38.79% indicating likely to return to such establishments.

Figure 1 Return patronage



Statements RP6 and 7 had the least impact on the likelihood of participants revisiting the establishment with a total of only 58.77% and 54.24%, respectively. These results show a similarity with the study by Tan, Aziz and Ngah (2020, 18) who indicated that ERPs affect guests return patronage intention and guests do value these initiatives. They are willing to participate because they believe that they are contributing to environmentally responsible practices and to the future generations. Therefore, guests' knowledge increases awareness and acceptance of green establishments and influences their behavioural decision to participate. The literature confirmed that knowledgeable guests would be willing to support ERPs and would revisit establishment following these practises (Tasci 2017,380). Guests have knowledge about eco-friendly behaviour and know that staying in a green establishment is costly and are willing to pay extra for their stay.

4.3 Effect of Knowledge and Education Have on Environmentally Responsible Practices

Theme three investigates the effect knowledge and education has on ERPs. Guests' perceptions whether the management of the accommodation does enough to inform them about their environmental practices. The responses can be seen in Table 4.

Table 4. Experience of the respondents in the establishment

Experience in the establishment		Yes	No	Not sure
Have you ever heard of an environmentally responsible accommodation establishment (environmentally friendly)?	N	97	12	9
	%	82.2	10.2	7.63
Is the issue of the natural environment and its protection important for the performance and development of accommodation establishments?	N	102	11	5
	%	86.4	9.32	4.24
Does the issue of linen reuse bother you (Sleep more than one night in the same linen)?	N	48	65	8
	%	40.7	55.1	4.24
Is there a brochure or pamphlet provided by the accommodation establishment to you as a guest indicating their involvement in saving the environment or their actions as the accommodation establishment to protect the environment?	N	62	22	33
	%	53.0	18.80	28.2

Most participants, 82.2%, have heard of environmentally responsible accommodation establishments. Most of the participants, at 86.04%, also agreed that the protection of the natural environment was important for the performance and development of accommodation establishments, while 9.32% did not regard it as important. Although 55.1% of the participants were not bothered by reusing their linen, 40.7% indicated that it bothered them, while 4.42% were unsure about this issue. These mixed responses might be motivated by the perception that accommodation establishments focus on linen reuse more than the other ERPs that they should consider. Chan, Tsang and Au (2022,103105) stated that linen re-use programmes are often used by management to save water and energy, hence it is the only sign of ERPs in some establishments.

More than half of the participants, at 53.0%, confirmed the presence of a brochure or pamphlet in the room informing them about the ERPs followed by the establishment. On the other hand, 18.8% indicated that it was not available while 28.2% were not sure if it was available in the room. Overall, the accommodation establishment was informing the guests of ERPs and highlighted the importance of natural resources and their protection. However, there seems to be a gap between the actions that the establishment was taking to protect the environment and the message to the guest to reuse their linen for environmental protection. Jaykumar (2021,64) indicated that guests with more knowledge on ERPs are more inclined to participate in environmentally responsible behaviour. Finally, water conservation is the statistically significant predictor of return patronage.

Conclusion

Guests preferred staying in accommodation establishments that practice energy efficiency, waste recycling, water conservation and educating guests about the ERP initiatives that establishment is taking part in. Interesting to note from the participants' selection on preferred ERPs is that it requires minimum effort from the guests. Although the participants understood ERPs and were willing to participate in this practice, they still do not want their comfort compromised. From the results it was found that water conservation, linen re-use programs and waste management initiatives were the ones contributing in guests returning to an establishment. Most of the participants were likely and very likely to return to an accommodation establishment where they stayed before.

More than 50% of the participants confirmed that there were pamphlets available, informing them about the ERPs of that establishment. Most guests indicated that accommodation establishments were actually educating them about ERPs, and most were willing to participate in ERPs, especially the linen reuse programmes. Despite these efforts there is still a gap in creating awareness and understanding of ERPs and to ensure that the guests take part in these efforts. This put pressure on establishments to implement ERPs that would benefit the establishment, guests, and the natural environment all at the same time. Knowledge is not gained from the establishment alone but also from other institutions such as government, the media and the private sectors.

Based on the findings, it is advised that accommodation establishments invest in ways to educate their guests about ERPs. Accommodation establishments and their management should seek help from the government to provide them with incentives so they can easily implement the practices and help educate the public about ERPs, not only in their homes but in accommodation establishments as well. Accommodation establishments' management need to to find ways to motivate guests to participate in environmental practices. Government needs to put measures in place that would force accommodation establishments to participate in environmentally responsible practices like offering compensation to the establishments that put in place ERPs to encourage others to do the same. Accommodation establishments' management needs to focus more on saving the environment rather than saving costs. This can motivate guests to support the intiative and in turn will increase return patronage.

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Credit Authorship Contribution Statement

Lulama Ndzungu: Investigation, Methodology, Project administration, Writing the original draft.
Carina Kleynhans: Conceptualization, Project administration, Supervision, Writing - review and editing.
Antoinette Roeloffze: Conceptualization, Supervision, Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Development of a Model of Strategic Priorities for Sustainable Development of Rural Areas in Kazakhstan until 2030. Example of the East Kazakhstan Region

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Abstract

The problems of sustainable development have been actively investigated by the scientific community. However, due to the difficulties of implementing this concept in practice, the focus of research is increasingly shifted to the study of certain aspects affecting the sustainable development of territories. In particular, this concerns the sustainable development of agriculture and rural areas, especially in socio-demographic, economic, and institutional aspects. The purpose of the article is to develop a model of strategic priorities for the sustainable development of rural areas in Kazakhstan until 2030. The article presents a model of strategic priorities for sustainable development of rural areas in the East Kazakhstan region according to socio-demographic and economic vectors, as well as institutional support with appropriate strategic goals, indicators, and target values. Solving the problem of sustainable development of rural territories is a long-term task, which can be achieved through the development of the economy of territories. The transition of rural territories to a sustainable development strategy will ensure effective farming, orientation to high standards of social protection of the rural population, multifunctional use of rural territories, preservation of the quality of the natural environment, and adaptation of institutional mechanisms to the functioning of rural agriculture and rural development.

Keywords: rural areas; strategic priorities; socio-demographic vector; economic vector; institutional support; transformation of economic processes.

JEL Classification: O18; O44; Q15.

Introduction

Considering modern global challenges, first of all, problems of ecology, rational use of natural resources, and food provision for all segments of the population (Syahidun and Nawangsari 2022, 154), the trend of socio-economic policy at the international and national level of developed countries is the concept of sustainable development (Ábel and Kóbor 2022; Michurina 2022, 349).

The full-fledged existence and sustainable socio-economic development of rural areas, including in Kazakhstan (Nardin and Nardina 2021, 1242), directly affects the level of food, environmental, and, consequently, economic security of the country (Marhasova *et al.* 2022, 441) and, in turn, depends not only on the efficiency of the functioning of agro-industrial enterprises located on them but above all on effective state policy (Voronov *et al.* 2023, 61).

In this connection, the need to substantiate the strategic priorities of sustainable rural development determines the relevance of the topic under consideration.

1. Literature Review

At the present stage of the development of social relations, rural territories are considered complex natural and economic territorial systems (Khoruzhy *et al.* 2023), the development of which is determined mainly by the degree of maturity of the internal systemic integration links between the economy (Lošonczi *et al.* 2022, 1411), social environment, and governing bodies (Agibalov and Kleimenov 2017). They are characterized by manifestations of the following specific qualities: integrity (unity of goals, functions, and structure), autonomy (striving for better orderliness), relative stability (preservation and development of internal structure), and two-dimensionality of management (allocation of common regional priorities, differentiation of economic standards of the state and economic interests of agricultural entities, local initiatives of rural population) (Merenkova 2017).

Researchers understand rural development as the sustainable development of rural areas, which ensures the growth, diversification, and improvement of the efficiency of the rural economy (Menshchikova 2013, 75), stabilization of the population and an increase in life expectancy (Brylev and Turchaeva 2020, 76), full and productive employment of the able-bodied population (Irkhina and Khrestina 2020, 58), improvement of the level and quality of life in rural areas (Molchanova and Abryandina 2016, 103), and rational use and reproduction of their natural resource potential (Grekov 2014, 62).

The issue of sustainable development of rural areas, according to scholars, is caused by the following reasons: fatigue of people in many countries from too highly urbanized civilization (Germanovich *et al.* 2020, 965) and the growing prestige of rural lifestyle as an alternative to urban (Tulla *et al.* 2017, 25); understanding that progress and harmonious development of society as a whole are impossible without sustainable development of rural areas (Masot and Gascón 2021); the growing crisis of rural life and the transformation of rural regions into zones of poverty and social disadvantage (Shaporova and Tsvettsykh 2020, 23); inefficiency/impossibility of using development mechanisms suitable for urban communities in rural areas (Loskutova 2013, 67).

According to researchers, sustainable development of rural areas has two directions: 1) sustainable development of rural settlements intended for the development and residence of the population with the development of appropriate engineering, transport, and other infrastructure (Sagaidak and Selyanskii 2021, 432); 2) stable development of rural settlements and their surrounding territories in terms of increasing agricultural production and agricultural efficiency, achieving full employment of the rural population, improving their standard of living, and rational use of land (Martynov 2014, 28).

The study of the situation in the social sphere of the village reflects the processes that ensure human life in society (Kashina *et al.* 2022, 2413). Its impact on the sustainable development of territories (Bantserova and Kasimova 2023, 939) can be divided into the following areas: the demographic sphere, the socio-industrial sphere, and the level and quality of life (Vartanova 2019, 1925). Improving the level and quality of life of the rural population, on the one hand, is a goal; on the other, it is a necessary condition for ensuring sustainable development of rural areas (Satybaldin *et al.* 2021, 6).

Criteria for assessing the level and quality of life of the rural population as indicators of sustainable development of rural areas are identified based on the concept of sustainable economic development of society (Moroz *et al.* 2020, 166). The main among them are the growth of real income and reduction of the gap from urban indicators (Skalnaya 2018, 62); reduction of poverty and social differences and formation of population groups with average incomes (Kizimbayeva and Saubetova 2021, 22); fair assessment of the level of wages and absence of delay of all types of payments (Gushchin and Kuznetsova 2014, 126); improvement of socio-psychological state and the confidence of rural the population in their future and the future of their children (Digilina *et al.* 2017, 125); improvement of the quality and level of social services available to rural residents and

preservation of the core of social infrastructure (Akupiyan and Kapinos 2018, 50). To no less extent, the sustainable development of rural areas depends on the filling of local budgets, a significant part of which is formed at the expense of their tax revenues (Anichin *et al.* 2020, 118).

Studies of sustainable development of rural territories in the Republic of Kazakhstan are focused on ensuring balanced economic, demographic, and social development of rural territories based on increasing competitiveness (Muhardi *et al.* 2020, 1025), the profitability of agricultural production and expansion of non-agricultural entrepreneurship in rural areas (Figus and Shaikin 2019, 27), protection and rational use of natural, labor, and production resources of rural territories (Seidakhmetova *et al.* 2022, 1993), and achievement of social standards and living standards for the rural population (Kornilova *et al.* 2022, 2248). However, in general, the problem of strategic priorities for the sustainable development of rural areas in the scientific literature of Kazakhstan remains little explored.

In this connection, the purpose of the article is to determine the strategic priorities of sustainable development of rural areas based on the example of the East Kazakhstan region.

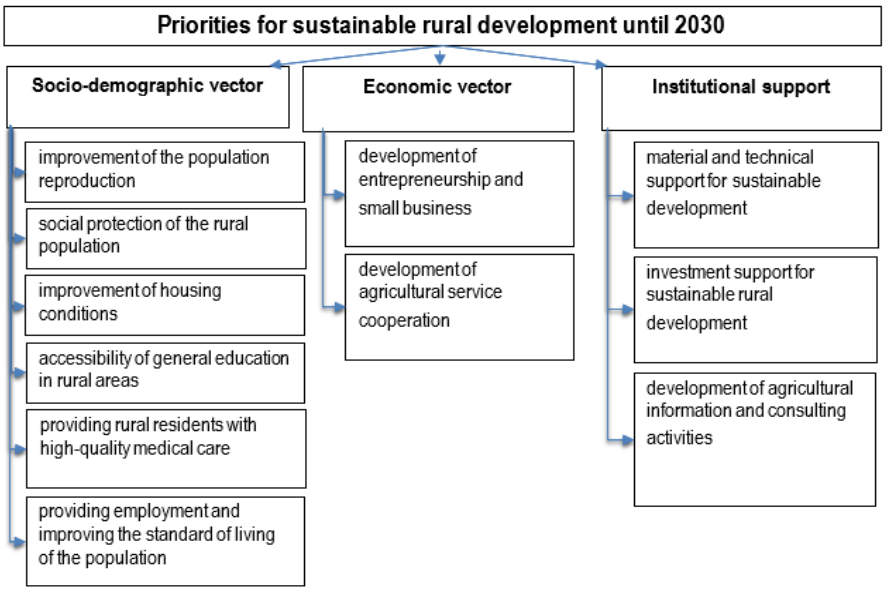
2. Methods

The study was conducted in the period from November 30, 2022, to December 30, 2022. We performed both field (at enterprises and organizations of the East Kazakhstan region) and desk research (at the Eurasian National University named after L.N. Gumilyov).

A qualitative approach to the study was chosen to achieve the research goal.

The rural population in Kazakhstan accounts for 38.3% of the available population (as of October 1, 2022), and agricultural land accounts for more than 70% of the country's land fund. The sustainability of rural development largely determines the sustainable socio-economic development of the country as a whole. Based on the need to understand the priorities of sustainable development, we developed a model of priorities for sustainable development of rural areas in Kazakhstan until 2030 (Figure 1).

Figure 1. Model of priorities for sustainable development of rural areas in Kazakhstan until 2030



To determine the indicators and targets (2030), we analyzed the Internet resources of the district Akimats of the East Kazakhstan region, based on which the selection of experts was carried out, including employees of Akimats responsible for the development of rural areas.

The expert sample consisted of 48 experts, three employees from each district Akimat, to whom e-mails were sent indicating the purpose and program of the research. Of the experts to whom letters were sent, 44 experts agreed to participate in the study and provide the necessary information.

The field study consisted in analyzing the current situation with the development of rural areas in the districts of the East Kazakhstan region and in-depth interviews with experts to determine the priorities of sustainable development of rural areas in the East Kazakhstan region.

During the interview, the purpose of the study was explained, and open-ended questions were asked, outlined to clarify the views and opinions of the experts on the priorities of sustainable rural development. The duration of each interview averaged 25-30 minutes.

During the desk study, the analysis of scientific sources on the problem of sustainable development of rural areas, as well as strategic and/or program documents of district Akimats provided by the experts by e-mail, aimed at solving the problem of sustainable development of rural areas in the East Kazakhstan region, was carried out.

3. Results

We justified the strategic priorities of sustainable rural development for the period until 2030 based on the results of the expert survey and the analysis of the strategic and program documents.

Strategic priorities with corresponding indicators and their target values are presented in Tables 1-3.

Table 1. Strategic priorities for the socio-demographic vector

Indicators	Targets (2030)
Improvement of the population reproduction	
increase in the total fertility rate of the rural population	12.4 people per 1,000 people of the existing population
increase in the total fertility rate of the rural population	2.215 children per woman
reduction of the overall mortality rate of the rural population	12.4 people per 1,000 people of the existing population
stabilization of the rural population	12,450 thousand people of the rural population
Social protection of the rural population	
coverage of rural residents by the social protection system through the introduction of social packages for employees and the creation of a mobile social service network in rural areas; increasing the level of provision of rural disabled people with the necessary means of rehabilitation (prosthetic and orthopedic products, self-service transport, etc.)	100% coverage of social services for pensioners, disabled, and single disabled citizens in rural areas
	annual increase in the share of social benefits to the poor who live in rural areas by 5-10%
Providing rural residents with high-quality medical care	
construction of new and restoration of the functioning of hospitals in large (more than 1 thousand) and medium (more than 500 inhabitants) settlements; maintenance of health care facilities in the rural settlement network following regulatory requirements	construction of new hospital facilities in large and medium-sized villages, as well as the restoration and repair of old hospital facilities in them, which will increase the security of the settlement network by 1,520% and significantly improve the quality of medical care for the rural population
Accessibility of general education in rural areas	
restoration of preschool institutions in those localities where there is a need for it; the opening of schools in large (more than 1,000 residents) villages that do not have them, but 50 children or more aged 6-17 years live in them; construction of new and major repairs of schools in large and medium (until 500 residents) rural settlements where 2,050 children live	opening of new preschool institutions and schools in large villages; carrying out major repairs in 35% of the existing number of preschool institutions and 40% of the existing schools in rural areas
Improvement of housing conditions in rural areas	
increasing the housing stock in rural areas providing young families with housing and land plots for the construction of new housing	an increase in the housing stock in rural areas by 3.3% according to the optimistic forecast (according to the pessimistic forecast by 1%)
	providing young families with housing within the norm (21 m^2 per inhabitant)
Providing employment and improving the standard of living of the rural population	
increasing and stabilizing the level of employment in rural areas	employment rate of the population in rural areas is 80%
increasing the level of formal employment in rural areas	share of the informally employed rural population in the total number of employed in rural areas is 10%
growth in the volume and share of wages and income from entrepreneurial activity in the monetary income of households	share of wages and income from entrepreneurial activity in the monetary income of households is 80%

Note: compiled by the authors based on the expert survey and analysis of strategic and program documents of district Akimats

Table 2 - Strategic priorities for the economic vector

Indicators	Targets (2030)
Development of entrepreneurship and small-scale farming in rural areas	
increase in the number of small and medium-sized businesses and employment in business structures operating in rural areas; an increase in the share of income of rural households from entrepreneurship and self-employment	creation of business structures in all rural settlements based on transformed personal farms; annual creation of new small enterprises in rural areas at the level of 1.5-2 thousand units
	share of income of rural households from entrepreneurship and self-employment is 13%
Development of agricultural service cooperation	
creation of a network of agricultural service cooperatives and the formation of new jobs in cooperative structures; the level of coverage of farms of the population agricultural we cooperatives	creation of agricultural service cooperatives (1 cooperative for 3-4 rural settlements)
	creation of 50 thousand new jobs in the rural cooperative network; coverage by agricultural cooperatives of over 30% of households; achievement of a 15% share of cooperative trade in the total volume

Note: compiled by the author based on the expert survey and analysis of strategic and program documents of district Akimats

Table 3. Strategic priorities for institutional support

Indicators	Targets (2030)
Material and technical support for rural development	
formation of the material and technical base following the regulatory need	increasing the volume of fixed assets of production to the standard level
increasing the supply of agricultural machinery, including national producers	achievement of the annual technological need for technical means, provision of technological needs with equipment of national production at the level of 55%
increasing security of agriculture with environmentally safe means of production	provision of agricultural production with fixed assets that meet environmental standards at the level of 50%
Investment support for rural development	
level of ensuring the production of agricultural products with capital investments	increase in capital investments in agricultural production up to $170-220 per 1 ha of agricultural land
increasing capital investment in agricultural production	annual increase in capital investment in agricultural production by 10-12% the ratio of own and attracted financial resources of rural producers 2 : 1
increasing the investment potential of rural producers in the context an optimal ratio between their own and attracted sources of financing resources	ratio between own and attracted financial resources of rural producers 2 : 1
support for investment in small agricultural businesses	ensuring the needs of personal peasant and farm households in attracted sources of investment financing by 100% through the support of small agribusiness investments
Development of agricultural information and consulting activities	
integrated system of information and consulting activities developed at the local level	creation of an effective information and consulting system based on a mixed model, where the state component is the main one
percentage of consulting services coverage	achievement of 90% coverage of the population of rural areas with socially oriented consulting services
increase in revenues to budgets of various levels	increase in income due to the increase in the efficiency of agricultural production and the development of rural entrepreneurship

Note: compiled by the author based on the expert survey and analysis of strategic and program documents of district Akimats

3. Discussion

The development of rural areas in Kazakhstan is conditioned by the urgent demand for modernity to get rid of the negative realities that have accumulated in the agricultural and social spheres of the village. Therefore, the model of the rural development strategy developed by us is based on the preservation and enrichment of the human potential of the village. The main strategic priority of the experts was identified as "Improving the reproduction of the population". The achievement of its goals is based on the satisfaction of human needs and the creation of attractive conditions for living and working in rural areas, which determine the economic and social vectors of sustainable development consistent with the results of the study ((Vartanova 2019, 1925).

According to the results of an expert survey, the accessibility of the rural population to social services is low; therefore, the formation of conditions for sustainable development of rural areas is closely related to solving the social problems of the village and achieving social standards and living standards for the rural population. In this connection, the following strategic priorities are defined:

- "Social protection of the rural population", the general purpose of which is to create the social usefulness of rural areas to ensure everyone's access to vital social benefits regardless of the place of residence, which is consistent with the opinion expressed in the work (Sagaidak and Selyanskii 2021, 432);
- "Providing rural residents with high-quality medical care", the purpose of which is to form a qualitatively new system of qualified medical care based on the maximum preservation of the existing and development of a new network of healthcare institutions, the development of new progressive forms of medical care, and the preservation of its accessibility, which is consistent with the opinion expressed in (Grekov 2014, 62);
- "Accessibility of general education in rural areas", which provides for ensuring optimal accessibility of high-quality preschool, general secondary (mandatory) education to every rural child, extracurricular, vocational, special secondary, and higher (optional) education to every citizen, regardless of their place of residence, health status, social background, and financial opportunities;
- "Improvement of housing conditions in rural areas", which means providing residents with comfortable housing that will meet the modern needs of various categories of the rural population and technological, economic, and environmental requirements.

Speaking about the economic vector of strategic priorities for sustainable development of rural areas, the experts noted that the financial ability to develop rural areas is fundamental. The determining factor in the growth of Akimats' incomes is to ensure the fullest and most productive employment of rural residents with an increase in their income in terms of wages and business activities.

The problem of poverty in rural areas, which has a large-scale and consistent nature, remains unresolved and leads to harmful long-term effects (Skalnaya 2018, 62). Traditionally, the total resources and monetary incomes of households in urban settlements are greater than in rural areas (by 7-10%) (Digilina *et al.* 2017, 125). The level of wages in agriculture, as in the main sphere of employment of rural residents, is lower than the average for the national economy (in the last 5 years by 23-40%), and incomes from entrepreneurial activity in rural areas do not exceed 6% of total incomes (Kizimbayeva and Saubetova 2021, 22). Therewith, employment problems remain acute in rural areas:

- there is a steady downward trend in the number of the economically active population in rural areas and employment in rural areas, which does not exceed 61%;
- rural employment, unlike urban settlements, is characterized by instability, proving significant fluctuations in the levels of economic activity and employment in rural areas;
- in rural areas, the problem of informal employment is particularly acute, because the share of informally employed in the total number of employed aged 15-70 is 40-50%.

Considering the above, as one of the strategic priorities, "Ensuring employment and improving the standard of living of the rural population" is justified. Its strategic goal is to guarantee the right to work to every able-bodied resident of the village to provide opportunities to implement their knowledge and professional and entrepreneurial abilities and to receive remuneration for their work that corresponds to a decent standard of living.

Ensuring employment is associated with the development of entrepreneurship in rural areas, therefore, the next strategic priority is defined as "Development of entrepreneurship and small forms of farming in rural areas", the purpose of which is to form a competitive business environment capable of providing employment and income growth for the able-bodied rural population, promoting agricultural products on the most favorable terms for agricultural producers and increasing the incomes of rural enterprises, households, and communities.

In the developed countries of the world, the successful business model of the rural economy is cooperation. Considering the proven success of this business model (Tulla *et al.* 2017, 25), one of the strategic

priorities is "Development of agricultural service cooperation", the strategic goal of which is the further formation of the cooperative sector for the development of an effective system of servicing agricultural producers and the population on the most favorable conditions for them and with their direct participation.

The experts substantiated strategic priorities for creating institutional conditions for development to ensure the implementation of the main directions of sustainable development of rural areas by social and economic vectors.

- "Material and technical support for the development of production and rural areas", aimed at increasing, both quantitatively and qualitatively, the provision of rural areas with capital investments that guarantee the effective execution of the entire volume of agricultural production based on modern environmentally friendly technologies and the creation of a material and technical base for business activity in the rural areas;
- "Investment support for the development of production and rural areas", providing for the establishment of the adequate conditions in order to increase the production of agricultural products based on the use of high technologies and the export orientation of the agricultural producer, meeting the needs of its own citizens in agricultural products, increasing the number of jobs in rural areas and increasing the income of rural residents.

The rapid change in production technologies and legislation, changes in demand in the market for the products of the rural economy, lead to an increase in the need for rural entrepreneurs and local authorities in consulting services. The lack of a system of advisory services developed at the local level, their low coverage due to the lack of a sufficient volume of supply hinders the development of rural entrepreneurship.

This leads to the justification of such a strategic priority as "Development of agricultural information and consulting activities", the purpose of which is to form an effective system of consulting services for the rural population aimed at improving the skills of conducting agricultural, entrepreneurial and other activities.

Conclusion

The model of the sustainable development strategy developed by us is focused on long-term economic development (as a basis for meeting human needs) and is based on certain conditions and standards (indicators). For the sustainable development of rural areas, regional and local programs for the socio-economic development of rural areas should be adopted and implemented, primarily aimed at increasing employment and incomes of the rural population, developing local self-government, and stimulating entrepreneurship in rural areas.

The implementation of the proposed model of sustainable development of rural areas is a long-term task, which can be achieved through the development of the economy of the territories. The limitation of the research results that affect the implementation of the proposed model is the attraction of long-term investments and the effective organization of economic programs and projects that can create the necessary financial flows to ensure the successful implementation of the model of sustainable socio-economic development of rural areas in Kazakhstan.

The transition of rural territories to a sustainable development strategy will ensure effective farming, orientation to high standards of social protection of the rural population, multifunctional use of rural territories, preservation of the quality of the natural environment, and adaptation of institutional mechanisms to the functioning of agriculture and rural development.

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Credit Authorship Contribution Statement

Kalamkas Nuralina: Conceptualization, Investigation, Formal Analysis, Writing – original draft. **Raisa Baizholova**: Conceptualization, Methodology, Supervision, Validation, Writing – review and editing. **Yergali Abenov**: Conceptualization, Methodology, Supervision, Validation, Writing – review and editing. **Dinara Mukhiyayeva**: Project Administration, Data Curation, Validation, Writing – review and editing. **Yerkezhan Moldakenova**: Project Administration, Data Curation, Validation, Writing – review and editing.

Declaration of Competing Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Investing in Human Capital for Green and Sustainable Development

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Abstract: Green and sustainable development is crucial for addressing environmental challenges and promoting a more sustainable future. Central to this endeavor is the investment in human capital, which involves developing and empowering individuals with the knowledge, skills, and mindset necessary to contribute and lead sustainable development efforts. Explores the importance of investing in human capital and the various ways in which it can be fostered to drive green and sustainable development. An analysis was made in the areas of investments in health care, education and environmental protection in order to develop a sustainable green development of the economy.

Keywords: green development; human capital; environmental protection; sustainable development.

JEL Classification: Q57; M54.

Introduction

The green economy is currently being differentiated as a separate direction in the economy that needs additional scientific research. What stands out is that it represents the efficient use of natural resources and the reduction of pollution in production processes. Along with the green economy, one can often come across the concept of "sustainable development". The direction of sustainable development of the green economy involves a process that affects the economic, social and political spheres of life of the population. An important component contributing to the process of implementing the green economy is human capital. Efficient distribution and use of

other types of capital will ensure the stable development of a sustainable green economy. Countries successfully implementing green economy principles have one of the highest human capital indices. Many states that successfully implement the principles of green development attract human capital from abroad.

Before the introduction of restrictions, human capital accounted for about two-thirds of the structure of national wealth in the world. However, in the post-quarantine period, the formation of human capital has become extremely important, since human skills and knowledge are the most important resource for the sustainable development of the green economy.

Socio-environmental and economic issues today have an important basis, characteristic of human life. Solving the problems of the ecological crisis, and hence reducing the level of poverty, actualizes the need to study the role and importance of human capital in the development of society. In this regard, the scientific substantiation of a number of criteria assessing human capital in the interests of the sustainable development of the green economy is of great importance.

1. Literature Review

The relationship between financial development and green growth is manifested in the fact that human capital and education spending are becoming one of the 2030 Sustainable Development Goals. Education and health have a positive and significant impact on economic growth and, by supporting higher growth rates, sustainable development. Human capital plays an important role in the process of economic growth, where education and health are key components. Economic growth is stimulated by such areas as life expectancy, the level of health care financing, technological progress, poverty reduction, child mortality, and fertility.

Thus, it is necessary to take adequate measures for the listed measures in the field of increasing health care costs and life expectancy while reducing poverty, mortality and fertility. Practice shows that health care spending has a significant negative correlation with economic growth. With a high level of human capital, the economic impact of spending on health care is enhanced.

The study of sustainable ways of conducting socio-economic activities leads to the inevitability of human overspending of natural capital. The formation of financial, natural and human resources for ecological systems is not well understood, which requires research on the combined impact of economic growth and capital on environmental sustainability. Natural resources and human capital help to reduce environmental impact, as does investment. Attracting investment and human capital will help the rapid introduction of innovation of states. Human capital influences the spread of intensive use of new technologies between countries, while ensuring economic growth (Cervellati *et al.*2023).The use of incompetent human capital leads to negative consequences of environmental degradation, which require the development of mechanisms for the implementation of nature management (Regier *et al.*2023).

Human capital knowledge, potential and skills have a significant positive relationship with organizational performance, as evidenced by the effect of innovation leadership between human capital knowledge and organizational performance (Ahakwa *et al.* 2023, Jandrić 2023). Food security and the environment has important implications for improving environmental sustainability and efficient use of food resources has implications for human capital research (Ashraf and Javed2023).

The study of strategic issues of working with human resources is in a positive relationship with the potential for the effectiveness of innovation. The need to implement a knowledge management strategy can rethink knowledge processes and unleash the full potential of their human resources, gaining a competitive advantage in a knowledge-based economy (Stefănescu and Stefănescu 2008), will positively affect the increase in life expectancy (Latifah *et al.* 2022, López-Cabrales *et al.* 2021, Budiarti 2018, Chung-Jen 2019).

The lack of research by foreign and domestic authors and the practical side of the issues of human capital formation show the need to develop theoretical and methodological foundations in this area.

2. Investments in Human Capital the Key to a Sustainable Recovery

Sustainable development requires a holistic approach that encompasses various aspects of life, including the environment, economy, and society. Investments in human capital, particularly education and training. By raising the level of education and skills of employees within a company, several positive outcomes can be achieved, including the reduction of negative environmental impacts.

All aspects of human capital have a positive effect on increasing life expectancy, which is explained by the demographic policy of many countries. However, increasing life expectancy hampers economic growth, probably due to an increasingly aging population (Sultana *et al.* 2022). Innovations in green technologies can bring dual benefits, *i.e.*, technological progress and energy savings, as well as emission reductions, which are considered

an effective means of achieving economic development and environmental protection. Human capital significantly contributes to green technology innovation (Zhang and Li 2023).

Human capital has a positive relationship between energy consumption and economic growth, although a significant negative relationship is found between R&D spending and energy consumption (Shahbaz *et al.* 2022). To achieve the Sustainable Development Goals (SDGs), the relationship between financial development and green growth is explored, where human capital and education spending are central to sustainable development (Ngo *et al.* 2022).

The impact of environmental regulations and foreign direct investment on the overall productivity of industrial sectors by controlling human capital will ensure the transition to a green economy that will benefit its own sustainable development (Qiu *et al.* 2021). The relationship between human capital and economic growth shows that both education and healthcare have a positive and significant impact on the green economy and thus support higher growth rates (Chaabouni and Mbarek 2022, Jayadevan 2021).

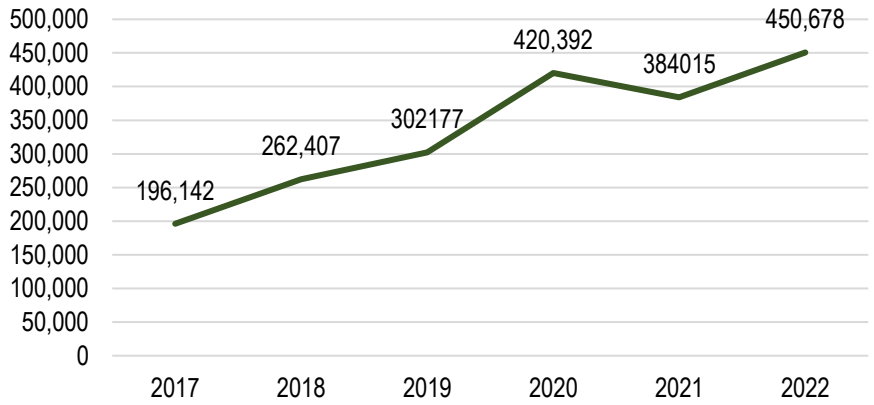
The results show that spending on health care and the green economy depends on different levels of human capital. In particular, when the level of human capital is low, health spending has a significant negative correlation with economic growth (Yang 2020, Puskarova 2022, Jabeen *et al.* 2023).

Economic growth and energy consumption are negatively related to the ecological footprint. Natural resources and human capital help reduce environmental impact, as does foreign direct investment (Zafar *et al.* 2019). A large number of publications devoted to the problems of human capital are confirmed by Kazakh researchers as Nakipova (2021), Aimurzina *et al.* (2021).

The investments in human capital can contribute to environmental sustainability as follows:

- Increased Environmental Awareness: Education can enhance individuals' understanding of environmental issues, their causes, and potential solutions. By providing education and training programs that focus on environmental sustainability, companies can raise awareness among employees about the importance of protecting the environment and adopting sustainable practices.
- Adoption of Sustainable Practices: Well-educated employees are more likely to be knowledgeable about sustainable practices and technologies. Through training and education, companies can promote the adoption of environmentally friendly practices, such as waste reduction, energy efficiency, and resource conservation.
- Innovation and Research: Investments in education and research can drive innovation in sustainable technologies and practices. Well-educated employees are more likely to develop innovative solutions to environmental challenges, sustainable production processes. These innovations can contribute to reducing the environmental footprint of businesses.
- Compliance with Environmental Regulations: Education and training can help employees understand and comply with environmental regulations and standards. By investing in the education of employees, companies can ensure that they have the necessary knowledge and skills to meet environmental requirements and implement sustainable practices in their daily work.
- Sustainability in Decision-Making: Education equips individuals with critical thinking and problem-solving skills. Employees with a higher level of education are more likely to consider the environmental impact of their decisions and incorporate sustainability principles into their work. This can lead to more environmentally conscious decision-making processes within the organization.

Figure 1. Costs for environmental protection, mln. tenge



Source: compiled by authors according to www.stat.kz

The data in Figure 1 show that the cost of environmental protection in 2022 increased by almost 2.3 times or 254,536 million tenge. Based on the foregoing, in recent years the level of social responsibility has been significantly reduced and environmental responsibility has been increased (priority to natural capital).

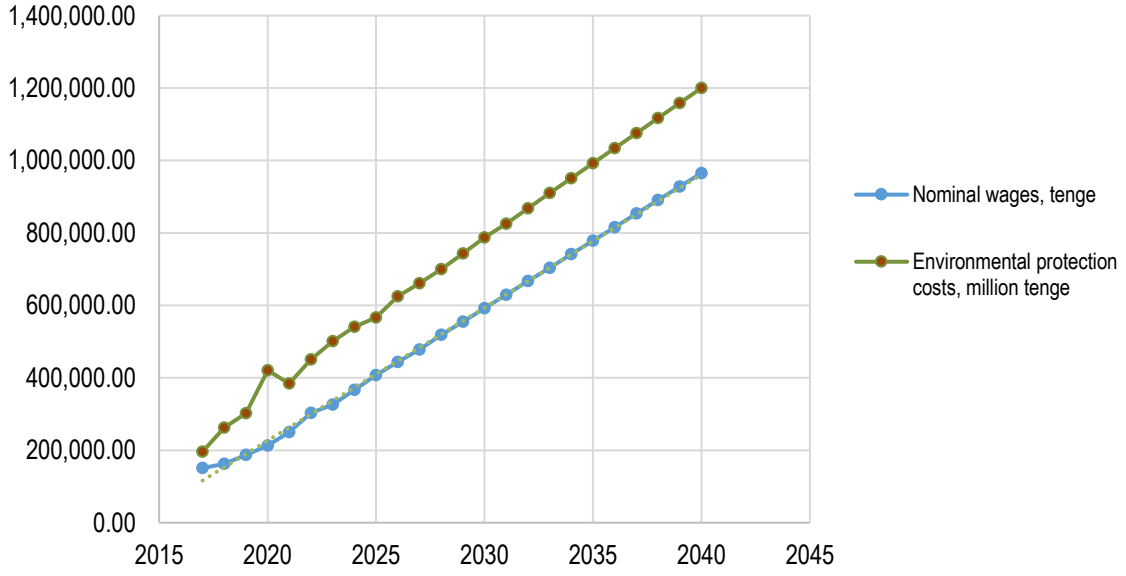
With the help of applied statistics methods, the dynamics of two factors of sustainable development were compared. Next, we will conduct an analysis of variance to determine whether the sustainability factors depend on the selected socio-economic and environmental parameters of the space.

Table 1. Forecast of two factors of sustainable development

Year	Nominalwages, tenge	Environmental protection costs, million tenge
2017	150.827	196.142
2018	162.673	262.407
2019	186.815	302.177
2020	213.003	420.392
2021	250.311	384.015
2022	303.000	450.678
2023 forecast	326.405,40	501.447,80
2024	366.660,22	540.390,24
2025	406.898,576	566.613,392
2026	443.705,651	625.101,594
2027	477.905,313	661.050,039
2028	518.328,609	700.095,362
2029	555.002,728	742.804,193
2030	591.617,554	787.345,527
2031	629.188,337	825.151,949
2032	667.165,006	867.925,610
2033	703.817,968	910.067,003
2034	741.311,698	951.190,568
2035	778.825,489	992.117,672
2036	816.087,998	1.034.449,48
2037	853.297,683	1.075.679,59
2038	890.788,886	1.117.046,09
2039	928.090,322	1.158.678,57
2040	965.387,242	1.200.309,80
	$y = 4587{,}1x^2 - 2110{,}8x + 148921$ $R^2 = 0{,}9988$	$y = -5403{,}5x^2 + 87988x + 109964$ $R^2 = 0{,}9266$

Source: compiled and calculated by authors

Figure 2. Linear relationship between two sustainability factors: nominal wages and environmental costs



Source: compiled and calculated by authors

A linear relationship between two sustainability factors, nominal wages, and environmental costs implies that changes in one factor are directly and proportionally related to changes in the other. In this context, it would mean that as nominal wages increase, environmental costs also increase, and vice versa. If nominal wages rise, it could lead to increased consumer spending and economic growth, which might result in higher production and resource consumption, subsequently raising environmental costs. On the other hand, if nominal wages decrease, there might be reduced consumption and production, potentially leading to lower environmental costs.

The linear relationship between two sustainability factors: nominal wages and environmental costs is expressed by the equation: y = 36725x - 7E+07, R^2 = 0,9988.

Table 2. Directions for investment in human capital

Investmentprograms	Results
Environmental protection	▪ Reducing harm to the environment. ▪ The use of clean energy through social subsidies for utilities. ▪ Implementation of environmental management through the training of professional workers in low-carbon enterprises.
Education (inclusive)	▪ Covering the poorest segments of the population with quality education programs.
Socialsphere	▪ Access to health care and social support for vulnerable groups, including persons with disabilities, especially in times of cataclysms or pandemics.

Source: compiled by authors

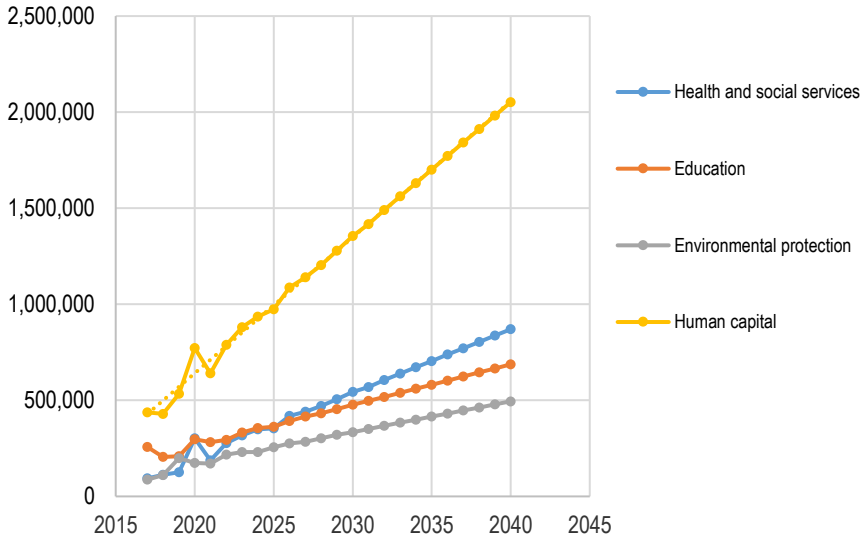
In order to determine the structure of investments in human capital from the point of view of formation, it is necessary to analyze them in terms of investment areas, namely investments in healthcare, education and environmental protection, which is possible as a result of applying the summation of investment flows in the formation of human capital (Table 3).

Table3. Forecast of investments in human capital, million tenge

Years	Investments in healthcare and social services (IH)	Investments in education (IE)	Investments in environmental protection (IEP)	Investments in human capital IHC = ∑I H+ ∑ I E +∑I EP
1	2	3	4	5
2017	93.717	257.223	86.962	437.902
2018	113.230	205.265	111.161	429.656
2019	126.494	209.162	198.722	534.378
2020	301.911	297.263	173.619	772.793
2021	187.287	282.907	171.165	641.359
2022	277.274,1	293.373,8	217.585	788.233
2023 forecast	317.903,58	332.582,94	230.037,7	880.524
2024	349.628,614	355.943,552	230.204,96	935.777
2025	354.616,4012	362.525,1716	256.135,718	973.277
2026	419.445,934	392.008,3213	275.794,0944	1.087.248
2027	440.090,6726	415.450,1392	284.706,3565	1.140.247
2028	470.594,4919	432.241,7751	301.853,7000	1.204.690
2029	505.097,0309	453.290,216	321.299,4014	1.279.687
2030	543.601,8513	477.632,1875	334.873,9458	1.356.108
2031	569.761,454	496.850,8706	350.131,3239	1.416.744
2032	605.533,7768	517.550,6002	367.733,9996	1.490.818
2033	639.280,6188	539.766,6213	383.356,2307	1.562.403
2034	671.744,6768	560.879,4661	398.571,0940	1.631.195
2035	703.725,9203	581.359,0415	415.119,0798	1.700.204
2036	738.251,2391	602.984,8822	431.226,1274	1.772.462
2037	770.671,3142	624.246,4175	446.825,4377	1.841.743
2038	803.521,1397	645.166,7883	462.897,6282	1.911.586
2039	836.732,354	666.365,9253	479.035,7013	1.982.134
2040	869.965,2238	687.683,3131	494.872,218	2.052.521
				y = 70778x - 1E+08 R^2 = 0,9947

Source: compiled and calculated by authors

Figure 3. Linear regression model of investment in human capital



Source: compiled and calculated by authors

Using the methods of correlation-regression analysis, the main static processes of the development of human capital were identified according to the criterion of maximum closeness of the pairwise correlation of such indicators as health care, education and environmental protection. The coefficient of determination (R2) is equal to $R^2 = 0.9947$.

Conclusion

Thus, the most important tool for the development of human capital is the process of investing in the sustainable development of a green economy. The transition to sustainable development towards a "green" economy determines the sustainability of the development of not only individual national economies, but also the conservation of natural resources and the uninterrupted supply of resources and ecosystem services.

Green growth will accelerate investment in human capital, which will lead to the formation of new professional skills among specialists. The education sector, which ensures the development of human capital in a new innovative environment, the digital economy with qualified and competitive personnel, should play an important role. Human capital should become an integral part of the concept of sustainable green development, along with the economic, social and environmental spheres.

Identifying talented youth and building a successful career in science to provide the sectors of the innovative economy with highly qualified personnel will become a platform for a green economy. The concept of developing human capital and intellectual potential should be based on the growth of investment in education, which will lead to the development of human capital and the socio-economic development of society. Human capital should also be considered as an economic and social resource for the development of any state by improving the system of higher professional education, ensuring continuous professional development and effective retraining of personnel.

The transition to a resource efficient economy requires a skilled and knowledgeable workforce that can adapt to changes in technology, politics and business practices. There is a need to acquire skills and knowledge related. It is necessary to rethink the priority of the social sphere and the formation of a multi-channel system of sources of investment in higher education and health care by increasing the financing of primary health care, in order to rapidly increase financial / human resources for emergency response.

Credit Authorship Contribution Statement

Ansagan Beisembina: Development of the concept of scientific work: the formation of ideas; formulation of key goals and objectives. Writing an introduction, designating problems that have not been resolved in previous studies. The formulation of the purpose and objectives of the study, the relevance of the topic and the degree of its importance at the moment and in this situation. Critical review of the literature, generalization of the main points of view, study and evaluation of existing works on this topic.

Alla Gizzatova: The formulation of the purpose and objectives of the study, the relevance of the topic and the degree of its importance at the moment and in this situation. Critical review of the literature, generalization of the

main points of view, study and evaluation of existing works on this topic. Description of the sequence of the study and justification for the choice of methods used to obtain reliable and reasoned results.
Yerlan Kunyazov: Conducting research, gathering data/evidence, analyzing and interpreting the findings. Systematization of statistical material in the form of tables, figures. Experimental part, analysis, generalization of data. Based on the studied scientific positions of scientists and experimental work, an analysis of the patterns and trends in the development of the process under study, a forecast of the data obtained during the study.
Takhir Ernazarov: Experimental part, analysis, generalization of data. Analysis of patterns and trends in the development of the process under study, forecast of the data obtained during the study. Application of statistical and mathematical methods for the analysis and synthesis of research data.
Nurlan Mashrapov: Drafting of the manuscript, preparation, creation and presentation of the published work. Final revision of the published version of the manuscript. Drawing up a conclusion as a brief formulation of the results of the study.
Sergey Dontsov: Preparation, creation of a published work in terms of data visualization/display. Final revision of the published version of the manuscript. A brief analysis of the results obtained, drawing reasoned conclusions. Acceptance of responsibility for all aspects of the work, the integrity of all parts of the article and its final version.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Top Management Support, Green Intellectual Capital and Green HRM: A Proposed Framework for Sustainability

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Abstract: Sustainability has become a crucial aspect of organisational strategy, with many organisations implementing sustainable actions to mitigate environmental effects and reinforce social responsibility. However, sustainability adoption in organisations may be challenging due to some factors including the lack of resources, conflicting priorities, and resistance to change. Considering that sustainability is a long-term agenda that requires continuous commitment and investment in human resources, companies should understand the drivers of their sustainability adoption to develop strategies that foster company longevity. This study discussed the resource-based view (RBV) theory that emphasises the strategic resources that could be utilised by an organisation to gain sustainable competitive advantage. A framework was proposed to demonstrate the ability of leveraging organisational key resources such as top management support (TMS), green intellectual capital (IC), and Green Human Resource Management (HRM) in promoting the adoption of sustainable practices in organisations. This research has contributed to the sustainability literature by establishing a unified framework that could be applied to assess the impacts of TMS, GIC, and Green HRM on sustainability and determine the ability of Green HRM to strengthen the relationships between TMS, GIC, and sustainability through mediation. The study results would assist the top management and policymakers in understanding the importance of their support towards sustainable development. The results would also enhance the understanding of the importance of continuous investment in green knowledge creation among employees to reap the benefits from GIC and Green HRM practices. Finally, researchers could adopt the proposed framework in future studies for further empirical explorations of the drivers of sustainability.

Keywords: sustainability; green intellectual capital; green human resource management; top management support.

JEL Classification: Q01; J21; J24; J29; M54.

Introduction

Sustainability denotes the implementation of economically, environmentally, and socially responsible practices that contribute to society's well-being (Sheehy and Farneti 2021). Achieving sustainability in organisations is a complex and major challenge (Dubey *et al.* 2015). This complex and challenging task requires coordination across multiple sectors and stakeholders, including innovative solutions to address the underlying drivers of unsustainable practices (Alharbi 2020; Yong *et al.* 2020). Pursuing long-term sustainability is gaining increasing recognition as an essential aspect of corporate strategy (Fernando *et al.* 2019). Therefore, businesses should identify and understand the factors influencing their sustainability to develop and implement effective sustainability strategies and practices (Salmanzadeh-Meydani *et al.* 2022) due to the global perception of sustainability strategies as the key strategic development (Amrutha and Geetha 2020). Promoting sustainability remains crucial to ensure economic, social, and environmental progress (Amjad *et al.* 2021).

1. Literature Review

1.1. Underpinning Theory

According to the Resource Based View (RBV) theory, the resources of a business comprise tangible and intangible assets that include a semi-permanent attachment to the company. Examples of the tangible and intangible resources are brand identities, efficient procedures, in-house expertise, machinery, trained labour, and trade contracts. These resources are valuable, scarce, and challenging to duplicate. Furthermore, the implementations and consequences of RBV increased the convergence of strategic HRM (Malik *et al.* 2020). The RBV theory was employed in this research, considering that it is a managerial framework utilised to specify the strategic resources required by a company to gain sustainability. Notably, HRM plays a crucial part in companies' competitiveness, evolutionary processes, institutional and societal forces, regeneration (Bombiak and Kluska 2018), and the need for the optimisation of natural resources when they are required (Sehnem *et al.* 2019). It also directs managers' attention to human attributes contributing to a firm's long-term viability (Macke and Genari 2019). With respect to natural resources, HR departments are established with strict criteria (Renwick *et al.* 2015).

The introduction of Green Human Resource Management (HRM) applications involves several advantages, including an increase in worker ecological knowledge that improves a company's sustainability policies (Bombiak and Kluska 2018). People are viewed as organisational resources that could be employed to implement long-term management strategies and objectives (Yong *et al.* 2019). In the pursuit of sustainability, business strategies expand the product value chain using environmentally oriented principles and ecologically solid premises (Sehnem *et al.* 2019). Furthermore, placing worth in human potential, showing respect to the social needs of specific communities, ethnic groups, and regions, using large data systems, and putting balance in the consistent demand of generating profits with environmental awareness are integral to sustainability (Malik *et al.* 2020; Singh 2018). This research applied an RBV viewpoint to examine the ability of HRM greening initiatives to assist in achieving sustainability to identify the link between Green HRM practices, green intellectual capital (IC), and top management support for sustainability.

1.2. Sustainability

Sustainability was described as the capability to retain a certain entity, result, or procedure over time (Jenkins 2009) and perform activities that do not involve excessive resources that the capability is based on (Klarin 2018). Meanwhile, Clough *et al.* (2006) described sustainability as a procedure that assists in developing a vibrant economy and high life quality while showing respect to the importance of sustaining natural resources and protecting the environment" (p. 30). Sustainability is an essential concept that has gained significant attention in recent years due to its importance in addressing global environmental challenges. It denotes the idea that the present and future human societies must live and meet their needs. The Brundtland Report in 1987 developed the "official" definition of sustainability for the first time. According to the World Commission on Environment and Development (WCED) (1987), sustainability is defined as "meeting the demands of the current generations without risking the capability of the incoming generations to fulfil their demands".

Malik *et al.* (2021) viewed sustainability as a process related to the implementation and development of specific approaches to solving environmental and social problems. This process was founded on three elements also known as the three Ps: profit, the environment, and people (Alhaddi 2015), which show mutual support. On the other hand, sustainability represents the capability of sustaining the three elements of a human system over time (Roca-Puig 2019). Based on these definitions, sustainability emphasises the importance of intergenerational

equity, recognising that today's actions could significantly impact the future. As a result, this general comprehension of sustainability could be integrated into all human activities and business procedures. Khan *et al.* (2021) emphasised that companies should act beyond legal and economic compliance and integrate economic, environmental, and social performance to improve their sustainability.

1.3. Top Management Support

Top management support (TMS) is a critical element for the successful project of any company. The term "top management" denotes the executive managers who are also leaders of the entire company with the highest authority in making business decisions (Rogers *et al.* 2022). Moreover, Lee and Joo (2020) asserted that top management is the most influential group in determining the strategy and direction of the company and projecting its performance and emphasized the impact of top management's supportive attitude toward green project. Kemei *et al.* (2018) described TMS as senior managers' positive attitudes and behaviours towards a project and their visible support throughout and after the implementation of the project. Khrosrowpour and Travers (1991) added that TMS is the readiness of top management to offer the required resources and authority or power for positive results from a project.

According to Alameri (2022), TMS is the primary element leading to a positive result of a project, indicating that top management participation in projects may have positive and negative impacts on project portfolio success. Therefore, the quality of TMS could thoroughly regulate a project's success. A company complies with the practices, endeavours, and instructions of the top management in deciding on the optimum developmental direction of an organisation (Wilms *et al.* 1994). Considering the primary role of TMS (Daily & Huang 2001), TMS becomes the major (Young & Jordan, 2008) and essential (Kannan *et al.* 2014) factor impacting a project success. According to Liu *et al.* (2020), top management directs a company's operations based on its position. Daily and Huang (2001) added that top management could also act as a change guardian to assist an organisation in making a smoother and more complete transition. Yusliza *et al.* (2019) reported that top management supervises the development and design of the policies that will be implemented. It also ensures proper and effective communication throughout a company. Similarly, Nguyen *et al.* (2022) opined that top management is essential for a successful introduction of new management practices; organisations with strong TMS would increase organisational environmental performance.

1.4. Green Intellectual Capital

Currently, intellectual capital has emerged as a factor in the identification of approaches that raise corporate environmental effectiveness (Arsawan *et al.* 2022; Guerrero-Baena *et al.* 2015; Tonial *et al.* 2019; Yong *et al.* 2019; Yusliza *et al.* 2020). Baharum and Pitt (2009) highlighted the purpose of IC, which is to analyse the explicit and implicit intelligence functions in the three components of IC and develop the methods of encouraging value creation within these components. Sudibyo and Sutanto (2020) further reported that IC is critical for businesses to improve their competitiveness. Intangible assets are normally perceived as creating competitive advantages that could successfully lead to the achievement of sustainable corporate goals (Chen, 2008; Yong *et al.* 2019). Moreover, Sidik *et al.* (2019) and Asiaei (2021) suggested that an organisation's intangible resources bank, abilities, expertise, wisdom, reputation, and information capable of boosting a company's skillset are described as an IC.

Yusliza *et al.* (2020) defined IC as a complex concept that supports non-monetary and non-physical resources of businesses built on practical abilities, knowledge, and experience. Chen (2008) stated that GIC could be classified under green human capital (GHC), green structural capital (GSC), and green relational capital (GRC). These three GIC components are interrelated and interact with each other (Kamukama, 2013) to develop knowledge. This knowledge is represented in diverse manners, which include employee knowledge, databases, external and internal relations, procedures, or systems (Bombiak, 2022). In summary, GIC is a crucial concept that enables organisations to manage environmental resources and enhance sustainable development.

1.5. Green Human Resource Management

Green HRM has been more widely recognised as a crucial technique for the implementation of green activities and the achievement of long-term sustainability (Abbas *et al.* 2021; Adubor *et al.* 2022; Malik *et al.* 2020; Yusoff *et al.* 2018; Zaid *et al.* 2018; Farooq *et al.* 2023). To gain a competitive edge and achieve the optimum environmental performance in industries, Green HRM practices have become critical for innovativeness, affecting credibility, customer satisfaction, and trust (Hollebeek & Rather, 2019; Kim *et al.* 2019; Yen *et al.* 2020; Yusliza *et al.* 2021). Ahmad (2015) described Green HRM generally as the promotion of causes of environmental

sustainability. More specifically, it was defined as the utilisation of HRM policies for promoting sustainability in the use of resources in companies. Similarly, Jabbour and Jabbour (2016) argued that Green HRMs are established by placing HRM practices in line with corporate environmental management goals. Malik *et al.* (2020) reported that the Green HRM practices and their correspondence to the environment are aimed towards limiting the waste of natural resources, which was subsequently achieved upon the workers' awareness of environmental concerns and their importance.

In general, green HRM generally denotes a set of HRM actions that clearly take a company's environmental objectives into account (Ren *et al.* 2018; Renwick *et al.* 2013). Green HRM improves the workforce environmental performance and ecological behaviour and represents various aspects aimed at developing a green employee (Farooq *et al.* 2022; Peng *et al.* 2020; Raut *et al.* 2020). This HRM holds a direct responsibility in the development of a green workforce that shows appreciation, understanding, and practices of green initiatives. The HRM also establishes green objectives throughout the HRM procedures of recruitment, employment, training, advancing, compensating, and establishing a company's human capital (Mathapati, 2013). It was added by Bombiak (2019), Soomro *et al.* (2021), and Ghouri *et al.* (2020) that Green HRM is essential for the implementation of sustainable development. Green HRM could be perceived as a proactive organisational practice aimed at ensuring environmental protection and promoting sustainability.

2. Proposition Development

2.1. Top Management Support and Sustainability

The necessity for considerable organisational changes that adopt sustainable practices increases the importance of the top management (Naranjo-Gil *et al.* 2016). The manner through which an organisation directs these coordination issues between its functional departments is based on the actions and decisions of the top management team (Naranjo-Gil 2016). The upper echelons perspective emphasises that the top management of an organisation is regarded as the most influential and decisive member of the company (Hambrick and Mason 1984). Thus, the attitudes and degrees of support by the top management have a considerable impact on the attitudes or participation of organisational members in terms of accepting practices, management activities, and human resource development efforts (Lee *et al.* 2017). Accordingly, Lee and Joo (2020) argued that it is unfeasible to offer a significant level of collaboration for executing management tasks without the active support or commitment of the company's top management. Subsequently, the support and participation of top management in corporate sustainability activities are recognised as essential for effective sustainability integration in businesses (Blackburn 2007; Epstein and Buhovac 2010; Kiesnere and Baumgartner 2019; Tacheva *et al.* 2020). Therefore, as strategic decision-makers, top management teams are the important internal drivers of sustainability implementation (Kiesnere and Baumgartner 2020).

The support of top management for specific organisational activities is essential for overcoming the obstacles to change within and outside a corporation by increasing information sharing and communication between companies (Teo *et al.* 1997). Amoako *et al.*'s (2022) study confirmed a significant positive association between top management support and environmental sustainability. It could also be said that the top management's support level has successfully carried out sustainability initiatives in an organisation. In line with this, the following hypothesis was established:

Proposition 1: Top management support positively affects sustainability.

2.2. Top Management Support and Green Human Resource Management

According to Zahrani (2022), top management serves a crucial role in building proactive attitudes toward environmental measures employed in businesses. According to Sanusi and Johl (2021), top management commitment and support are crucial for the design and execution of policies and strategies in an organisation. Therefore, Green HRM sustainability initiatives require top management's commitment and support, which begins from the executive level and subsequently affects the organisation as a whole. Support and commitment at the executive level highlight sustainability as an organisational priority. Moreover, top management commitment has gained attention in the recent literature as a significant Green HRM predictor. For instance, Yusliza *et al.* (2019) asserted that top management commitment is essential for implementing Green HRM practices to achieve positive environmental performance. Similarly, Haldorai *et al.* (2022) suggested that top management green commitment has significantly and positively impacted Green HRM and environmental performance. Therefore, it can be assumed that top management support would positively impact Green HRM implementation.

Memon *et al.* (2022) explained that when the top management identifies the potential benefits of specific environmental projects, it would be motivated to support environmental sustainability. Caliskan and Esen (2019) suggested that support from top management may be perceived as a success factor for the human aspect of environmental management. Support may take the form of promoting Green HRM practices including green recruitment and selection, training, and development (green abilities), performance management, reward and compensation (green motivation), and workers' involvement and leadership (green opportunities) to gain an organisation's green competitive advantage (Muisyo *et al.* 2021). Following these discussions, it was assumed in this study that the support from top management would improve Green HRM implementation. The following hypothesis was developed:

Proposition 2: Top management support has a positive impact on Green HRM.

2.3. Green Intellectual Capital and Sustainability

Green IC is essential for strengthening sustainable growth prospects and boosting business performance and competitiveness (Chen 2008). Given the importance of organisational assets and resources in accelerating an organisation's productivity and development, the value of a company's intangible assets (*e.g.*, IC) in enhancing performance is significant (Chaudhry and Chaudhry 2022; Martín-de-Castro *et al.* 2011). Yusoff *et al.* (2019) stated that an organisation's sustainable performance is improved by gaining a competitive edge and corporating GIC into its commercial operations. The GIC assists enterprises in adhering to stringent global environmental processes (Chang 2011; Huang and Kung 2011). According to Chen (2008), for industry to successfully implement a sustainable ecological approach, environmental knowledge is essential to seek the related potentials for process and product development. In the current times, knowledge and comprehension of culture, agents, administrators, and convergent thinkers are crucial to resolving organisational problems (Gharib *et al.* 2022).

IC is believed to be advantageous to workers through the assistance offered in acquiring new knowledge, expertise, and experience (Chen, 2021). According to De Vos and Van der Heijden (2017), the sustainability of the business condition is contingent on the skills and abilities of the company's personnel. Moreover, Geng *et al.* (2017) and NR and Yurniwati (2018) found that the majority of emerging economies have currently prioritised the development of green skills among their workforces. Ullah *et al.* (2021) stated that in the Chinese manufacturing sector, the relationship and impact of GIC on business sustainability were statistically significant, suggesting that organisations should increase employee awareness to place their objectives in line with those of the companies. This action is carried out to achieve sustainability and develop environmental protection training programmes with an emphasis on GIC. Considering these arguments, the following hypothesis was proposed:

Proposition 3: Green intellectual capital positively impacts sustainability.

2.4. Green Intellectual Capital and Green Human Resource Management

Environmental management could be enhanced when individuals are recruited based on green initiatives, green training, and growth and they adhere to green discipline actions (Jyoti 2019; Mandip 2012). While the majority of existing studies highlighted that green HRM practices are crucial factors required to achieve various aspects of GIC (Jirawuttinunt, 2018; Nisar *et al.* 2021; Sudin & Saad, 2018; Yang & Lin, 2009), only a few investigated the reverse effect of GIC on green HRM (Malik *et al.* 2020; Yong *et al.* 2019). For instance, Ma *et al.* (2021) argued that the provision of green training to workers improves their capabilities, conduct, commitments, knowledge, and expertise in environmental management. Their findings also demonstrated that providing green training to employees creates green human capital, which is a component of GIC.

A correlation was observed between environmental awareness and green employee behaviour (Rayner & Morgan, 2018). Huang and Kung (2011) asserted that competitive advantage and sustainable performance could be achieved through structural capital. On the other hand, green relational capital is essential for the development of long-running associations between two parties (Tonial *et al.* 2019). According to Golicic and Smith (2013), organisations are concerned about sustainability due to their desire to express to their stakeholders that they are concerned about environmental issues and their management. As a result, businesses are expressing concern regarding the societal impact of GIC, Green HRM practices, and sustainable performance (Malik *et al.* 2020). Based on Jirawuttinunt's (2018) study that linked Green HRM practices with GIC, it was found that Green HRM actions play a crucial role in boosting pro-environmental psychological capital. On the other hand, the findings by Yong *et al.* (2019) indicated that GIC significantly impacted Green HRM practices. Additionally, enterprises with high levels of green human capital and green relational capital could boost their Green HRM practice adoption. In line with these findings, the following hypothesis was established:

Proposition 4: Green intellectual capital positively impacts Green HRM.

2.5. Green Human Resource Management and Sustainability

The primary objective of Green HRM is to encourage sustainable development through HRM practices (Peerzadah *et al.* 2018). Bhutto and Auranzeb (2016) argued that sustainable environmental performance could be attained by implementing certain Green HRM practices. Furthermore, Cherian and Jacob (2012) stated that Green HRM actions increase competitive advantage and performance in general through improved employee morale, retention of employees, improved public image and recruitment of personnel, higher productivity, and sustainability. According to Mehta and Chugan (2015), while businesses are sustainable due to their operations and culture, employees develop and implement eco-friendly policies and establish a green corporate culture. It was added that without the training for employees and implementation of sustainable strategies, going green would be a challenging initiative (Mehta and Chugan 2015). Meanwhile, Hamadamin and Atan (2019) asserted that human resource practices are the essential elements of sustainable corporate growth and competitive advantage.

According to Russo and Fouts (1997), incorporating environmental considerations into a company's culture may result in environmental capabilities, which rivals would struggle to imitate, subsequently developing a competitive advantage. The literature demonstrated the significant impact of Green HRM as a sustainability driver. For example, Adubor et al.'s (2022) study revealed a significant association between the components of Green HRM (green recruitment and selection, green training, and green rewards) and corporate sustainability in the manufacturing industry in Nigeria. It was also suggested that workers who were provided with greening abilities and training carried out the reduction of waste and practised reusing materials, improved an organisation's reputation, drew in and maintained green customers, and made the reduction of negative environmental impacts to gain corporate sustainability. Similarly, Malik *et al.* (2020) found that two components of Green HRM practices (green recruitment and selection and green rewards) positively impacted a company's sustainability. Therefore, the following hypothesis was suggested:

Proposition 5: Green HRM has a positive impact on sustainability.

2.6. Green Human Resource Management as a Mediator

In achieving success within the corporate community and facilitating the shareholders' maximisation of their profits, today's organisations should focus on social and environmental elements besides economic and financial elements (Arayssi *et al.* 2016; Daily *et al.* 2007; Finger and Rosenboim 2022; Xu *et al.* 2019). Currently, business communities have been increasingly aware of going green and implementing a wide range of environmental management approaches. Notably, the successful implementation of these sustainable corporate approaches in a company indicates the importance of solid, sustainable leadership (Iqbal *et al.* 2020a; Iqbal *et al.* 2020b; Metcalf and Benn 2013) and environmental knowledge, which is accessed through GIC (Amores-Salvadó *et al.* 2021), and focused on attracting personnel who can make significant contributions (Yong 2020) through sustainable HRM practices (Mohiuddin 2022; Farooq *et al.* 2022). In addition, Green HRM has been developed into the primary business approach for prominent companies where HR departments are mainly involved in going green at the office (Ahmad, 2015).

Sustainability concern has become one of the priorities among the strategic leaders of the corporate world due to the increased consciousness of the incorporation of "green" into the corporate approach to business (Brockhaus *et al.* 2017; Hambrick, 2007; Politis and Grigoroudis 2022). The concept of sustainable HRM, which includes Green HRM, socially responsible HRM, triple bottom line HRM, and common good HRM (Piwowar-Sulej 2021), is recently taken into account in view of sustainability as a method of gaining a set of skills, motivation, values, and confidence to prevent the harmful environmental impacts through the adoption of justice, development, and welfare (Cohen *et al.* 2012; Ehnert *et al.* 2016). Ahmad (2015) argued that Green HRM is the most crucial factor of sustainability. Corporate sustainability performance is attributed to the management and workers' green practices including Green HRM and dynamic capabilities (Schaltegger and Burritt 2018). Accordingly, the following hypotheses were suggested:

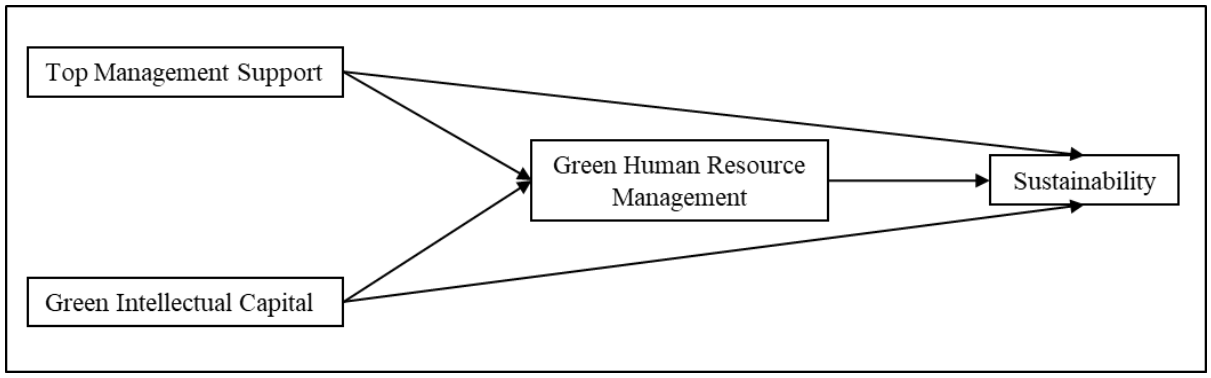
Proposition 6: Green HRM positively mediates the association between top management's support and sustainability.

Proposition 7: Green HRM positively mediates the association between green intellectual capital and sustainability.

3. Proposed Framework

The uniqueness of this study is evident through the assessment of the mediating role of Green HRM in the relationship between TMS, GIC, and sustainability. Figure 1. presents the proposed conceptual framework.

Figure 1. Conceptual Framework of the Study



Conclusion

This proposed research highlights the important association between TMS, GIC, Green HRM, and sustainability, with Green HRM playing a crucial role as the mediator. The results from the literature review suggest that TMS and investment in GIC could positively impact sustainability efforts by developing and implementing Green HRM practices. The review also demonstrated the importance for managers and policymakers to prioritise sustainability adoption and Green HRM as the key components of their overall strategy. To illustrate, this strategy comprises the investment in training and development programmes ensuring that workers are equipped with the knowledge and expertise crucial for supporting sustainability initiatives and implementing performance metrics to measure the success of these efforts.

Managers and policymakers should prioritise the development of a culture of sustainability within their organisations. This development includes incentivising sustainable behaviour, integrating sustainability into decision-making processes, and encouraging collaboration across departments to ensure that sustainability is incorporated into all aspects of business. Overall, this proposed study contributes a valuable understanding of the significance of TMS, GIC, and Green HRM in driving sustainable practices in organisations. Overall, by considering the findings of this research and implementing the highlighted recommendations, managers and policymakers would be able to develop a more sustainable and environmentally responsible future.

Credit Authorship Contribution Statement

The authors contributed equally to this work.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Human Capital Management Based on the Principles of Green Economy and the Creation of Green Jobs for Sustainable Territorial Development

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Abstract: As a result of the actualization of sustainable development and the strengthening of the role of green responsibility at all levels of the economy, there are significant changes in modern management practices to improve long-term economic, social, and environmental indicators of territorial development through the introduction of green technologies. The purpose of the study is to determine the possibilities of managing human capital based on the principles of a green economy and creating green jobs for sustainable territorial development in the Republic of Kazakhstan. Using the example of the Akmola region, Kazakhstan, quantitative indicators of green jobs in the fields of activity related to green technologies are determined, an expert survey is conducted, and a SWOT analysis of the strengths and weaknesses of creating green jobs in various sectors of the economy is carried out. It is concluded that green human capital management focuses on the introduction of environmentally friendly green technologies, forms the social foundation of high ecological awareness and proper skills of eco-innovation work of employees, and acts as a factor in the growth of sustainable territorial development.

Keywords: sustainable development; human capital; green human capital management; green jobs; green technologies.

JEL Classification: E24; O15; J24; Q01; R11.

Introduction

Environmental protection and economic territorial development (Bantserova and Kasimova 2023, 939), the development of human capital (Balova *et al.* 2021, 1269) and its management based on the principles of the green economy (Tatibekova *et al.* 2022, 2002), and the creation of green jobs and the introduction of environmentally friendly green technologies (Nardin and Nardina 2021, 1242) are global trends that have a chance to help solve problems related to environmental degradation resulting from expansive human actions (Amui *et al.* 2017, 308). Until now, humanity has thought little about the consequences of the intensive use of natural resources (Mukhlynina *et al.* 2018, 633). This implies that actions must be taken by the modern generation so that future generations can live healthy life in favorable conditions.

The task is to create solutions that will not remain just a concept but will be used in practice. Practice shows that actions and initiatives on the ground determine the form and nature of global changes (Kashina *et al.* 2022, 2413) Environmental knowledge is the basis for understanding environmental problems (Dao *et al.* 2011, 63), and human capital must meet the needs for the development and elaboration of certain strategies of enterprises and organizations regarding modern challenges (Unsworth *et al.* 2021, 1). Therefore, the concept of human capital and its management based on the principles of the green economy (green management) is

considered a new approach to solving environmental problems (Lawler and Worley 2012, 265), since human capital plays a key role in achieving sustainable development through the transfer of environmental knowledge, green practices and technologies, and environmental innovations (Yong *et al.* 2019, 364).

The purpose of the article is to determine the possibilities of human capital management based on the principles of a green economy and the creation of green jobs for sustainable territorial development in the Republic of Kazakhstan.

The purpose of the study provides for the solution of the following tasks:

- systematization of basic terms, concepts, and approaches to green human capital management and definition and design of the organizational and economic content of green human capital management as a modern management practice;
- quantitative analysis of the creation of green jobs as one of the main functions of green human capital management in areas of activity related to green technologies (based on the example of the Akmola region, Kazakhstan);
- SWOT analysis of the strengths and weaknesses of creating green jobs in various sectors of the economy (based on the example of the Akmola region).

1. Literature Review

A significant amount of scientific research has been devoted to the issue of human capital and its management based on the principles of the green economy (green management).

Thus, E. Bombiak (2019) defines green human capital management as a systematic, planned alignment of ordinary human resources with the practices of managing the environmental goals of an organization. According to R. Chaudhary (2019), green human capital management includes the overall impact on the effectiveness of an organization by: 1) the selection of employees who are sufficiently familiar with the aspects of environmental management in the organization (green hiring); 2) provision of environmental pieces of training for members of the organization to participate in environmental events to increase environmental awareness (green training and participation); 3) provision of non-monetary and monetary compensation to members of the organization for based on their environmental achievements (green efficiency and compensation management).

Green human capital management is a practice that helps to create a green workforce that can both perceive and appreciate the green culture in its organizations. Green innovation can apply its green goals to the entire personnel management process in the context of recruitment, selection, training, compensation, growth, development, and preservation of human resources (Guerci *et al.* 2016, 129).

Green human capital management concerns all activities related to the development, implementation, and maintenance of a system aimed at preserving green employees in the organization (Martirosyan *et al.* 2022; Tang *et al.* 2018, 31). The transformation of ordinary workers into green is the responsibility of personnel management, and its goal is to achieve environmental goals and a significant share in environmental sustainability (Hooi *et al.* 2021, 763). Green human capital management is also responsible for raising awareness, informing, and establishing interaction between employees (Khoruzhy *et al.* 2022), especially on environmental issues: through the formation of environmental policy, employees are oriented to fulfill their environmental responsibilities (Shah 2019, 771).

Green human capital management contributes to environmental protection and the implementation of a sustainable development strategy in organizations (Garnov *et al.* 2022), which can positively affect the training and recruitment of employees and their well-being, improving organizational performance and health (Ren *et al.* 2018, 769). It improves the level of organizational commitment of employees, their environmental behavior, and the environmental performance of the organization (Roscoe *et al.* 2019, 737). In the long term green human capital management positively, together with other factors, affects the environmental and financial performance of green entrepreneurship organizations (Severo and De Guimarães 2022) and other business entities (Jabbour and De Sousa Jabbour 2016, 1824). The support of senior management and environmental orientation has a positive impact on the green management of human capital of organizations, companies, and firms (Yusliza *et al.* 2019, 2015).

One of the main functions of green human capital management of economic entities is the creation of green jobs (Dumont *et al.* 2017, 613).

Green jobs (green-collar jobs) are environmentally friendly jobs that can arise in any sector of the economy, considering the principles of sustainable development (Rayner and Morgan 2018, 56; Zelenko *et al.* 2021, 207). According to (Kato *et al.* 2009, 183), green jobs include positions at different levels, the tasks of which include caring for the environment. This concern lies in the economical and rational use of material

resources (Sharma *et al.* 2021, 301). First of all, these are works related to the sector of public transport, renewable energy sources, construction, and waste management (Sharma *et al.* 2022, 419). Green jobs also include positions at enterprises that participate in social and environmental responsibility programs (Chreif and Farmanesh 2022). Their heyday is associated with the growing belief that climate change is the result of human activity, so its inhibition requires economic changes that ensure the preservation of environmental well-being and the creation of new jobs for the unemployed and those working in sectors that currently contribute most to global warming, such as the automotive industry or energy production *(*Syahidun and Nawangsari 2022, 154; Umrani *et al.* 2020, 50*).*

2. Methods

2.1. Research Design

The data were collected in the period from September 15 to November 15, 2022, by conducting both a field study (at enterprises and organizations of the Akmola region) and a desk study (based on the Alikhan Bokeikhan University, Eurasian National University named after L.N. Gumilyov, and Kyrgyz-Russian Slavic University).

A qualitative and quantitative approach was chosen for the study.

The work was carried out in the context of the impact of human capital on the development of the economy of territories and green technologies. Since Kazakhstan is a country that actively implements green technologies and at the same time occupies a significant territory, we clarify that the focus of our research is focused on analyzing the situation in the Akmola region as a region surrounding the capital of Kazakhstan – Astana – and, therefore, of important socio-economic importance.

2.2. Selection of Experts

According to the purpose of the research through the Google.com search engine, we selected web pages of enterprises and organizations (state, commercial, NGOs) using keywords (green technologies, green jobs, etc. related to the investment of human capital in the development of the territorial economy and green technologies). Based on the sample obtained, the selection of an expert pool from the employees of these enterprises and organizations was carried out according to such parameters as (I) a green workplace and (II) work experience in the position held for at least 5 years.

On the one hand, green jobs were identified as jobs that were created to introduce green technologies (for example, backyard sewage treatment plants and solar panels) and, on the other, as positions created for training and promotion in the use of existing green technologies (for example, tourism services or training of consultants in the field of green jobs, green technologies, etc.).

The expert pool consisted of 71 experts who met the specified criteria. They were sent e-mail messages indicating the purpose and program of our research. Thus, experts who meet the specified criteria and agreed to participate in the study were selected and provided all the information necessary for the study.

2.3. Data Collection

The field study consisted in analyzing the current situation with the availability of green jobs at enterprises and organizations of the Akmola region related to the introduction of green technologies and in-depth interviews with the experts. In-depth interviews were used for SWOT analysis (strengths and weaknesses) of green jobs in the Akmola region, depending on the industry affiliation of the enterprise (organization). The identification of strengths and weaknesses is, on the one hand, the basis for taking measures that take advantage of the opportunities that are undoubtedly numerous environmental initiatives undertaken in the region, with the support of funds allocated for this purpose. On the other hand, the formulation of strengths and weaknesses allows for minimizing the risks that arise.

The interviewer introduced themself at the beginning of the interview, explained the purpose of the study, and presented open-ended questions that were outlined by us to clarify views and opinions on the research problem. The average duration of each interview was 25-30 minutes. The received interview recordings were transcribed during the field study using the service zapisano.org.

The desk study was aimed at a quantitative analysis of green jobs (in the sectoral structure, in the context of individual districts) and was carried out using corporate reports provided by the experts by e-mail.

Several researchers participated in information processing. After that, a discussion was held on each issue, and the results agreed upon by all participants of the study were recorded in the final document. The triangulation process allowed us to increase the reliability of the interview data, as to whether they accurately reflect the state of green jobs, and to improve the quality of the information received.

3. Results

Based on the results of a field study (in-depth interviews), green jobs were identified in the fields of detail related to green technologies in the Akmola region (Table 1).

Table 1. Green jobs in the industry structure

No.	Industries	%
Non-governmental sector		
1	NGOs	81.5
2	Consulting, training, and other services in the field of green technologies	23.1
3	Technical services	29.2
4	Mechanical engineering	13.1
5	Food industry	43.3
6	Transport	29.2
7	Ecological construction	35.4
8	Other enterprises using environmental solutions	11.1
9	Development and maintenance of green spaces	40.5
10	Ecotourism	24.3
11	Organic agriculture and agricultural production of renewable energy	22.9
12	Renewable energy sources	25.0
Public sector		
13	Energy management	26.5
14	Wastewater management	27.8
15	Municipal and industrial waste management	54.3
16	Forest and nature management	35.4
17	Environmental policy, environmental monitoring	10.8

As the results of in-depth interviews have shown, NGOs have the largest share of green jobs among the surveyed subjects (81.5%). In other industries, green positions account for 10.8 to 54.3% of the total number of positions.

Further research has shown that state institutions, taking an active part in shaping the environmental policy of the region, influence the formation of new green jobs (Table 2).

Table 2. Green jobs in the public sector in selected areas

No.	Districts	Number
1	Akkol district with Stepnogorsk	85
2	Arshalynsky district	36
3	Astrakhan district	41
4	Atbasar district	20
5	Bulandynsky district	63
6	Burabay district	42
7	Egindykolsky district	38
8	Enbekshildersky district	9

No.	Districts	Number
9	Yereymentausky district	39
10	Esilsky district	6
11	Zhaksynsky district	63
12	Zharkainsky district	30
13	Zerendinsky district with Kokshetau	192
14	Korgalzhynsky district	25
15	Sandyktau district	17
16	Shortandinsky district	23
17	Tselinograd district with Astana	374

Thus, the majority of people in green positions in the public sector are employed in the Tselinograd district with Astana, the Zerendinsky district with Kokshetau, the Akkol district with Stepnogorsk, and the Bulandynsky and Zhaksynsky districts.

The NGO sector was also analyzed (Table 3).

Table 3. Green jobs in NGO organizations in some districts of the Akmola region

No.	Districts	Number
1	Akkol district with Stepnogorsk	9
2	Arshalynsky district	10
3	Astrakhan district	12
4	Atbasar district	-
5	Bulandynsky district	-
6	Burabay district	-
7	Egindykolsky district	-
8	Enbekshildersky district	-
9	Yereymentausky district	-
10	Esilsky district	-
11	Zhaksynsky district	-
12	Zharkainsky district	-
13	Zerendinsky district with Kokshetau	27
14	Korgalzhynsky district	20
15	Sandyktau district	-
16	Shortandinsky district	10
17	Tselinograd district with Astana	221

In general, the analysis showed that almost every third of employees is employed in a green workplace in the employment structure of public sector enterprises and NGOs.

Further, based on the results of a desk study, an analysis of strengths and weaknesses (strategic information) in the development of green jobs in the Akmola region was carried out using SWOT analysis.

Table 4. SWOT analysis of green jobs in Akmola region (public sector, NGOs, green labor market)

Strengths	Weaknesses
Public sector	
a high percentage of employees employed under an employment contract, for an unlimited period, full-time, high level of education of people employed in green jobs, high environmental awareness of public sector employees, great activity of employers in the organization of employee training	the high cost of modernizing state-owned enterprises, lack of public awareness of the benefits and barriers associated with the introduction of green technologies, low efficiency of campaigns to promote green economy ideas, high cost of employee training
NGOs	
readiness for ideological and voluntary actions, meaning that if such a social need arises, such activities will be carried out, ample opportunities for raising funds for activities, privileges in the field of activity (attraction of external sources of financing, media interest, political support), employees with a high level of education	low level of technological innovation in the field of sustainable development, low level of activity of employers in continuing education, the need for large expenditures on modernization and development of human capital
Green labor market	
a significant degree of employment stability in green workplaces – labor resources in such positions are valuable human capital, wide training offer on the market, creating the competitiveness of enterprises based on green technologies, environmental products, and the company's image, high ability to expand the scope of activities by expanding the range of products and territories, relatively high demand growth rates, high awareness of a significant group of entrepreneurs about the need for measures to introduce green technologies	a small share of green jobs in the structure of enterprises, a small proportion of people working in key green jobs and having a higher technical education, the low percentage of companies hiring employees involved in continuing education, low awareness of the need to improve the quality of labor resources, low ability to expand the scope of activity by acquiring new audiences for the products offered, low level of implementation of innovative green technologies, lack of prospects for the introduction of green technologies

4. Discussion

As the results of in-depth interviews have shown, the majority of green jobs in the employment structure of the Akmola region are generated by municipal and industrial waste management, followed by the food industry and the industry engaged in the development and maintenance of green zones (natural parks and forestry, which were qualified as forest and natural resources management, are excluded from this group – here the share of green places concerning the total number of jobs is slightly more than 35%). The lowest percentage of green jobs is observed in state institutions engaged in environmental policy and monitoring. This is a natural trend due to the organizational structure and competence of these subjects. The low percentage of green positions in mechanical engineering can be considered alarming. These results are largely consistent with the data obtained earlier (Chreif and Farmanesh 2022; Kato *et al.* 2009, 183).

We concluded that today, organic agriculture and agricultural production of renewable energy sources in Kazakhstan are not the main sources of potential for the development of green jobs, although they occupy an important place. Only one in five jobs is green in this sector. Although researchers (Babugura 2020, 108) conclude that the creation of green jobs in agriculture is an opportunity to promote gender equality and empower women in a sector covered by serious gender inequality. This is a sector in which women make up the majority of the workforce. We believe that there will be a potential for creating green jobs due to the development of this sector in the future.

The following industries are moderately green: water supply and sewerage, energy, and renewable energy sources. According to interviews, every fourth employee works in a green position.

The activities of NGOs are primarily related to environmental education and actions to promote an environmentally efficient lifestyle. The activity of NGOs engaged in monitoring the causes of environmental degradation and developing plans for the restoration of destroyed territories, as well as attracting funding sources for environmental political activities, was observed, which is consistent with the results (Dumont *et al.* 2017, 613).

In addition, there are organizations in the region with recognizable brands engaged in the dissemination of best practices following the principles of sustainable development.

The analysis suggests that about 10% of organizations in the NGO sector, given the small number of competitors and high growth rates of demand for the services offered, have a strong position in the market and can represent a competitive force for the corporate sector. This result is associated with consulting and training in environmental activities, including waste separation and disposal activities (Zelenko *et al.* 2021, 207). The fashion for a healthy and eco-friendly lifestyle suggests that the demand for services related to this will grow, and the development of a particular subject will depend on this process (Boas Berg *et al.* 2018, 33; Tang *et al.* 2018, 31).

The analysis of the current state of employment of research subjects in quantitative terms showed that the largest number of green positions is in the construction industry (904 positions) and the public sector, in the field of environmental policy and environmental monitoring (371 positions out of 3,272), and the smallest is in renewable energy sources (wind power plants – seven positions).

The experts noted that the main activity of state institutions in the field of green technology implementation is focused on waste separation and waste recycling. The incentive for activity in this area is mainly the high environmental awareness of people working in green workplaces. As a rule, highly qualified specialists work in the public sector and actively expand their knowledge by attending training.

The use of environmentally friendly resources and solutions in the region is primarily influenced by campaigns to promote green economy ideas, financing environmental investments, as well as the development of green public procurement. The most serious obstacles to the implementation of environmental policy are the lack of financial resources for the modernization of subjects. Thus, state institutions primarily expect financial support. The training organized for people holding green positions is most often funded by the organizations themselves or their employees, and the most useful are seminars on waste management and environmental standards.

Also, according to the respondents' statements, farmers, operators of machinery and equipment, builders, and ordinary workers using recycled materials most often work in green workplaces. To a lesser extent, these are environmental protection specialists and engineers of technical sciences. The development potential of the studied enterprises is based mainly on the specifics of a company's activities, the image, and the attractiveness of the price of the products offered. The development potential stated by the respondents allows the research subjects to compete, first of all, in local and regional markets. To a much lesser extent, the offer is aimed at Russian and sometimes foreign audiences.

The enterprises included in the study can be defined as representing a relatively low level of innovation. Only every fifth company participating in the study is actively involved in the implementation of environmentally friendly solutions.

Conclusion

Green human capital management forms the social foundation of high ecological awareness and proper skills of eco-innovation work of employees and management, creativity, and proper attitude to solving ecological and economic problems of territories.

The article presents a quantitative analysis of the creation of green jobs in the Akmola region. The SWOT analysis allowed us to identify strengths and weaknesses in the development of green jobs in the Akmola region and also showed promising areas of activity, such as information, education, and implementation of developed environmental initiatives and the introduction of environmentally friendly (green) technologies.

Credit Authorship Contribution Statement

Gulmira Rakhimzhanova: Conceptualization, Methodology, Investigation, Formal analysis, Writing – original draft.
Aigul Maidyrova: Supervision, Validation, Writing – review and editing.
Ainura Kocherbaeva: Project administration, Data curation, Validation, Writing – review and editing.

Declaration of Competing Interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

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Integrated Urban Solid Waste Management: Knowledge, Practices, and Implementation

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Abstract:

The current study sets out to ascertain the residents of Kabankalan City's degree of solid waste management knowledge, practices, and implementation. This further established the relationship between their knowledge, practices, and degree of solid waste management program implementation. The researcher-made questionnaire was used to assess solid waste management practices and program implementation, while a modified version of the questionnaire from the study by Trondillo, *et al.* (2018) was utilized to assess knowledge levels. For the study, 365 residents of Kabankalan City were chosen at random. The primary analysis employed in this inquiry was the Pearson r correlation. According to the findings, locals have a fundamental grasp of and a modest level of practice with solid waste management. The city's solid waste management program was only partially implemented. Last but not least, the amount of knowledge and implementation was substantially correlated with the residents' solid waste management practices.

Keywords: urban solid waste management; knowledge; practices; implementation.

JEL Classification: Q53; Q56; Q01; R11.

Introduction

For the majority of developing countries, improper waste disposal of solid waste is a major concern that encourages behavior that helps people acquire the knowledge, attitudes, values, commitments, and skills necessary for problem-solving (Eshete, *et al.* 2023; Yusuf and Fajri 2022).

Globally, an astounding 2.2 BT/year will be produced in solid waste by 2030, up from an estimated 1.3 BT/year today. In addition to increasing the manufacturing and consumption of disposable masks and other household wastes such as packed food, fresh food, and meal delivery, COVID-19 has created a new environmental challenge (Das *et al.* 2021; Mallick *et al.* 2021; Parashar and Hait 2021; Filho *et al.* 2021). Urbanization, economic development, changing lifestyles, and rapid population growth all played a role in the rise in resource use and waste production (Al-Dailami, Ahmad, Kamyab, *et al.* 2022).

Many developing and growing countries have had to contend with rapid population and economic expansion. Along with such rapid expansion, solid waste generation has greatly increased (Ahangar *et al.* 2021; Browning *et al.* 2021; Patwa *et al.* 2021). Many developing and growing countries have had to contend with rapid population and economic expansion. Along with such rapid expansion, solid waste generation has greatly increased (Ahangar *et al.* 2021; Browning *et al.* 2021; Patwa *et al.* 2021). This is further supported by Khan, et.al (2022) who posit that due to the increase in global population, urbanization, and industrialization, solid waste generation has risen quickly. Likewise, a lack of awareness of solid waste management may contribute to the implications of poor solid waste disposal (Singh *et al.* 2022).

According to Chati (2021), the majority of developing countries now face a serious problem with solid waste management. Solid waste is seen to be a beneficial resource if well managed, but when left, it may become a source of environmental and human concerns if not adequately handled. Excellent solid waste management practices exist in many industrialized nations that recycle trash. Due to their high population density and unstable economies, developing nations confront various difficulties, including sorting and processing municipal solid waste (MSW). Mismanagement like this might hasten the development of negative socioeconomic

and environmental issues (Khan *et al.* 2022). The environmental condition in the Philippines has reached crucial ratios in terms of managing solid waste, requiring immediate and collaborative action at all levels of the executive. The ecological solid waste management program was created to provide proper solid waste segregation, collection, transport, storage, treatment, and disposal.

In order to fully implement the Republic Act, the Local Government Units (LGUs), which are the principal implementers, are responsible for the majority of the duties. Likewise, this also requires public involvement for the effective implementation of waste management plans (Republic Act 9003)

1. Research Background

Kabankalan City demonstrated exceptional initiatives in managing solid waste and even increased its efforts to maintain its 2nd Platinum Environmental Award (Daily Star, June 2019). Likewise, the city received the Award of Seal of Environmental Good Governance. E.O. No. 2005- 011 explicitly established a multi-sectoral Task Force called "Kalinisan" to take charge of enforcing the City Ecological Solid Waste Management Ordinance. However, implementation of the law is not an easy process. It faced a lot of challenges encountered, including a lack of community decision-making ability, information flow that frequently occurs through government structures that are influenced by political contexts, and inequity in the allocation of budget (Zikargae *et al.* 2021; Jabeen *et al.* 2022). Furthermore, the management of solid waste has not made much progress. Local governments often lack the expertise needed to evaluate technologies or solutions in order to identify the most appropriate ones for their situation (EPA, 2020).

The main challenges experienced by many countries on solid waste management partially result from the lack of stakeholder awareness, inclusion, and participation (Singh *et al.* 2022). This is also supported by Awino and Apitz (2023) who posit that the major waste and environmental management challenges that continue to pose in many countries are economic constraints, weak policies and governance, waste trading, non-inclusive stakeholder participation, data limitations, and limited public awareness**.** Additionally, Kihila *et al.* (2021) underscores that a lack of awareness, weak regulatory frameworks, and enforcement, a lack of economic incentives, and a low priority in planning were given low attention by the authorities were among the reasons why solid waste management implementation is affected.

For sustainability and environmental security, the participation of stakeholders is very important. The project's success depends on the involvement of all stakeholders (Zikargae *et al.* 2022). The community supposedly possessed extensive expertise in solid waste management, according to Muiruri, Wahome, and Karatu's (2020) hypothesis.

In order to lessen the detrimental effects of garbage on the environment, Local Government Units have committed to implementing safe and effective waste management practices in their community. Because they believe they have no other options for handling their solid waste, in particular, most communities in underdeveloped countries frequently use garbage disposal methods that have been shown to be harmful to human health, like open dumping and burning which are the most prevalent practice. The practice of these garbage disposal causes several environmental issues like deterioration of water quality due to leaching from open dumping of municipal solid waste (Jabeen, *et al.* 2022).

The findings of the Sampulna (2022) research served as a reminder to the community that solid waste management is still a major problem in the Philippines even after the passage of Ecological Solid Waste Management of 2000, which mandates segregation at the barangay level. In the study of Kihila, *et al.* (2021), he emphasized that the fundamental issue has been a lack of waste segregation both at the source and during the later phases of waste management. Waste and recycling collection thus becomes ineffective. Combining garbage makes handling more complex and makes it more challenging to separate recyclables. Lack of recycling makes it impossible to reduce the amount of garbage produced and forces a sizable percentage of it to be collected, transported, and disposed of.

Note that, recycling, waste reuse, and trash reduction are the greatest waste management strategies. The employment of these approaches can result in a variety of environmental advantages. It has the potential to minimize or avoid greenhouse gas emissions, pollutant discharge, resource conservation, energy conservation, and the requirement for waste treatment technologies and landfill space (cyen.org). As the foundation for effective waste management, municipalities, and local governing bodies must involve the public actively in decision-making and implementation processes (Brotosusilo *et al.* 2020).

Solid waste management is underdeveloped and ineffective in various other nations. A lack of coordination amongst stakeholders, institutional flaws, a lack of recycling laws, and uncoordinated initiatives were some of the major problems noted (EPA, 2020).

The researcher is motivated to conduct a study to determine the knowledge, practices, and implementation of the Solid Waste Management Program as a consequence of this understanding.

2. Research Methodology

In this study, the City of Kabankalan's solid waste management program's implementation, knowledge level, and practice were assessed. This descriptive study involved the 365 randomly selected residents of the nine barangays of Kabankalan City Población as the respondents. For the purpose of assessing solid waste management knowledge, the researcher modified a questionnaire from Trondillo's, et.al (2018) study; nevertheless, a researcher-made questionnaire was crafted to assess practices and the extent of implementation. The instrument was put through validity and reliability tests to make sure the data gathered was relevant, significant, and meaningful. The result of the validity testing was 3.50 which provided a good rating in terms of its constructiveness and alignment with the purpose of the study. Likewise, the questionnaire was pilot-tested on other residents outside the sample but had the same characteristics as the target respondents. A Cronbach's Alpha of .841 for knowledge, .946 for practices, and .912 for the reliability of indicators in solid waste management implementation were obtained. A survey instrument with three (3) parts was utilized to collect the primary type of data. Part I included 20 questions that were answered with "yes," "no," or "I don't know." Based on the percentage, solid waste management knowledge was assessed. The greater the percentage, the more knowledgeable the locals were about solid waste. The percentage was interpreted using the scale below:

Score Rating	Descriptive Rating
76-100	Very knowledgeable about
51-75	Knowledgeable about
26-50	Somewhat knowledgeable about
1-25	Not knowledgeable about

Part II had twenty (20) statements regarding solid waste management practices. On a scale of 1 to 5, with 5 being the strongest agreement, responses were scored. Finally, Part III included 20 statements on the level of implementation for solid waste management. Answers to each question were given on a 5-point scale ranging from "always" to "never."

The mean and standard deviation were used to assess the City of Kabankalan's solid waste management practices and level of implementation. The mean scores were calculated using a five-point rating scale.

Mean Score Rating	Descriptive Rating	
	Practices	Implementation
4.50-5.0	Very Highly Practiced	Very Highly Implemented
3.50-4.49	Highly Practiced	Highly Implemented
2.50-3.49	Moderately Practiced	Moderately Implemented
1.50-2.49	Slightly Practiced	Slightly Implemented
1.0-1.49	Very Slightly Practiced	Very Slightly Practiced

To determine if there was an association between residents' knowledge and the extent of their solid waste management practices and implementation, the researcher employed Pearson's r correlation analysis.

3. Research Results and Discussions

3.1 Residents' Knowledge about Solid Waste Management Program

Generally, residents were informed about solid waste management. This proved that the residents were familiar with the concepts of solid waste management.

Table 1. Residents' Knowledge about the Solid Waste Management Program

No	Statements	F	%	Interpretation
1	Do you know any awareness program conducted by a local authority/school regarding waste management?	115	36.5	Somewhat knowledgeable
2	Do you know the penalties for violation of solid waste management?	105	33.3	Somewhat knowledgeable
3	Do you know how to dispose of the e-waste?	106	33.7	Somewhat knowledgeable
4	Unbroken or broken glass waste is disposed into a cardboard box lined with a black bag and taped.	115	36.5	Somewhat knowledgeable
5	Do you know that waste papers, plastic bags, a piece of metal and wood, and clothes are not garbage?	107	34.0	Somewhat knowledgeable
6	Do you think that residents in your barangay have an important role to play in the implementation of solid waste management at school?	273	86.7	Very knowledgeable
7	Do you know about the segregation of waste?	268	85.1	Very knowledgeable
8	Do you think waste segregation is important in the barangay or household?	270	85.7	Very knowledgeable
9	Waste segregation is beneficial to my barangay and house.	286	90.8	Very knowledgeable
10	Do you have a role to minimize the barangay and house waste	265	84.1	Very knowledgeable
	Over-all Knowledge	**58.03**		**Knowledgeable**

(Only the top 5 statements with the highest and lowest percentage ratings were included in the table)

Statements 6, 7, 8, 9, and 10 in particular had significant percentage distributions and were interpreted as being very knowledgeable. The residents were able to understand the advantages and significance of garbage segregation by comprehending their pivotal responsibilities in the implementation of solid waste management. Just by doing this, they were able to show how crucial garbage separation was to them, both at home and in the community. The extremely informed conclusion implied that locals were properly informed about solid waste management concepts. According to Muiruri, Wahome, and Karatu's (2020) evaluation of attitudes and practices connected to solid waste management, the community has an excellent grasp of waste management.

However, five (5) of the statements—more specifically, 1, 2, 3, 4, and 5—demonstrated that residents were at least somewhat informed about solid waste management. This indicated that residents had limited knowledge about managing solid waste.

Observed that residents had limited knowledge of programs conducted by the local authority/ school on waste management. They had limited knowledge about e-waste and how to dispose of it and the unbroken or broken glass waste was disposed of in a cardboard box lined with a black bag and taped. They were even having limited knowledge that waste papers, plastic bags, a piece of metal and wood, and clothes were not garbage. The result implied that residents' knowledge of the solid waste management concept was not adequate.

The main reasons for the current decline in ecosystem quality and harm to human health, according to Hasan, Hanafiah, and Satchet (2019), were a lack of awareness, a lack of knowledge of pertinent laws and regulations pertaining to solid waste, and poor management of solid waste.

3.2 Residents' Solid Waste Management Practices

The residents' overall mean rating for their solid waste management practices was 2.95, which was considered to be a moderate level of practice.

The residents' solid waste management practices had an overall mean rating of 2.95, which is regarded as a moderate practice. Of the five (5) practices indicated, the waste campaign got the highest mean rating of 3.0 interpreted as a moderate practice.

This shows that the city made a moderate effort to manage solid trash by conducting educational projects, educating the public, and communicating with them. However, only a little quantity of signs, instructional bulletins, and other campaign materials were employed to increase public knowledge of solid waste management. The city also adopted solid waste management rules, ordinances, and regulations.

Table 2. Residents' Practices of the Solid Waste Management Program

Practices	Mean	SD	Interpretation
Waste Segregation & Volume Reduction	2.98	1.162	Moderately Practiced
Waste Disposal Methods (Composting, Burying, Open dumping, Land Filling)	2.97	0.881	Moderately Practiced
Waste Recycling	2.89	1.296	Moderately Practiced
Waste Campaign	3.00	1.266	Moderately Practiced
Overall Practices	**2.96**	**1.151**	**Moderately Practiced**

Waste segregation and volume reduction also received a high mean score of 2.98, indicating moderate practice. The quantity of garbage that the residents separated into biodegradable and non-biodegradable components was moderate. Waste containers in the designated areas were moderately provided with covers and properly marked. Likewise, respondents moderately collected organic waste for animal feed.

The finding of Sampulna (2022) also reminded the community that despite the passage of Republic Act (RA) 9003, which required segregation, and solid trash management remained a significant issue in the Philippines, primarily due to the improper management of waste segregation at the local level.

Waste disposal methods got also the highest mean rating interpreted as moderate practice. Respondents indicated that they practiced moderately disposing of their waste through open dumping. Residents typically dumped or disposed of their trash in this manner and placed it in a disposal location. Additionally, respondents directly expose their garbage to fire in order to burn it. They also used composting as a means of getting rid of their garbage.

Of the waste disposal methods, burying and landfilling have low ratings. These methods of waste disposal need larger space, designed, constructed, and maintained by engineers These techniques were not workable for the residents. Most communities in developing countries frequently use garbage disposal methods that have been shown to be unhealthy for people, like open dumping and burning (or unregulated landfills), because they believe they have no other options for handling their solid waste. The practice of these garbage disposal cause several environmental issues like deterioration of water quality due to leaching from open dumping of municipal solid waste (Jabeen, *et al.* 2022).

Finally, the respondents' use of waste recycling was moderate. They used containers as garbage cans, receptacles, and bags while emphasizing the 3 R's (reduce, reuse, and recycle). During community events, city personnel reused their old decor. The moderate practice of recycling waste may be due to the fact that the city had only one (1) Materials Recovery Facility (MRF) which was considered a depository facility for waste materials. According to www.cyen.org, the best solutions to waste management were trash reduction, waste reuse, and recycling.

3.3 Solid Waste Management Program Implementation

The total mean rating of 2.89, which is considered moderate, represented the solid waste management program implementation indicators.

The social aspect earned the highest mean rating out of all the dimensions. According to the residents, the government and community were only moderately involved in implementing the solid waste management program. It was evident that the city and community were cooperating to execute a solid waste management program to a reasonable level by employing practical applications or environmentally sound trash reduction tactics including resource conservation, segregation, and recycling.

Table 3. Extent of Solid Waste Management Program Implementation

Dimensions	Mean	SD	Descriptive Interpretation
Institutional/Governance Aspects	2.88	1.272	Moderate
Social Aspects	3.03	1.215	Moderate
Health and Environmental Aspects	2.83	1.296	Moderate
Economic Aspects	2.75	1.363	Moderate
Overall Implementation	**2.89**	**1.166**	**Moderate**

As the foundation for effective waste management, municipalities, and local governing bodies must involve the public actively in decision-making and implementation processes (Brotosusilo *et al.* 2020).

Institutional/governance aspects, on the other hand, displayed a high mean rating. Residents moderately noted that the city has specific sites and bins for collecting recyclable goods, sorting them, and then collecting them for collection by the responsible committee. To oversee and carry out a solid waste management program, the city designated staff or a committee to work with the authorized office. To successfully manage solid waste, one of the city's barangays had a Materials Recovery Facility (MRF) for the segregation, processing, and/or acquisition of recyclables. MRF was created as a result of the development of the city's solid waste management policies, rules, and laws.

Residents also noted that the city provided receptacles or bins to a moderate extent of implementation protecting the health and well-being of the town and its citizens. To further enhance public safety and the welfare of the neighborhood, the city collected solid waste in a reasonable manner that prevented damage to the container and leaks or being dispersed inside the collecting area. Agricultural trash and other items were only sparingly composted.

Finally, to reduce the amount of waste as observed by the citizens, the city moderately implemented the sale of bottles, plastics, cans, and other scraps to junkshops. The city moderately implemented the crafting of protocols, benchmarks, and marketing strategies for recyclable materials as well as new production facilities for products made from recovered and post-consumer materials. The city contacted potential customers and reviewed and modified how the commodities were processed to somewhat increase their marketability.

Solid waste management was not well established and inefficient in several other countries due to a number of serious issues like a lack of stakeholder participation, institutional structural flaws, a lack of mandated recycling, and uncoordinated approaches, according to EPA (2020).

3.4 Association between the Level of Solid Waste Management Implementation and Residents' Solid Waste Management Knowledge and Practices

Table 4. Association between respondents' knowledge and practices about solid waste management and the degree to which the solid waste program has been implemented

Variables	rho	p-Value	DECISION FOR H_0	CONCLUSION
Knowledge and Practices	.576	.000	Reject Ho	Highly Significant
Knowledge and Implementation	.612	.000	Reject Ho	Highly Significant
Practices and Implementation	.740	.000	Reject Ho	Highly Significant

***Correlation is significant at 0.05 level (2-tailed)*

At 5% level of significance, the results revealed a significant positive correlation between respondents' knowledge and their level of practice (rho =.576, p =.000), level of implementation (rho =.612, p =.000), and level of practice and implementation (rho =.740, p =.000).

The strong correlation implied that respondents' practice levels improve as their knowledge levels do, and vice versa. This implied that when respondents' knowledge level rises, their extent of practice increases, and vice versa. When respondents have a high degree of practice, solid waste management implementation also increases to a greater extent. Not to mention, as knowledge levels increase, implementation levels rise as well, and vice versa.

Conclusions and Further Research

There are still several residents that don't know much about solid waste management. The residents were able to fairly manage their garbage, nevertheless. The city's solid waste management program was fairly implemented, necessitating great social responsibility and commitment from the government and community to increase program effectiveness. Finally, the respondents' understanding of solid waste management concepts had an impact on their practices and how the city carried out its solid waste management program.

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Declaration of Competing Interest

The author declares that she has no known competing financial interests or personal relationships that might influence the work reported in this paper.

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Issues Concerning the Improving Organizational and Legal Support of Victimological Prevention for Environmental Crimes

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Abstract: Environmental crimes have become a pressing issue in today's world, with the degradation of ecosystems, pollution, and climate change threatening the very foundation of our planet. These crimes not only harm the environment but also have adverse effects on individuals and communities. Recognizing the need for effective prevention strategies, victimological approaches have gained prominence. Victimology focuses on understanding and addressing the needs of the victims, aiming to prevent victimization and promote justice. This essay explores the importance of legal support in victimological prevention of environmental crimes and highlights the key measures required to achieve this goal.

Keywords: environmental crimes; victim; prevention; offender identity; environment; sustainability.

JEL Classification: K32; K39; R11.

Introduction

One of the key aspects of victimological prevention for environmental crimes is the implementation of proactive measures to identify and mitigate potential harm. By establishing robust environmental regulations, governments can set clear guidelines to prevent harmful activities, such as illegal logging, poaching, or toxic waste dumping.

Strict enforcement of these regulations is crucial to ensuring compliance and holding offenders accountable for their actions. Additionally, the development and implementation of comprehensive monitoring systems, including satellite technology, can help detect environmental crimes early on and provide valuable evidence for legal proceedings.

The study of victimological prevention is of constant interest to criminologists. When discussing this issue, special attention is paid to the characteristics of the victim, certain social conditions in which the victim-personality grew, grows and becomes an accomplished person, a person with his achievements in society, with a social circle, and, possibly, vice versa, an anti-social person (Andresen *et al.* 2021). In this case, it will be necessary to establish the reasons why the fate and the current state of the person-victim developed in such a way, which exposed him to such a state.

Particular attention is paid to age categories, moral development and financial situation. An analysis of the victimological characteristics of crime, combining the study of statistical data, the results of research by criminologists and sociologists, will make it possible to describe the object under study - criminal victimization - not only on the part of the victims of crimes, but also to determine the impact of their behavior on the mechanism of criminalization of criminals. Additionally, this analysis allows for an examination of the impact of victim behavior on the criminalization process. The integration of victimological characteristics, statistical data, and research findings enables a more nuanced understanding of criminal victimization. This knowledge can inform policy development, crime prevention strategies, and victim support services to effectively address the needs of victims and contribute to the overall criminal justice system.

1. Literature Review

Environmental criminology and spatio-temporal criminology can broaden our understanding of victimization. Some researchers emphasize the theoretical aspects of environmental criminology and its contribution to the study of victimization. However, we note that environmental criminology has the potential to study victimization, where not enough research has been done in this area so far.

Some studies also discuss how certain crime prevention strategies can have unintended consequences, including further victimization of vulnerable and marginalized groups. However, most research in environmental criminology, based on everyday activities, indirectly operationalizes goals. Claiming that places with more attractive targets or people engaged in certain everyday activities are at higher risk of victimization can be seen as blaming the victim, even if there is no such intention. This is important to consider to avoid negative consequences and misperceptions (Armitage 2018).

Crime Prevention Techniques through Environmental Design (CPTED) aims to reduce opportunities for crime by designing and managing the built or natural environment based on principles that guide the design of buildings and the organization of space around them. CPTED provides guidance, and compliance with design principles is often assessed through award systems such as Secured by Design (SBD) in the UK and Police Label Secured Housing in the Netherlands. By incorporating these principles into the design and management of the built environment, these programs aim to create more secure spaces that deter crime and enhance community well-being. It's important to note that CPTED principles can vary slightly across different regions and programs, but the overall goal remains the same: to reduce opportunities for crime through thoughtful design and management of the environment.

Research has consistently supported the effectiveness of CPTED. The study by Chopin, Caneppele, and Beauregard (2019) further supports the effectiveness of CPTED in reducing crime, fear of crime, and enhancing safety. It is worth noting that the success of CPTED implementation relies on careful planning, collaboration between architects, urban planners, law enforcement agencies, and community members, and ongoing evaluation to ensure the sustainability and effectiveness of CPTED strategies.

Corcoran, Zahnow, Kimpton, Wickes, and Brunsdon (2019) explore the role of criminologists, including victimologists, in expanding understanding of the effects of climate change and other forms of environmental degradation. The authors discuss how climate change and environmental degradation can contribute to the emergence of new forms of crime and victimization. They may examine the linkages between environmental factors, such as extreme weather events, resource scarcity, and shifts in land use, and their influence on crime patterns.

Gibbs and Boratto (2019) examine the causes of environmental crime, finding that it is a complex and multifaceted concept used to refer to crimes related to biodiversity, wildlife, animals, natural resources, hazardous wastes, prohibited substances, and environmental quality.

For example, White and Heckenberg (2020) discuss the following environmental issues:"brown" - related to urban life and pollution (*e.g.*, air quality), "green" - related to wildlife and conservation issues (*e.g.*, logging), and "white" - related to scientific laboratories and the impact of new technologies (*e.g.*, genetically modified organisms).

According to the Interpol Environmental Crime Program, there are three main areas: biodiversity, natural resources, and environmental quality (White2020). Biodiversity crimes include illegal removal of flora and fauna from the natural environment, animal cruelty, illegal possession, trade, and exploitation of wildlife (Wellsmith2018). Cosaro, Pizarro, and Shafer (2020) also address crimes against natural resources in their research.

Criminological research has consistently confirmed the tendency of crimes to cluster in both space and time. For example, a study of Melo, Andresen and Mathias (2018) investigated the phenomenon of repeat victimization (where the same victim is exposed to crime again within a short period of time) and near-victimization (where locations close to the original victimization are exposed to crime within a short period of time). This study found considerable support for the phenomenon of repeat and near victimization, although the extent of this phenomenon varied by crime type.

Mihinjacand Saville's (2019) analysis highlights early research by Jeffrey, who first introduced the term "crime prevention through environmental design" and called for an interdisciplinary science examining criminal behavior and its prevention and suggested that the physical environment influences the ability to commit crime and therefore crime can be prevented through urban environmental design. Jeffrey's work laid the foundation for the concept of CPTED, which suggests that the design and arrangement of physical spaces can influence criminal behavior. This approach seeks to create environments that deter crime by incorporating elements such as natural surveillance, territorial reinforcement, access control, and maintenance.

However, unlike proponents of Newman's "protective space" theory, Jeffrey did not believe that crime and its prevention were entirely determined by the physical environment, as his approach was to define "environment" using broad perspectives, and his proposals included integrating several previously unrelated theoretical approaches into the science of criminal behavior and prevention. His approach was a broader definition of "environment" that included the organic sciences as well as the physical sciences to help explain the physical possibilities of crime).

2. Understanding Environmental Crimes. The Role of Victimology in Environmental Crimes

Environmental crimes encompass a range of offenses, including illegal dumping, wildlife trafficking, illegal logging, hazardous waste disposal, and pollution. These acts cause severe harm to ecosystems, endanger wildlife, jeopardize public health, and impact communities dependent on natural resources. By adopting a victimological perspective, it becomes evident that environmental crimes have significant consequences for individuals directly affected by the harm caused to the environment.

The Role of Victimology in Environmental Crimes: Victimology plays a crucial role in addressing environmental crimes from a human-centric perspective. It acknowledges that individuals and communities suffer harm due to environmental degradation, making them victims of these crimes. By recognizing victims' rights, needs, and experiences, victimological approaches aim to prevent further victimization and ensure justice.

To provide effective victimological prevention for environmental crimes, legal frameworks must be continually strengthened and adapted. Governments should enact legislation that specifically addresses environmental offenses, ensuring appropriate penalties and deterrents. These laws should prioritize victim protection, including provisions for witness protection programs, confidential reporting mechanisms, and the right to legal representation. Furthermore, fostering public-private partnerships can enhance the effectiveness of prevention efforts, encouraging businesses and industries to adopt sustainable practices and environmental responsibility.

An analysis of various conceptual views on victimological prevention as social management in the context of society transformation shows that in the countries of Western Europe and the United States, the emphasis is on the soft regulatory impact. The most important function of victimological prevention is to maintain in society the necessary balance between the inevitable, which are the result of objective reasons, the processes of criminalization and the processes of decriminalization of society (Pease and Ignatans2018, Kyle and Vogel2019).

It's important to note that the presence or absence of a victimological protection system and policy can depend on various factors, including the legal and institutional frameworks in place, cultural and societal norms, and the stage of development of the criminal justice system in a particular country. In countries where victimological protection systems are still evolving, there may be ongoing efforts to enhance victim support

services, promote victim rights, and improve the overall response to victimization. These efforts often involve collaboration between governmental and non-governmental organizations, legal reforms, training programs for criminal justice professionals, and raising public awareness about victim issues.

In Kazakhstan, and in the CIS countries, unlike the countries of Western Europe and the United States, there is no complete system of victimological protection of the population and a targeted victimological policy of the state, which would be comparable to Western counterparts. Given the weak development of the institutions and intentions of civil society, we can assume that it is unlikely to be as effective in our country as in the West. It is necessary to structure (and stimulate) the victimological movement, which is carried out from a single center. Therefore, it seems expedient to form a single coordinating and directly acting victimological association according to the English model, with the active role of the state.

In order to strengthen the victimological prevention of crime, it is necessary to strengthen its legal and organizational order. Consider all possible ways and means of its strengthening and effective strengthening. Thus, we can offer the following ways to improve the organizational, managerial and legal support of victimological prevention:

- systematization of normative material concerning the implementation of victimological prevention;
- use and development of useful ideas, principles and provisions, *i.e.*, everything useful that forms the basis of the current system of administrative and legal support for victimological prevention;
- maximum reflection and consideration of the essence and characteristics of victimological and preventive activities, its goals, content, main directions and conditions of existence;
- strengthening not only responsibility, but also legal guarantees for participants in public relations in the field of victimological and preventive activities, giving the most important of them the force of law;
- comprehensive consolidation of the provisions, which have traditionally been used in practice and have positively justified themselves;
- achieving higher efficiency and effectiveness of victimization and prevention activities, it is proposed to apply available management forms, methods and techniques, as well as structures and schedules, taking into account their integrated use;
- improving the legal provision of victimization prevention, it is possible to use the existing experience of administrative and legal regulation of victimization measures in other countries.

To achieve a high level of effectiveness and unity of victimization prevention, it is recommended to formalize these activities within a unified legal system, ensuring consistency, coherence and continuity of functions of all subjects of this activity. A unified legal system should be a legal tool for implementing measures to influence victimization.

Figure 1. The relationship between the environment and victimological crime prevention

Source: compiled by authors

The relationship between the environment and victimological crime prevention is important. The environment, including the physical, social and economic environment, influences the likelihood of crime and becomes a factor influencing human victimhood and vulnerability. Figure 1 shows some key points highlighting the relationship between the environment and victimological crime prevention:

- Physical environment including urban design, infrastructure, and geographical characteristics, can affect crime rates and victimization. Factors such as building layouts, street lighting, presence of security measures, and the accessibility of public spaces can contribute to creating a safe or crime-prone environment.
- Social environment comprising community dynamics, social norms, and collective efficacy, influences crime rates and victimization. Strong social cohesion, positive community relationships, and active community involvement can act as protective factors against crime and victimization by fostering informal social control and reducing opportunities for criminal behavior.
- Economic environment including income disparities, poverty levels, and employment opportunities, plays a role in crime and victimization. Communities with high poverty rates and limited economic opportunities may experience higher crime rates and a greater vulnerability to victimization. Addressing socioeconomic inequalities and promoting economic stability can contribute to reducing crime and victimization.
- Ecological environment including natural and ecological features, can have an impact on crime and victimization. Factors such as the presence of green spaces, access to recreational areas, and the maintenance of natural environments can contribute to community well-being, social interaction, and a reduced likelihood of criminal activities.

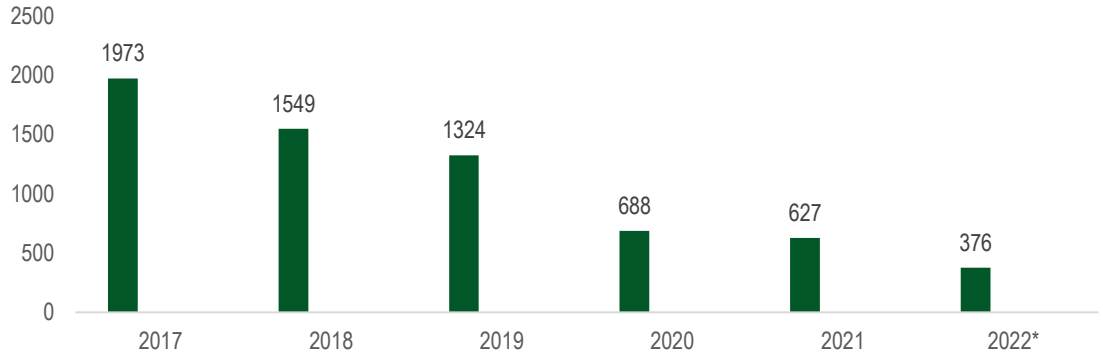
The environment can shape individuals' risk perception and fear of crime. Perceived insecurity and fear can impact individuals' behaviors, limiting their mobility, reducing community engagement, and affecting their overall well-being. Creating environments that promote feelings of safety and security can help alleviate fear of crime and enhance the quality of life for residents. Perceptions of risk and fear can be subjective and influenced by a range of factors beyond the objective crime situation. Understanding the relationship between the environment and individuals' risk perception and fear of crime is crucial for developing strategies to address and alleviate fear, enhance feelings of safety, and promote community well-being.

Environmental crimes happen wherever you can make money on illegal transactions that harm the environment. According to a UN report, environmental crime is larger than the illegal trade in small arms, which is estimated at about $3 billion. The financial losses caused by environmental crime are more than 10,000 times greater than the amount spent by international agencies to stop it (the total budget is only $20-30 million).From the beginning of 2017 to September 2022, about 1.1 thousand criminal environmental offenses were committed annually in Kazakhstan. Despite the fact that their number is decreasing every year, the financial damage they bring to the country is growing. Last year, environmental violations cost Kazakhstan 5.3 billion tenge, a record amount since 2017.The two most common types of crimes are:

- the crime of unlawful handling of rare and endangered plant or animal species, as well as prohibited species, their parts or derivatives (under Article 339);
- unlawful harvesting of fish resources, other aquatic organisms, or plants (Article 335).

They accounted for 62.8% of all criminal environmental offenses in 2021, and 56.1% in the first nine months of this year (Figure 2).

Figure 2. Number of registered criminal environmental offenses, in units



Starting from 2017, offenders cause damage to Kazakhstan on average in the amount of 3.5 billion tenge annually - both to the state itself and to legal entities and individuals. However, the perpetrators are in no hurry to replenish the treasury, compensating for the damage. So, on average, over the past five years, violators have compensated only 676.5 million tenge per year, or only 19% of the total amount of damage. This includes compensation for damages during the pre-trial investigation, as well as in cases sent to court. As part of this analysis, the author identified indicators of environmentally sustainable development (Table 1).

Table 1. Indicators of environmentally sustainable development

Indicator group	Unit	Indicator	Kazakhstan
Ecology	thousand tenge	The volume of current costs for environmental protection	210.397.122
	thousand tenge	Investments aimed at protecting the environment	173.618.612
	thousand tenge	Air emissions	2.441
	thousand tenge	Environmental taxation	1.389.912.223

Source: compiled by authors

In the Republic of Kazakhstan, environmental problems are aggravated every day, and the environmental crisis is intensifying, which leads to a crisis of all civilizations. Kazakhstan needs a robust climate change adaptation strategy that considers the specific vulnerabilities and risks faced by different regions and sectors. This strategy should involve a multi-stakeholder approach, integrating the expertise of government agencies, scientific institutions, civil society organizations, and local communities. Kazakhstan clearly needs the right strategy for adapting to climate change, as evidenced by the data characterizing that there are problems that affect the changing situation in Kazakhstan and the environment, which subsequently affect the number of natural hazards (Figure 3).

Figure 3. Indicators influencing the change in the situation in Kazakhstan and the environment

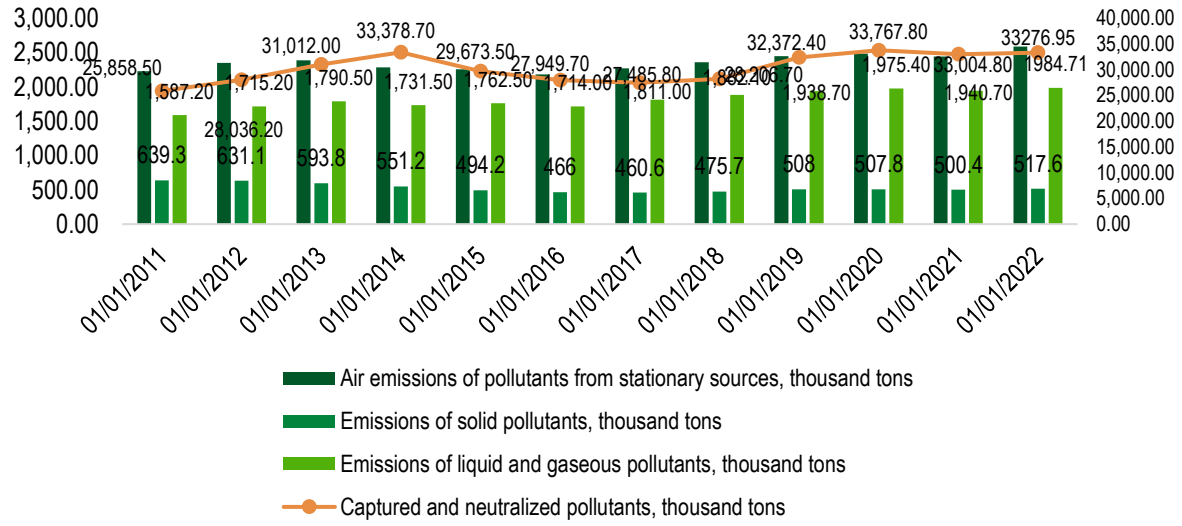
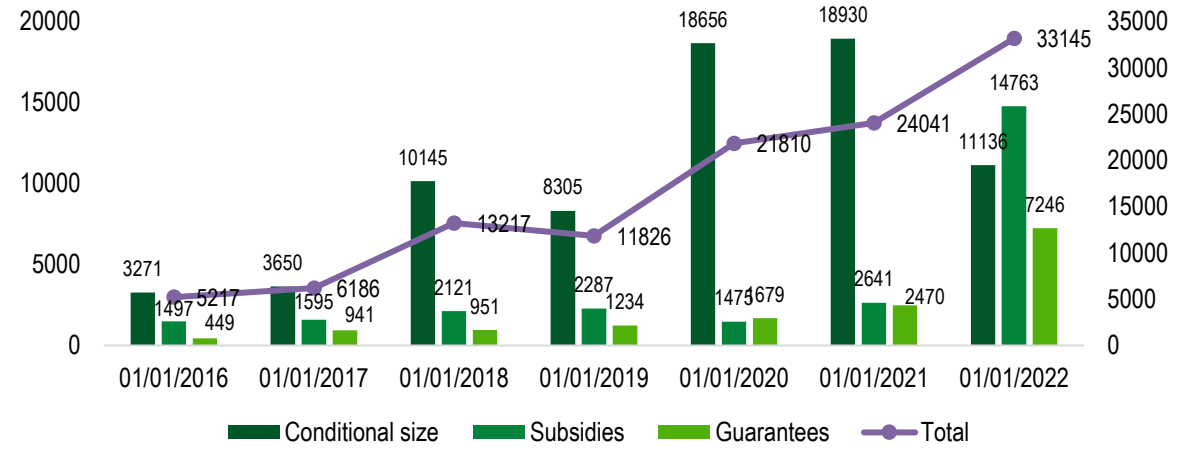


Figure 4. Number of funded environmental projects, million tenge



Summarizing the above, it can be noted that the study of the identity of the victim is of great importance not only for the qualification of the crime, but also for the study and prevention of crime of various kinds and

types, as well as in the environment. In recent years, more and more attention in criminological research has been paid to the development of a new scientific direction in criminology - victimology, which helps in the development of preventive measures. Therefore, issues related to victimology in general, including the problem of protection of victims of crime, have always attracted the attention and interest of domestic scientists in the field of criminal law, criminology and criminal procedure.

Conclusion

The legal support of victimological prevention for environmental crimes is a crucial aspect of combatting these offenses and promoting a sustainable future. By adopting proactive measures, providing victim compensation, fostering international cooperation, and strengthening legal frameworks, we can deter environmental criminals and safeguard the well-being of affected individuals and ecosystems. Governments, organizations, and individuals must work together to ensure that justice is served, and those responsible for environmental crimes are held accountable. Only through collective action can we create a world where environmental crimes are minimized, victims are supported, and the planet thrives.

The study gives grounds to offer some conclusions, thanks to which it is possible to improve measures for victimological prevention of crime:

- improve the legal support of victimization prevention it is recommended to systematize this activity in a unified legal system, which will contribute to achieving a high level, unity, continuity and consistency in the performance of functions by the subjects of this activity. A unified legal system should be a legal tool for implementing measures to influence victimization;
- develop a concept for victim assistance and victimological prevention, aimed at distributing unified state funds for social, legal and material assistance to all victims of crime, and introducing special protection measures for public servants;
- creation of a state-public system of victimological assistance to citizens and legalization of schemes for compensatory support for victims at the expense of decentralized support funds, which can be formed by imposing additional legal costs on criminals;
- coordinating activities for organizing and conducting victimological and preventive work should belong to local executive authorities, and at the republican level - to republican executive authorities. This, in turn, will mean that they perform directly managerial functions (analysis, planning, organization, control and interaction), and will also allow all participants (subjects) of prevention activities to concentrate their efforts on the implementation of victimological tasks, to determine the range of general crime prevention measures, with taking into account the specifics of the region (served territory), the implementation and implementation of measures to influence victimization, purposefully and rationally use the available forces and means;
- increasing the professional level of employees of internal affairs bodies through courses, seminars, borrowing foreign experience.

Addressing the environmental challenges and climate change impacts in Kazakhstan requires a proactive and coordinated approach. Adopting a comprehensive adaptation strategy, Kazakhstan can strive to mitigate the environmental crisis, protect its natural resources, and enhance the resilience of its ecosystems and communities in the face of a changing climate.

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Credit Authorship Contribution Statement

Dauren Malikov proposed and substantiated the concept of scientific research, due to its purpose of implementation and the tasks set and planned the study.
Natalya Sidorova carried out a comparative analysis on the topic under study and thereby summarized the results of the study, and formulated conclusions and proposals on the problem under study.
Saltanat Atakhanova developed the design of an experimental study on the topic, collected and systematized the data that were obtained during the scientific study and accumulated them into a research model.
Manshuk Rakhimgulova concept the methodology and formal analysis of the research, conducted an analysis of the scientific literature and its generalization, and also collected data on the necessary literature on the topic.
Sholpan Malikova contributed to the analysis and results of research, carried out the development of the methodology of scientific research.

Larissa Kussainova wrote the data curation and visualization and funding acquisition, carried out a critical review of the text of the article and its editing in accordance with the requirements and provisions, as well as its design.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Management of Bioculture Potential with Environmental Perspective Based on Local Wisdom

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Abstract: This paper analyzes how the system for managing bio culture potential is based on the local wisdom of the Duanu tribe, Indragiri Hilir Regency, and aims to develop a strategy for managing potential with an environmental perspective based on the local wisdom of the community. In this regard, is used a mixed method by distributing questionnaires, a sample of 100 respondents using a purposive sampling approach, and data collection techniques using surveys, interviews, and observations. The findings of this study conducted the strategy formulation by determining alternative strategies obtained from the results of the SWOT analysis. The tool used in this analysis is the Quantitative Strategic Planning Matrix to see the priority strategies and set the environmental perspective based on local wisdom.

Keywords: bioculture; environment; local wisdom.

JEL Clasiffication: F64; M14; Q51; R11.

Introduction

Bioculture (bioculture) is a combination of biological and cultural factors that influence human behavior (Boyd 2006). Human behavior and culture arise from complex connections among genetic dispositions and environmental circumstances, from the physical aspects of the biosphere to imaginary cultural concepts.

Indigenous community behavior patterns tend to be oriented toward cultural values and local wisdom. Dachlan (2013) and Prasojo (2011) state that indigenous peoples contain strong cultural values and have potential local wisdom supported by various aspects such as natural resources and human resources. The

majority of indigenous peoples live in coastal areas (Dachlan 2013, Prasojo, 2011). By carrying out the concept of local wisdom, the community can maintain tradition during the development of the modernization era.

The consistency of the Duanu Tribe community in Indragiri Hilir Regency in managing menongkah products to how they maintain local wisdom in menongkah activities is a challenge if they want to apply new things in their lives. It is hoped that the biocultural approach will change the behavioral patterns of the Duanu people to explore their potential and participate in the use of information technology without having to eliminate the side of local wisdom as a form of economic, ecological, and social balance. This suggestion is in accordance with the results of Pujiwiyana's research (2010) which states that the use of information technology is able to shape the capabilities of modern society based on local understanding. So, it is essential to have a potential management strategy with a biocultural approach whose output is a novel way of processing shellfish products so that it can improve the community's economy, and good environmental management while maintaining the culture and values of local wisdom of the Duanu Tribe community in Indragiri Hilir Regency.

From this background, the researchers want to conduct their studies on strategies for managing the potential of bioculture, with an environmental vision of the Duanu tribe based on local wisdom. These are the problems that can be achieved:

- How are the environmental condition in the residential area and the displacement of the Duanu Tribe, Indragiri Hilir Regency?
- What are the social conditions in dealing with the use of information technology in the Duanu tribal community, Indragiri Hilir Regency?
- What is the appropriate amount of income for the Duanu tribal community in Indragiri Hilir Regency each month?
- How is the strategy model for managing bio culture potential based on the local wisdom of the Duanu tribe in Indragiri Hilir Regency?

1. Literature Review

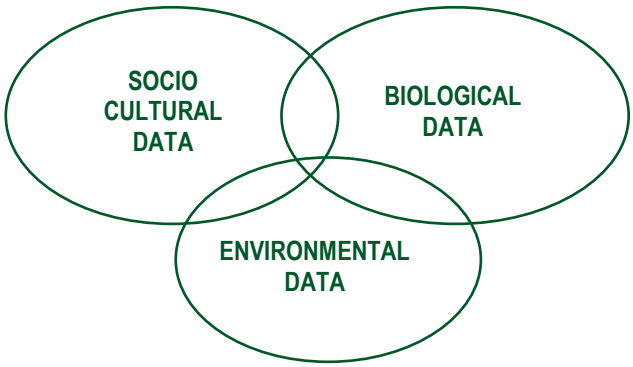
1.1. Bioculture Concept

In the humanities, researchers have relied on culture, as it is the only causal factor limiting human behavior and cultural production, but the emergence of multiple disciplines shows a more complex human image as biocultural beings (Boyd 2006). Some physical and chemical parameters of the river water were recorded monthly at three stations representing the upper, central and lower reaches of the Subyang River. In each station (Darmadi Ahmed) the left, central and right bank of the river was taken in 2023.

Human behavior is not the fruit of culture, nor is it the result of biology. Human behavior and human culture arise from the complex interplay between genetic attitude and environmental conditions. Environmental conditions range from the physical aspects of the biosphere to hypothetical cultural structures. The aim of this work package is to create a comprehensive biocultural theoretical paradigm that considers biology and culture as causal factors in the history of human evolution (Davis and Morris 2007).

Biocultural diversity consists of the diversity of life, in its manifestations – biological, sociocultural and environmental, in complex socio-ecological systems (Maffi 2008). McElroy (1990) says that deep bioculture is calculated in an integrated model, as shown below in Figure 1 below:

Figure 1. Biocultural integrative model



1.2. Environmentally Friendly Bioculture Potential Management

Environmentally friendly resource management means resource management without sacrificing environmental aspects in the process, or in other words, being environmentally friendly. Environmentally sound management aims to maintain environmental functions in line with the utilization carried out. Environmentally sound resource management is generally carried out by maintaining biological resources such as mangrove forests in aquaculture areas. Environmentally minded can be interpreted as a perspective on the environment, the ability to understand ways of adjustment or placement in the environment.

Environmentally sound resource management is generally carried out by maintaining biological resources such as mangrove forests in aquaculture areas. Environmental insight can be interpreted as a perspective on the environment, the ability to understand ways of adjustment or placement in their environment. The environment consists of 3 components, namely: first, Abiotic or Physical components (water, soil, air); second, biological or biotic components (flora, fauna, microbes and their elements (water/fauna/culture and others)) and third, Cultural components (social, economic, cultural). These three components are mutually influenced or have an influence on fellow components (Tandjung 2001).

Environmentally minded comes from the word's insight and environment. Insight by means of perspective. Meanwhile, the environment in Law Number 32 of 2009 about Ecological Shield and Management is the agreement of space with all objects, power, conditions, and living things, including humans and their behavior, which affect nature itself, the continuity of life, human welfare, and extra alive things.

1.3. Local Wisdom

Local wisdom is the identity or cultural identity of a nation that causes nations to absorb, as well as other nations coming from culture/outside, into their natures and abilities (Wibowo, 2015). Identity and identity, of course, are adapted to the direct vision of the circus community so that there are no changes in values. Local wisdom is one of the means of cultivating culture and defending culture itself from foreign cultures that are not good. Local wisdom is a view of life and knowledge, as well as the living strategies of local communities to respond to various problems to meet their needs.

The forms of local wisdom are the harmony of diversity as a social practice based on cultural knowledge. The types of local wisdom in society can be like cultures (values, rules, ethics, beliefs, customs, customs, and special norms). Among the noble values related to local wisdom are love of God, his character and content, his responsibility, discipline, independence, honesty, respect and courtesy, compassion and care, trust, creativity, hard work, never defeated, justice and leadership, kindness and humility, tolerance, love of peace and unity (Haryanto 2014).

According to Mitchell (2003) in Sedyawati (2006) and Njatrijani (2008), local wisdom has six dimensions, namely:

1. Dimensions of Local Knowledge. Each community has the capacity to adapt to their environment, as they have local knowledge to control nature. Also public knowledge about climate change and other natural phenomena. (Fifi Nofiyanti 2021).
2. Local Value Dimensions. Each society has local norms or values regarding the actions or behaviors that all members come together and agree on, but these values will vary depending on the progress of the community. The values of actions or behaviors integrated in one group will not necessarily be agreed or admitted in other community groups. Like Daya, she has a habit of tattooing and piercing some parts of her body.
3. Dimensions of Local Skills. Every society has the ability to survive (survive) to meet the needs of families or satisfy what is called the survival economy. It is a way of sustaining human life that depends on nature, from hunting, gathering and farming to domestic industries.
4. Dimensions of Local Resources. Each Community will use local resources according to its needs and will not exploit them on a large scale or commercialize them. The community must balance the balance of nature so that it does not have a dangerous impact on it.
5. Dimensions of Local Decision-Making Mechanisms. Each community has, above all, its own municipal government, called tribal government. The tribe is a legal institution that orders citizens to act in accordance with long-agreed rules. So if someone breaks those rules, they will rely on a series of sanctions, such as decision-making, passing by the tribal leader.
6. Dimensions of Local Group Solidarity. Men are social beings who need the help of others to do their job, as men cannot live alone. Humans work together to protect the environment.

2. Research Methods

This research on biocultural potential management strategies for the Duanu Tribe community in Indragiri Hilir Regency uses a mixed-method approach. The mixed process approach in this study uses a sequential mixed method, especially in the consecutive explanatory strategy. The first stage is to conduct interviews and then analyze qualitative data about how social conditions are with the local wisdom of the Duanu Tribe in Indragiri Hilir Regency to answer the second problem formulation. The next step is to conduct a survey by distributing questionnaires to obtain quantitative data, namely how the potential of bioculture can empower the community while still being based on the Duanu Tribe community in Indragiri Hilir Regency.

This research was conducted in Indragiri Hilir Regency. The aim for selecting this position is that the Duanu Tribe still has a fairly high poverty rate because the community is not open to the development of information technology to develop a creative economy. The sampling method was chosen with the consideration that there is no heterogeneous sample because it is in the same area or location, without paying attention to certain characteristics of the respondents. The sample consists of 100 respondents.

The technique used in this research is a survey, interview, and observation. The data analysis technique used in this study, according to Miles and Huberman (1984), is a qualitative analysis method in Sugiyono (2013:246), which suggests that in the qualitative analysis of the data activities are carried out interactively and that they are produced permanently so that the data are saturated. The analysis of the data used will be carried out through a formulation of strategy, specifying alternative strategies obtained from the results of the SWOT analysis. The tool to analyze this stage is the use of the QSPM matrix (Quantitative Strategic Planning Matrix). The QSPM matrix is used to see priority strategies for managing the Duanu tribe's capacity to rape, based on the local wisdom of Hilir Regency. The TT alternative strategy is the most active alternative strategy for the empowerment of the Duanu community of Indragiri Hilir Regency.

3. Findings, Results and Discussion

3.1. Hypothesis Test

Based on the data and information collected from respondents who have been determined such as; gender, age, occupation, education level, income level, and other variable data can be explained as follows:

- Gender

Table 1. Gender data

No	Gender	Frequency	Percentage
1	Man	79	79%
2	Girl	21	21%
Amount		100	100%

- Age Level

Table 2. Respondents' age level

No	Age	Frequency	Percentage
1	<18	0	0%
2	18-24	3	3%
3	25-31	18	18%
4	32-38	26	26%
5	>39	53	53%
Amount		100	100%

- Respondent's type of work

Table 3. Respondents' occupations

No	Work	Frequency	Percentage
1	Student	0	0%
2	Government Employees	0	0%
3	Private Sector Employee	0	0%
4	Self-employed	1	1%
5	Farmer	0	0%
6	Fisherman	99	99%
Amount		100	100%

- Respondent's education level

Table 4. Respondents education level

No	Level of education	Frequency	Percentage
1	SD	96	96%
2	SMP	3	3%
3	SMA	0	0%
4	Bachelor	1	0%
Amount		100	100%

- 4. Respondents' Income Level

Table 5. Income level of respondents

No	Income	Frequency	Percentage
1.	< Rp. 1.500.000	97	97%
2.	Rp. 1.500.000 - Rp. 3.500.000	2	2%
3.	Rp. 3.500.000 - Rp. 5.000.000	1	1%
4.	> Rp. 5.000.000	0	0%
Total		100	100%

3.2. Discussion

3.2.1. Bioculture Potential Based on Local Wisdom of the Duanu Tribe in Indragiri Hilir District

Basically, the implementation of community empowerment through a biocultural model strategy is very appropriate to be applied to the Duanu tribal community because the very tight integration of customs and local wisdom will have a positive impact on the Duanu tribal community. However, there are several obstacles that cause the empowerment of this culture model not to be fully implemented which are divided into social aspects, economic aspects, and ecological aspects.

Therefore, SWOT is used to formulate a strategic model of analysis to manage the potential of the Duana tribal culture based on the local wisdom of Hilir Regency. In the analysis of the internal environment of Duanu community empowerment, the strategic internal factors that encompass the strengths and weaknesses of Duanu community empowerment can be identified. Once the internal strategic factors have been identified, an IFAS (Internal Factors Analysis Summary) table is prepared to formulate the strategic factors within Strength and Vulnerability. The results of the identification of strategic internal factors reached 5 factors of robustness and 4 factors of vulnerability. Strengths and weaknesses are given the rating and weight, and the entire score is calculated to see the priorities of the tribal community's strengths and issues. The results of the Duanu tribe's internal empowerment strategy can be seen in the table below:

Table 6. IFAS – EFAS Matrix

No	Internal Strategic Factors	Weight	Rating	Score
A. Strengths				
1	Has a distinctive and identical culture and is based on the preservation of environmental control	0,12	4	0,48
2	Culture of mutual cooperation in work and decision making	0,10	3	0,30
3	Menongkah confirmed as an intangible cultural heritage by the Indonesian Ministry of Education and Culture	0,10	3	0,30
4	High work ethic	0,10	3	0,30
5	Preserving cultural heritage to date	0,12	4	0,48
B. Weaknesses				
6	Weak capture marketing network and lack of business diversification	0,12	2	0,24
7	Low bargaining position of HR due to lack of special advantages and expertise	0,12	2	0,24
8	High levels of poverty and limited infrastructure facilities, and livable housing, tools and technological resources	0,11	2	0,22
9	Low desire to modernize	0,11	2	0,22
Total IF Score (A+S)		1,00		2,78

The strength factor of bio culture potential with empowerment based on local wisdom of the duanu tribal community of Indragiri Hilir Regency consists of 5, namely (1) Having a distinctive and identical culture based on the preservation of environmental control; (2) a culture of mutual cooperation in work and decision-making; (3) Indonesian Ministry of Education and Culture confirms Menongkah as intangible cultural heritage; (4) high work ethic; (5) Preserving cultural heritage to date. The weakness factors for bio culture potential with empowerment based on local wisdom of the Duanu tribal community, Tanjung Pasir Village, Indragiri Regency consist of 4, namely (1) Weak marketing network for catches and lack of business diversification; (2) low bargaining position of human resources due to the lack of special advantages and expertise; (3) The high level of poverty and limited infrastructure facilities, and decent housing, technological tools, and resources; (4) Low desire to modernize.

External strategy factors include opportunities and threats for bio culture potential with empowerment based on local wisdom of the Duanu tribal community, Tanjung Pasir Village, Indragiri Hilir Regency. From the identification of external strategic factors, there are 4 opportunity factors and 4 threat factors. The opportunity and threat factors are then given a rating and weight and a total score is calculated to see the priorities of the opportunities and threats owned by the duanu tribal community.

Potential bio culture opportunity factors with empowerment based on local wisdom of the duanu tribal community of Indragiri Hilir Regency consist of 4, namely (1) potential marine biota diversity; (2) The strategic location of the large fishing ground; (3) good water quality; (4) Availability of budgets related to poverty alleviation, cultural preservation, and environmental preservation both from the central and regional governments as well as foreign assistance. The threat factors for bio culture with local wisdom-based empowerment of the Duanu tribal community in Tanjung Pasir Village, Indragiri Regency consist of 4, namely (1) lack of social access; (2) Damage to aquatic ecosystems due to company and community activities that are not based on conservation: (3) Government assistance programs are still ineffective; (4) Erratic change of seasons.

3.2.2. Strategy Model for Managing the Bioculture Potential of the Duanu Tribe Based on Local Wisdom

Based on the consequences of the study, using the QSPM matrix, this conclusion can be drawn, as follows:

- total attractiveness score (TAS) of the alternative strategy for managing bioculture potential with empowerment based on the wisdom of the Duanu tribal community, Indragiri Hilir Regency to the maximum, namely optimizing the bioculture strategy model through community empowerment has a score of 7.16;
- the strategy of developing new economic opportunities by utilizing the wealth of aquatic resources based on local wisdom and conservation of water areas has a score of 6.92;
- the strategy of training, coaching and developing marketing networks as well as business diversification on the catch has a score of 6.82;
- the appropriate technology transfer strategy the use of menongkah activities and catch processing has a score of 6.71;
- the strategy for business capital assistance, decent housing and education for the Duano tribe's children has a score of 6.70;
- the social security strategy, capital and infrastructure structure from the local government has a score of 6.61, an integrated business development strategy on access to business capital such as corporate CSR, BANK, Cooperatives and BUMDes has a score of 6.54;
- a strategy to integrate the role of government, private, educational institutions and community communities in economic development and development the duanu tribal community has a score of 6.51;
- the strategy for synchronization and program integration between the central government, regional governments, and other stakeholders in poverty alleviation by optimizing local potentials of the region has a score of 6.50;
- the strategy for developing group-based business development patterns has a score of 6.40;
- the strategy involving the role of the duanu tribal community in water conservation activities has a score of 6.35;
- the strategy to improve marine security with community integrity based on the value of local wisdom 6.34.

Conclusion

The results of the identification of internal strategic factors in the management of bio culture potential with empowerment based on local wisdom of the Duanu tribal community, Tanjung Pasir Village, Indragiri Regency, consisted of 5 strength factors, namely: (1) Having a distinctive and identical culture and based on the preservation of environmental control; (2) a culture of mutual cooperation in work and decision-making; (3)

Menongkah is confirmed as an intangible cultural heritage by the Ministry of Education and Culture of the Republic of Indonesia; (4) high work ethic; (5) Preserving cultural heritage to date. The weakness factors of the 4 are (1) a Weak marketing network for the catch and the lack of business diversification; (2) low bargaining position of human resources due to the lack of special advantages and expertise; (3) The high level of poverty and limited infrastructure facilities, and decent housing, technological tools, and resources; (4) Low desire to modernize.

The results of the identification of external strategic factors consisted of 4 opportunity factors, namely: (1) Potential diversity of marine biota; (2) The strategic location of the large fishing ground; (3) good water quality; (4) Availability of budgets related to poverty alleviation, cultural preservation and environmental preservation both from the central and regional governments as well as foreign assistance. The threat factors consist of 4, namely: (1) the lack of social access; (2) Damage to aquatic ecosystems due to company and community activities that are not based on conservation: (3) Government assistance programs are still ineffective; (4) The erratic change of seasons.

The results of the space matrix for managing bio culture potential are in quadrant one position. The strategy that must be applied in this condition is to support the development policy of the Duanu tribal community in an inclusive, collaborative and aggressive manner (growth-oriented strategy), as follows:

- SO strategy, namely (1) Development of new economic opportunities by utilizing the wealth of aquatic resources based on local wisdom and conservation of water areas; (2) Program synchronization and integration between the central government, regional governments, and other stakeholders in poverty alleviation by optimizing local potentials; (3) Development of a group-based business development pattern.
- WO strategies for managing bio culture potential with empowerment based on local wisdom of the duanu tribal community in Indragiri Hilir Regency, namely (1) training, coaching, and developing marketing networks and business diversification on catch products; (2) Transfer of appropriate technology in mining activities and processing of catches (3) Assistance for business capital, decent housing and education for the children of the Duanu tribe.
- ST strategy for managing bio culture potential with empowerment based on local wisdom of the Duanu tribal community in Indragiri Hilir Regency, namely (1) Optimizing the bio culture strategy model through community empowerment; (2) Improving marine security with community integrity based on the value of local wisdom; (3) Integrated business development on access to business capital such as corporate CSR, BANK, Cooperative, and BUMDes.
- WT strategies for managing bio culture potential with empowerment based on local wisdom of the duanu tribal community in Indragiri Hilir Regency, namely (1) Integrating the roles of government institutions, private sector, educational institutions, and community communities in fostering and developing the economy of the duanu tribal community; (2) Social security, capital and infrastructure from local governments; (3) Involving the character of the duanu tribal community in water conservation activities.

The results of the QSPM Matrix analysis show the Total Attractiveness Score (TAS) of alternative strategies for managing bio culture potential with empowerment based on the wisdom of the duanu community of Indragiri Hilir Regency to the maximum, namely optimizing the bio culture strategy model through community empowerment, strategies for developing new economic opportunities by utilizing resource wealth water resources based on local wisdom and conservation of water areas, training strategies, coaching and development of marketing networks as well as business diversification on catch products.

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Credit Authorship Contribution Statement

Trio Beni Putra: Design of the research methodology, research background research at national and international level with scientific articles published in Scopus and web of science indexed journals.
Thamrin Thamrin: Construction of the theoretical framework, with scientific articles published in journals indexed in Scopus and web of science on the title Interactive Planning as Part of a Territorial Strategy to Develop Tourism Sites.
Zulfan Saam: Conceptualization of the research idea, supervision of the execution of the research, review and editing of the final article Interactive Planning as Part of a Territorial Strategy to Develop Tourism Sites.

Sofyan Husein: Administration of the database with the collected information, SPSS v26 software, statistical analysis using tables and hypothesis testing, uploading the paper to the journal and raising comments as corresponding author.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Analysis of the Environment Impact on the Inclusion of Children with Special Educational Needs

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Abstract: This paper highlights the critical role of the environment in facilitating the inclusion of children with special education needs (SEN) in educational settings. The physical environment, social interactions, curriculum, instructional practices, and policy frameworks all contribute to creating an inclusive environment. Considering and addressing the impact of these environmental factors, educators, policymakers, and school leaders can promote the successful inclusion and participation of children with SEN, ultimately enhancing their educational experiences and outcomes. Further research is needed to delve deeper into specific environmental factors and their interrelationships to develop comprehensive strategies for promoting inclusive education.

Keywords: pollution; environment; inclusive environment; inclusive education; education system.

JEL Classification: Q52; I25; Q56; Q57; R11.

Introduction

A favorable environment is an environment whose condition ensures environmental safety and protection of public health, conservation of biodiversity, prevention of pollution, sustainable functioning of ecological systems, reproduction and rational use of natural resources. Environmental factors play a vital role in the support and development of children with special educational needs, which include the physical, social and behavioral characteristics surrounding the child, as defined by the International Classification of Functioning, Health and Disability (ICF) (Anabi *et al.* 2018).

Analysis of the factors influencing inclusive education is an important task for understanding and improving the educational system includes an assessment of how the environment and environmental factors can facilitate or create barriers to the successful integration of these children into the educational environment. Here are some aspects to consider in such an analysis:

- Physical accessibility. The environment must be accessible to all children, including those with physical disabilities. The availability of suitable infrastructural conditions, such as adapted buildings, accessible ramps, elevators, wide doorways, etc., allows children with special education needs (SEN) to move freely within educational institutions;
- Healthy and safe learning and living environment. The quality of the environment plays an important role in ensuring the comfort and safety of children with SEN. This includes the availability of clean air, safe drinking water, proper waste management, and physical safety in classrooms and school buildings;
- Accessibility of educational resources. Environmental factors can influence the availability and access to educational resources for children with SEN. This includes the availability of special educational materials, technologies and equipment, as well as access to information technology and the Internet;
- Natural environment and environmental education. Diverse natural environments such as parks, gardens, ecological reserves, etc. can provide unique opportunities for inclusive education. The development of environmental education programs that include children with SEN and encourage their participation in activities related to nature, promotes their integration and positive interaction with the environment.

Despite a growing body of evidence on environmental impacts on child participation, little is known about the environmental barriers faced by preschool children with disabilities in Taiwan. Knowledge of environmental barriers will help develop environmental modification solutions or strategies to support children's access to and participation in daily activities (Kang *et al.* 2018)

1. Literature Review

The impact of environmental pollution cannot but affect human health. The most vulnerable groups of the population to harmful effects are pregnant women and children. The problem of the influence of harmful environmental factors on the health of children in Kazakhstan has been studied since the 90s, however, there are only a few works devoted to the study of the impact of harmful substances on children with special education needs (SEN).

Every child deserves to learn in an environment adapted to their specific needs. Inclusive education offers a wide range of benefits, from social and emotional to academic achievement.

There are numerous studies that have shown that inclusive education has its benefits in terms of the cognitive, social and emotional development of persons, arguing that inclusive education provides more opportunities for the development of social, emotional and behavioral skills not only in children who need additional support, but also in children with typical development (Magyar *et al.* 2020, Molina Roldán *et al.* 2021, van Kessel *et al.* 2021). Some studies show that students who have not experienced problems have positive attitudes, positive beliefs and a willingness to accept students with disabilities, along with a positive attitude towards co-education with them, which is a very important factor for successful inclusion (Radisavljevic-Janic*etal.*2018, Alnahdi and Schwab 2021).

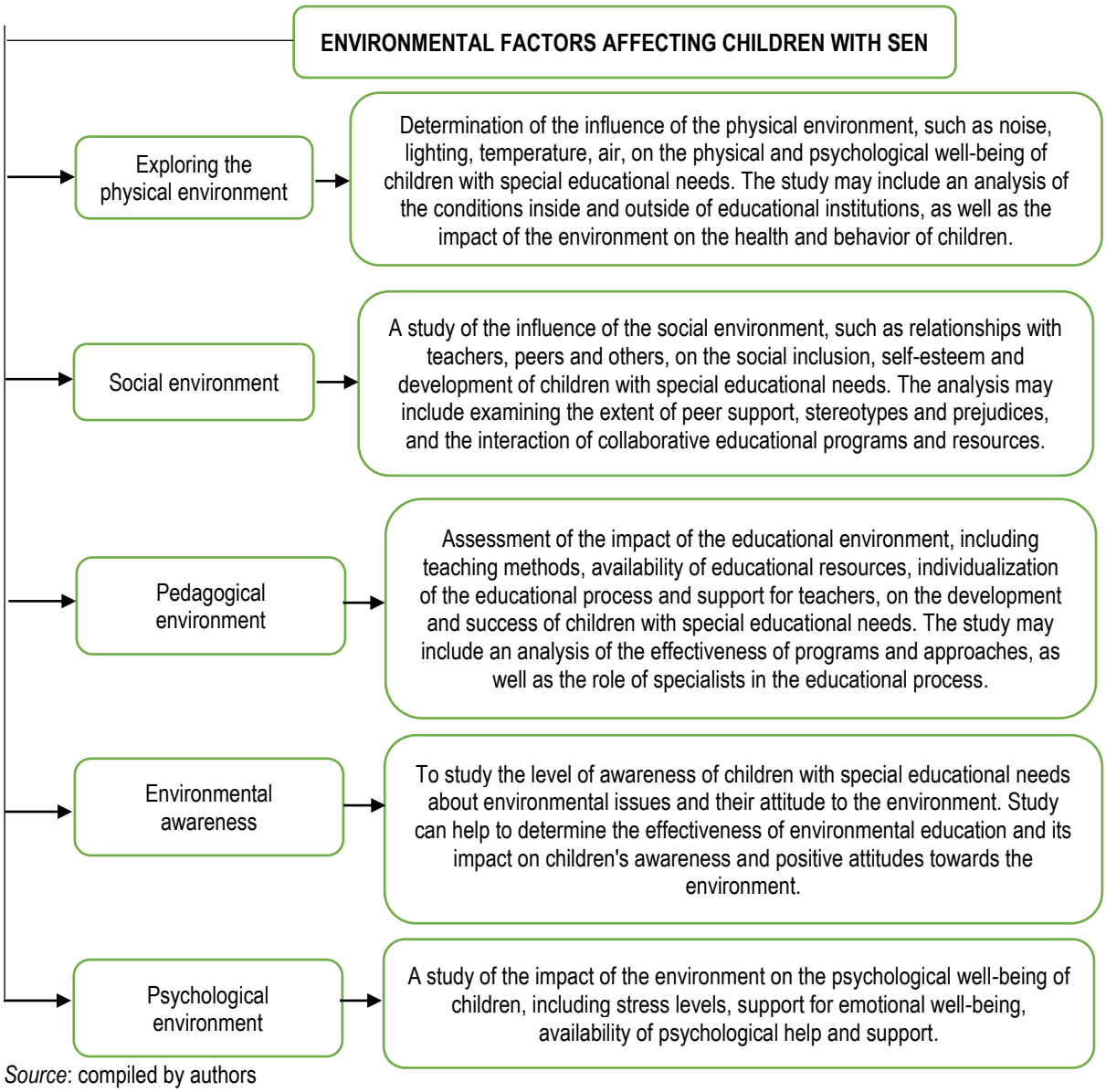
Changes in educational policy bring many positive results, avoiding discrimination of children with SEN (Artiles *et al.* 2020), creating equal opportunities in education, having some academic success (Gregorz *et al.* 2018), improving communication and social interaction. However, in reality, these benefits can be reduced due to various barriers in the educational environment, for example, the reluctance of some teachers, peers, parents or leaders to include these children in the educational process (Sedláčková *et al.* 2021).

The experience of students with different types of special educational needs (SEN) within the framework of inclusive education (IE) has been studied and repeatedly described in the literature by foreign scientists (Okyere *et al.* 2019, Sedláčková 2018).

Greenberg and Nielsen (2018) and Mitchell (2019) note that education systems can become places where collaboration, creativity, problem solving, communication, and critical thinking take place among diverse populations if they are truly inclusive. These end goals are qualitatively different from those at the heart of the placement debate, but are key to the evolution of inclusion because, as noted by Nikolić and Popović (2018) and Peters (2019), a child can be present in a regular school without actually being included in it. For many European countries, according to Meijer and Watkins (2019), changing the financing systems for inclusive education can still be considered as a key lever to achieve the goal of wider coverage of students with special educational

needs. The key guidelines of state support and directions of financial assistance in European countries are reflected in the series of documents (Lemechshenko *et al.* 2022).

Figure 1. Environmental factors affecting children with SEN



Source: compiled by authors

The quality of the development of inclusive education raises many questions from researchers, including the inefficiency of the use of innovative forms of education in inclusive education, insufficient knowledge of international experience, and the impact of the environment. Environment can have both direct and indirect effects on children with special educational needs (SEN). Here are some ways that environmental factors can affect children with SEN:

- Health and well-being: Poor environmental quality, such as air pollution, water or soil, can negatively affect the health of children, including those with SEN. They may be more vulnerable to pollutants and be more sensitive to adverse environmental conditions.
- Accessibility and facilities: Some natural and public spaces may not be accessible or adequate for children with SEN. For example, the lack of accessible ramps, elevators, or accessible facilities can make it difficult for children with disabilities to get around and participate in activities.
- Social inclusion: Environmental factors may influence the opportunities for social integration of children with SEN. The inaccessibility or lack of adapted environments for play and interaction in the natural environment may limit the ability of children with SEN to participate in activities and interact with other children.

- Environmental education: The development of environmental education programs that include children with SEN can promote their active participation and education. Such programs can help children with SEN develop environmental awareness, participation in environmental projects, and a positive attitude towards the environment.
- Environmental support and adjustment: It is important to provide appropriate environmental support and adjustment for children with SEN. This may include adapted teaching materials, equipment and technology.

All these problems together require the solution and the combined efforts of all stakeholders and an integrated approach for its successful implementation in the country (Nurgalieva *et al.* 2018). As part of the study of environmental factors affecting children with special educational needs, there are certain tasks (Figure 1).

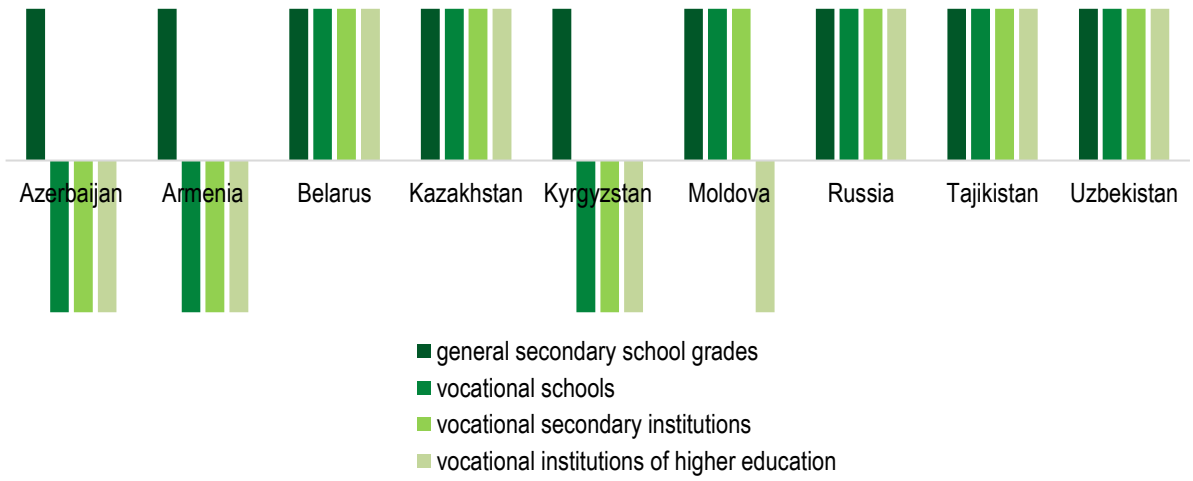
In this context, research related to the impact of the environment on the health and behavior of children with SEN will help identify key issues and offer recommendations for creating a supportive and supportive environment that promotes their health, development, and learning. The study of the influence of the environment on the formation of patterns of behavior and lifestyle of children includes an analysis of the availability of healthy food, opportunities for physical activity, environmental education and attraction to nature. Research into policies and programs aimed at creating a healthy and safe environment for children with SEN may include the effectiveness of existing interventions and suggestions for improving policies and programs at the community, school or state level.

2. Research Methodology for Influence of Environment upon Inclusive Education

The adoption of the UN Convention on the Rights of Persons with Disabilities approved the principles on which the state policy towards persons with disabilities should be built (UN Convention). In some Commonwealth countries, the "accessible environment" program has been adopted and is being successfully implemented, the purpose of which is to create conditions for a full life and integration into society of people with disabilities and other people with limited mobility. But, as cross-country analysis shows, conditions for inclusive education have not been created everywhere.

In accordance with Article 24 of the Convention, paragraph 1 “States Parties recognize the right of persons with disabilities to education. In order to realize this right without discrimination and on the basis of equality of opportunity, participating States shall ensure inclusive education at all levels and lifelong learning”. What you can’t really say, since the data indicate that there are certain problems in the coverage of inclusive education for children with disabilities and children with disabilities (Figure 2).

Figure 2. Educational institutions that have created conditions and ensured barrier-free access for the education of persons with disabilities



Source: compiled by authors according to https://www.cisstat.org

According to statistics, the number of registered disabled people in the Republic of Kazakhstan and children covered by inclusive education indicates that a fairly large number of parents of disabled children do not consider it necessary to develop, let alone educate a child. If we considered in the regional aspect, the number of

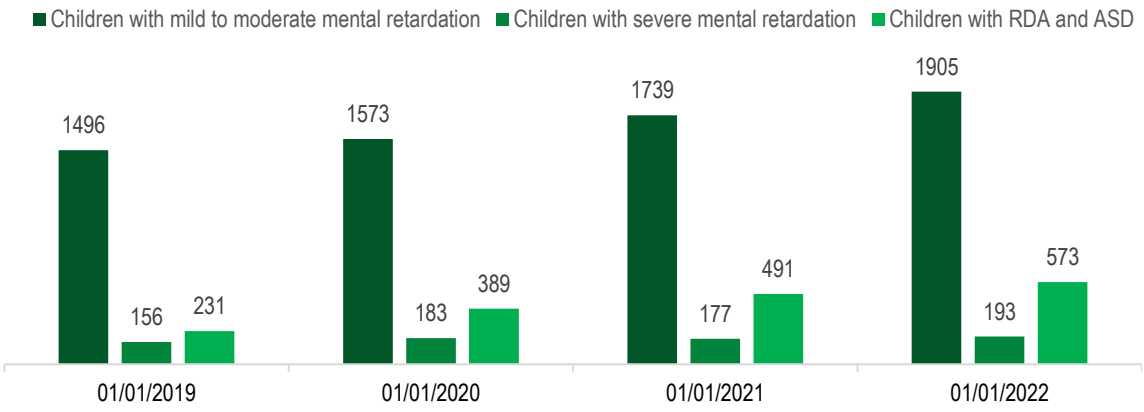
registered disabled children under 18 years of age has a certain upward trend, especially in such regions as the Almaty region, Turkestan, East Kazakhstan, Almaty, Astana. Some regions of Kazakhstan are known for their environmental problems, which can affect the health and behavior of children with SEN. Here are a few regions that may be affected:

- Karaganda region. This region is characterized by a developed industry, including metallurgical and chemical enterprises. Emissions and pollution associated with this industry can have a negative impact on the environment and the health of children, including children with SEN.
- East Kazakhstan region. The region is characterized by the presence of extractive industries, including the extraction of minerals such as coal and uranium. This may be accompanied by emissions of pollutants and negative impact on the environment.
- Akmola region. The capital of Kazakhstan, Nur-Sultan, is located in this region, which is a major center of industry, transport and infrastructure. A high level of motor transport and industrial enterprises can lead to air pollution and affect the health of children.
- West Kazakhstan region. The region is characterized by the presence of oil producing and oil refining industries. The emissions and pollution associated with this industry can have a negative impact on the environment and children's health.

Undoubtedly, the influence of ecology pays great attention to the development of children, and due to the fact that the ecological situation in the regions of Kazakhstan is deteriorating, the number of children with various degrees of disability increases every year. The existing practice of socialization of children with special educational needs at the moment in Kazakhstan is not sufficiently developed. This weakens the social position of the child and exacerbates his unequal social status. Despite the numerous government measures aimed at resolving this situation, the problem of unequal access to education in Kazakhstan exists and requires targeted action. This is evidenced by data characterizing the number of children with disabilities from 0 to 17 years old, including the number of children covered by inclusive education. Also, the influence of the environment has on such types of deviations as:

- mild and moderate mental retardation;
- severe and profound mental retardation;
- children with RDA and ASD (Figure 3 and Figure 4).

Figure 3. Total number of children with severe disabilities caused by environmental degradation



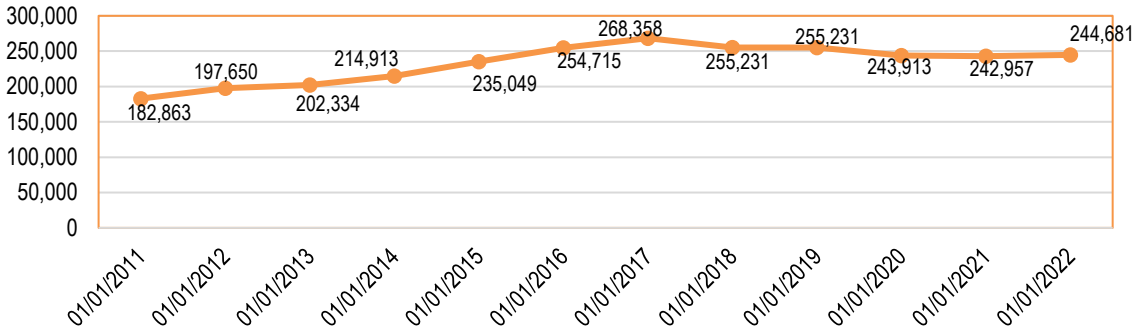
Source: compiled by authors according to https://www.stat.gov.kz

An increase in the number of stationary sources of pollution can lead to a number of negative consequences for the environmental situation. Here are some of them:

- Air quality deterioration: Stationary pollution sources such as industrial plants, power plants and factories can emit harmful substances and pollute the air. This can lead to an increased content of toxic gases, aerosols and other pollutants in the atmosphere, which adversely affects human health, flora and fauna.
- Water pollution: Some stationary sources of pollution may release waste and industrial effluents into water resources such as rivers, lakes and seas. This can lead to water pollution with toxic substances, oil products, chemicals and other harmful substances, which negatively affects the ecosystems of aquatic organisms and can cause problems for drinking water supply.

- Loss of biodiversity: The expansion of stationary sources of pollution can lead to the destruction and loss of natural habitats for many species of animals and plants. Environmental pollution can disrupt ecological balances, reduce populations and alter the biodiversity of a region.
- Adverse health impacts: An increase in stationary sources of pollution can increase the risk of disease in people living near such sources. Emissions of pollutants can cause problems with the respiratory and cardiovascular systems, as well as contribute to the development of cancer and other chronic diseases.
- Climate impact: Some stationary sources of pollution, especially those associated with energy, can contribute to the release of greenhouse gases such as carbon dioxide (CO_2) into the atmosphere. This can lead to an increase in the greenhouse effect and changing climatic conditions, such as global warming, changing weather patterns and other climate changes.

Figure 4. Number of stationary sources of pollution, units



Source: compiled by authors according to https://www.stat.gov.kz

In general, the increase in the number of stationary sources of pollution can lead to serious environmental problems that require the adoption of appropriate measures to control and reduce pollution, as well as to switch to more environmentally sustainable and cleaner sources of energy and production. It should also be noted that investments are required aimed at protecting the environment by types of environmental activities (Table 1).

Table 1. Investments aimed at protecting the environment by types of environmental protection activities, thousand tenge

Indicator	01.01.2019	01.01.2020	01.01.2021	01.01.2022
Investments aimed at protecting the environment	111.161.429	198.721.626	173.618. 612	171.165.359
including:				
- protection of atmospheric air and the problems of climate change	10.333.129	11.008.007	15.426.845	8.046.476
- wastewater treatment	6.179.506	2.909.014	11.775.069	31.016.559
- waste management	7.541.510	9.069.412	11.151.011	14.408.303
- protection and rehabilitation of soil, groundwater and surface water	9.882.630	8.775.234	7.108.863	10.485.558
- to reduce noise and vibration impact	16.584	x	-	x
- for biodiversity and habitat conservation	3.573.298	4.154.484	5.236.991	755.868
- for radiation safety	90.958	x	34.392	149.142
- for research work	323.022	82.229	475.202	327.785
- to other areas of environmental protection related to the "green economy"	73.220.792	162.722.471	122.410.239	105.952.068
of them:				
- investments in renewable energy sources	70.941.690	162.448.828	114.218.620	98.901.557
- investments in energy-saving technologies and energy efficiency	1.793.464	234.749	5.959.183	4.833.394
- investments aimed at reducing greenhouse gas emissions	105.610	399.190	65.385	31.988

Source: compiled by authors according to https://www.stat.gov.kz

Tighter environmental taxation can have a positive effect on improving the environment (Table 2).

Table 2. The indicators of environmental taxation (ET)

Type of ET	Unit	01.01.2017	01.01.2018	01.01.2019	01.01.2020	01.01.2021	01.01.2022
Energy taxes	thousand tenge	849052365,6	1213029733,2	1654232346,1	1706402804,8	881692071,6	1192382808,8
Transport taxes		50494764,9	64334 011,1	72060 566,9	78318 677,5	63439 188,2	77638335,0
Pollution taxes		67216275,7	72528 707,3	87125 547,6	100809 615,2	85593 121,1	110934387,7
Resource taxes		182369080,1	284612 858,7	335135 667,3	394415 327,2	359187 842,0	487890932,2
Total ET		1149132486,3	1634505310,4	2148554128,0	2279946424,8	1389912223,0	1868846463,7
Share of environmental taxes in GDP							
Energy taxes	in %	1,8	2,2	2,7	2,5	1,2	1,4
Transport taxes		0,1	0,1	0,1	0,1	0,1	0,1
Pollution taxes		0,1	0,1	0,1	0,1	0,1	0,1
Resource taxes		0,4	0,5	0,5	0,6	0,5	0,6
Total ET		2,4	3,0	3,5	3,3	2,0	2,2
Structure of environmental taxes							
Energy taxes	in % to total	73,9	74,2	77,0	74,9	63,4	63,8
Transport taxes		4,4	3,9	3,4	3,4	4,6	4,2
Pollution taxes		5,8	4,4	4,1	4,4	6,2	5,9
Resource taxes		15,9	17,4	15,6	17,3	25,8	26,1
Total ET		100,0	100,0	100,0	100,0	100,0	100,0

Note: ET- environmental taxes.
Source: compiled by authors according to https://www.stat.gov.kz

Here are some arguments supporting the need for tougher environmental taxation:

- Promoting environmentally responsible behavior. Higher taxes on pollution and emissions can provide incentives for businesses and individuals to reduce their negative environmental impact. This may encourage the development and implementation of cleaner technologies, energy efficient solutions and environmentally sustainable practices.

- Reduce pollution and emissions. Increased taxation can provide a financial incentive for companies and individuals to reduce pollution and emissions. Higher taxes on emissions encourage businesses to reduce their emissions or switch to cleaner technologies, which in turn reduces their negative environmental impact.

- Financing of environmental projects and programs. Additional funds received from environmental taxation can be used to finance environmental projects and programs, such as the development of renewable energy sources, the protection of natural reserves, the restoration of ecosystems and other initiatives that contribute to the improvement of the environment.

- Social responsibility and justice. Tighter environmental taxation can contribute to a more equitable distribution of environmental responsibility. Companies and individuals that pollute the environment more will pay more taxes, which is in line with the polluter pays principle. This can contribute to a more even distribution of the environmental burden.

Tightening environmental taxation can be one of the tools to help reduce the negative impact of human activities on the environment and promote the transition to more environmentally sustainable practices and technologies. However, such measures need to take into account economic, social and political dimensions in order to ensure the equity and sustainability of such changes. Despite the fact that there are regions where the largest number of disabled children is observed, in general, the situation in the development of inclusive

education has a negative trend. According to the data presented in Table 1, we observe an annual increase in children not covered by the right to develop inclusive education. This circumstance is facilitated by certain factors, among which are:

- lack of awareness of programs for the development of inclusive education in rural areas and villages;
- lack of interest of parents in the development and education of children with disabilities;
- insufficient subsistence level of the quality of life of parents of children with disabilities;
- insufficient state funding for children with disabilities and children with disabilities.

Analyzing Tables 1-3, in different regions of the Republic of Kazakhstan there is a certain number of benefits for disabled children ("+" / "-"), due to the fact that in some areas the industry is most developed, which has an adverse impact on the environment and public health (see Table 3)

Table 3. Impact on the environment and public health

Year	Republic of Kazakhstan		Almaty		East Kazakhstan		Karaganda		Turkestan		Astana	
	CD	Avg. SDA, tenge	CD	Avg. SDA, tenge	CD	Avg. SDA, tenge	CD	Avg. SDA, tenge	CD	Avg. SDA, tenge	CD	Avg. SDA, tenge
2011	149.043	14.863	7.597	15.009	12.309	15.139	12.547	14.973	41.525	14.559	5.126	15.007
2012	151.216	16.172	8.732	16.321	12.420	16.448	13.589	16.263	40.130	15.860	5.737	16.318
2013	148.652	17.310	9.767	17.476	12.322	17.642	13.484	17.411	35.819	16.956	6.228	17.420
2014	138.513	18.543	9.222	18.630	11.369	18.916	11.120	18.607	33.445	18.224	7.125	18.689
2015	141.952	20.753	10.061	20.799	12.651	21.157	11.035	20.822	32.415	20.443	7.927	20.909
2016	141.821	22.192	9.966	22.241	13.914	22.629	10.808	22.236	30.023	21.893	8.504	22.326
2017	144.783	29.684	10.527	29.700	15.208	30.223	8.904	29.677	28.362	29.333	9.297	29.836
2018	147.396	31.695	11.085	31.682	14.901	32.276	8.987	31.630	28.661	31.337	7.874	31.891
2019	153.230	39.897	11.914	39.837	14.998	41.613	11.183	39.523	20.051	39.142	7.557	40.023
2020	161.156	41.801	13.255	41.723	15.733	43.621	11.672	41.351	19.149	41.057	9.065	41.957
2021	161.826	46.011	14.579	46.036	15.528	48.080	12.879	45.428	19.475	45.150	11.453	46.242
2022	175.082	58.656	15.600	58.601	15.217	58.650	14.091	57.967	21.361	57.966	13.597	54.062

Note: CD- Children with disabilities; SDA – social disability allowances.

Source: compiled by authors according tohttps://www.stat.gov.kz

Accordingly, in these areas there is an increase in congenital diseases that have led to disability and limited opportunities. Among the possible causes and risk factors affecting congenital and acquired disability in children, a special place should be attributed to environmental pollution. Every year, a huge number of pollutants is emitted into the atmosphere, including from stationary sources, and hazardous waste is generated.

Table 4. Dynamics of the considered indicators

Year	Number of registered disabled children under 18, in people	Air emissions of pollutants from stationary sources, in thousand tons	Hazardous waste generation, thousand tons
01.01.11	49.349	168.712	303.117,0
01.01.12	61.196	182.863	420.668,3
01.01.13	65.844	197.650	355.952,5
01.01.14	69.111	202.334	382.214,3
01.01.15	72.574	214.913	337.414,8
01.01.16	75.712	235.049	251.565,6
01.01.17	79.662	254.715	151.390,1
01.01.18	83.462	279.997	126.874,6
01.01.19	86.956	278.911	149.962,4
01.01.20	91.573	262.716	180.506,7
01.01.21	94.660	266.703	211.051,8
01.01.22	97.745	240.751	42.090,0

Source: compiled and calculated by authors

Let us put forward and test a hypothesis about the existence of a relationship between the indicator "Number of registered children with disabilities under 18 years old, pers." and the following factors:

- atmospheric emissions of pollutants from stationary sources, thousand tons;
- generation of hazardous waste, thousand tons.

To test the hypothesis, we use the correlation-regression analysis. The statistics used for the analysis are presented in Table 4.

The results of the regression analysis applied to the growth rates of the initial data show that there is a statistically significant and reliable relationship between the considered indicators (Table 5).

Table 5. Growth rates of the considered indicators

Year	Number of registered disabled children under 18, %	Air emissions of pollutants from stationary sources, %	Hazardous waste generation, %
01.01.12	24,007	8,388	38,781
01.01.13	7,595	8,086	-15,384
01.01.14	4,962	2,370	7,378
01.01.15	5,011	6,217	-11,721
01.01.16	4,324	9,369	-25,443
01.01.17	5,217	8,367	-39,821
01.01.18	4,770	9,926	-16,194
01.01.19	4,186	-0,388	18,197
01.01.20	5,310	-5,807	20,368
01.01.21	3,371	1,518	16,922
01.01.22	3,087	5,805	3,446

Source: compiled and calculated by authors

The results of data approximation using the least squares method are presented in Table 6.

Table 6. Results of data approximation

R	0,855
R^2	0,731
Adjusted R^2	0,654
Fisher test	9,508 (p – value = 0,010)
Variables	
Growth rate in the number of registered disabled children under 18, % - dependent variable	
Constant	2,291
Growth rate of air emissions of pollutants from stationary sources, %	0,989***
Growth rate of hazardous waste generation, %	0,244***
* p<0,1; ** p<0,05; *** p<0,01	

Source: compiled and calculated by authors

Analysis of the obtained parameters of the multiple linear regression equation allows us to draw the following conclusions:

- an increase in the growth rate of emissions of pollutants into the atmosphere from stationary sources by 1% will contribute to an increase in the growth rate of the number of registered children with disabilities by an average of 0.989%.

- an increase in the growth rate of hazardous waste generation by 1% will contribute to an increase in the growth rate of the number of registered children with disabilities by an average of 0.244%.

Thus, the hypothesis put forward by the author about the impact of atmospheric emissions of pollutants and the formation of hazardous waste on the number of registered children with disabilities is confirmed. This hypothesis confirms that patterns of disability in a given country are influenced by trends in the development of pathological conditions, as well as trends in the development of environmental factors. It becomes obvious that the current legislation of the Republic of Kazakhstan focuses on violations of the functions of the human body as the main cause of disability (without taking into account environmental and social factors), but with special attention to the issues of correction, restoration of impaired functions.

Taking into account international recommendations on the need to switch to new standards for measuring disability, the Ministry of Health and Social Development of the Republic of Kazakhstan is currently carrying out appropriate work to amend and improve legal and by-laws in order to reflect the biopsychosocial model underlying the ratified Convention on the Rights of Persons with Disabilities.

Thus, the tasks of developing inclusive education include identifying the driving force behind the social development of different children (young people) included in a single space of educational activities, determining indicators and criteria that allow evaluating the results of development, the level of adaptation of a “special person” to life in society. Identification of the patterns of human development in the context of inclusive education, the role of the environment of an inclusive class (a group of a preschool institution or a university) in the formation of a personality, in the development of a child's intellectual experience of educational activities, the experience of social interaction can play a decisive role in introducing the ideas of inclusion into the work of educational organizations (Akhmetova *et al.* 2018).

Increasing emissions of pollutants into the atmosphere is undesirable from a public health point of view. There is a significant amount of research that demonstrates the negative impact of air pollution on various aspects of children's health, including respiratory diseases, allergies, asthma, developmental delay and other problems.

In order to ensure the health and well-being of children, it is necessary to strive to reduce emissions of pollutants into the atmosphere and take measures to improve the quality of the environment. This includes:

- application of modern technologies and methods for cleaning emissions,
- development of effective standards and regulations for pollutants,
- conscious consumption and use of resources, taking into account environmental consequences.

It is important to note that addressing the health of children with SEN and the environment is complex and requires the cooperation of various stakeholders, including government agencies, scientific and research institutions, public organizations and society as a whole.

Conclusion

Environmental factors, including air pollution, water pollution, increasing amounts of chemicals and climate change, are becoming increasingly important for protecting the health of children as the most vulnerable group. Approaches are being developed to protect children's health from environmental harm within the framework of international human rights processes, including the international legal regime of the Convention on the Rights of the Child, the activities of specialized organizations on the issue of human rights obligations regarding the use of a safe, clean, healthy and sustainable environment.

The analysis demonstrates that the environment significantly impacts the inclusion of children with special educational needs. The physical environment must be accessible and conducive to their learning and participation. The social environment should foster acceptance, positive peer relationships, and reduce barriers to inclusion. The instructional environment must be adaptable, utilizing differentiated instruction and inclusive teaching practices. Additionally, involving parents and the community enhances the overall support system for inclusive education.

The development and implementation of strategic environmental programs aimed at reducing the rates of children with special educational needs (SEN) in the Republic of Kazakhstan (RK) is an important task that requires an integrated approach and cooperation of various stakeholders. Here are some possible policy measures and programs that could be implemented:

- Environmental quality monitoring: Develop and implement a system for monitoring the quality of air, water and soil, as well as other aspects of the environment that may have a negative impact on the health of children with SEN. This will allow more accurate identification of problem areas and sources of pollution.

- Air Pollution Reduction: Develop and implement strategies and programs to reduce pollutant emissions from various sources such as industry, transport and domestic heating systems. The introduction of energy efficient technologies and the use of renewable energy sources can also help reduce air pollution.
- Improving the quality of drinking water: Implementation of programs to ensure access to clean drinking water, including the construction and modernization of water supply and water treatment systems. This will reduce the risk of diseases associated with water pollution, which can have a negative impact on the health of children with SEN.
- Environmental Education and Awareness: Develop and implement environmental education programs aimed at raising awareness among children, parents, teachers and society at large of the importance of the environment for children's health and well-being. This may include conducting lessons, seminars, campaigns and other educational activities.
- Support for environmentally responsible initiatives: Encourage and support the development of environmental initiatives and projects that aim to reduce environmental pollution and create a safe and healthy environment for children with SEN. This may include financial support, assistance in the organization and promotion of such projects.

It is important to note that the successful implementation of strategic environmental programs requires the active participation of state bodies, scientific and research institutions, educational institutions, public organizations and the public in general.

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Credit Authorship Contribution Statement

Marzhan Turlubekova wrote the conceptualization, investigation, formal analysis of the paper.
Valeriy Biryukov wrote the methodology and literature review according to statistics of Kazakhstan Republic.
Zulfiya Magrupova wrote the project administration which includes environmental quality monitoring, air pollution reduction, improving the quality of drinking water, environmental education and awareness, support for environmentally responsible initiatives.
Galiya Kishibekova wrote data curation and validation according to the Convention on the Rights of the Child, Statistics, https://www.cisstat.org.
Roza Bugubayeva added review and editing, visualizing, writing, funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Perception and Awareness of Marine Plastic Pollution in Selected Tourism Beaches of Barobo, Surigao del Sur, Philippines

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Abstract: Tourism is a significant economic activity in coastal communities, but when badly managed, it degrades the health of the marine-coastal ecosystem, increasing litter pollution and repels beach visitors. This study aims to assess the tourism impact on litter pollution on four growing tourism beaches of Barobo, Surigao del Sur, Philippines. Plastic litters were sampled from four tourism sites (Cabgan Island, Turtle Island, Dapdap Beach, Panaraga Beach) of Barobo by establishing transect lines with quadrats. Those who agreed to participate in perception and knowledge tests about marine debris were interviewed at the aforementioned beaches. Respondents was generally aware of marine pollution problems, specifically marine pollution relating to human and ecological health. Respondents identified tourism as a main litter source and plastic packaging as the most common litter type, which is true based on macrolitter collection. Because tourism causes plastic pollution on all of the beaches studied, stronger regulations, educational, and awareness efforts are crucial to reduce litter pollution and avert ecological and socioeconomic consequences.

Structured Abstract: *Purpose*: Tourism plays a big role in the economic status of a country. It provides livelihood to the community and helps in poverty elevation. But tourism also brings pollution, *i.e.*, plastic pollution, if not properly managed. The primary objective of this study is to evaluate the perception and awareness of tourists on plastic pollution and its impacts on tourism.

Design/methodology/approach: The study was limited to surveys and key informant interviews (KII) since fora and assemblies are not allowed due to pandemic health protocols. Survey sampling was done simultaneously with the macroplastic collection from July 10 to August 12, 2021. Convenience sampling design was used, and data was collected on willing individuals present in the area. The awareness questionnaire used the Likert Scale method, while the individual perception used multiple choice or open-ended questions. Statistical data analysis was performed using SPSS and Microsoft excel.

Findings: A total of 105 willing individuals were legally part of this study. Of the 105 respondents surveyed, 70 of which are tourists from island beaches and 35 are from mainland beaches. Respondents were generally aware of most issues presented to them. The top issues that the respondents relate the most are related to plastic effects on health and environment. The majority of the surveyed tourists on island beaches perceived high macrolitter pollution, while those on mainland beaches perceived low pollution. This perception of respondents agrees with the litter quantities registered and collected. Furthermore, the perception of plastic packaging as the most common type of litter has been found out to be true based on sampling collections. Tourists on the beaches of Barobo are aware of the problem of marine litter and see the tourism sector as a source of waste, notably plastics.

Originality: This research paper submitted by us is an outcome of our independent and original work. We have duly acknowledged all the sources from which the ideas and extracts have been taken. The paper is free from any plagiarism and has not been submitted elsewhere for publication.

Keywords: plastic pollution; macroplastic; microplastic; perception; beach; tourism.

JEL Classification: Q51; Q53; Q54; R11; Z32.

Introduction

Studies on plastic pollution has been growing over the past decade, however there is limited data regarding marine plastic pollution in the Philippines. Studies carried out in the Philippines mostly focused on sediments and water (Arcadio *et al*., 2022; Navarro *et al*., 2022; Browne *et al*., 2011; Esquinas *et al*., 2020; Kalnasa *et al*., 2019; Paler *et al*., 2019) and living organisms (Argamino & Janairo, 2016; Abreo *et al*., 2016; Espiritu *et al*., 2019; Bucol *et al*., 2020). There are a few studies on sandy beaches (Sajorne *et al*., 2021), but none has focused on tourism as a contributing factor. Whilst there is considerable scientific literature on the abundance, physical causes and impacts of marine litter, few research to date have examined the public's views and perception regarding both the problem and the potential solutions. Furthermore, no conducted study views macroplastic pollution in the tourism sector in the Philippines. Thus, this study was carried out to determine the perception and awareness of beach users in the tourism environment of Barobo, Surigao del Sur, specifically; Cabgan Island, Turtle Island, Dapdap Beach, and Panaraga Beach.

The results of this study will be used to draft policy recommendations that will help the local government units of Barobo, Surigao del Sur for the initiatives and interventions regarding waste management for the tourism sector. Through this, tourism destinations will aesthetically improve resulting in revenue increase. Tourist and local communities will also benefit from the ecosystem services such as its provisioning and supporting services.

1. Literature Review

Plastics are regarded as one of the most problematic aspects of marine litter because of their profusion, longevity and the fact that large marine debris break down into even smaller parts termed microplastics (Law and Thompson 2014). Numerous effects of this pollutant to the marine ecosystem have been globally recognized and documented, and that includes the tourism sector. Wilson and Verlis (2017) believed that, when tourism is discussed in relation to marine litter, there is a great number to examine when it comes to the impacts of this

pollutant. Marine littering causes serious economic damages by disturbing a variety of natural environments that are considered primary ecotourism attractions. Landscape degradation by littering is not only a matter of aesthetics, but also of economy. Due to people's aversion to visiting polluted beaches, it inhibits leisure activities. As a result, this will have an influence on the local community, whose livelihood is based on beach tourism. According to Galgani *et al*. (2015), the best way to reduce marine littering is to prevent its yield from the main donors, namely; from the coastal human settlements and the beachgoers who pollute the beaches during their visitations (Santos *et al*. 2005; Sarafraz *et al*. 2016). Thus, all stakeholders must participate in making beaches as clean as possible.

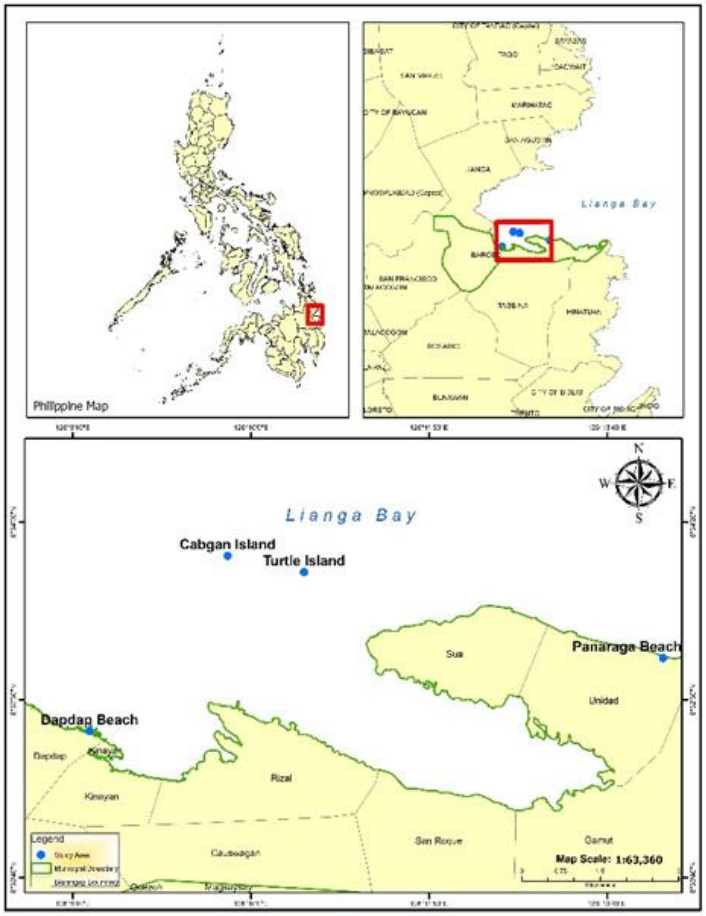
But Rees and Pond (1995) suggest that raising public awareness and initiating a change in attitude is vital for reducing the quantity of waste reaching the marine environment. The behavior of consumers is essential at all stages of a plastic life chain and it is mostly influenced by knowledge, attitudes, and level of concern about this environmental issue, along with motivation to engage in solutions (Hartley *et al*. 2015). Therefore, understanding social perception and behavior is a critical step in efforts to engage society in this plastic concern and progress towards more sustainable procuring, use and discarding of plastic materials. By involving the beachgoers and local community in the solution of this problem, it may efficiently increase their awareness, and eventually halts littering (Löhr *et al*. 2017). Several studies have suggested that hands-on or an experiential approach to marine litter is a good way to improve the awareness about this problem.

2. Materials and Methods

2.1 Study Area

The study was conducted in Barobo, a third-class municipality located in the central part of the province of Surigao del Sur, Philippines (Figure 1).

Figure 1. Map of Barobo, Surigao del Sur, Philippines showing the sampling sites



It is bounded on the north by Lianga Bay and the municipality of Lianga, on the south by the municipality of Tagbina, on the southeast by the municipality of Hinatuan, on the east by the Pacific Ocean, and on the west by the municipality of San Francisco, Agusan del Sur. It has a total land area of 24,250 hectares and 15,000

hectares of it is used for the tourism industry. According to the 2015 census, it has a total population of 49,730 people. Sampling points were located on growing tourism areas around Barobo Surigao del Sur, namely; Panaraga Beach, Dapdap Beach, Turtle Island, and Cabgan Island.

2.2 Perception and Level of Awareness

The study was limited to surveys and key informant interviews (KII) since fora and assemblies are not allowed due to pandemic health protocols. Survey sampling was done simultaneously with the macroplastic collection from July 10 to August 12, 2021. Convenience sampling design was used, and data was collected on willing individuals present on the area. Convenience sampling is a method adopted by researchers where they collect research data from a conveniently available pool of respondents. It is the most used sampling technique as it's incredibly prompt, uncomplicated, and economical. In many cases, members are readily approachable to be a part of the sample which is the best tool for tourist areas. Survey questions was modified based on the studies of Phelan *et al*. (2020) and Garcés-Ordóñez *et al*. (2020). The awareness questionnaire used the Likert Scale method, while the individual perception used multiple choice or open-ended questions.

Since the study required the participation of tourists visiting the beaches of Barobo, Surigao del Sur, certain ethical issues were addressed first. Before conducting the survey proper, free, prior, and informed consent were sought and obtained from the Office of Municipal Mayor. This was followed by a courtesy call through the Office of Municipal Environment and Natural Resources [MENRO]. The data gathering procedures and protocols were explained to them so as not to influence the perceptions of the respondents. The respondents, being a legitimate part of the study, were assured of their rights embodied in the ethical guidelines for research of the Mindanao State University – Iligan Institute of Technology [MSU- IIT] Institute Ethics Review Committee [IERC] by accomplishing the free, prior, and informed consent form to enable the respondents to decide whether or not to participate in this study, personally or through a representative. Confidentiality was also assured by not revealing their names or any of their personal information in the research. Only relevant information related to answering the research problems were included in the discussion.

2.3 Data Analysis

The data were analyzed using basic statistical computations like averaging and frequency. One-way analysis of variance (ANOVA) was also used to test the significant difference of results between island and mainland beaches. Statistical data analysis was performed using SPSS and Microsoft excel.

3. Research Results

3.1 Socio-Demographic Profile

With the use of convenience sampling, a total of 105 willing individuals were legally part of this study. From the 105 respondents surveyed, 70 of which are tourists from the island beaches and 35 are from the mainland beaches. Majority of the respondents who made themselves available are female (63%). Most respondents belonged to the active population and are commonly aged 20-29 years old. Table 1 reveals that almost 69% of the tourists are single. Religious affiliation is mostly Roman Catholic, which inclines to the recorded 2000 Census of National Statistics Office (2003 wherein three-fourths of the population were found to be Roman Catholics). Interviewed tourists was generally recorded to have 5,000 below monthly revenue, although income profile results were fairly distributed.

Table 1. Summary of socio-demographic profile of the respondents; N = 105.

Category	No.	Description	Percentage (%)
Gender	66	Female	62.9
	39	Male	37.1
Age	27	15-19	25.7
	39	20-29	37.1
	20	30-39	19.0
	15	40-49	14.3

Category	No.	Description	Percentage (%)
	4	50-up	3.8
Status	72	Single	68.6
	28	Married	26.7
	1	Widow	1.0
	3	Live-in	2.9
	1	Separated	1.0
Religion	71	Roman Catholic	67.6
	14	Born Again	13.3
	5	Jehovah's Witness	4.8
	5	Assembly of God	4.8
	10	Others	9.5
Education	2	Elementary Level	1.9
	3	Elementary Graduate	2.9
	23	High School Level	21.9
	10	High School Graduate	9.5
	27	College Level	25.7
	34	College Graduate	32.4
	6	Post Education	5.7
Employment	40	Employed	38.1
	7	Employed-Part time	6.7
	21	Unemployed	20.0
	3	Self-employed	2.9
	6	Homemaker	5.7
	26	Student	24.8
	2	Others	1.9
Income	31	5,000 below	29.5
	24	5,001-10,000	22.9
	29	10,001-25,000	27.6
	11	25,001-40,000	10.5
	10	40,001-up	9.5

3.2 Awareness of Tourists on Marine Litter Pollution

General results shows that there is no significant difference ($p=0.86>0.05$) in awareness between the island beaches and mainland beaches. Respondents were generally aware of most issues presented unto them. Table 2

shows that all remarks range from moderately aware to fully aware. The top issue that the respondents relate the most is about the negative effect of burning rubbish and plastic to human health, garnering 4.5 mean weighted average. Moreover, respondents also are fully aware that plastic waste have a negative effect into the environment making it the second issue on top. The issues that accumulated the lowest average are issues about the years that plastic litter like plastic bottle and fishing lines last in the ocean.

Table 2. Awareness of the 105 users surveyed regarding marine litter problem on the tourism beaches evaluated in this study in Barobo, Surigao del Sur. Expressed in Mean ± SD.

Issues	Location		General Remarks
	Island	Mainland	
1. Organic waste (*e.g.*, food waste, plant litter) thrown on the ground will quickly break down and disappear (become part of the soil)	**4.30** ± 0.85	**4.34**	Fully Aware
2. Snack food wrappers and other plastic packaging thrown on the ground DO NOT quickly break down or disappear	**4.14** ± 0.36	**4.37**	Fully Aware
3. Fish and other marine animals eat plastic waste	**3.97** ± 1.00	**3.97**	Aware
4. Plastic waste have negative effect on the environment.	**4.36** ± 0.23	**4.60**	Fully Aware
5. Burning rubbish, including plastic, affect human health.	**4.41** ± 0.13	**4.69**	Fully Aware
6. Rubbish left on the ground will eventually make its way into the ocean.	**4.03** ± 0.06	**4.43**	Fully Aware
7. In the ocean, a plastic bag lasts up to 20 years.	**3.57** ± 0.91	**3.54**	Aware
8. In the ocean, a plastic bottle lasts up to 400 years.	**3.37** ± 0.84	**3.43**	Moderately Aware
9. In the ocean, a fishing line lasts up to 600 years.	**3.13** ± 0.30	**3.43**	Moderately Aware
10. Plastic litter can disintegrate into more harmful substance called "microplastics"	**3.56** ± 0.87	**3.51**	Aware
11. Marine plastic litter can be transmitted in the human body	**3.60** ± 0.51	**3.43**	Aware
12. Solid Waste Management Act or RA 9003 prohibits throwing of plastics into the environment	**3.74** ± 1.00	**3.74**	Aware

5-point Likert's scale range remarks: 1.0-1.8 – Not aware, 1.81-2.60 - Slightly aware, 2.61-3.40 – Moderately aware, 3.41-4.20 – Aware, 4.21-5 – Fully aware.

3.3 Perception of users on marine litter pollution on the beaches

Most of the surveyed tourists on island beaches perceived high macrolitter pollution, while those on mainland beaches perceived low pollution (Table 3). Pearson's Chi-square test showed significant differences between the perception of macrolitter pollution and the type of beaches, indicating a probable association between these variables ($\chi 2 = 9.4198$ $P = .0242$). Respondents indicated that plastic packaging is the most common litter items on island beaches. On the other hand, respondents said that plastic bottle is the most common litter on the mainland beaches. Moreover, more than 70% of the respondents both in island and mainland beaches identified tourists as the most common source of macrolitter. More than 51% of respondents indicated that to avoid litter on the beaches they practice proper litter disposal. 69% from island beaches and 63% of mainland beach respondents manifested that yes, tourists do generate plastic waste. Both responses from island and mainland beaches said that plastic management is a problem to both beach community and plastic has indeed a negative effect to the tourism industry.

Futuristic perception results shows that respondents perceived that by the next 5 and 10 years, tourist were more likely to increase on both island and mainland beaches. Meanwhile, island beach respondents concluded that plastic waste in the years will increase tremendously but mainland respondents answered that they are not sure. Statistical results reveal that there is no significant difference between futuristic perception between two beaches ($p>0.05$).

Table 3. Perception of the 105 users surveyed regarding marine litter on the tourism beaches evaluated in this study in Barobo, Surigao del Sur; Island Beaches, n=70, Mainland Beaches, n=35.

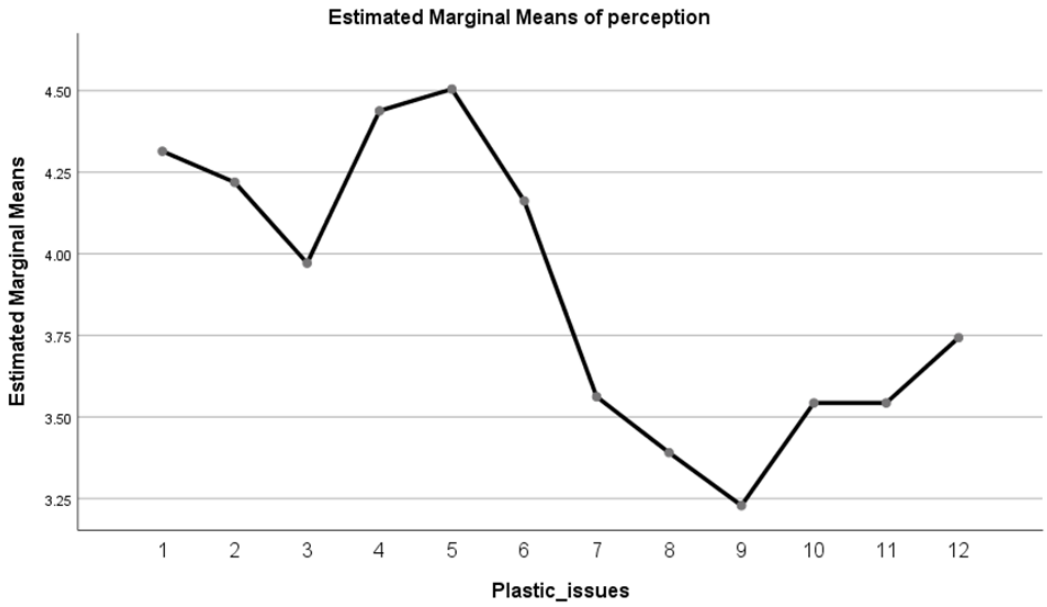
Issues	Choices	Island Beach (%)	Mainland Beach (%)
1. How much litter do you perceive on this beach?	Very Low	17.1	17.1
	Low	25.7	54.3
	High	30.0	14.3
	Very High	27.1	14.3
2. Which do you think is the most abundant litter type on this beach?	Plastic Packaging	45.7	37.1
	Plastic Bottles	31.4	40.0
	Nets and Fishery Lines	11.4	17.1
	Industrial Scrap	7.1	2.9
	Others	4.3	2.9
3. What do you think is the more common origin of litter on this beach?	Beach Tourist	72.9	71.4
	Residents	18.6	14.3
	Near Industries	4.3	2.9
	Fishing Industry	1.4	8.6
	All	2.9	2.9
4. What do you do to avoid litter on this beach?	Collects Own Litter	28.6	28.6
	Collects Others Litter	7.1	8.6
	Proper Disposal	51.4	57.1
	All	12.9	5.7
5. Do you think tourism generate plastic waste?	Yes	68.6	62.9
	No	7.1	17.1
	Not Sure	24.3	20.0
6. Do you think plastic waste increases due to tourism?	Yes	74.3	60.0
	No	10.0	17.1
	Not Sure	15.7	22.9
7. Do you think plastic management is a problem to this community?	Yes	64.3	57.1
	No	12.9	14.3
	Not Sure	22.9	28.6
8. What effect (if any) might plastic waste have on tourism?	Positive Effect	27.1	11.4
	Negative Effect	64.3	74.3
	No Effect	1.4	5.7
	Not Sure	7.1	8.6

Issues	Choices	Island Beach (%)	Mainland Beach (%)
9. Do you think this community have regular waste collection services provided by the village or local government?	Yes	45.7	57.1
	No	20.0	11.4
	Not Sure	34.3	31.4

4. Discussions

The surveyed tourists of Barobo beaches are aware of the problems caused by marine litter. Among the 12 issues identified, the three issues where respondent have higher awareness are issues number 5, 4, and 1 (Figure 3). All of which are related to plastic effects on health and environment, this could be due to IEC activities of Republic Act 9003 that the local government of Barobo has been conducting and other sources of information. This implies that respondents are aware that plastic waste have a negative effect on both human and environment's health when thrown irresponsibly. Moreover, the respondents three issues that is ranked at the bottom are issue number 8, 9, and 10. These issues were generally about the longevity of plastic life when thrown into the ocean. Furthermore, respondents noted that they are least aware of plastics being broken down further into microplastic which has more detrimental health hazards. In order to effectively address the public awareness about the issue of marine trash, it should be understood that everybody is part of both the problem and the solution (Rayon- Viña *et al*. 2019). Increasing the public's awareness regarding marine trash can be used to encourage public participation in the fight against it. An increase in the number of people who participate in public awareness efforts would also be beneficial. This increased local awareness may prompt people to take personal action against the problem in addition to asking for better administration (Bruyere and Rappe 2007; Shye 2009).

Figure 3. Estimated marginal means between 12 awareness issues presented unto 105 beach users of Barobo, Surigao del Sur.



4.1 Perception of Users on Marine Litter Pollution on the Beaches

Differences in perceptions and expectations were identified between respondents from island and mainland beaches. Most of the respondents perceived high pollution on island beaches, while low pollution on mainland beaches. This perception of respondents agrees with the litter quantities registered and collected. Furthermore, the perception of plastic packaging as the most common type of litter has found out to be true based on sampling collections (Inocente and Bacosa 2022). A clear relationship between litter pollution level and perception of beaches users also was reported by Garcés- Ordóñez *et al*. (2020) on Colombian Caribbean beaches, Rayon-Viña *et al*. (2018, 2019) on Spanish beaches, and by Kiessling *et al*. (2017) on Chilean beaches.

Respondents recognized tourists as the main marine litter source on touristic beaches of Barobo, Surigao del Sur, which is closely associated with use of different types of macrolitter by tourist that were identified in the

characterization like food packaging, cigarettes and plastic cups (Table 5). Similar results were obtained in a marine litter perception study on Chilean and Colombian Caribbean beaches, where respondents also identified visitors as the main litter source (Garcés-Ordóñez *et al*. 2020; Kiessling *et al*. 2017). Users surveyed in Barobo, Surigao del Sur also said that plastic waste increases due to tourism which supports results from other studies that tourism serves as a waste-generating sector (Gössling 2002; Biubwa *et al*. 2014; and Jang *et al*. 2014).

Table 5. Most common macrolitter items found on the tourism beaches of Barobo, Surigao del Sur, in this study.

Item type	No. of items	Possible sources
Food Packaging	411	Tourist
Ropes	42	Aquaculture
Cigarette	38	Tourist
Plastic fragments	180	Tourist, sea, river
Plastic Bags	186	Tourist, aquaculture
Styrofoam	106	Tourist, aquaculture
Nylon fishing line	32	Aquaculture
Plastic bottle (PET)	142	Tourist, sea, river
Plastic caps	79	Tourist
Plastic cups	88	Tourist
Toiletries	41	Tourist
Aluminum	38	Tourist, sea, river
Others	170	Tourist, sea, river, aquaculture

Most respondents said that by properly disposing their waste they help lessen beach pollution (51–57%), and some tourists said that they collect their own wastes. On mainland beaches, it is common to observe certain management collecting PET bottles and glass bottles for recycling and selling. However, not all of the trash generated by tourists is collected; they frequently leave the smallest litter (bottle caps, cigarette butts, etc.) on the beach, where they become buried in the sand. A high percentage of respondents (57%-64%) also said that there is plastic management problem to both island and mainland beaches. These results need proactive response from the local government units and management since, high marine debris on beaches can have both aesthetic and economic consequences, especially through reduced visitors and coastal and water-based businesses and recreational pursuits (Wilson and Verlis 2017). Which is also supported by this study's result where users concluded that plastic have indeed a negative effect to tourism.

The majority believed that there is a regular waste collection services provided by the local government. But based on the key informant interviews, only mainland beaches have the regular waste collection which happens once every month. Meanwhile, solid waste management have a hard time reaching the island beaches thus, tourist boat owners initiated to transport wastes from their visitors during their beach visits to help lessen wastes disposal on the islands. Support from private and government units is essential because mismanaged plastic waste, contributes significantly to ocean pollution in developing and developed countries (Jambeck *et al*. 2015). Most importantly, tourism cost and benefit should be seen as a stakeholders' relations among institutions on the ground (Gutierrez 2021; Requiron *et al*. 2023). Thus, the problems arising out of tourism activities need to be internalized by institutional stakeholders (the state, family, local government units, and civil society organizations) who are exposed to both the windfall of tourism and its impact to the ecology.

Conclusions and Further Research

This study provides information on the perception of beach users regarding marine pollution, which helps to understand the problem and guides local government efforts to reduce litter on the beach. Plastic packaging,

plastic bags, plastic fragments are the most abundant types of litter, and the tiniest of these are accumulating in the sand (cigarette butts and plastic caps). There is high significant difference between the number of debris collected between island beaches and mainland beaches. Tourists on the beaches of Barobo are aware of the problem of marine litter and see tourism sector as source of waste, notably plastics. There is still a lot to work on when it comes to solid waste management of tourism areas in Barobo. First, basic solid waste management strategies must be implemented or enhanced like proper waste disposal bins, warning signages, regular waste collection and adequate cleaning staff. Lastly, the local government and private beach owners must come in consortium to discuss and plan proper interventions to promote the protection and conservation of the beach ecosystem and to fulfill their roles as beach caretakers in order to reduce pollution, prevent ecological and socio-economic impacts, and develop sustainable tourism by keeping beaches litter-free.

On a related issue, beachfronts and coastal tourist areas must observe DENR policies on the minimal production of solid waste. This can be done by integrating sound community-based practices such as the usage of renewable and biodegradable materials that are culturally ingrained in the community – *i.e.*, bamboo cups instead of plastic bottles, banana leaves instead of food wrappings. The integration of laws and culture in promoting sustainable tourism is a sound option to minimize solid waste generated by tourism.

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Credit Authorship Contribution Statement

Inocente, Sherley Ann T.: Conceptualization, Investigation, Methodology, Formal analysis, Writing – original draft, Data curation, Validation, Writing – review and editing Visualization, Funding acquisition.
Gutierrez, Carlo S.: Formal analysis, Data curation, Validation, Methodology, Writing – review and editing.
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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Role of State Institutions in Protecting the Environment. Improving Management System of the Public Services

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Abstract: The development and implementation of environmental policy and the application of relevant legislation is an area of public administration responsibility that is important for the protection of the environment. With the growing challenges facing governments around the world, the effective functioning of public services is becoming increasingly important. In the 21st century, public services based on a capacity-based approach will be a key competitive advantage for states. The provision of key public services, such as health care, sanitation, electricity and water, is critical to achieving global development goals. The relationship between public administration and ecology includes the role of state institutions in environmental protection and sustainable development, as well as the impact of environmental issues on the effectiveness of public administration. Governments around the world should attach great importance to environmental issues, as environmental problems can seriously affect the well-being of the population and the economy.

Keywords: environmental protection; public services; motivation; sustainability.

JEL Classification: Q51; H77.

Introduction

For public administration to strike a balance between economic interests and environmental protection, Governments must create incentive mechanisms and support measures for enterprises operating in accordance with environmental requirements. It is also important to ensure that environmental expertise is carried out when making decisions in the field of public administration in order to minimize possible negative consequences on the environment. Public administration plays an important role in the development and implementation of environmental policy, as well as in the creation and enforcement of legislation aimed at protecting the

environment. At the same time, environmental problems can affect the effectiveness of public administration in a negative way. For example, environmental pollution can lead to diseases in the population and, consequently, an increase in health care costs. In addition, environmental disasters can lead to an economic crisis and a decrease in government revenues.

Nowadays, considering climate change, the depletion of natural resources and other environmental problems, public administration must consider the state of the environment and the environmental consequences of its actions. At the same time, the economic interests and needs of the various sectors of the economy must also be considered. Public administration must strive to maintain sustainable economic development without upsetting the ecological balance.

1. Literature Review

Finding the right balance between economic interests and environmental protection can lead to an improved quality of life for citizens, improve environmental performance, and contribute to the sustainable development of society as a whole. Over the past decade, Kazakhstan has made more intensive efforts to improve the situation regarding the quality of public administration. Despite recent reforms, rigid power structures, lack of transparency and subjectively high levels of corruption have affected the quality of governance in Kazakhstan over the past decade.

Low salaries among civil servants contributed significantly to the spread of corruption. As a result, internal corruption has had a negative impact on Kazakhstan's administration and the effectiveness of the political process and governance in the country, reducing the effectiveness of reform measures and political processes within the country. Public administration issues point to the need to increase transparency and decentralization in public administration, citizen participation and be more open in governance, the rule of law, professional ethics, and integrity.

The government positions administrative reform as a key component of its 100 Concrete Steps plan (2015). The importance of this task has been recognized, and the initiatives that have resulted from it are encouraging. However, despite progress in many areas, such as performance budgeting and e-government expansion, much remains to be done, in particular focusing on the right balance between economic interests and environmental protection.

Kazakhstan has taken a number of measures under which the open government policy is implemented. In 2015, the laws of the Republic of Kazakhstan "On Access to Information" and "On Public Councils" were adopted. The government is actively involved in various initiatives to support and promote open government, including the Extractive Industries Transparency Initiative and the Open Budget Index. However, government transparency needs to be increased and the legal framework needs to be streamlined to facilitate enforcement and reduce opportunities for corrupt practices. In this context, the authorities intend to intensify the fight and strengthen the rule of law by announcing measures to promote competition and the private sector, as well as to improve the efficiency of the administration.

Reforms are needed to improve people's living standards and quality of life, address stagnant productivity, and accelerate the transition to a low-carbon economy. Realizing the problems associated with professional ethics and honesty in the public sector, as well as the need to modernize public administration, the authorities have taken the necessary measures in recent years to solve these problems. In addition to changes in legislation and institutions, attention must be paid to administrative reform and the introduction of effective public administration. Improving the interaction between society and the state through constructive dialogue and open communication can contribute to more effective development and implementation of public policy.

The growth of civic engagement in Kazakhstan indicates the maturity of society and the need for its participation in the governance process. To understand and clarify the signs and tasks of personnel management in public service, it is necessary to refer to the basics of personnel management.

With regard to problems related to environmental protection at the level of public administration, it is worth noting the lack of a legislative framework and strategic documents in Kazakhstan concerning "green" workplaces. Despite this, government agencies such as the Ministry of Labor and Social Protection, Ministry of National Economy and Ministry of Energy are aware of the risks of massive job losses and the negative impact on certain communities and industries in the transition to a green economy. The concept of transition to a "green economy" provides the possibility of creating several thousand new jobs in various sectors through the measures envisaged. However, there is no officially approved definition of "green" jobs in Kazakhstan.

Environmental taxes and fines collected at the local level are not used effectively to improve the environment and the development of a "green" economy. Only about 30% of the collected environmental

payments are used to finance environmental protection activities. In fact, environmental payments at the local level are used as subsidies for other economic or social projects. In this regard, it is necessary to:

- explore opportunities to improve the efficiency of using collected environmental payments to protect the environment at the local level;
- encourage businesses to invest in resource-saving and clean technologies by optimizing energy subsidies and reorienting environmental permitting and enforcement requirements towards comprehensive pollution prevention measures, not just end-of-life remediation measures.

Sustainability is always considered in the strategic planning of organizations at the global level, as pointed out by Das, Biswas, Jilani and Uddin (2019).They consider the social impact of their activities on employees, communities, and stakeholders. This may involve promoting diversity and inclusion, ensuring fair labor practices, supporting local communities, and fostering positive social relationships. This integration of sustainability helps organizations align their operations with the broader goals of environmental protection, social well-being, and economic prosperity.

According to Zhao, Liu and Ws (2020) organizational environmental strategy to reduce negative environmental and ecological impacts includes defining a vision, goals, plans, and activities that promote environmental safety. Organizational environmental strategy encompasses a proactive approach to ensure environmental safety. This includes complying with environmental regulations, conducting regular environmental audits and assessments, managing environmental risks, and integrating environmental considerations into the organization's decision-making processes.

Researchers like Xiang-De Liu (2021) investigate the impact of green public employees' attitudes, green behavior intentions, organizational environmental strategy, green lifestyles, and formalism on green behavior adoption. Their findings can inform the development of strategies and interventions to promote sustainability within organizations, improve environmental performance, and contribute to broader sustainability goals.

Lu, Liu, Chen, Long and Yue (2019) argue that human behavior has always played a key role in climate change and environmental disasters. The arguments put forward by them highlight the critical need for individuals, communities, and societies to recognize the role of human behavior in climate change and environmental disasters. By promoting awareness, education, and responsible actions, individuals and organizations can contribute to mitigating and adapting to these challenges, ultimately fostering a more sustainable and resilient future.

According to Salim et al. (2020), international organizations and government agencies should develop clear strategies to protect the environment and promote environmentally responsible behavior among employees. These strategies contribute to a collective effort in protecting the environment, mitigating climate change, and achieving sustainable development goals.

Kamysbaev, Omarbakiev and Yeralina (2020) conduct a comparative analysis of personnel management principles and practices in developed countries, such as those in Western Europe and North America. They compare these principles with the existing personnel management practices in Kazakhstan to identify similarities, differences, and potential areas for improvement. Voronkina (2020) offers insights into the domestic and international perspectives on personnel management. It provides a platform for understanding different approaches, identifying best practices, and stimulating further discussion and research in the field of personnel management in Kazakhstan.

The research of Kaparov (2018) is likely a comprehensive resource that aims to contribute to the enhancement of public administration and governance in Kazakhstan. It offers insights, analyses, and recommendations for policymakers, practitioners, and researchers in the field of public service development and reform in the country, while Nurtazin (2018) offers a focused analysis of personnel management practices within the local government sector in Kazakhstan. It provides insights, recommendations, and practical guidance for personnel practitioners, policymakers, and researchers interested in understanding and improving personnel work in local government administration.

Turisbekov (2020) highlights best practices and strategies for effective public service management in Kazakhstan. The authors may draw on national and international experiences to present practical approaches for improving organizational efficiency, service delivery, and performance within the public service sector.

Akchurin and Abdina (2018) discuss the conceptualization and design of a career growth system for public servants in Kazakhstan, identifying the criteria for career progression, outlining the necessary qualifications, skills, and competencies for different levels of public service positions, and exploring strategies for performance assessment and promotion.The authors provide recommendations for policymakers, HR practitioners, and public

administrators on how to design and implement such systems to attract, develop, and retain high-quality personnel.

When analyzing the experience of foreign scholars in the field of public administration, the following works can be highlighted: Stelina (2019), Mullagulov (2018), Lockhart (2018). Their researches contribute to the understanding of key concepts and principles in public administration, such as the legal framework of public service, the significance of human resource quality, and the relationship between employee competencies and organizational performance. Analyzing the experiences and perspectives of foreign scholars, these works provide insights that can inform the development of effective public administration practices and policies, as follows.

Stelina (2019) presents theoretical models of the legal institution of public service and examines its role within the legal system. The work likely explores the legal frameworks and principles that govern public service, emphasizing its significance in upholding democratic values, ensuring transparency, and promoting effective governance.

Mullagulov (2018) emphasizes the importance of human resources in public administration and highlights the impact of human resource quality on the effectiveness of public services. The work likely explores the role of competent and skilled public servants in driving efficiency and enhancing various spheres of economic and social life.

Lockhart (2018) highlights the direct link between organizational efficiency, productivity, and the competencies of employees in the field of public administration. The work likely discusses the importance of recruiting, developing, and retaining competent and skilled employees to ensure the effectiveness and success of public organizations.

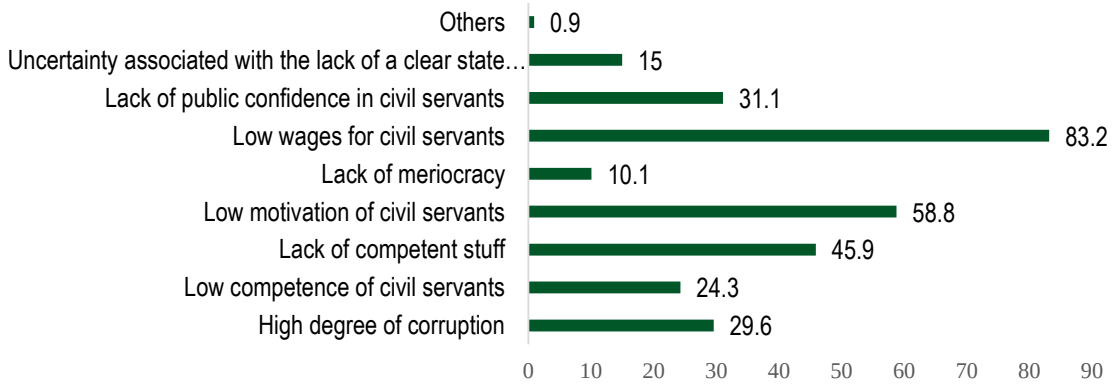
Thus, continuous development and improvement of human resource policies are prerequisites for successful economic and social reforms. This is only possible with the active cooperation of state bodies and the public. In this regard, high demands are placed on the modern civil service, which provides services in the field of public administration, defense, and compulsory social security. Engaging citizens in decision-making processes, incorporating their perspectives, and ensuring transparency and accountability are key elements of successful reforms. Civil service acts as an intermediary between the state and the public, facilitating communication, responsiveness, and effective service delivery.

2. Enforcing Environmental Regulations and Standards

According to the Concept of development of public administration in the Republic of Kazakhstan until 2030 (Decree № 522 of February 26, 2021), the system of public administration faces a serious challenge of forming a model of decision-making based on the active participation of civil society. This is especially important in light of current social processes and new economic challenges, such as the pandemic.

The results of a survey conducted by the Academy of Public Administration under the President of the Republic of Kazakhstan as part of the Astana Civil Service Hub project showed that the main problem, according to respondents, is the low level of salaries of civil servants in Kazakhstan, as mentioned by 83.2% of respondents. This low remuneration affects the overall motivation of civil servants, as confirmed by the results of the survey (Figure 1).

Figure 1. Actual issues of public service in Kazakhstan



Source: compiled by authors

Most participants (58.8%) believe that there is indeed a low level of motivation to work in the public sector among the country's civil servants. In addition, 88.1% of respondents agree that the main problem in human capital is the lack of competent personnel (59.5%), as well as the low competence of civil servants (28.6%). The assessment of the current state of public service in Kazakhstan given by the majority of respondents is relatively low (47.6%), while only 10.5% of participants gave a high assessment. Nevertheless, based on the results of the study, it can be assumed that the civil service is seen by Kazakhstanis as a fairly stable and attractive institution to work.

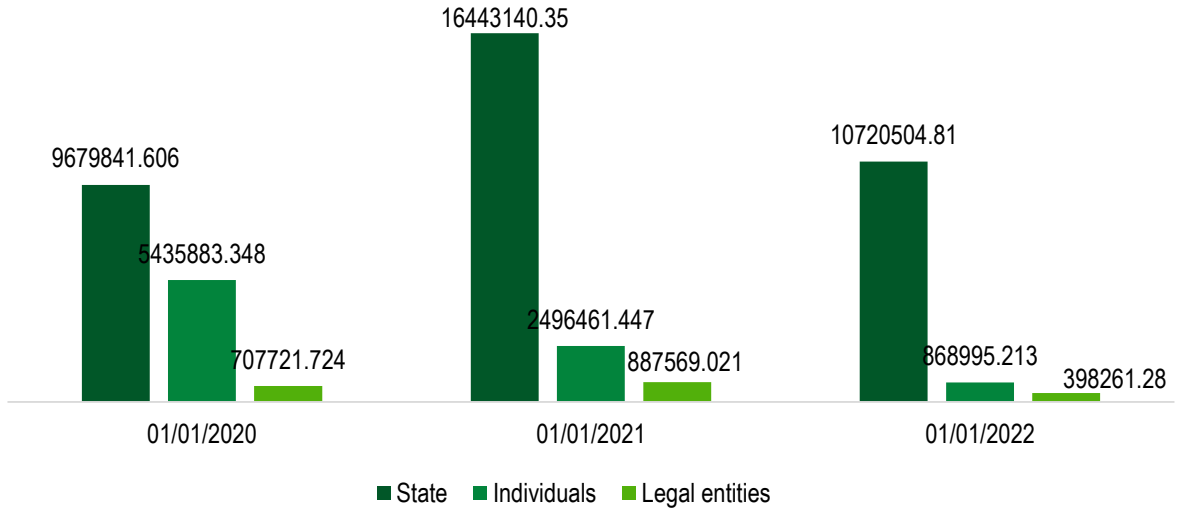
For a long time, the Republic of Kazakhstan lagged behind in the implementation of administrative reform, not taking into account global trends and scientific achievements in the field of management. The results of national and international research in this area are recognized as valuable and applicable to the administrative system of Kazakhstan, but in practice they have not been effectively applied.

Currently, other countries demonstrating high efficiency of public administration have abandoned the model of administrative order with its linear-functional and vertical-hierarchical structure and moved to a network structure and interactive model of decision-making and implementation.

International experience has shown that the public service model evaluated and implemented in Kazakhstan can serve as an important transitional stage to participatory governance. However, unlike many other countries, Kazakhstan has not yet made this transition and continues to develop its service delivery model as the most consistent with the principle that public bodies should fulfill their mission of serving the population. Limited resources for public sector development, uncertainty and unpredictability of social, economic and environmental factors, as well as increasing demands of citizens force government agencies to take decisive measures to improve governance using best management practices.

When considering the factors affecting the motivation system of public service employees, a more specific understanding of the approaches that enhance potential, develop professional careers, and achieve high performance in public service can be developed. At the same time, each of the identified factors affecting the formation and development of managerial personnel should take into account the influence of modern trends in the development of Kazakhstani society and the national economy. This is due to the need to apply the principles of a systematic approach and conduct comprehensive scientific research. An important factor affecting the management system of civil servants is corruption, the damage from which amounted to the maximum share in the total damage in 2019 - 5%. In 2020, its share decreased to 2.9%, and in 2021 it increased to 4.4% (Figure 2).

Figure 2. Damage from corruption crimes in Kazakhstan, 2019-2022



Source: compiled by authors

The challenges arising in the external environment challenge any state to reform the administrative system and adapt it to the global changes and demands of society. These changes require reducing public expenditures, reducing the number of civil servants, optimizing the structure of government, improving the quality and efficiency of public administration, and providing services in the field of public administration.

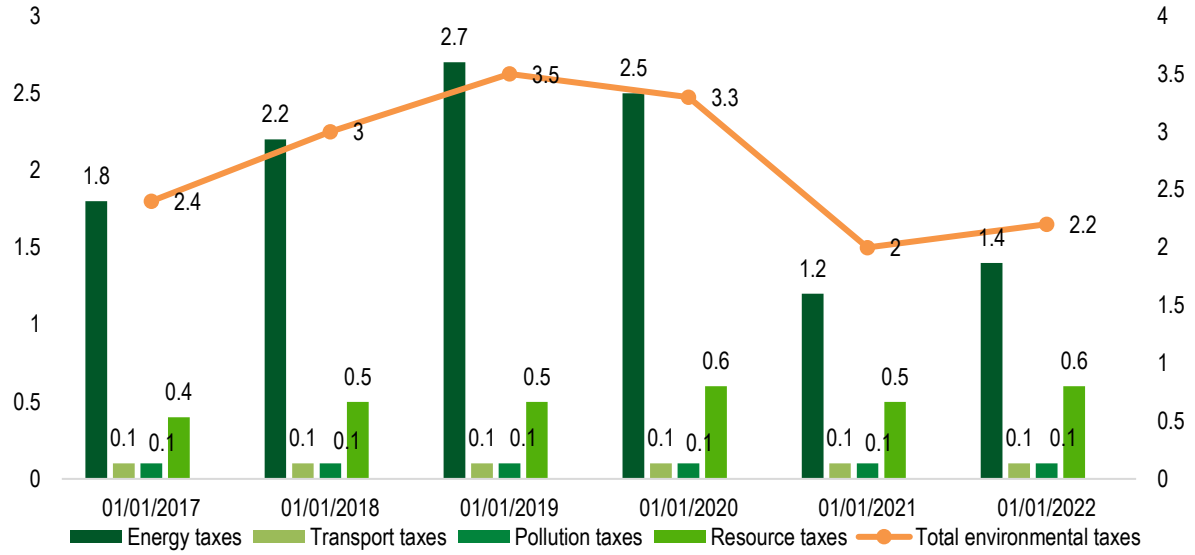
Public servants play an important role in developing, implementing, and enforcing environmental regulations and standards. They develop and enforce legislation, develop environmental policies and programs,

and monitor and supervise compliance with these regulations. Their work aims to protect nature, biodiversity, restore ecosystems and prevent pollution.

Recently, these issues have received special attention due to the deterioration of the environmental situation caused by technological progress. Kazakhstan, with its vast territory and significant natural resources, is no exception. However, the country's leadership gives priority attention to improving the environmental situation, expanding the use of renewable energy sources, and fostering a respectful attitude toward nature.

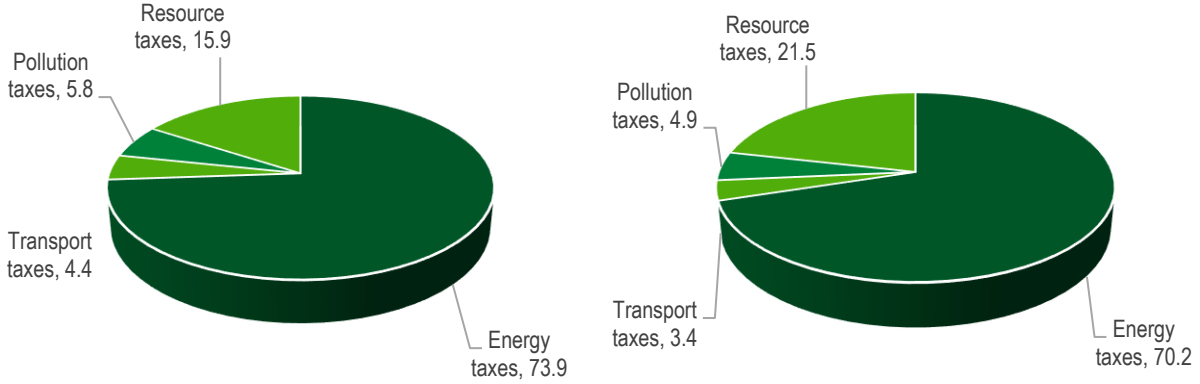
The main event in the field of ecology in 2019 was the creation of the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan. The purpose of this central executive body is to improve the country's environmental policy, create conditions for the development of the waste management sector and effective taxation (Figure 3 and Figure 4).

Figure 3. Share of environmental taxes in GDP, %



Source: compiled by authors https://www.stat.gov.kz

Figure 4. Structure of environmental taxes, %



01.01.2017 01.01.2022

Source: compiled by authors https://www.stat.gov.kz

Civil servants play an important role in the field of environmental taxation. Environmental taxation is a mechanism for using tax instruments to encourage the sustainable use of resources and environmental protection. Their involvement is crucial for the effective implementation of environmental taxation as a tool for environmental protection and sustainable development. The relationship between civil servants and environmental taxation can be considered from several aspects:

- Development and implementation of tax policies: Government officials responsible for tax policy can develop and implement tax measures aimed at reducing the negative impact on the environment. This may

include the introduction of tax incentives or rebates for businesses engaged in environmentally friendly activities, as well as higher tax rates on emissions of harmful substances or the use of non-natural resources.

- Monitoring and control compliance with environmental taxation: Civil servants working in tax authorities and environmental agencies monitor and control compliance with environmental taxation. They conduct audits, checks and analyzes of tax returns of enterprises to ensure that environmental taxes are correctly calculated and paid. In case of violations, civil servants can apply sanctions and fines in accordance with the law.
- Education and advice: Government officials also play a role in educating and advising businesses and taxpayers on environmental taxation. They can provide information, training and advice to help businesses understand and comply with environmental tax requirements.
- Government officials involved in environmental taxation often collaborate with other organizations and stakeholders to effectively implement environmental policy and achieve their goals. Here are some examples of collaboration:

- cooperation with environmental organizations: Public servants can cooperate with non-governmental organizations involved in environmental protection for the exchange of information, consultations and joint development of environmental policy. This makes it possible to take into account the opinion of experts and members of the public when making decisions and creating tax mechanisms;

- partnerships with businesses: Government officials can partner with businesses, especially those that are active in environmental activities or have environmental innovations. Engagement with such enterprises allows for the exchange of experience, training programs and the development of tax incentives to encourage the environmental responsibility of business;

- coordination with other government agencies: Government officials involved in environmental taxation often cooperate with other government agencies, such as environmental agencies, tax authorities, ministries and departments, to coordinate their actions and ensure consistency in tax policy and environmental measures;

- interaction with international organizations: As part of the global efforts to protect the environment, government officials can cooperate with international organizations such as the United Nations, the World Bank.

3. Predictions Values for Public Services and Their Implications

To develop a trend model for predicting the values of the indicator "Public administration and defense services; compulsory social insurance services, million tenge" for 2023-2024 using statistical data from the Republic of Kazakhstan, several steps are typically followed. Checking the time series for anomalies using the Irwin criterion (Table 1) to detect outliers or anomalies in the time series dataset. It is assessed whether a data point significantly deviates from the other values in the series.

Table 1. Checking for anomalous observations in a time series

Year	Services in the field of public administration and defense; compulsory social security services, million tenge	Observed value of the Irwin criterion	Calculation formulas
01.01.2010	669.867,8		▪ Calculation formulas; ▪ Observed value of the Irwin criterion: $\lambda_t = \frac{\lvert y_t - y_{t-1} \rvert}{\sigma_y},\ t = \overline{2,11}$ ▪ Critical value of the Irwin criterion: $\lambda_{0,05} = 1{,}5$
01.01.2011	815.065,7	0,256	
01.01.2012	1.009.479,9	0,343	
01.01.2013	1.225.449,9	0,381	
01.01.2014	1.386.994,2	0,285	
01.01.2015	1.516.375,2	0,228	
01.01.2016	1.708.422,4	0,339	
01.01.2017	1.645.153,2	0,112	
01.01.2018	1.814.341,0	0,299	
01.01.2019	1.948.244,8	0,236	
01.01.2020	2.316.089,2	0,649	
01.01.2021	2.519.136,0	0,358	
01.01.2022	2.612.487,4	0,549	

Source: compiled and calculated by authors

With 95% probability we can say that the original time series does not contain anomalous observations, because all the values of the Irwin criterion, which were considered, are below the critical value. Further, using the "ascending" and "descending" criteria, it was determined that the time series in question contains a trend component (Table 2).Identifying the trend component in a time series is an essential step in understanding its behavior and making forecasts. It enables the selection of appropriate modeling techniques, such as trend analysis, regression, or time series decomposition, to capture and analyze the trend component properly.

Table 2. Checking for a trend

General view of the criterion of "ascending" and "descending" series (Violation of at least one inequality is sufficient for a trend to exist)	Estimated values with a chance of error $0{,}05<\alpha<0{,}097$
$\nu(n)>\left[\frac{2n-1}{3}-1{,}96\sqrt{\frac{16n-29}{90}}\right]$	3<5
$K_{\max}<[K_0(n)]$	6> 5

Source: compiled and calculated by authors

Approximation of the initial data was performed using a polynomial of the first degree:

$y_t = a_0 + a_1 t + \varepsilon_t$,

The parameters of the selected growth curve were estimated using the least squares method. As a result, the following trend model was obtained:

$y_t = 540305{,}49 + 155012{,}22t$

To assess the quality of the resulting model two main steps were performed: checking the adequacy and assessing the accuracy of the model. To check the adequacy of the model, a series of residuals, i.e., the discrepancy between the values calculated by the model and actual observations, was investigated. The residual component has several important properties, including zero mathematical expectation, randomness and conformity with the normal law of distribution. The results of the residual series analysis conducted to test the adequacy of the model are presented in Table 3.

Table 3. Checking the adequacy of the model

Property under test	Used statistics		Border	Conclusion
	Name, calculation formula	Received value		
Accident	Criterion of "peaks" (turning points): $p>\left[\frac{2}{3}(n-2)-1{,}96\sqrt{\frac{16n-29}{90}}\right]$	6 > 4	4	Adequate
Normality	RS- Criterion: $RS=\frac{e_{\max}-e_{\min}}{S}$	2,84	2,80-3,91	Adequate
The mathematical expectation of the levels of the residuals series is 0	T-Student statistics: $t_{observ..}=\frac{\lvert\bar{e}\rvert}{S}\sqrt{n}$	0	2,23	Adequate

Source: compiled by authors

To assess the accuracy of the model, the average relative approximation error was calculated:

$E_{rel..}=\frac{1}{n}\sum_{i=1}^{n}\frac{|e_t|}{y_t}\cdot 100\%=4{,}42\%$, a value that indicates a sufficient level of model accuracy.

Thus, the model is qualitative and can be used for forecasting. Using the corresponding values of the variable, a point forecast was calculated in the created model. In order to obtain the interval, forecast, the confidence interval was determined at a given level of significance. The results of the point and interval forecasts for the years 2023-2024 are presented in Table 4.

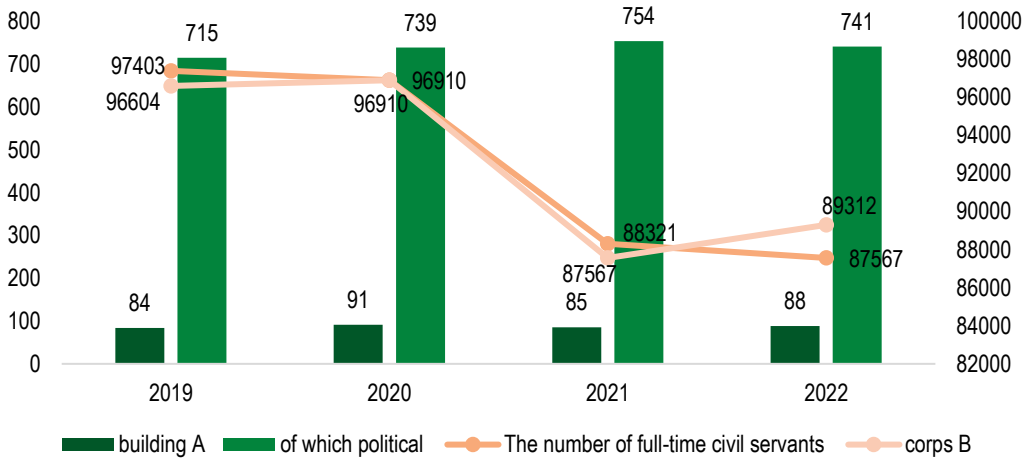
Table 4. Point and interval forecasts of the volume of services in the field of public administration and defense; services on compulsory social security, 2023-2024

Year	Point forecast, million tenge	Interval forecast million tenge	
		Max	Min
01.01.2024	2.865.488,835	2.595.348,098	3.135.629,571
01.01.2025	3.020.501,058	2.739.861,758	3.301.140,357

Source: compiled by authors

According to the presented calculations, we can observe an increase in the volume of services provided by civil servants in Kazakhstan, which is associated with the formation of new regions (Abay, Zhetysu, Ulytau), the new district "Turan" in Shymkent city, the reorganization of the Ministry of Education and Science (by dividing into the Ministry of Education and Ministry of Science and Higher Education), the opening of offices of the National Center for Human Rights in the regions, as well as increasing the number of foreign ministry staff in general have caused a growth of 1,732 e(Figure 5).

Figure 5. Number of civil servants in the RK, 2019-2022



Source: Data of the Committee on Statistics of the Republic of Kazakhstan for 2009-2022. https://www.stat.gov.kz

Thus, according to the study, the effectiveness of the performance of the Government of Kazakhstan has upgraded by improving the quality of the state apparatus and maintaining stability in the political and economic course, as well as in the level of public satisfaction with the provision of basic public services. This includes better environmental governance, stronger enforcement of environmental regulations, sustainable development planning, and public participation in environmental decision-making processes. It's important to note that ensuring environmental effectiveness requires a comprehensive and holistic approach, including strategies for natural resource management, climate change mitigation and adaptation, biodiversity conservation, pollution control, and sustainable development. Evaluating the environmental effectiveness of the government involves assessing a wide range of environmental indicators, monitoring progress, and implementing targeted policies and actions to address environmental challenges specific to Kazakhstan's context.

Conclusion

Modern public administration increasingly emphasizes the importance of achieving a balance between economic interests and environmental protection. This indicates a growing awareness of the relationship between economic growth and environmental protection, rather than their mutually exclusive nature. One of the promising areas of development of public administration in this area is the improvement of management mechanisms, including the development of strategies, policies and programs in the field of environmental protection. This requires the use of modern technology, data analysis, and the active involvement of the public.

Also, it is important to improve coordination between government agencies responsible for economic development and environmental protection, as well as the establishment of rules and regulations that would oblige enterprises to take into account the environmental consequences of their activities, avoiding corrupt

practices. In general, the prospects for the development of public administration in the field of balance between economic interests and environmental protection are associated with the adoption of integrated and long-term approaches to management, considering public opinion, sharing knowledge and experience between countries and using the latest technologies and tools.

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Credit Authorship Contribution Statement

Yuliya Kim conducted the investigation and most of the research on topic, was of full control of project administration and validation, wrote the original draft and made the Formal analysis.
Laura Kundakova wrote the conceptualization and methodology of the paper based on foreign and local experience in the system of management's improvement of the public services.
Serik Daribekov made the data curation according to the official resource of the new concept of public administration: key aspects. https://strategy2050.kz/ru/news/ novaya-kontseptsiya-gosupravleniya-klyuchevye-aspekty/.
Dinar Sikhimbayeva made the supervision of the paper, was responsible for Funding acquisition and was fully involved in the process of Formal analysis of the paper.
Gulnara Srailova did review and editing and made the Visualization of the paper, worked on the final presentation and qualitative readability of the paper, finalized the Content and Conclusions.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Interactive Planning as Part of a Territorial Strategy to Develop Tourism Sites

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Abstract: Using the Callejón de Huaylas region as a case study, this article analyzes the role of interactive planning in the design of tourism areas from a territorial perspective. To begin tackling the complexity of the Callejón de Huaylas region, we chose degrees of municipal intervention in planning and the units of analysis for the questionnaire, and practices of participatory planning. This study is of a cross-sectional, non-experimental, descriptive design. As its instrument, a web-based questionnaire was provided by the out-of-the-ordinary circumstance, verified by a panel of 5 experts, and sent to a sample of 38 agents involved in direct and indirect roles in interactive planning for tourism places. In the end, it was found that the Callejón de Huaylas neighborhood benefits from a direct connection between the participatory planning procedures and the territorial planning strategy in the creation of tourism places.

Keywords: territorial strategy; interactive planning; tourism zone; Callejón de Huaylas.

JEL Classification: R58; Z32; Q56; O21; R11.

Introduction

The evolution and development of tourism in our nation, and especially in the region of the Callejón de Huaylas (CDH) as a place of study, is an important economic and natural phenomenon with an important physical geographic diversity that the visitor enjoys during his stay in the area. According to the statistical report, it receives an annual flow of visitors only in its most important support center, the city of Huaraz. For this reason, it

is necessary to broaden the study beyond economic considerations and orient its analysis towards the sustainable use of tourist areas with a real and visible territorial planning for the future.

At present, tourism in the Callejón de Huaylas has become a less competitive area for tourist visits compared to other tourist destinations at national level, placing us in a less significant position (we are in 16th place according to a market study carried out by Promperú), which makes tourism an unsustainable activity. This is evidenced by the fact that the Ancash Region and its capital, Huaraz, have a low level of competitiveness. The absence of a tourism planning model is evident in the insecurity of decision-makers in the whole process, which also translates into a lack of knowledge and commitment of local agents and actors. In addition, local tourism must be reoriented towards quality and diversification, solutions must be found for regular tourist transport, communication and productive structures in order to increase the tourist value of new locations through new tourism planning procedures and regular regeneration of older sites. Tourism development should be planned in such a way as to minimize the damage caused by the activity, while taking advantage of its proximity to the resident and visitor population.

Likewise, the potential of the study area can be seen as a strategy for the development, transformation and management of the territory, so it is necessary to plan the natural, historical, cultural, landscape and biodiversity resources as emerging heritage elements in an innovative way and with adaptation to adverse conditions both internally (local population, residents and tourist population) and externally (policies, intervention and tools) in a way that benefits society, but also serves as a guarantor of its preservation; To establish a link between interactive planning with a territorial approach in the Callejón de Huaylas region. In this order of ideas, also the purpose of this study is to establish a connection between interactive planning and the change of procedures with a territorial approach in the Callejón de Huaylas region. To establish a connection between interactive planning and the development of methods and techniques of territorial planning in the Callejón de Huaylas area, as well as to establish a connection between interactive planning and the development of methods of territorial intervention in the Callejón de Huaylas area.

The article is also justified in pointing out some of the works pointed out that strengthen the theoretical bases as found in Rojas-Vega *et al.* (2023) concludes that a plan focused on the environment and sustainability should be elaborated for the region of Orpesa. The municipality needs a tourism strategy that can identify the problems of the local tourism system from a broad point of view, not only from the point of view of urban development, but no matter also how sustainable the urban development plan is planned. Therefore, Yumisaca *et al*. (2022) provide an integrated model based on specific methods and indicators, which, articulated from their actors, guide a tourism planning effort towards the optimal use of both indigenous and migratory assets and Espinoza *et al.* (2022) Despite the vast territory of the Metropolitan District of Quito, where different scenarios can be determined, there is an important dynamic that has affected the landscape and natural resources, with visible changes in the physical-environmental structure in some sectors, particularly near the population centres and the city of Quito. Other communities, often located in rural areas, develop a wide range of activities, but nevertheless prioritise the preservation of vital ecosystems.

It is hoped that the following contents will provide valuable elements for tourism specialists and planners to take on a much more relevant task in establishing a methodology for the processes and tools used in the plans and their implementation.

1. Tourism Planning

According to the literature found on the genesis and historicity of the evolution of the term planning, it is said that it began as a tool for reconstruction after the First World War, was first used by the Soviet Union in its five-year plans, then was adopted by free market countries after the Second World War and, finally, was applied to developing nations in the 1950s. On the other hand, we seek to account for the term planning and then tourism planning, just as in its conceptualization, the definitions expressed by international bodies such as the World Tourism Organization or by some recognized authors in the academic and intellectual sphere of the field of tourism are very diverse. For this reason, we deal with some definitions related to the study (Ciriquián *et al.* 2018, Castillo *et al.* 2022).

The Royal Spanish Academy explains that the word planification has two meanings: to draw up the plans for the execution of a work or to make a plan or project for an action. The former is derived from an architectural and clearly territorial concept, while the latter seems to allude to any set of actions programmed in order to achieve a goal. Both meanings, although insufficient from the point of view of the specialists, give us the starting point to differentiate Territorial Planning, the former, from the latter.

In general, the notions of planning and planning are used synonymously. In this case, we always refer to planning. According to Bustos and Molina (2012) planning is a process, a technique, a set of practices of contemplation and prospective studies or prefiguration of the future that are used to determine the methods and courses of action to be produced in pursuit of certain objectives with the intention of intervening in a given reality. The plan is the ultimate deliverable of this procedure, it is an intellectual product prior to action (Vinuesa and Torralba 2018) that takes the form of a written record. According to Spíndola (2016), the planning process consists of two main stages: the creation of the plan and its implementation. It is crucial to finalize both stages of planning so that the documents are more than just pieces of paper. The planning of tourism activities, as well as the creation of the plan and its implementation, which is reflected in a document, are considered crucial in the definitions of both theorists.

While for the definition of the term tourism planning or tourism planning; According to Yumisaca *et al.* (2022) it coincides with the UNWTO definition of tourism planning as an instrument that aims to establish the general circumstances of a region over a broad period of time and as an important instrument of tourism development that has changed its focus over time. The physical design of tourist attractions and services, as well as advertising, used to be the main focus, but today it has broadened to include the demands of businesses, visitors, the neighborhood and even the environment and sustainability.

For Schenkel (2019), to ensure the continued viability of a destination's natural and cultural resources and the ability of the local community to benefit from and enjoy tourist attractions both now and in the future, tourism planning must address three fundamental conditions. First, the plan must be forward-looking, following a thorough examination of the current situation of the destination. Secondly, the plan must constitute a forum for consensus among the different territorial stakeholders involved in tourism-related activities (Melgarejo *et al.* 2018; Ramirez *et al.* 2022). Thirdly, the plan must establish a program that defines a series of important strategic lines and, based on these, launch a series of programs and initiatives.

The above definition proposes that tourism planning should be guided by the principles of sustainability and by the basic conditions that concern the plan: its projection into the future, the creation of a space for consensus and participation of all the territorial agents involved in tourism activity and the management of a programming of major strategic lines, based on long-term sequential programs and flexible projects aimed at solving the problems that spontaneously arise during the planning process of any tourist destination, as cited in Rojas (2017).

Mora *et al.* (2020) planning in the tourist industry may be defined as the method used to determine the sector's goals and strategy. First, and most importantly, a diagnosis is established, which is the initial stage of any tourist planning process. This phase involves establishing and assessing the current state of a destination, as well as cutting off time to compare the tourism conditions of the place before and after planning. It is also the main resource for determining the feasibility of plans, programs and initiatives, and for locating the instruments needed to evaluate the results of these efforts (Masot *et al.* 2020; Soto *et al.* 2023). Additionally, Baidal and Rebollo (2019), tourism planning is a destination management technique that focuses on how visitors imagine the present and future of the destination. In this way, we can methodically build a procedure that moves the destination away from the present and towards the future, making the most of the resources at our disposal.

A close examination of the above concepts and the information obtained above leads to the conclusion that tourism planning is best done in the context of spatial planning that actively involves the local community. As such, it is a management tool for tourism sites that considers visitors' impressions of the site today and their expectations for the future, determined by a methodical and well-thought-out analysis of the relevant data. From this analysis, objectives, and strategies for achieving them can be deduced, allowing for the early incorporation of considerations of environmental sustainability, economic vitality and community well-being into current planning (Montes de Oca and Cabrera 2020).

2. Interactive Planning and Its Close Link with the Territorial Approach

Tourism planning, according to UNWTO, has the same ultimate objective as tourism policy, which is to develop high quality destinations and increase productivity (Bustos and Molina 2012), but UNWTO also points out that there is a significant difference between the traditional and interactive approaches to planning. The aim of the new approach is to develop appropriate mechanisms to meet the objectives decided by the different actors involved in tourism activity. This requires the use of a technique, such as meetings and encounters between the different stakeholders, in order to identify the key lines of growth for the future, which can be enunciated by technical specialists and adapted to the objectives of the tourism policy (Schenkel 2019, Huaranga-Toledo *et al.* 2023).

Consequently, sectoral (or thematic) and territorial planning must be in line with public policies, both socio-economic, sectoral and regional, as these are materialized respectively in planning proposals such as development plans, sectoral strategic plans and land-use plans, to name but one type of each, it should be borne in mind that public intervention in the field of tourism involves a set of clearly interrelated sectoral and territorial policies and planning. However, it is the planners and political representatives who are the decision-makers. On the other hand, the cooperation of private actors is necessary for its development, but it is not a consensus-based model like strategic planning (Montero *et al.* 2016). Public action can substitute private action if necessary and legal instruments exist. However, with the development of new governance criteria at the local level, strategic planning practices (such as Local Agendas) are being put in place that condition territorial planning, in such a way that the latter indirectly becomes an expression of the consensus of the actors involved. Trade-offs, cooperation and agreement are becoming increasingly important in the development of planning with a territorial approach.

Finally, the authors argue that interactive planning is closely linked to the territorial approach and can be complemented in the new processes as a method of tourism planning from a scientific perspective, oriented towards interdisciplinarity, local community involvement and sustainability of tourism.

3. Methodology and Research Results

A descriptive-correlational, cross-sectional, descriptive-correlational research methodological process with a quantitative approach was used. The unit of analysis was constituted by agents of the public activity, private and mixed activity in a total of 38 actors that intervene in the processes of the tourist planning of the zone of the Callejón de Huaylas. Document analysis, observation and statistical methods were used to obtain information.

Table 1. Relationship between interactive planning and the territorial approach

Planning with a territorial approach	Interactive planning					
	Regular		Adequate		Total	
	n	%	n	%	n	%
Regular	4	10.5	3	7.9	7	18.4
Good	3	7.9	28	73.7	31	81.6
Total	7	18.4	31	81.6	38	100.0
$X^2 = 11.764$ gl = 1 P-value = 0.003						

Source: Prepared by authors (2023)

The table shows that 79.4% of the total number of actors involved in the spatial tourism activity in the area of the CDH state that there is adequate interactive planning and consequently territorial planning is good. It can also be seen that 8.8% of the total number of actors involved in the spatial tourism activity in the area of the CDH perceive that there is regular interactive planning and therefore territorial planning is also regular.

Table 2. Relationship between interactive planning and the development of processes with a territorial approach

Planning with a territorial approach	Interactive planning					
	Regular		Adequate		Total	
	n	%	n	%	n	%
Regular	4	10.5	4	10.5	8	21.0
Good	3	7.9	27	71.1	30	79.0
Total	7	18.4	31	81.6	38	100.0
$X^2 = 8.467$ gl = 1 P-value = 0.005						

Source: Prepared by authors (2023)

The table shows that 76.5% of the total number of actors involved in the spatial tourism activity in the CDH area say that there is adequate interactive planning and consequently the development of territorial planning

processes is good. It can also be seen that 8.8% of the total number of actors involved in the spatial tourism activity in the CDH area perceive that there is regular interactive planning and therefore the development of territorial planning processes is also regular.

Table 3. Relationship between interactive planning and development of methods and techniques with a territorial approach

Planning with a territorial approach	Interactive planning					
	Regular		Adequate		Total	
	n	%	n	%	n	%
Regular	6	15.8	4	0.5	10	26.3
Good	1	2.6	27	1.1	28	73.7
Total	7	17.4	31	1.6	38	100.0
X^2=21.134 gl=1 P-value = 0.001						

Source: Prepared by authors (2023)

The table shows that 76.5% of the total number of actors involved in spatial tourism activity in the area of the CDH say that there is adequate interactive planning and consequently the development of methods and techniques of territorial planning is good. In addition, 14.7% of the total number of actors involved in spatial tourism activity in the area of the CDH perceive that there is regular interactive planning and therefore the development of methods and techniques of territorial planning is also regular.

Table 4. Relationship between interactive planning and the development of methods of territorial intervention

Planning with a territorial approach	Interactive planning					
	Regular		Adequate		Total	
	n	%	n	%	n	%
Regular	4	10.5	2	.3	6	15.8
Good	3	7.9	29	6.3	32	84.2
Total	7	18.4	31	1.6	38	100.0
X^2 = 14.268 gl = 1 P-value = 0.002						

Source: Prepared by authors (2023)

The table shows that 82.4% of the total number of agents involved in the spatial tourist activity in the CDH area say that there is adequate interactive planning and consequently the development of methods of territorial intervention is good. It can also be seen that 8.8% of the total number of agents involved in the spatial tourist activity in the CDH area perceive that there is regular interactive planning and consequently the development of methods of territorial intervention is also regular.

4. Discussion

The study's methodological examination indicates unintended consequences of expanding tourism. These discrepancies exist both in the technologies themselves and in the rhetorical language surrounding their use. To curb the production of unsustainable growth, physical-spatial planners employed sub-regional planning methods in the instance of the Callejón de Huaylas. One of its weaknesses is that it has been developed slowly in comparison to other parts of Peru. This is especially true when considering the growth planning policies that have been in place in other parts of Peru for over a decade.

In addition, it details the range of ideologically linked planning interpretations that might be applied to a territorial focus. Unsustainability is sometimes pinned on the most economically and socially disadvantaged segments of society, however this is merely one interpretation of tourist planning, relating only to the quantitative demographic variety. True proponents of degrowth say it should help the most disadvantaged people in society (Cirio, 2016). In oversaturated tourist areas, when a decrease in the number of customers is needed, creating a pro-growth consensus can help accomplish the former by discouraging visits from individuals with weaker

purchasing power. Urban-tourist territorial planning is used as a tool of confinement by these alliances of socioeconomic classes and hegemonic power (Cartuche *et al.* 2018). So, the value of the Callejón de Huaylas region rises as a result of the creation of unpaid externalities as a result of the protection of the land, with the elimination of the expectation of additional tourism development. Growth control measures reduce supply, which in turn stimulates economic expansion.

Another contradiction of interactive planning in touristic spaces is that this territorial model of tourism uses the discourse of sustainability as a device to favor the monopolization of services in the region and control mechanisms to exercise power in tourist services (Bustos and Molina 2012). Tourism pressure on these territories and climatic changes, or indeed the COVID- 19 pandemic, can be aggravated by social policies to restrict tourists' access to tourism spaces. The contradictory relationship between the implementation of limitations and the subsequent growth of tourism business borders is also noted. As a result, areas outside of the city that are near to urban tourist hotspots might benefit from tourism growth as much as the conventional urban core. Capital looking for profit and convenience is drawn to areas with monopolies due to the potential of higher profits (Baidal and Rebollo 2019). Social movements that oppose tourist gentrification and demand the right to the city and access to housing coexist with organizations that support tourist rental housing.

Results show that the general hypothesis was correct; Callejón de Huaylas is intrinsically linked to the iterative processes of territorial design in touristic zones. These findings are similar to those identified by Blázquez-Salom *et al.* (2019), who note that the planning shows inconsistencies in terms of compliance with the regulatory measures for tourist use in practice. The failure to implement monitoring and punishment procedures to reduce disparities and boost competition on the Spanish island of Mallorca is a major flaw in the rule. And it reaffirms what Dasí *et al.* (2018) in their discourse comments on the relationship of territorial cooperation and tourism development from the transregional scale and of metropolitan and rural tourist spaces.

Regarding the first specific hypothesis it is confirmed that interactive planning and the development of territorial planning processes have a direct relationship in the area of the CDH, this result complements what is stated by Rojas (2017) defends that the treatments of Andalusian urban tourist spaces in territorial and sectorial planning are of vital importance and supports that it would improve the development of tourism in the localities near the tourist attractions. Furthermore, it is supported by the theory proposed by Saehu *et al.* (2022) who advocates the inclusion of tourism in the development of rural areas in order to preserve cultural and natural resources.

Regarding the second specific hypothesis, it is confirmed that interactive planning and the development of methods and techniques of territorial planning are directly and significantly related in the Callejón de Huaylas area, i.e. One of the plans' flaws is that choices are decided through political consultative processes, and another has to do with societal tensions and outside interference, this reality is similar to that described by Corzo-Arévalo (2019), who conducted a diagnosis on the organization of the tourism development plan for the destination of Santander, Colombia (2019) who conducted a diagnosis on the organization of the tourism development plan of the destination Santander, Colombia and complements what is defined by Spíndola (2016) on space, territory and territoriality proposes that a particularly rich aspect in the postcolonial approach is the interaction between space and subject that occurs within the limits of an interdisciplinary perspective to understand the fundamental conceptual and methodological challenges involved in the study of space.

To conclude, the third hypothesis confirms that interactive planning and the development of territorial intervention methods are directly related in the area of the Callejón de Huaylas, which is why the present result contradicts those shown by Vinuesa and Torralba (2018) presents a territorial vision of heritage and sustainability of tourism and exposes that interactive planning lacks a monitoring and evaluation program of the effectiveness of the approved proposal, this implies the impossibility of implementing a long-term action due to the need to modify the established processes.

Conclusion

Tourist hotspots like the Callejón de Huaylas are intrinsically tied to the iterative, territorial-based development procedures that characterize these locales. Interactive planning with a territorial approach complements the new tourism planning processes by adapting to external (policies, interventions and tools) and internal (local population, residents and tourist population) conditions.

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Credit Authorship Contribution Statement

Edwin Ramirez-Asis: Conceptualization of the research idea, supervision of the execution of the research, review and editing of the final article Interactive Planning as Part of a Territorial Strategy to Develop Tourism Sites.
Abu Bakar Bin Abdul Hamid: Design of the research methodology, research background research at national and international level with scientific articles published in Scopus and web of science indexed journals.
Nor Hazila Binti Mohd Zain: Construction of the theoretical framework, with scientific articles published in journals indexed in Scopus and web of science on the title Interactive Planning as Part of a Territorial Strategy to Develop Tourism Sites.
Mohsin Raza: Administration of the database with the collected information, SPSS v26 software, statistical analysis using tables and hypothesis testing, uploading the paper to the journal, and raising comments as corresponding author.
Jose Rodriguez-Kong: Reliability and validity of the data collection instruments, application of the questionnaire to the participants of the research entitled Interactive Planning as Part of a Territorial Strategy to Develop Tourism Sites.
Cinthy Espinoza-Requejo: Writing of the original draft, proofreading, and spell-checking and adaptation to the publication standards of the Journal of Environmental Management and Tourism.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Travels and Sustainable Tourism in Italy. Selected Dilemmas

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Abstract: The scientific article regards travels and sustainable tourism in Italy in terms of employment, spending, and GDP. The principal purpose of the article is the analysis of travels and sustainable tourism in Italy in terms of employment, spending, and GDP. The paper carried out the documentation analysis, but also very important was the application of the statistical, dynamics, and comparative analysis. The time scope of the study is 2019-2021. Italy's economic recovery will be greatly aided by the travels and sustainable tourism, according to the World Travel and Tourism Council (WTTC). In 2020, the sector was just 0.3% below its pre-pandemic levels. The sector's contribution to GDP in 2019 exceeded €194 billion, according to the World Trade and Technology Council's (WTTC) latest Economic Impact Report (EIR). However, employment in the industry may return to levels seen before the epidemic. Further, the Travel & Tourism industry in Italy is expected to increase at an average annual rate of 2.5 percent over the next ten years, which is five times the growth rate of 0.5 percent of the country's entire economy. In the meanwhile, it's expected to surpass €226 billion by 2032.

Keywords: sustainable tourism; employment; spending; tourist; GDP; Italy.

JEL Classification: L83; R41; Q01; Q56; Z32; R11.

Introduction

Italy's Mediterranean location and it's over 7,600 kilometers of coastline bring in tens of millions of tourists annually. Northern Europeans in particular are attracted to Italy's mild weather and picturesque landscapes. The history, culture, and architecture of Italy are well-known all over the globe. Many of the countries over a hundred thousand historical monuments date back to the days of the ancient Roman Empire. More than any other nation, the United States has more than 50 locations designated as World Heritage Sites by UNESCO. Historic districts of Rome, Venice, and Florence are like vast outdoor galleries. Architects from antiquity to the Renaissance left their namesakes in stone in many places around the globe (Mrozek 2022b).

Italy is home to many great painters throughout history, including Michelangelo, Raphael, and Leonardo da Vinci. Small villages in Tuscany's wine country, for example, have a certain charm that draws tourists even when they're not interested in the region's famed art and culture. Sunbathers may choose from a wide choice of activities on the Mediterranean's long stretches of sandy beaches throughout the summer. In the hottest parts of the summer, temperatures may go beyond 30 degrees. It's warmer than much of Europe, even in the winter. Skiing is a popular winter activity for visitors since the country's northern region is bordered by the Alps. Tourists may do downhill skiing, cross-country skiing, or snowboarding at any one of the 290 ski resorts. Winter activities, however, can't keep up with the influx of tourists from April through November. The most visited cities in Italy include Rome, home to the Vatican and countless ancient buildings from almost 3000 years of art history and architecture; Venice, home to the lagoon and famous for its canals and gondola rides; Florence, capital of Tuscany and known for its Renaissance art and architecture; Pisa, home to the Leaning Tower of Pisa and a renowned cathedral; and Milan, located in the north and known as a hub for fashion and design (Italian Traditions 2023, Luiss Open 2023).

The Gothic Milan Cathedral and Leonardo da Vinci's "The Last Supper" fresco are both located in the same monastery, Santa Maria delle Grazie. When comparing 2018's numbers to those for 2021, the Italian tourist industry comes close to pre-pandemic levels in both air traffic and the tourism sector. In 2022, the Italian tourism industry as a whole nearly recovered to its pre-pandemic levels, with the number of international visitors almost doubling from the previous year. This revival was felt across the board, from tour operators to hotel chains, but the sectors that saw the biggest uptick in demand were those directly related to transportation, such as travel agencies and airlines. While many European nations have suffered significant losses due to the present scenario brought on by the spread of the coronavirus and its novel variations and Russia's invasion of Ukraine, Italy is among those who have suffered just minimal losses, according to the research.

The industry group has identified transportation as a key component of the tourist sector and airports as a crucial aspect of the travel experience, while also emphasizing that they are among the primary difficulties for a connected and speedy future. Preventive measures, such as travel bans and other restrictions, intended to control the spread of the coronavirus and its novel forms, have had a substantial impact on Italy's tourist industry, resulting in huge losses throughout the country's economic sectors.

Although the tourist industry was among those hit worst by the outbreak of coronavirus and its novel forms, Italy was one of the last European nations to lift all such restrictions. Despite major progress in Italy's tourist industry last year, the country still faces formidable obstacles. ISTAT, Italy's national statistical institute, reports that between January and August of last year, the country saw a total of 74.1% more overnight stays than it did in all of 2021. The inhabitants of Germany, Switzerland, Austria, the Netherlands, and Denmark were said to have made up 75% of all overseas tourists to Italy last year (Future market insights 2023, OECDa 2023).

1. Research Questions and Methodology

The paper regards travels and sustainable tourism in Italy. The principal purpose of the article is the analysis of travels and sustainable tourism in Italy in terms of employment, spending, and gross domestic product.

The author depicts the subsequent exploration dilemmas:

- What is the heterogeneity of travels and sustainable tourism in Italy in terms of employment, spending, and GDP?
- Which of the research aspects of travels and sustainable tourism in Italy showed the most important changes?

The theory section of the paper has presented the tourism industry and sustainable tourism in Italy. Documentation, statistical, comparison, and dynamic analysis are used in the research. Reports, datasets, books, manuals, academic and commercial publications, and scholarly articles were used to compile the information for this study. The method of reasoning was logical.

2. Theoretical Analysis

2.1. Tourism Industry in Italy

After almost two years of inactivity owing to the COVID-19 epidemic, Italy's tourism industry has rebounded in recent months, seeing favorable results. Also, the tourism industry in France, like many other countries, has been significantly impacted by the COVID-19 pandemic. The recovery of the tourism industry in France is subject to ongoing monitoring and adaptation to changing conditions related to the pandemic and global travel trends (Mrozek 2022a).

However, Italians and businesses still face several long-term challenges. There was a 74.7 percent increase in the number of overnight stays recorded in Italian accommodation places between January and August of 2022, as reported by ISTAT, the Italian agency for statistics, at the first national conference for the sector. Travelers from all over the world, particularly those seeking a relaxing vacation, flock to the country. Travelers interested in spas and other wellness activities have made Italy a top destination for their vacations. In addition, Rome is a popular tourist destination. In 2022, 10.5 million tourists stayed in Italian campgrounds and tourist villages, an increase of 11% over the previous year. This equated to 73 million nights, 57% of which were occupied by visitors from outside of Italy.

The majority of visitors (75%), who came from Germany, Austria, Switzerland, the Netherlands, and Denmark, stayed for seven nights on average, up from 6.8 days in the previous year. More than 40 million international tourists visited Italy every year around the turn of the 21st century, attesting to the country's fame as a prime vacation spot. On the other hand, only around 20% of Americans go overseas for their vacation. Italy's tourism business fell from 1987 on, especially during the Persian Gulf War and the global recession, but it recovered in the 1990s, with increases in both international and domestic visitors. Millions of people visited Rome

and the Vatican City enclave in 2000 for the Jubilee festivities organized by the Roman Catholic Church to welcome the new century. As a result of Pope Francis's proclamation of 2016 as an Extraordinary Jubilee of Mercy, the number of visitors to the Vatican has increased.

The tourism sector has grown rapidly thanks to the support of both domestic and foreign customers. Beyond the major cities of Rome, Florence, Venice, and Naples, the most visited areas are those along the coast or in the mountains and lakes of the north. These include the Ligurian and Amalfi rivieras, the northern Adriatic coast, the Tyrrhenian Islands (Elba, Capri, and Ischia), the Emerald Coast of Sardinia, Sicily, Gran Paradiso National Park and the Dolomites, and Abruzzo National Park (OECDb 2023, Reportlinker 2023, The Global Economy 2023).

2.2. Sustainable Tourism in Italy

According to the UNWTO (World Tourism Organization), 2017 was the year of sustainable tourism. Since then, there has been a steady rise in the general public's understanding of the idea, building on a trend that is making inroads in terms of the expectations and behavior of both travelers and industry professionals. Sustainable tourism is described as tourism that meets the demands of consumers, the industry, the environment, and host communities while also minimizing negative impacts on the environment, society, and the economy. A comprehensive idea that incorporates every facet of travel and every party involved.

A responsible and eco-friendly vacation combines environmental consciousness with cultural exploration by carefully planning one's mode of transportation, lodging, diet, and activities to minimize negative impacts on the local ecosystem (Zlopaša and Solarević 2019). The sustainable tourism market in Italy is expanding both in terms of customers and businesses. Italy places a premium on environmental conservation and the preservation of its cultural legacy, two of the country's incontestable strengths. In a nutshell, eco-friendly vacations benefit not just the environment but also the businesses and communities directly linked to the sector. What started as a social phenomenon is now an opportunity for the local economy and the benefit of all residents. Fotis, and Korre (2023) integrate sustainability principles into tourism practices as essential condition for ensuring long-term competitiveness while safeguarding the environment and the well-being of host communities.

Sustainable vacations provide visitors with a wide range of advantages, including the pleasure of knowing that they have not contributed to environmental degradation. Among them are: the opportunity to combine experiences, the health benefits of exercise, the savings from reduced spending and consumption, the conservation of local resources, the preservation of cultural artifacts, and the spread of a positive, contagious vibe are just a few of the many benefits of multi-activity vacations. If you look at the sustainable tourism map, you'll see that Italy provides a wide variety of activities and attractions (FS Italiane Group 2023, Schengen visa(B) 2023, World Data 2023).

For instance, the alberghi diffuse (scattered hotels) provide lodging and meals in refurbished buildings spread throughout Italy's historic villages, such as those on the hills of Liguria's Western Riviera or in Sardinia's Barbagia mountain area, thereby avoiding new construction and the resulting increase in land consumption. In some instances, structures that were formerly used for one purpose have been repurposed for another. The former Porto Tolle thermal power station, for example, will be transformed into an innovative and sustainable open-air tourist center, offering water sports facilities, experiences to enable visitors to appreciate the surrounding environment and landscape, and a facility for developing the local fishing and agriculture industries, among other things, with a capacity to accommodate 40 guests (Branchini 2015).

The Italian Association for Responsible Tourism (AITR) has released a map of sustainable travel destinations in Italy. The World Wildlife Fund (WWF) manages some nature reserves, hotels, and campgrounds that have received environmental certification from Legambiente, and the Institute for Ethical and Environmental Certification (ICEA) has certified several organic agritourism facilities. Consideration of social and ethical issues, as well as the quality of the food offered, are further tenets of sustainable tourism. Use of zero-mile food goods, for instance, or "pizzo-free" tourist trips in the Valle del Sosio, Palermo Province, to combat the Mafia's control over the local economy via the extortion of 'pizzo' protection money, are two examples. To further reduce their environmental impact, eco-friendly tourists choose to travel by foot, bicycle, or electric car. Hikers and walkers in the Alps and Apennines have long adhered to the notion of "zero emission travel", a view shared by those who prefer to traverse ancient pilgrimage routes like the Via Francigena. However, electric bikes allow visitors who are interested in cycling to experience excursions without exerting themselves too much, such as on the island of Elba or among the historic sites of Recanati, the birthplace of poet Giacomo Leopardi. An electric automobile is an option if you need to transport more than two people (Betta *et al.* 2021). To encourage the use of electric vehicles in Italy's most popular tourist destinations, the Enel Group and the country's Ministry of Cultural Heritage

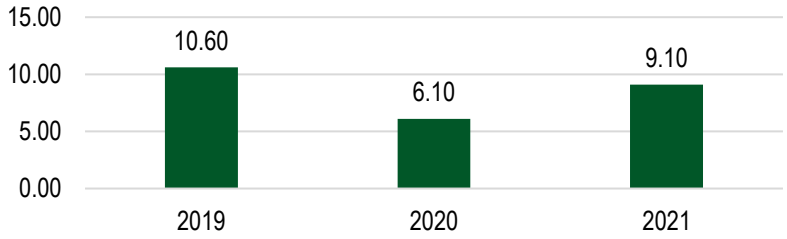
and Tourism struck an agreement in February 2018 (Foreign Policy 2023, The World Bank 2023, Trading economics 2023).

3. Quantitative Analysis

3.1. Analysis and Results of the Research

The research is carried out within the structure, statistical, comparative, dynamics, and documentation analysis. The time scope of the study is 2019-2021, but some issues that were broadened. The results of the carried-out research present significant modifications between the research variables in the given analyzed areas. The analysis was carried out within such issues as the share of travel and tourism's total contribution to GDP in Italy from 2019 to 2021 (in %); total contribution of travel and tourism to GDP in Italy from 2019 to 2021 (in billion euros); distribution of travel and tourism spending in Italy in 2019 and 2021, by type of tourist (in %); distribution of travel and tourism spending in Italy in 2019 and 2021, by type (in %); total contribution of travel and tourism to employment in Italy from 2019 to 2021 (in million jobs).

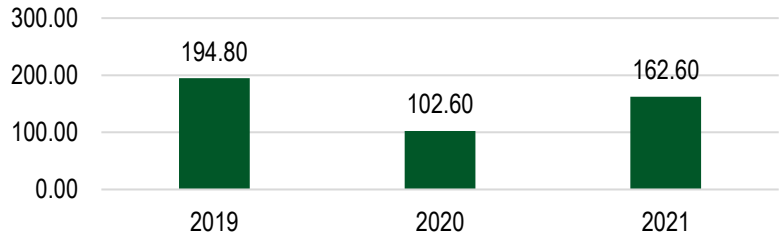
Figure 1. Share of travel and tourism's total contribution to GDP in Italy from 2019 to 2021 (in %).



Source: Schengen Visa (A, B) 2023.

After a significant decline in 2020 owing to the coronavirus (COVID-19) pandemic, Italy's travel and tourism sector's contribution to GDP rose in 2021 compared to the previous year. Direct and indirect contributions to Italy's GDP from the tourist industry reached 9.1 percent in 2021, up from 6.1 percent in 2020 but still below pre-pandemic levels (Figure 1). As a whole, tourism in Italy added over 163 billion euros to the country's GDP that year. As with other countries hit hard by the epidemic, Italy saw a significant drop in travel and tourism's overall contribution to employment in 2020, only to see it largely rebound the following year. In the most recent year available, the tourist industry in Italy supported 2.64 million employments. With governments enacting stay-at-home regulations to address the health disaster, the COVID-19 pandemic completely flipped the travel and tourist business in Italy. The amount of money foreign visitors spent in Italy in March 2020 was much lower than in the same month the previous year. While things looked brighter in 2021, monthly spending by visitors still fell short of pre-pandemic highs. However, in 2021, domestic tourist spending in Italy rose again, exceeding 2019's numbers by a little margin (Italy tourism market 2023, Financial Times 2023).

Figure 2. Total contribution of travel and tourism to GDP in Italy from 2019 to 2021 (in billion euros)

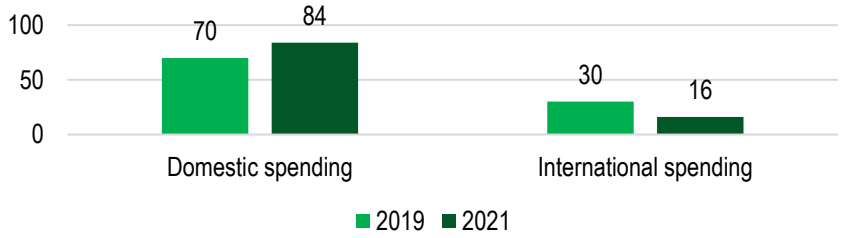


Source: Knoema 2023

After a precipitous decline in 2020 due to the coronavirus (COVID-19) pandemic, travel and tourism's overall contribution to Italy's GDP increased by roughly 60 billion euros in 2021 over the previous year. Direct and indirect spending related to tourism in the nation was 162.6 billion euros in 2021 (Figure 2.). Although this number increased significantly each year, it was still lower than it had been before the epidemic. As a whole, tourism accounted for almost nine percent of Italy's GDP that year (2021). While spending by domestic tourists in Italy recovered strongly in 2021 after a dip caused by the COVID-19 epidemic, that of international visitors was slower to recover. In particular, in 2021, Italians spent 107 billion euros on domestic tourism, a rise of 76% from the 96

billion euros recorded in 2019. Italy's overseas tourist receipts, on the other hand, grew by 3.5 billion euros compared to the previous year but still fell short of the levels seen before the global health crisis. As for domestic tourism in Italy during the COVID-19 pandemic, it has increased in popularity since the outbreak began. In terms of where Italians traveled in 2021, almost nine out of 10 excursions were conducted inside Italy. In the meanwhile, 44% of Italians planning a trip in the next six months said they would stay inside the country (International and Italian tourism scenario 2023, Knoema 2023, World Travel & Tourism Council (A-D) 2023).

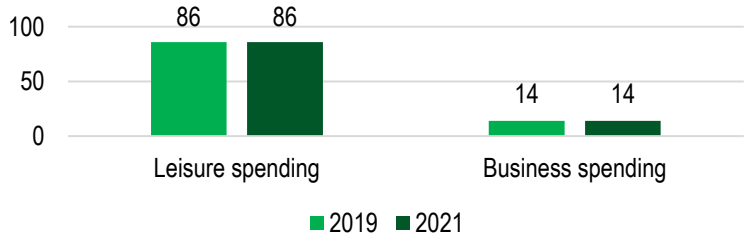
Figure 3. Distribution of travel and tourism spending in Italy in 2019 and 2021, by type of tourist (in %)



Source: World Travel & Tourism Council (A-D) 2023

Travel restrictions and high levels of uncertainty during the coronavirus (COVID-19) epidemic led many visitors to stay inside their nations rather than go abroad. Domestic tourists accounted for the bulk of Italy's tourism revenue in 2021. In that year, domestic tourists accounted for 84% of all expenditures, a rise of 14% over the next year (Figure 3.) (CNN 2023, The World Tourism Organization 2023).

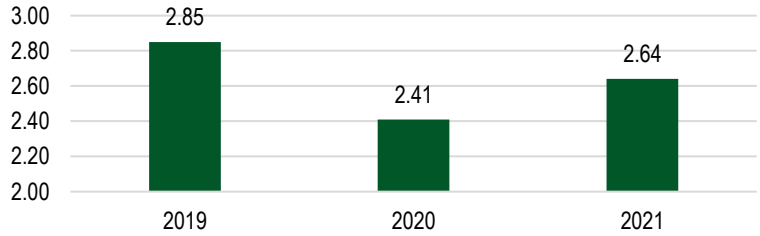
Figure 4. Distribution of travel and tourism spending in Italy in 2019 and 2021, by type (in %).



Source: Visas Association 2023

The majority of money spent on tourism in Italy in 2021 was on vacations. In that year, as in 2019, leisure travel accounted for 86% of all tourist expenditures in the nation (Figure 4.). Spending by international visitors to Italy increased by a constant 6.2% in 2019, with visitors from the rest of Europe and North America continuing to be the primary contributors. The amount spent overseas by Italian tourists also increased, by 6.3%. The result was a rise in the surplus from tourism to 1% of GDP in 2019 from 0.9% in 2018, albeit small, this is the continuation of a trend that began at the turn of the decade. While foreign tourism as a whole increased dramatically, Italy's share of the market remained stable. Global tourist earnings increased by 7.4 percent to €1,322 billion in 2019. Both the United Kingdom and Italy continue to share the fifth spot in global tourist revenue (CEIC 2023, International Trade Administration US Department of Commerce 2023).

Figure 5. Total contribution of travel and tourism to employment in Italy from 2019 to 2021 (in million jobs)



Source: OECD (a-b) 2023.

About 2.64 million people had employment that year because of tourism in Italy. Even while this number is 9.5% higher than it was in the first year of the coronavirus (COVID-19) pandemic, it is still lower than it was before the outbreak (Figure 5). The prediction also shows that during the next decade, the travel and tourism industry in

Italy will generate over half a million (533,00) new employment, or more than 53,000 new positions annually. In 2022, the industry added 8.7 percentage points to GDP, bringing its total contribution to more than 176 billion euros (9.6 percentage points of GDP). Approximately 2.7 million new jobs will be created in this industry during the next several years. More than 400,000 employees, or 15.4 percent, were lost as foreign travel came to a virtual halt, bringing the total number of jobs supported by the industry down to just over 2.4 million in 2020. In 2021, however, it contributed 58.5% more to GDP, totaling €162.6 billion, and it employed 9.4% more people, for a total gain of almost 2.6 million (Britannica 2023, Cassa Depositi e Prestiti 2023, Take-profit.org 2023, World Travel & Tourism Council(A) 2023).

Conclusions

Italy's economic recovery will be greatly aided by the travel and tourism industry, according to the World Travel and Tourism Council (WTTC). In 2020, the sector was just 0.3% below its pre-pandemic levels. The sector's contribution to GDP in 2019 exceeded €194 billion, according to the World Trade and Technology Council's (WTTC) latest Economic Impact Report (EIR). However, employment in the industry may return to levels seen before the epidemic. Further, the Travel & Tourism industry in Italy is expected to increase at an average annual rate of 2.5 percent over the next ten years, which is five times the growth rate of 0.5 percent of the country's entire economy. In the meanwhile, it's expected to surpass €226 billion by 2032. The prediction also shows that during the next decade, the travel and tourism industry in Italy will generate over half a million (533,00) new employment, or more than 53,000 new positions annually. The industry's contribution to GDP was at 9.6 percent of the economy in 2022, or more than 176 billion euros. Employment in this field is anticipated to grow by 2%, reaching over 2.7 million people. As a result of the epidemic, Italy's travel and tourism industry took a serious hit, losing billions of dollars as companies closed and thousands of people lost their jobs. The entire contribution to GDP before the pandemic began was 10.6 percent, or 194.8 billion, and dropped to 6.1 percent, or otherwise 102.6 billion, in 2020. In addition, the industry accounted for about €2.9 million in employment until the near extinction of foreign travel caused a loss of more than 400,000 jobs, or 15.4 percent, bringing the total to just over 2.4 million in 2020. In 2021, however, it contributed 58.5% more to GDP, totaling €162.6 billion, and it employed 9.4% more people, for a total gain of almost 2.6 million (Brookings 2023, Schengen visa(A) 2023).

The COVID-19 epidemic has had a devastating effect on the travel and tourist industry. Spending by international visitors to Italy dropped by about a third in 2020 compared to 2019, according to data from the Bank of Italy's Survey on International Tourism. Spending by Italians on international vacations saw a similar decline. This reversed a trend that had been ongoing since the turn of the past decade, resulting in a significant fall in the travel surplus of the balance of payments (to 0.5 percent of GDP in 2019 from 1.0 percent in 2019). Despite a worldwide decline in visitor numbers, Italy had a 3.7% increase in its proportion of the international tourism-related gross domestic product. The stricter entrance restrictions and greater geographical distance contributed to an above-average decline in spending by non-EU international tourists in Italy. When looking at European nations, the percentage of tourists coming from neighboring countries has risen. Vacations in major cities have been hit worse than those in coastal resorts, and hotel stays have been hit harder than those in other types of lodging due to the epidemic. The fear of spreading disease and the subsequent inclination for isolating oneself from others undoubtedly underlies many of these trends. The macro-region of Central Italy, which had benefited the most from cultural tourism before the epidemic, was impacted the most. Due to the effect of the epidemiological crisis and the limits on international movement, international visitor flows into and out of Italy remained at extremely low levels in the first four months of 2021. The number of international visitors, notably those from the European Union, seems to be on the rise again as of late April, according to the available statistics (Social Europe 2023, World Travel & Tourism Council(A) 2023, World Travel & Tourism Council(B) 2023).

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Credit Authorship Contribution Statement

Michał Mrozek: The contribution of the author regards such actions as conceptualization, investigation, methodology, carrying out the formal analysis, writing original draft, data curation, writing, editing, visualization. The paper carried out the documentation analysis, but also very important was the application of the statistical, dynamics, and comparative analysis. The secondary data were used in the analyses. Reports, datasets, books, manuals, academic and commercial publications, and scholarly articles were used to compile the information for this study.

Declaration of Competing Interest

The author declares that it has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Safety Management Model of Tourism City Municipalities in Eastern Economic Corridor

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Abstract: This research was aimed to assess the level of concern and satisfaction level of safety, study safety management, and suggest a safety management model of Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province, Thailand. A mixed method research was employed which was a combination of quantitative research and qualitative research by examining 400 samples and 30 significant participants. The research instruments consisted of a questionnaire about general information, safety concern level, safety satisfaction level, and a semi-structured interview about security management of Na Jomtien Municipality.

Quantitative data were analyzed using mean, standard deviation, and analyzed the qualitative data using coding analysis. The results were that foreign tourists had a high level of security concern and a high level of safety satisfaction. In addition, it was found that Na Jomtien Municipality had a concrete safety management that was consistent with various policies and responded to the needs of the local people. The study revealed that the safety management model for the tourism city municipalities in Eastern Economic Corridor (EEC) should contain each of the following aspects, including 1) Crime, 2) Accident, 3) Natural disaster, 4) Prevention of disappearance/getting lost, 5) Travel, 6) Exploitation, 7) Health and hygiene and 8) Environment.

Keywords: safety management model; tourism safety; tourism municipality; Eastern Economic Corridor; Thailand.

JEL Classification: L83; L88; L89; Z10; Z19; R11.

Introduction

Currently, Thailand is implementing national development according to the Thailand 4.0 policy under the 20-year national strategy that focuses on driving the economy towards stability, prosperity and sustainability, with good-income tourism and medical tourism (Affluent, Medical and Wellness Tourism) as one of the government's priorities that support, promote further development, and elevate the competitiveness of the manufacturing and service sectors based on knowledge, technology and innovation. Thus, resulting in tourism in the 4.0 era that can compete with other countries and is a power to drive the country's economy (Division of Research Administration and Educational Quality Assurance, 2016).

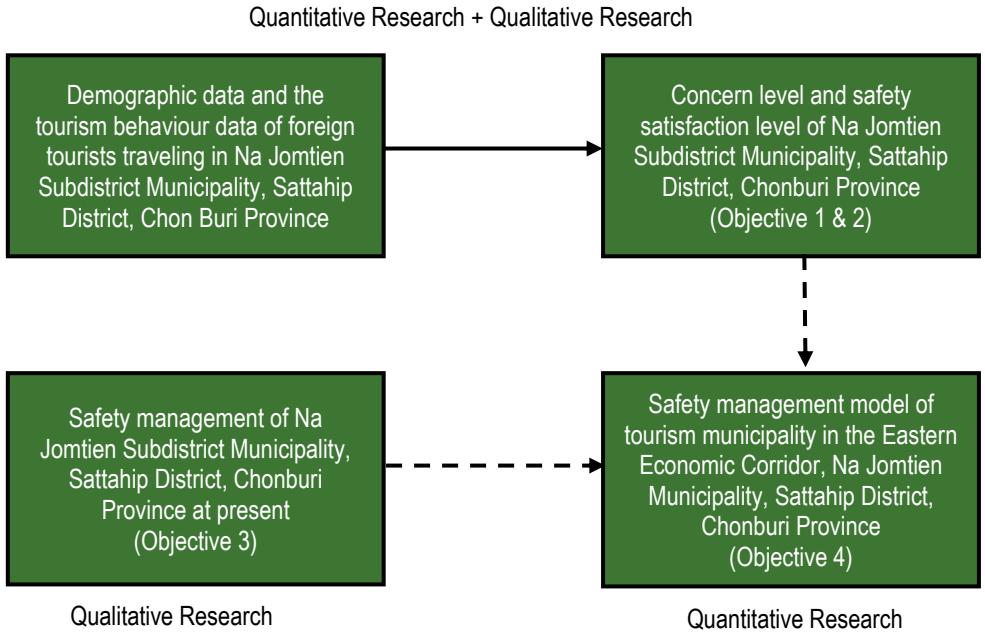
The Eastern Economic Corridor (EEC) project is a strategic plan for Thailand under 4.0 to extend the development of the Eastern Seaboard area that focuses on developing 3 provinces in the eastern region including Rayong, Chonburi and Chachoengsao, to become leading economic areas and is a livable city in Asia that will help support the increase of competitiveness, economic expansion of the country including improving the quality of life and income of the people (Gajanandana 2017). At the same time, an action plan for developing and promoting tourism in the Eastern Economic Corridor was formulated which is one of the sub-plans under the development plan of the Eastern Economic Corridor to be able to achieve the objective of enhancing the quality of tourism in the 3 provinces in the eastern region to sustainable world-class tourism, supporting high-income and health-oriented tourists to generate higher income from tourism for people in the area due to the increase in the number of tourists (Eastern Economic Corridor Office of Thailand, 2018). To raise the quality of tourism in the 3 provinces in the eastern region to sustainable world-class tourism that can support high-income and health-conscious tourists, it is necessary to develop tourism by building tourist confidence by creating measures and

setting up a health safety system and the safety of tourists to be reliable efficient and productive, helping tourists to be satisfied, and reduce travel anxiety (Thawornprapasawat 2019).

According to the preliminary study, the researcher found that Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi province is a large community. There is an area adjacent to the Special Administrative Area of Pattaya City, which is a famous tourist attraction. There are important beaches that are popular with both Thai and foreign tourists, such as Na Jomtien Beach and Ban Amphur Beach, which are beaches with scenic views and serene atmosphere. It is less crowded than Pattaya Beach and has a wide range of hotels. In terms of health and safety in the region, it was found that Na Jomtien Municipality does not yet have a large hospital to directly support tourists in the area. In term of the area of safety, it was found that Na Jomtien municipality has some narrow and isolated transportation routes. Some points have incomplete traffic signs, and there is a problem with the drainage system, flooding, and damaged traffic surface. In addition, it was also found that Na Jomtien Municipality has a 3-year manpower plan (2021-2023) that has laid out a strategic plan and set the first strategy, which is the development of tourism and aims to make Na Jomtien Municipality become a tourist city and provide quality services standard for tourists, but no health safety issues were found and safety of tourists in the aforementioned strategic plan (Najomtien Municipality 2020).

Therefore, this research aimed to study the level of concern and satisfaction level of Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province in view of foreign tourists, analyze the security management style of the area, and suggest the safety management model of tourism municipalities in the Eastern Economic Corridor in order to use the results from the research as a guideline to drive efficient and effective safety management of the tourism municipality. The research objectives were 1) To assess the level of security concerns of the Na Jomtien Subdistrict Municipality, 2) To assess the level of satisfaction with safety of Na Jomtien Subdistrict Municipality, 3) To study the safety management of Na Jomtien Subdistrict Municipality at present and 4) To suggest the safety management model of Na Jomtien Subdistrict Municipality.

Figure 1. Conceptual framework



Source: Author's illustration

1. Literature Reviews

1.1 The Meaning of Tourism Safety

Tourism safety refers to the state of being free from danger or loss, and with no tendency to cause injury to people or damage to property. It was an unexpected event, not intending to happen cannot control, and it cannot be avoided (Wang *et al.* 2019), thus making tourism safety a priority for the tourism industry. It is an important component of the quality of tourist attractions, and a factor that affects the decision before traveling, and affects the satisfaction of tourists during the trip (Thawornprapasawat 2019).

1.2 Types of Tourism Safety

Tourism safety is divided into the following categories (Ma *et al.* 2020; Thawornprapasawat 2019, Wang *et al*. 2019):

- Water safety is the safety from water accidents that may occur to tourists, resulting in injury or death to tourists. The most common water safety accident is drowning, while other causes include boat sinks, crashes of tourist boats, etc.
- Road safety is the safety of car and motorcycle rental accidents that result in injury or death to tourists caused by their non-compliance with the law.
- Safety from being deceived and exploited is the safety from accidents that happen to foreign tourists due to deceiving tourists in various ways; for example, taxis do not press the fare meter and charge fares at exorbitant prices.
- Life and property safety is the safety from accidents of tourists that affect the lives and property of tourists.

1.3 Tourism Security Measures

Security measures that are consistent with the cause of the problem of various types of disasters, consists of the following important measures based on several researchers as Gidebo (2021), Cui *et al.* (2016), Kokovic and Markovic (2009), Esichaikul (2001):

- Crime security measures include the establishment of checkpoints and incident reporting units in tourist attractions in areas prone to theft, organizing training for volunteer groups to protect against thieves in tourist attractions, reminding tourists of crime by creating pamphlets, and warning signs.
- Accident safety measures consist of setting up warning signs about the types or nature of accidents that may occur in areas with high risk of accidents, training of disaster relief volunteers, preparation of materials and equipment at the point of rescue that can provide assistance to victims as quickly as possible, creating permanent defenses such as railings and fences for walking up the hill, establishment of a first aid unit in an appropriate location, determination of measures to control business operators that have the potential to cause accidents to tourists such as transportation business, travel business.
- Public health security measures consist of stipulating measures to control entrepreneurs in the food and beverage business and operate under sanitary conditions and as required by law, inspecting restaurants with good hygiene and declaring them to be certified as clean restaurants, and maintenance of cleanliness in tourist attractions.
- Natural disaster security measures consist of providing rescue teams in high-risk areas of natural disasters, preparing rescue equipment as appropriate for various perils and installing them at risky points, ongoing training for volunteers to help victims of disasters, providing emergency rescue troops that can rotate at any time, installing an early warning system before natural disasters, establishing a network system with agencies involved in the occurrence of natural disasters.
- Safety measures against getting lost include orientation for tourists to familiarize themselves with tourist areas, preparation of navigation signs and maps showing the location of things within tourist attractions, training of tour guide volunteers and supervising the operation of tour guides to be correct and suitable, establishing barriers to prevent tourists from getting lost in tourist attractions.
- Plant and animal safety measures include orientation and posting of warning signs to inform tourists in advance of any plants and animals that may pose a risk to tourists, arranging staff or volunteers to look after and take care of the risky areas, and making fences to prevent tourists from disturbing or destroying plants or animals during the visiting.

1.4 Eastern Economic Corridor

Eastern Economic Corridor (EEC) is a strategic plan under Thailand 4.0 that has an important goal to upgrade and increase the country's competitiveness, promote economic expansion, increase employment, and elevate the quality of life and income of the people (Tontisirin and Anantsuksomsri 2021). It is a spatial development that builds on the success of the Eastern Seaboard plan. In the first phase, the area was set to cover three provinces in the eastern region: Chachoengsao, Chonburi and Rayong, as well as other related provinces which is ready for transportation, infrastructure needs of operators sourcing of resources and links with other economic centers to develop the area into a leading economic area and the main trading gateway to Asia. It is also the location of the Regional Offices of foreign companies, Targeted Industrial Center (First S-Curve and NEW S-Curve),

Maintenance Facility Airport Center, Regional Ports, both commercial and cruise ports, Free Zone, etc. (Eastern Economic Corridor Office of Thailand 2018, Gajanandana 2017).

2. Research Design

A mixed method research was employed which is a combination of quantitative research and qualitative research.

2.1 Population and Sample

Quantitative data: The population included 636,672 foreign tourists traveling in Chonburi Province (Data from the Ministry of Tourism and Sports as of January 2023). The sample groups were 400 foreign tourists traveling in Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province. Taro Yamane 's formula was utilized to calculate the sample size, which was assigned a 5% margin of error (Yamane 1973). The sample selection criteria were as follows:

1) being a foreign tourist;
2) traveling in tourist attractions located in Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province (not including Pattaya Special Administrative Areas);
3) able to read, listen, write English at the basics and
4) willingly consent to participate in the research. Non-probability sampling, namely purposive sampling was employed in this research.

Qualitative data: The important participants were 30 municipal officials and members related to safety management of Na Jomtien Subdistrict Municipality, Sattahip District, Chon Buri Province. Purposive selection was used to select those participants.

2.2 Research Instruments

The research instruments consisted of quantitative research instrument was questionnaires, and qualitative research instrument was semi-structured interviews. Questionnaires was divided into 3 parts:

- Part 1 - General information questionnaire about respondents. The form of the questionnaire is a check list survey and fill in the blanks.
- Part 2 - A questionnaire on the level of security concerns of Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province. The form of the questionnaire is a 5-level rating scale.
- Part 3 - A questionnaire on safety satisfaction level of Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province. The form of the questionnaire is a 5-level rating scale as follow:
  - 5 refer to the highest level of concern/satisfaction;
  - 4 refer to the high level of concern/satisfaction;
  - 3 refer to the moderate level of concern/satisfaction;
  - 2 refer to the low level of concern/satisfaction;
  - 1 refer to the very low level of concern/satisfaction.

The questionnaires were examined on content validity by checking for Item Object Congruence (IOC) such as index values for consistency between the content in the questionnaire and the objectives and the correctness of the language and improved the questionnaire to be appropriate according to the advice of 5 experts. It was found that the mean of the IOC was 0.60-1.00. Then, the revised questionnaire was used for pre-testing with 30 sample groups who were not a sample but had a context close to the sample groups in the research, and the reliability value was 0.875 using Cronbach's alpha coefficient (Cronbach 1991).

Semi-structured Interviews contain open-ended questions about the security management of Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province. The interview form has been checked for quality by experts and the interview form has been revised to be appropriate according to the advice of 5 experts.

2.3 Data Analysis

Quantitative data. Descriptive statistics were applied to analyze the data consisting of frequency, percentage, mean and standard deviation, and interpret the meaning of the specified criteria as follows:

- 4.50-5.00 refer to the highest level of concern/satisfaction;
- 3.50-4.49 refer to the high level of concern/satisfaction;
- 2.50-3.49 refer to the moderate level of concern/satisfaction;
- 1.50-2.49 refer to the low level of concern/satisfaction.
- 1.00-1.49 refer to the very low level of concern/satisfaction.

Qualitative data. The data obtained from in-depth interviews were analysed using coding analysis and descriptive analysis was presented.

3. Research Findings

3.1. Results of Demographic Analysis and Tourism Behavior Data

Most of the samples were female, aged 31 to 40 years old, residing in the United States, American race, single status, Christianity. The education level is a bachelor's degree. They were private employees/employees. Their income ranged from $2201 to $2700. They travelled to visit their friends and relatives by traveling by themselves with a friend and taking travel insurance prior visiting. It was also found that the sample group travelled 2-3 times to Na Jomtien Beach and surrounding areas at night. The travel period within the area took 1-2 days, and they had a desire to revisit for the next opportunity. The important factor in traveling is the reputation of tourist attractions.

3.2. Safety Concern Level Assessment

Assessment of the level of safety concerns in Na Jomtien Subdistrict Municipality, using Mean, Standard Deviation, and the level of safety concern was shown in Table 1.

Table 1. Level of safety concerns in Na Jomtien Subdistrict Municipality

Safety Factors	Mean ($\bar{X}$)	Standard Deviation (S.D.)	Concern Level
1. Life safety	3.90	0.70	High
2. Properties/items safety	3.89	0.72	High
3. Exploitation	3.88	0.74	High
4. Health and hygiene	3.91	0.73	High
Total Average	3.89	0.72	High

Source: Research Results

From Table 1, foreign tourists have a high level of safety concerns in Na Jomtien Subdistrict Municipality with a mean of 3.89 and a standard deviation of 0.72. When considering each aspect, it was found that foreign tourists were concerned about the safety of their lives, properties/items safety, exploitation, and health and hygiene. The mean was 3.90, 3.89, 3.88, 3.91, respectively, and the standard deviation was 0.70, 0.72, 0.74, 0.73, respectively. Tourists were concerned in all aspects at a high level.

3.3. Safety Satisfaction Assessment

Assessment of the level of safety satisfaction in Na Jomtien Subdistrict Municipality, using Mean, Standard Deviation, and the level of safety satisfaction was shown in Table 2.

Table 2. Level of safety satisfaction in Na Jomtien Subdistrict Municipality

Safety Factors	Mean ($\bar{X}$)	Standard Deviation (S.D.)	Satisfaction Level
1. Crime	3.83	0.75	High
2. Accident	3.85	0.72	High
3. Hygiene/Public Health	3.83	0.74	High
4. Natural disaster	3.86	0.74	High
5. Prevention of disappearance/Getting lost	3.84	0.71	High
6. Travel	3.84	0.74	High
Total Average	3.84	0.73	High

Source: Research Results

From Table 2, foreign tourists have a high level of safety satisfaction in Na Jomtien Subdistrict Municipality with a mean of 3.84 and a standard deviation of 0.73. When considering each aspect, it was found that foreign

tourists were concerned about the safety of crime, accident, hygiene/public health, natural disaster, prevention of disappearance/getting lost, and travel. The mean was 3.83, 3.85, 3.83, 3.86, 3.84, 3.84, respectively, and the standard deviation was 0.75, 0.72, 0.74, 0.74, 0.71, 0.74, respectively. Tourists were concerned in all aspects at a high level.

3.4. Safety Management Research

A local development plan (2022-2027) has been formulated by Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province to drive various public benefits to the local people both in terms of development to support tourism, integrated environmental management and coastal management, improving the quality of life, educational development, development administration, development in transportation, and economic development concretely to comply with government policy, Chonburi province policy, Sattahip district policy and the municipal administrators policies that have been announced to the Na Jomtien Subdistrict Municipality Council and respond to the needs of local people including safety management in life and property safety, accident, hygiene, natural disaster, exploitation, environment, and traveling.

3.5. Analysis of Safety Management Model

The data from the semi-structured in-depth interviews with 30 participants found that the area had a priority concern on road accident safety on risky areas which commonly agreed. Also, 22 out of 30 participants mentioned that crime was another serious concern at tourist destinations nowadays because of economic recession. Few participants discussed the prevention of lost items as well as unclear directional signages. Eight out of 30 participants stated about travel safety, exploitation and natural disaster plans to be prepared at tourist destinations. Also, health and hygiene were critically discussed due to the devastated COVID-19 issues. Lastly, environmental safety was mentioned by few participants.

From studying, analyzing and reviewing local development plans, operational plans, various strategies, with in-depth interviews with agencies responsible for safety management of tourism municipalities in Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province, using coding analysis, it is found that there are 8 safety aspects that need to highly put emphasis on, including 1) Crime safety management, 2) Accident safety management, 3) Natural disaster safety management, 4) Prevention of disappearance/getting lost safety management, 5) Travel safety management, 6) Exploitation safety management, 7) Health/hygiene safety management, and 8) Environmental safety management.

Conclusions and Suggestions

According to research, it was found that the factor of safety in life and property is one of the three important factors that make foreign tourists travel to Na Jomtien beach and surrounding areas which shows that the factor of safety, which is an important element of the quality of tourist attractions, is a factor that affects the decision before traveling and affects the satisfaction of tourists during the trip because the starting point for tourists' decisions and expectations is to gain new experiences that they have never had before. When planning a trip, they had to compare the experience they would get with the prices and risks from insecurity in tourist destinations that they are not familiar with (Ma *et al.* 2020, Thawornprapasawat 2019). Therefore, security in life and property safety are important elements that will help build confidence in traveling for tourists and promote a better image of tourism (National Institute of Development Administration 2015).

For *the level of concern* of the safety management of the tourism municipality of Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province, foreign tourists are concerned at a high level. When considering each aspect, it was found that tourists were concerned at a high level in all aspects. The highest level is hygiene/public health. The secondary is life safety, properties/items safety, and exploitation safety, respectively. These supported the research of Chitphong (2018) that foreign tourists are concerned about public health safety, exploitation safety in the purchase of goods and services, life safety, and property safety. However, threats to tourists are often caused by tourist attractions that cannot be directly controlled and completely eliminated. That is why tourists are worried about insecurity (Mansfeld and Pizam 2006). As the research of Amir *et al.* (2015) shown that individuals would have security concerns when traveling to non-national destinations which related to the studies of Cui *et al*. (2016) and Kokovic (2009).

For *the level of satisfaction* of the safety management of the tourism municipality of Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province, foreign tourists are satisfied at a high level. When considering security management for crimes, which foreign tourists were highly satisfied, it was found that foreign tourists were most satisfied with the presence of volunteers on site to provide security. It supported the research of

Tontisirin and Anantsuksomsri (2021) and Suthikul and Wiruchnipawan (2017) that important guidelines for the development of municipal tourism management in Phuket according to the philosophy of sufficiency economy was that personnel should be employed for the safeguarding of tourists appropriately.

Tourism municipality in Na Jomtien Subdistrict Municipality, Sattahip District, Chonburi Province has '*safety management model'* that consists of criminal safety management, accidental safety management model, natural disaster safety management, prevention of disappearance/getting lost safety management, travel safety management, exploitation safety management, health/hygiene safety management, and environmental safety management. The security management model is consistent with the strategy to build confidence in the safety of life and property of foreign tourists of Tourism Safety and Security Standards Division, Permanent Secretary of Ministry of Tourism and Sports, which has the main mission to monitor the situation and check the indications that have an impact or may affect the safety of tourists, published to alert tourists, develop standards regarding the safety of tourists, as well as being a centre for coordinating and building cooperation of all sectors in providing assistance, facilitating, troubleshooting fraud, ensuring safety and relief for tourists by collaborating with government agencies and the private sector to work together to create a network and strengthen the whole system (Division of Standards and A Tourist Safety Supervision 2023, Thawornprapasawat 2019). It can be seen that the most effective prevention of safety and security incidents in tourist destinations should cooperate fully with tourists, communities, private sectors in the tourism industry, and the government in building confidence and safety for tourists.

To give suggestions, tourism operators and related tourism agencies should continuously promote and communicate online marketing to the tourist population in order to attract tourists to return to travel again and participate in various festival activities in the Na Jomtien Beach and surrounding areas. Organizations involved in safety management should realize and build confidence in the safety of life and property for tourists through various security measures as well as communicating to tourists to create a good image and find ways to create awareness among tourists in order to communicate to increase confidence in the safety of crime and reduce the concerns of tourists in various aspects.

In further research, it should study effective safety management communication guidelines and styles for foreign tourists in order to develop a communication style suitable for different groups of tourists as a result to be more effective in the future.

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Credit Authorship Contribution Statement

Chayapoj Lee-Anant confirms responsibilities for the following: Conceptualization, Investigation, Methodology, Project administration, Software, Formal analysis, Writing – original draft, Supervision, Data curation, Validation, Writing – review and editing, Visualization, and Funding acquisition.

Declaration of Competing Interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Impact of War on the Natural Preserve Fund: Challenges for the Development of Ecological Tourism and Environmental Protection

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Abstract: The global deterioration of the quality of the natural environment causes an increase in the importance of ecological tourism, primarily at the sites of the nature reserve fund. This paper is one of the first attempts to fill the existing gaps in the question of the impact of war on protected natural areas. The article determines the development trends, current state, and problems of the objects of the nature reserve fund in Ukraine in the conditions of unjustified full-scale russian military aggression and makes an approximate calculation of the damages caused as a result of hostilities. It was established that during 2012–2020, the number of objects of the nature reserve fund in Ukraine increased by 605 units or by 7.5 %; the area of these objects increased by 562,460.6 hectares or by 14.3 %. Due to russian military aggression, danger threatens 900 protected areas, which is 1.2 million hectares or about 30 % of the area of all protected areas of Ukraine. The damage calculation was carried out on the example of the Feldman EcoPark regional landscape park in the Dergachy district of the Kharkiv region. It was established that the approximate estimate of damages from the loss of ecosystem services of this landscape park as of 20.05.2022 was 16,979.5 thousand USD, including in terms of ecosystem services: (i) recreation and ecotourism – 13,846.2 thousand USD; (ii) air purification from solid fine particles and harmful gases – 272.1 thousand USD; (iii) biodiversity habitat – 2,861.3 thousand USD. In addition, the amount of damage caused to the regional landscape park due to the loss of animals, calculated based on special fees for calculating the amount of damage to the nature reserve fund, amounts to 63,350 USD. The determined damage estimates are preliminary and need to be clarified after the end of the war.

Keywords: ecosystem services; ecological damage; ecological tourism; nature reserve fund; Ukraine.

JEL Classification: O13; Q50; Q57; R11.

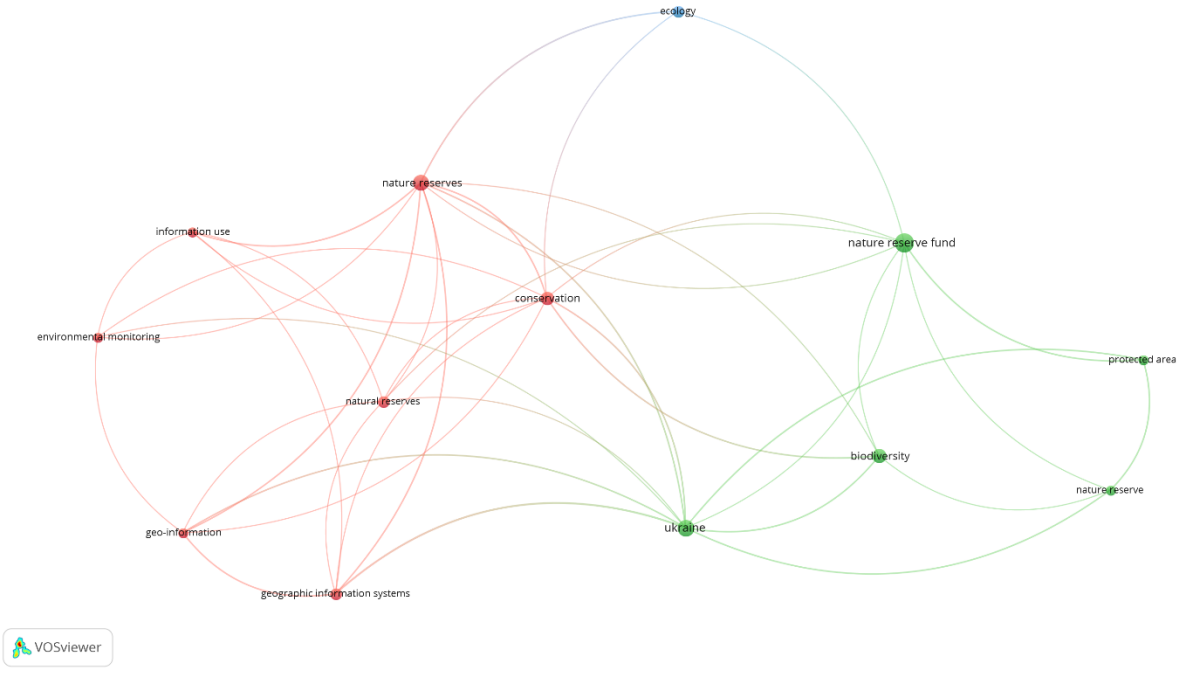
Introduction

The global deterioration of the natural environment is causing the growing importance of ecological tourism. The objects of the nature reserve fund (NRF) are the core for the development of ecological tourism. The development of ecological tourism has a particularly high potential in regions with a high share of natural heritage (Melnyk and Chyr 2019). Ecological tourism is designed to form the ecological consciousness of society, to convey to people the urgency and importance of issues of environmental protection.

The results of a search in the Scopus database with the search query “nature reserve fund” in the search field “TITLE-ABS-KEY” allowed to find 38 indexed documents. At the same time, a combined search for the phrases “nature reserve fund” and “ecological tourism” made it possible to find only two works devoted to the issues of the natural reserve fund of the Transcarpathian region as a core of the development of ecological tourism (Melnyk and Chyr 2019) and the rural “green” tourism as a driver of local economy development (Yakymchuk *et al.* 2021). The paper by Melnyk and Chyr analyzed the dynamics of nature protecting in the Transcarpathian region, the potential of the nature reserve fund of the region for the development of ecological tourism; in particular, for comparison, the authors analyzed the part and ratio of functional zones in the national natural parks of Europe and Ukraine (Melnyk and Chyr 2019). In the article by Yakymchuk *et al.* the prerequisites for the improvement of the nature reserve fund as a basis for the development of ecological tourism have been formed, the use of ethno-festivals as an innovative form of tourism activation within regional landscape parks and other categories of the nature reserve fund has been substantiated (Yakymchuk *et al.* 2021).

The bibliometric analysis of the metadata of the specified 38 documents allowed us to identify three clusters of keywords that reflect the main directions of research on the objects of the nature reserve fund in the world (Figure 1).

Figure 1. Network visualization of the connection between nature reserve fund and other related categories

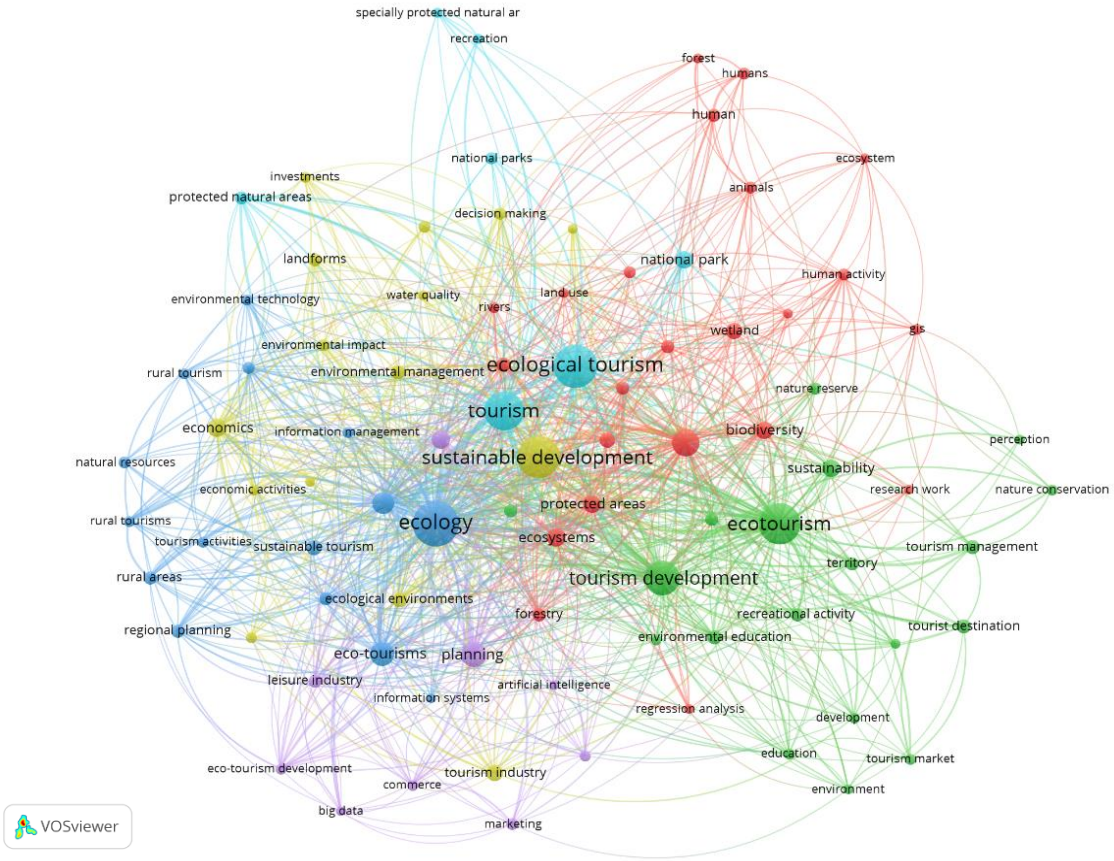


Source: developed by the authors based on the Scopus database using the program VOSviewer.

On the other hand, the results of a search in the Scopus database with the search query “ecological tourism” in the search field “TITLE-ABS-KEY” allowed us to find 386 indexed documents. The largest number of works were published by Chinese scientists. The distribution of documents by type indicates that the leading positions are occupied by articles (60.8 %) and conference papers (30.1 %). Environmental science (23.2 %), earth and planetary sciences (12.6 %) and social sciences (12.6 %) take the leading positions in the subject area. According to the results of the bibliometric analysis of the metadata of these documents, we identified six clusters of keywords that reflect the main directions of research on the objects of ecological tourism in the world (Figure 2). Each cluster is marked with different colors. For example, the largest is the red cluster, which includes 23 keywords and focuses on environmental protection. The second largest is the green cluster, which includes 19

keywords and focuses directly on the development of ecological tourism. The smallest is the blue cluster, which includes 7 keywords and focuses on tourism in general and ecological tourism in particular.

Figure 2. Network visualization of the connection between ecological tourism and other related categories



Source: developed by the authors based on the Scopus database using the program VOSviewer.

The objects of the nature reserve fund provide the population with ecological services, which, according to the international project "Millennium Ecosystem Assessment", are understood as all the useful benefits that can be obtained from proximity to nature (Millennium Ecosystem Assessment 2005). As part of this project, scientists have developed methods for estimating the cost of clean air, a beautiful landscape, the rustling of leaves, and the singing of birds. In Ukraine, comprehensive studies have been conducted on the assessment of ecosystem services of forests (Soloviy 2016; Soloviy and Burda 2022), wetlands, and swamps (Andreieva *et al.* 2021).

Environmentalists and economists around the world have developed methods for estimating the cost of clean air, a beautiful landscape, the rustle of leaves, and the singing of birds. These natural benefits, which are so familiar to us, are becoming more and more precious and desirable against the background of the rapid movement of life in the capital. According to the studies of scientists (Constanza *et al.* 1997; Sedell *et al.* 2000), the total value of forest ecosystem goods and services is 4.7 trillion USD annually, of which the total cost of boreal forests (temperate zone) is 894 billion USD annually. Depending on the region, the cost of soil stabilization services per hectare of forest varies from 1.94 to 5.5 million USD per ton for cleaning the air from solid fine particles (dust, soot) and harmful gases, each tree costs an average of 4.16 USD annually. For biological diversity, the forest is a habitat, 17.5 thousand USD is worth a hectare of forest, if you count the participation of birds in the fight against insect pests. The value of pollination services is 19.23 thousand USD up to 33.65 thousand USD for a year.

In Ukraine, similar comprehensive studies on the assessment of ecosystem services of forests have been conducted. Thus, the work presents approaches to the assessment of forest ecosystem services, analyzed the ecosystem services provided by the forests of Ukraine and their indicators, and proposed an institutional-and-organizational mechanism for the payment of fees for forest ecosystem services, the use of which will facilitate the identification and integration of previously undervalued services into economic activity, improving the well-being of forest-dependent communities and entering the international markets of ecosystem services (Soloviy

2016). Valuable for our work is the study of modern trends in the development of methodological bases for assessing the value of forest ecosystem services within nature-reserved territories, as a result of which it was established that the economic assessment of ecosystem services is an attempt to assign them quantitative indicators of economic value, including services that are at least partially covered market and those that are not yet valued on the market today. From a methodological point of view, the assessment of ecosystem services should be interdisciplinary, and from a practical point of view, it should consider the experience of assessments in other countries and the best practices of international projects (Soloviy and Burda 2022).

Unfortunately, for Ukraine, similar comprehensive studies on the assessment of ecosystem services of the objects of the nature reserve fund have hardly been conducted. However, there are some developments in this direction as well. Thus, the study identified the values of Holosiivsky forest ecosystems and found out the reasons for their degradation as a result of the impact on the forest ecosystems of a large city and the imperfect organization of the territory of the national nature park (NNP) "Holosiivskyi" in the city of Kyiv (Shyshchenko *et al.* 2019). An economic evaluation of the ecosystem services of NNP "Holosiivskyi", the area of which is 10,988.14 hectares, was also carried out. Each of the three million residents of Kyiv, even if they are not in the national park, receives from it obvious benefits of their own, which pass unnoticed by the residents, because there is no need to pay for such services. Calculations show that every resident of Kyiv should pay about 70 UAH to the state treasury every day for the work that wild nature does instead of complex technologies (Soloviy 2016; Soloviy and Burda 2022).

EPL ecologists have calculated the cost of some ecosystem services of the NNP "Holosiivskyi" according to the methods used in other countries of the world, especially for the residents of Kyiv. Unfortunately, not all services can be estimated, at least roughly in monetary terms. In particular, it can be calculated that the national park provides the following ecosystem services for one year (at a minimum estimate) (Soloviy 2016; Soloviy and Burda 2022):

- air purification – 480 million UAH;
- soil stabilization – 60 million UAH;
- fight against insect pests – 5,775 million UAH;
- pollination of plants – 6,346.9 million UAH;
- recreation – 240 million UAH;
- cooling the city in summer, forming a microclimate – 3,816 million UAH;
- wood (including firewood) – 40 million UAH.

The total cost of ecosystem services of the NNP "Holosiivskyi" is at least 76.7 billion UAH every year. Every year, every citizen of Kyiv receives 25,500 UAH from the national service park free of charge. From this calculation, it is clear that the most valuable resource among those provided by the forest is not wood at all. Therefore, by preserving natural territories in a wild state, we get much more than by taking resources from them (Soloviy 2016; Soloviy and Burda 2022).

Another article presents calculations of the cost of direct use and the potential economic value of the ecosystem services of the Askania steppe, the main part of which is part of the Askania-Nova biosphere reserve. According to the classification established within the project "Evaluation of Ecosystems on the Threshold of the Millennium", four types of ecosystem services are distinguished: (1) providing; (2) supporting; (3) adjustment rooms; (4) cultural (Lukavenko and Derevska 2017).

Preservation of the objects of the nature reserve fund is particularly important in the context of achieving the goals of sustainable development, in particular in the fight against land degradation. It was established that during the period from 2000 to 2018, the consumption of "clean" land in Ukraine occurred at a rate of 48.8 km^2 or 0.01 % per year in cities and 266 km^2 or 0.04 % per year in villages and towns. Despite the decrease in the total number of the population, including urban residents, there was an intra-regional migration increase of 2.1 %, caused both by the search for work and the resettlement of the population from the temporarily occupied territories of the Donetsk and Luhansk regions of the Autonomous Republic of Crimea, which led to an unjustified increase in the area of built-up land in settlements of individual regions (Budziak *et al.* 2021). Ukrainian scientists are also investigating the issue of directions for ensuring the sustainability of rural tourism (Okolovych 2022), challenges and guidelines for strengthening of environmental security of territories in war conditions (Irtyshcheva *et al.* 2022), the strategic directions for restoration of environmental security in the post-war period (Zamula and Shavurska 2023) and economic recovery of post-war Ukraine (Lemishko *et al.* 2022).

However, research on assessing the impact of war on nature reserves is in its infancy, which served as one of the key motivations for this work.

1. Materials and Methods

The research was carried out in two stages. In the first stage, the development trends, current state, and problems of the objects of the nature reserve fund in Ukraine under the conditions of russian military aggression were determined. In the second stage, an approximate calculation of damages caused as a result of hostilities was carried out (on the example of Feldman EcoPark).

In 2013, a regional landscape park "ECO PARK" was created in the Dergachy district of the Kharkiv region by the decision of the Kharkiv regional council. The landscape park with an area of 140.5 hectares includes 37 hectares, seized from the permanent land user – the Danyliv State Experimental Forestry Research Institute of Forestry and Agromelioration named after Vysotskyi, 78 hectares of the Danyliv forest farm, 3 hectares of the "Lisova Polyana" recreation complex, 3.15 hectares of the "Halychyna" recreation camp, 18.5 hectares of the reserve lands of the Dergachy district administration, the "Feldman EcoPark" zoo (Website of Feldman EcoPark 2022; Klimov *et al.* 2005).

This park has been in the line of fire since the first days of the full-scale invasion and is under fire every day. Because of this, the park suffers losses, animals die, and the infrastructure of the park is destroyed. Unfortunately, due to military operations, the authors cannot conduct the necessary research to fully assess the damage, but we decided to try to calculate the damage with the help of information that everyone can find freely available.

We were not able to find a specific method by which the damage caused to the NRF facility was previously assessed. Because of this, the authors chose two methods of determining damages – ecosystem services were calculated and assessment through fees, which were approved by the Resolution of the Cabinet of Ministers of Ukraine (2022).

Most of the park consists of forest plantations, so the number of ecosystem services provided by this area is very large. These include air purification and treatment of respiratory diseases, soil stabilization, pest control, plant pollination, cooling of the city in summer, microclimate formation, wood (including firewood), conducting scientific activities, forming a system of knowledge and values, recreational and conservation activities, tourism, protection of soils from erosion, genetic and decorative resources, biological diversity. We evaluated some of them, determined by the possibilities of obtaining information, namely: loss of ecosystem services related to recreation and ecotourism, air purification, and loss of biological diversity and its habitat.

The information base of the research at the first stage is data on the statistics of the nature reserve fund for 2012–2020, obtained from the statistical collections of "Environment of Ukraine", at the second stage – data collected by the authors from open sources.

2. Results and Discussion

2.1. Development Trends, Current State, and Problems of Nature Reserve Fund Objects in Ukraine in the Conditions of Russian Military Aggression

1.1. Trends in the development of nature reserve fund objects in Ukraine. The determination of the development trends of the nature reserve sphere is based on the statistical analysis of the series of dynamics regarding the number (Table 1) and area (Table 2) of the objects of the nature reserve fund of Ukraine.

Table 1. Indicators of the dynamics of the number of objects of the nature reserve fund of Ukraine

Years	The number of objects of the nature reserve fund, units	Absolute increase, units		Growth rate, %		Growth index, %		Absolute value of 1% increase, units
		basic	chain	basic	chain	basic	chain	
2012	8,028	-	-	100.0	-	-	-	-
2013	8,101	73	73	100.9	100.9	0.9	0.9	80
2014	8,154	126	53	101.6	100.7	1.6	0.7	81
2015	8,184	156	30	101.9	100.4	1.9	0.4	82
2016	8,245	217	61	102.7	100.7	2.7	0.7	82
2017	8,296	268	51	103.3	100.6	3.3	0.6	82
2018	8,396	368	100	104.6	101.2	4.6	1.2	83
2019	8,512	484	116	106.0	101.4	6.0	1.4	80
2020	8,633	605	121	107.5	101.4	7.5	1.4	85

Source: authors' calculations based on data from the State Statistics Service of Ukraine.

After analyzing the data, we can conclude that the number of NRF facilities in Ukraine is increasing every year. Absolute base growth during 2012–2020 ranged from 73 to 605 units and indicates a positive trend towards an increase in the number of NRF objects. The dynamics of chain growth confirm the stability of this positive trend. The most productive year for the formation of the NRF network was 2020 when 120 facilities were put into operation. The least productive year was 2015 when 30 facilities were commissioned. The chain rate of growth over the last three years exceeded 1 %, and the growth rate also significantly accelerated during the analyzed period. So, the data in the Table 1 shows that during 2012–2020, the number of NRF facilities in Ukraine increased by 605 units or by 7.5 %. The absolute value of 1 % growth increased from 80 units in 2012 to 85 units in 2020.

The analysis of the dynamics of the area of objects of the Nature Reserve Fund of Ukraine (Table 2) shows that during 2012–2020 the growth trend was ambiguous since a period of unambiguous growth of the area was recorded – from 2013 to 2016, during which time the area increased by 10.1 % compared to 2012; in 2017, the area of NRF facilities decreased by 7.7 % compared to 2016, but then again a positive trend towards the growth of this area was recorded.

Table 2. Indicators of the dynamics of the area of objects of the nature reserve fund of Ukraine

Years	The number of objects of the nature reserve fund, units	Absolute increase, units.		Growth rate, %		Growth index, %		Absolute value of 1% increase, units
		basic	chain	basic	chain	basic	chain	
2012	3,922,563.2	-	-	100.0	-	-	-	-
2013	3,958,769.0	36,205.8	36,205.8	100.9	100.9	0.9	0.9	39,226
2014	3,992,521.3	69,958.1	33,752.3	101.8	100.9	1.8	0.9	39,588
2015	4,082,780.6	160,217.4	90,259.3	104.1	102.3	4.1	2.3	39,925
2016	4,318,224.1	395,660.9	235,443.5	110.1	105.8	10.1	5.8	40,828
2017	3,985,022.4	62,459.2	-333,201.7	101.6	92.3	1.6	-7.7	43,182
2018	3,991,638.5	69,075.3	6,616.1	101.8	100.2	1.8	0.2	39,850
2019	4,085,862.4	163,299.2	94,223.9	104.2	102.4	4.2	2.4	39,916
2020	4,485,023.8	562,460.6	399,161.4	114.3	109.8	14.3	9.8	40,859

Source: authors' calculations based on data from the State Statistics Service of Ukraine.

So, after analyzing the data, it can be noted that the dynamics of the area of objects of the nature reserve fund of Ukraine are mostly positive. The absolute basic increase in the area of objects of the nature reserve fund fluctuated in a wide range of 36,205.8–562,460.6 ha. The absolute value of 1 % growth increased from 39,226 hectares in 2012 to 40,859 hectares in 2020. The highest chain growth rate of the analyzed area was recorded in 2020 when it was 9.8 %, which correlates with the highest growth rates of the number of objects nature reserve fund in the specified year. Therefore, during 2012–2020, the area of objects of the nature reserve fund of Ukraine increased by 562,460.6 hectares or by 14.3 %.

1.2. The impact of the war on the objects of the nature reserve fund of Ukraine. According to the data of the Ministry of Environmental Protection and Natural Resources of Ukraine (Briefing on the environmental damage caused by Russias war of aggression against Ukraine, 2022), about 20 % of all nature conservation areas of Ukraine have been affected by the war, 0.9 million hectares of protected areas suffer from the war, and 812 objects of the nature reserve fund are in danger (Figure 3).

The nature reserve fund of the highest level of protection (national parks, natural and biosphere reserves, national natural parks) in Ukraine covers 1,236,366 hectares. At the same time, 44 % of them were in the war zone, under the temporary control of the russian invaders, or are inaccessible to Ukraine; 11,600 hectares of protected areas burned in 4 months of the war. Also, due to the military actions in most regions, the processes of creating new territories for the nature reserve fund have stopped (Vasyliuk 2022).

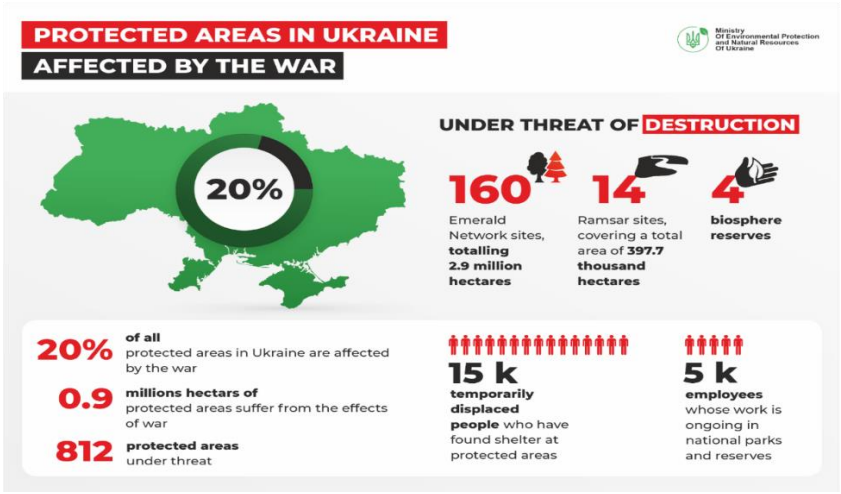
As of August 15, 2022, 900 protected areas are at risk due to military actions, which is 1.2 million hectares or about 30 % of the area of all protected areas in the country. As a result of hostilities, the number of forest fires increased almost threefold, and the area of fires increased 90 times. The territories and objects of the nature reserve fund along the Azov-Black Sea coast and the eastern and northern borders of Ukraine are under

particular threat. As of the specified date, the Kherson region has already lost more than 5,000 hectares of forest, which is a real ecological disaster for the region, where the natural reproduction of forests is almost impossible (Ilyina and Kobzar 2022).

As noted by R. Strelets, the damage to the environment reached almost 1 trillion UAH during half a year of the war. About 20 % of protected areas are affected by war; in the risk zone – 2.9 million hectares of the territories of the Emerald Network and 17 Ramsar sites with an area of more than 600 thousand hectares. The russians occupied 8 Ukrainian nature reserves and 12 national natural parks. Some of them are in critical condition. For example, almost "80 % of the territory of the National Park "Holy Mountains" was destroyed; in May, the Kinburn Spit burned for a whole week due to hostilities, and relict forests burned there; there is currently a humanitarian crisis in the occupied "Ascania Nova" (Strilets 2022).

The main problems for the territories of the nature reserve fund, caused by military actions, include the following: death and scaring of animals; destruction of vegetation and loss of biodiversity; damage to the territory by military equipment and ruptures from explosions; destruction of the upper layer of soils; pollution of ecosystems by-products of explosions due to the burning of objects affected by shelling, as well as due to the destruction of military equipment; fires in forests and other natural ecosystems; disruption of the regular lifestyle of wild animals, depopulation and mass migration of species; cessation of nesting of birds, instead, alien species fly in their place; distribution of abandoned pets in nature; the threat of death of animals due to mining; spread of alien plant species on damaged areas; problems with keeping animals (impossibility to buy feed for animals; scaring of animals kept; impossibility to care for animals; destruction of pens for animals) (Ilyina and Kobzar 2022; Vasyliuk 2022).

Figure 3. Basic data on the impact of the war on the protected territories of Ukraine as of 20.05.2022



Source: data from the Ministry of Environmental Protection and Natural Resources of Ukraine (Briefing on the environmental damage caused by Russias war of aggression against Ukraine, 2022).

2.2. Calculation of Damages Caused as a Result of Hostilities. The Example of Feldman EcoPark

2.1. Estimation of losses from loss of ecosystem services about recreation and ecotourism. According to mass media, in recent years, the park has been visited by about 2.7 million tourists per year. Since the visit was free, to calculate the value of tourist services, we took the price of tickets determined for the Kharkiv Zoo. It was planned that a ticket for visitors to the Kharkiv Zoo would cost 100 UAH for children and 200 UAH for adults (Feldman will build a new ecopark in Odesa for $15 million. Economic truth, 2020; Zoo in Kharkiv: how to get there, how to sign up and schedule, 2022). So, we calculated the average price of a ticket – 150 UAH. That is, on the condition that a ticket would cost 150 UAH for one visitor on average, then the annual cost of the tourist component of ecosystem services provided by the park would be 405 million UAH.

2.2. Assessment of damages from the loss of an ecosystem service related to air purification from solid fine particles (dust, soot) and harmful gases. Unfortunately, we do not have the opportunity to count the number of trees on the site, but a tree from a tree is usually planted at a distance of about 5 meters. Accordingly, there are 20 trees at a distance of 100 m, and 400 on an area of 100x100 m. Further, we assume that the entire territory, except for the zoo and the recreation camp, has forest plantations – this is 163.5 hectares. As for the ecosystem service of cleaning the air from solid fine-dispersed substances (dust, soot) and harmful gases, each tree on average annually provides them for 4.16 USD (Holosiiv National Park – a treasure trove of free benefits Press

release – Ecology Right Human, 2022). Based on these data, we calculated that 65,400 trees are growing on this territory, which provides 272,064 USD worth of ecosystem services. At the current exchange rate, this is equivalent to 7,957,872 UAH.

2.3. Assessment of damage from the loss of an ecosystem service about the habitat of biological diversity. For biological diversity, the forest is a habitat. A hectare of forest costs 17.5 thousand USD, if we consider the participation of birds in the fight against insect pests (Holosiiv National Park – a treasure trove of free benefits Press release – Ecology Right Human, 2022). Thus, the economic loss from the damages of this ecosystem service is 2,861,250 USD. At the current exchange rate, this is equal to 83,691,563 UAH.

As a summary, it can be noted that the estimated number of damages from the loss of ecosystem services of the regional landscape park "Feldman - EcoPark" is 16,979,467 USD (Table 3).

Table 3. Approximate assessment of losses from the loss of ecosystem services on the example of the regional landscape park "Feldman - EcoPark" of Dergachy district, Kharkiv region

Ecosystem service	Damages	
	UAH	USD
Recreation and ecotourism	405,000,000	13,846,153
Air purification from solid fine particles and harmful gases	7,957,872	272,064
Biodiversity habitat	83,691,563	2,861,250
The loss of three ecosystem services	496,649,435	16,979,467

Source: authors' calculations based on available data.

2.4. Damage assessment based on special fees for calculating the amount of damage to the nature reserve fund. It is possible to determine the damage caused by taxes. Fires start every day due to shelling, animals die, and their habitats disappear. Institutions of the Nature Reserve Fund, the State Environmental Inspectorate, and state enterprises in the forest industry record crimes against nature. The damage caused to the territories and their biodiversity is assessed for further compensation to Ukraine for the loss of biodiversity thanks to approved fees for calculating the amount of damage to the nature reserve fund in the following cases (https://mepr.gov.ua/news/39175.html):

- illegal felling or damage to trees and plants with lignified stems;
- destruction or damage of forest crops, natural undergrowth, and self-sowing, seedlings and saplings;
- destruction or damage to lawns and flower gardens;
- illegal collection or destruction of wild herbaceous plants, forest litter, medicinal plants, wild fruits, nuts, berries, and secondary forest materials; illegal extraction or destruction of objects of the animal world, damage or destruction of their dwellings and structures, places of stay and reproduction;
- damage to karst speleological, geological, and hydrological objects;
- traffic, flights, and landings of aircraft;
- arbitrary occupation of land plots;
- destruction or damage to drainage ditches, drainage, and anti-erosion systems, roads, and other objects.

It should be noted that, according to the authors, these taxa are more suitable for peacetime. In the territories where military operations are taking place, it is worth considering in more detail: the factors of disturbance of vegetation cover and soil, factors affecting/affecting animals, physical pollution and transformation of the landscape, and impact on forest plantations.

The main factor in the disturbance of vegetation and soil is shell explosions. Factors affecting/affecting animals – the death of animals, noise, provoking the escape and/or migration of animals. The main impact on forest plantations is fired due to explosions.

At this time, we do not know the exact number of animals that died due to the shelling of the park. However, you can calculate the approximate number by collecting information from the official website, social networks, and media publications. Thus, as of May 20, 2022, it is known about the death (Ryazantseva 2022; Website of Feldman EcoPark 2022; Solodovnik 2022; Primates died during shelling in the Kharkiv Ecopark 2022; The baby was left an orphan: the russians killed a couple of bison in the Kharkiv Ecopark 2022): 2 bison; 4 does; 3 welsh goats; 1 mandrill; 9 red deer (another 20 escaped); 2 orangutans; 1 chimpanzee; 2 kangaroos.

According to the taxes of 2022, one individual deer is worth 45,565 UAH, so the losses amount to

410,085 UAH, and if we consider the escaped deer, then 1,321,385 UAH. According to the taxes of 2022, one doe is worth 30,377 UAH (Resolution of the Cabinet Ministers of Ukraine, 2022), so the losses amount to 121,508 UAH. Thus, the amount of damage caused to the regional landscape park "Feldman - EcoPark" due to the loss of animals, calculated based on special fees for calculating the amount of damage to the nature reserve fund, amounts to 1,852,978 UAH or 63,350 USD. Comparing the results of our research with recently published data, it should be noted that the state environmental protection inspectors of the Kharkiv region recorded the criminal consequences of Russian aggression and calculated at least 1,280,000 UAH in damages caused to the environment due to the death of animals in the park "Feldman - EcoPark". We agree with the opinion that the rescue of animals from the park "Feldman - EcoPark", its preservation and restoration is an event that deserves a special place in the great book of the struggle of the people of Ukraine for life and freedom in this terrible war unleashed by Russia. This is a story that not only shows the indomitable will and dedication of people, but also reveals their humanism and faith in the future (Kharkiv Ecopark will welcome visitors again, 2023).

So, as of May 20, 2022, we were able to calculate losses from the loss of ecosystem services and the loss of animals for 497,502,413 UAH or 17,042,817 USD. This is a huge amount and, unfortunately, not final; there is an assumption that it could be significantly larger.

While discussing and summarizing the obtained results, it should be noted that several assessment methods should be used for a more comprehensive assessment of the damage caused. Research suggests that, in contrast to the traditional method of using a single approach, economic valuation of ecosystem services using multiple methods helps to address several limitations (Vicente *et al.* 2023). One of the obstacles to overcoming information limitations is the lack of access to complete data on the damage caused. Despite all the difficulties and challenges, on June 1, 2023, on International Children's Day, the park "Feldman - EcoPark" opened for visitors the first location "Alpacas Valley", which was demined, restored, and made safe for visitors (Kharkiv Ecopark will welcome visitors again, 2023). Restoration and development of protected areas and objects should become one of the components of the Ukraine Recovery Plan (Shvedun *et al.* 2023). At the same time, at the post-war stage, it is necessary to rethink the practice of ecological tourism in nature conservation areas and bring it to a "sustainable course" (Perera *et al.* 2023). Future planning for the restoration of war-damaged nature reserves and the development of sustainable tourism will require research to develop methodological recommendations and strategic plans.

Conclusions

A bibliometric analysis of publications on the nature reserve fund and ecological tourism based on the Scopus database proved the presence of gaps in the development of ecological tourism in the territories of the nature reserve fund in the conditions of martial law and the loss of ecosystem services due to the war. This article is one of the first attempts to fill the existing gaps. The development trends, current state, and problems of the objects of the nature reserve fund in Ukraine in the conditions of russian military aggression were determined, and an approximate calculation of the damage caused because of hostilities was carried out. After analyzing the data, we noted that the dynamics of the area of objects of the nature reserve fund of Ukraine are mostly positive. The absolute basic increase in the area of objects of the nature reserve fund fluctuated in a wide range of 36,205.8–562,460.6 hectares. The absolute value of 1% growth increased from 39,226 hectares in 2012 to 40,859 hectares in 2020. During 2012–2020, the area of the country's natural reserve fund increased by 562,460.6 hectares or by 14.3 %. Due to military actions, 900 protected areas are at risk, which is 1.2 million hectares or about 30 % of the area of all protected areas of Ukraine. As a result of hostilities, the number of forest fires increased almost threefold, and the area of fires increased 90 times. The territories and objects of the nature reserve fund along the Azov-Black Sea coast and the eastern and northern borders of Ukraine are under particular threat. Since we did not find a specific methodology, according to which the damage caused to the NRF object was previously assessed, therefore we chose two methods of determining the damage – (1) calculated damage from the loss of ecosystem services about (a) recreation and ecotourism, (b) cleaning the air from fine particulate matter and harmful gases, (c) biodiversity habitat, and (2) assessment using taxes, which were approved by the Resolution of the Cabinet of Ministers of Ukraine. As a result of the calculations, it was established that the total amount of damage caused to the regional landscape park "Feldman - EcoPark" due to the loss of ecosystem services and the loss of animals as of 20.05.2022 amounted to 17,042,817 USD. However, this figure is not final, and it will probably be much higher, but it will be possible to determine it after the end of the war. Therefore, a promising direction of research is the development and testing of an internationally recognized methodology for determining the damage caused by military aggression to the objects of the nature reserve fund. The development of a program for the post-war restoration of nature reserve objects as a basis for environmental protection and the

development of ecological tourism should also be included among the promising directions.

Credit Authorship Contribution Statement

Anatolii Kucher: Conceptualization, Investigation, Methodology, Formal analysis, Writing – original draft, Supervision, Writing – review and editing.
Anna Honcharova: Investigation, Formal analysis, Writing – original draft, Data curation, Validation.
Lesia Kucher: Conceptualization, Investigation, Project administration, Software, Writing – original draft, Writing – review and editing, Visualization, Funding acquisition.
Mariia Bieloborodova: Investigation, Writing – original draft, Data curation, Funding acquisition.
Liudmyla Bondarenko: Data curation, Funding acquisition, Investigation, Writing – original draft.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Sustainable Development and Environmental Tourism. The Case of Lake Karla – Thessaly, Greece

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Abstract: Sustainable development is the common ground between the three components: environment, economy, and society, which are also known as sustainability pillars. In this work, an attempt was made to investigate whether Lake Karla - Mavrovouni, supporting agriculture, biodiversity and cultural activities and being part of the Natura 2000 protected area network, in combination with the diverse topics of environmental education, can contribute for the sustainable development of local societies, with the contribution of the collective bodies of local self-government. For the holistic management of the protected area of the "Karla" lake, the managers must consider on the one hand the protection of the natural and cultural heritage and on the other hand the sustainable development of the area through the promotion of the natural and cultural heritage and the promotion of environmental tourism. For this purpose, managers need to know socio-economic and demographic characteristics of visitors. Here, questionnaire responses were used to investigate the profile, environmental perception, knowledge, and behavior of visitors. In total, more than 300 questionnaires were sent, and finally 161 questionnaires were fully answered, which constitute the research sample. The analysis of the results showed that the natural and cultural environment contribute to the sustainable development of the wider area of Lake Karla-Mavrovouni, highlighting through them serious advantages and opportunities to exploit the area by the local bodies.

Keywords: sustainability; ecotourism; Lake Karla; pathways; ecosystem services; environmental education.

JEL Classification: Q01; Q56; R11.

Introduction

Lake Karla, until the drainage in 1962, was one of the important natural wetland ecosystems of Greece and the Mediterranean more broadly. The provision of ecosystem services by the natural environment encompasses a multitude of benefits such as water purification, air quality improvement, climate regulation and biodiversity

conservation. These services are vital for the well-being and resilience of local communities. However, beyond their utilitarian value, natural environments offer additional advantages through their capacity to serve as educational resources and recreational spaces. This unique attribute is particularly relevant within Protected Areas, which are designated regions that safeguard natural and cultural heritage (Szell and Hallett 2013; Trakala, Tsiroukis, Martinis 2023).

In addition to the ecosystem services that the natural environment provides to local communities, it presents a propitious setting for environmental education and recreation, specifically within Protected Areas (PAs). The pedagogical and leisurely worth of the natural environment exhibits a robust interconnection with the sustainable development of neighbouring communities, particularly in regions of Greece that have experienced environmental degradation and economic downturn, exemplified by the Lake Karla - Mavrovouni region.

Efforts to restore the Lake Karla and highlighting the wider area and the biodiversity of the region Mavrovouni, can involve initiatives such as the creation of nature centres, interpretation trails and educational programs that capitalize on the ecological significance of the area. These endeavours can attract visitors, including tourists, students, and researchers, who can contribute to the local economy while gaining valuable knowledge about the region's unique ecosystems. Moreover, collaboration between local communities, environmental organizations and governmental bodies can facilitate the implementation of sustainable tourism practices that prioritize conservation and respect for the natural environment (Moyle *et al.* 2017).

Environmental Tourism has been broadly defined as the involvement in biophysical and socio-cultural environments (Zhong *et al.* 2011). Rural tourism stands apart from other forms of tourism due to its strong dependence on the natural and socio-cultural environments (Richards 1996). As a result, the conservation and preservation of the tourism environment, particularly in rural tourism destinations, assume utmost significance. Hiking is a popular form of ecotourism, providing travelers with a sense of satisfaction and awareness of the sustainability of the environment (Poudel and Nyaupane 2016). At the same time, the use of hiking pathways by local residents contributes to the development of walking routes, highlighting longer and better routes, through specific destinations in their area (Joseph and Zimring 2007). Walking routes are the link between tourism, culture and the environment per region, as the traveler crossing the path where he has chosen, is able to come into contact with the history, culture and local tradition of the region, gaining awareness and responsibility for the protection of the local ecosystem and its historical monuments (Evans and Jones 2011).

According to Manning (2001), the importance of connecting people with nature is very important, because nature offers experiences and knowledge to visitors. Moyle *et al.* (2017), link the ability of visitors to gain experiences in nature with the simultaneous sustainable development of local communities. In the work of Petrosilio showed that the higher the level of education, the greater the knowledge, awareness and environmental behavior of visitors and that the level of education is directly related to knowledge, information, awareness and environmental behaviour. Petrosilio also stated that environmental consciousness is an important variable that depends on education level and place of residence. In addition, the promotion of natural wealth and the protection of the environment, cultural heritage (archaeology, folklore, tradition) through the preservation and promotion of the most important cultural elements (monuments, architectural ensembles), the possibility of recreation, the utilization of monuments and places of natural beauty, as well as and certified walking pathways-routes give added value to the area.

Furthermore, according to Tsonis, community-based tourism has been defined as a form of tourism that grants communities a certain level of authority to make decisions and safeguard the environment, while concurrently fostering cross-cultural awareness (Tsonis 2009). The fundamental objective of community-based tourism is to promote the economic, social and cultural well-being of communities residing in sustainable tourism destinations (Brohman 1996). Achieving sustainable development in this context, necessitates the implementation of a balanced and harmonious approach that ensures the quality of development, both from cultural and environmental perspectives. Furthermore, this approach should prioritize the needs, interests and potentials of the community and its residents, as they play a crucial role in sustaining tourism development (Razzaq 2011). Concerning the area of Lake Karlas, the highlighting of the natural wealth and the protection of the environment, through a certified walking path - route with the neighboring ecosystems of Kissavos, Mavrovouni and Pelion, will give added value to the area. In addition, the utilization of the flora, birdlife and fish fauna (Catsadorakis 2019), will become a pole of attraction and multiple topics for environmental education, but also for alternative tourism, which has been widely recognized as a key tool for regional sustainable development (Trakala 2023). In fact, environmental education (EE) and education for sustainable development (ESD) is characterized as important tools to address knowledge, values and behavior and to achieve sustainable development.

Besides, there are many factors that shape environmentally friendly behavior, such as social, demographic, self-identifying, cognitive and exogenous factors. Characteristically, one of the parameters that influence people's attitudes towards the environment and therefore their behavior, is their level of knowledge towards important issues related to the ecosystem, such as protected areas (Petrosillo *et al.* 2007; Shamuganathan and Karpudewan 2015; Genc and Akilli 2016).

Accordingly, through the findings of scientific research, it has been shown that certain demographic factors shape environmental attitudes, among them the educational level (Gardner and Stern 2002; Teksoz *et al.* 2014; Newman and Fernandes 2016; Martinis 2020). Therefore, through environmental education, people are able to form a more friendly attitude towards protected areas, since their value is recognized. Thus, through environmental education, it is possible to realize the value of the cultural path (path) and to adopt a higher degree of friendly behavior for animate and inanimate materials, along it (Martinis *et al.* 2015, 2017). Also, the sound walk along the environmental and cultural route (pathway) provides the framework for active listening, analysis and understanding of the environment, focusing both on the physical characteristics of sounds and their meanings (Westerkamp 2011; Minotou 2012; Minotou *et al.* 2007).

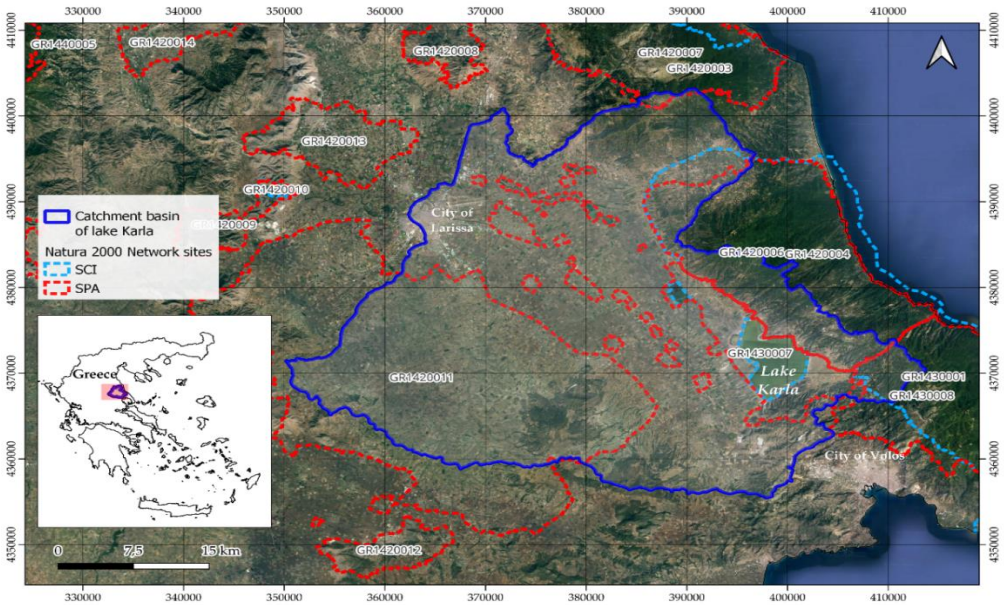
1. Aim of the Research

The desiccation of Lake Karla has resulted in a substantial degradation of the surrounding environment, with significant ramifications for the rural areas within the Thessalian plain. In response, efforts to partially restore the lake ecosystem have presented remarkable prospects for advancing sustainable development within the broader region. By focusing on the restoration of the environment, these initiatives provide an ideal framework for the establishment of environmental and cultural routes, effectively showcasing the area's inherent natural and cultural heritage. The primary objective of this study is to explore the perceptions and opinions of visitors regarding the conservation of biodiversity, cultural heritage, and landscape within the region. Through the acquisition of such insights, this research seeks to facilitate the transformation of the area into a sustainable destination, offering valuable opportunities for environmental education and awareness programs targeted at students and visitors alike. The ultimate goal is to foster the establishment of the region as a center for sustainable practices, preserving its natural and cultural assets while serving as a platform for environmental learning and engagement.

2. Methodology and Study Area

The research part includes statistical analysis with questionnaires, that is, a quantitative analysis carried out with the main objective of examining certain research questions related to the perceptions of the participants regarding environmental education, as to whether it is possible to contribute to the sustainable development of an area of Lake Karla, in the central Greece (Figure 1).

Figure 1. Study area: the catchment basin of lake Karla, Thessaly, Greece. With a blue outline the catchment basin of lake Karla is depicted. Natura 2000 protected area network sites in the area, *i.e.*, Sites of Community Importance (SCI) and Special Protection Areas (SPA) are also presented.



Baseline map source: Google Earth, Trakala *et al.* 2023.

In total, more than 300 questionnaires were sent and finally 161 questionnaires were fully answered, which constitute the research sample. The participants of the research answered the questions included in the questionnaire, after the voluntary character of the participation and also their anonymity was known through a note. The participants expressed their opinions by completing the questionnaire, between September - November 2022, in electronic form (Google-forms), after it was preceded by a pilot sample with 25 questionnaires in paper form. The questionnaire included questions on a five-point scale (Likert), where the degree of agreement or disagreement on certain topics related to the research is examined. the research questions that the research participants were asked to answer are the following:

1.What is the prevailing situation in the wider area of Lake Karla - Mavrovounio?

2.Can environmental education contribute to the sustainable development of the region?

3.What are the educational tools of Environmental Education in the teaching practice?

Further questions investigated are the reason for visiting the area, as well as the degree of environmental interest of the participants. For the conduct of the statistical analysis of the data, the descriptive analysis and the interconnections analysis were used between the variables. For the conduct of the statistical analysis of the data, the descriptive analysis and the interconnections analysis were used between the variables. The data analysis was realized with the application of the statistical package SPSS 27.0. In addition, a SWOT analysis is carried out to highlight the strengths, weaknesses, opportunities, and threats of the region.

2.1 SWOT Analysis

Table 1. Swot Analysis

Strong points	Weak points
✓ Excellent location. ✓ Outdoor activities. ✓ An environment conducive to tranquility and peace of mind. ✓ Existence of historical sites covering long periods starting from prehistory. ✓ Existence of cultural monuments. ✓ Well-developed road network. ✓ The inclusion of the area in a protection regime (Natura 2000 Network). ✓ Existence of a statutory body for the management of the lake.	✓ Seasonal traffic model. ✓ Short-term visitors. ✓ Flooding of an underground aquifer. ✓ Existence of nitrates and consequences for eutrophication. ✓ Lack of road connections between the Parakarlian villages and Pelion / Ossa ✓ Abandonment of archaeological sites. ✓ Insufficient clearing of pathways from vegetation. ✓ Lack of observatories to monitor the birdlife. ✓ Low rate of repeat visitors.
Opportunities	**Threats**
✓ Positioning the area as a unique destination. ✓ Complete identity for the destination. ✓ Extending the traffic period. ✓ Quality management of public spaces and natural environment. ✓ Development of environmental education activities. ✓ Development of sustainable tourism. ✓ Reconstruction of Lake Karla. ✓ Motivation to utilize cultural elements. ✓ Holidays with a local character. ✓ Utilization of pathway for walking routes. ✓ Application development for the pathway. ✓ Completion of the plan of the area under study.	✓ Pandemic crisis with a blow to the economy. ✓ Reduction of citizens' disposable income. ✓ Slower growth in key target market economies. ✓ Postponements and delays in projects. ✓ Risk of loss of biodiversity, soil pollution and landscape degradation. ✓ Disturbance of ecological balance. ✓ The tendency of residents to migrate to large urban centres.

2.2 Map Suggested Routes, via Google Earth Pro Application

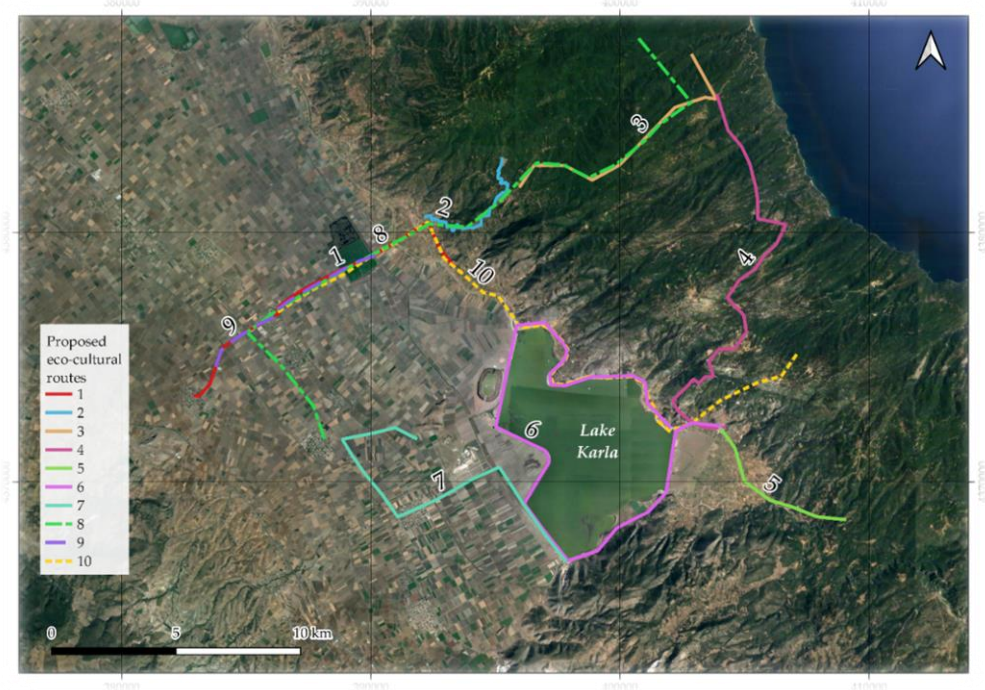
In the following thematic map, (Figure 2), we have mapped through the Google Earth Pro application, 10 suggested routes of ecological, historical and cultural interest, very useful for environmental education in the field.

Suggested Routes:

1. Farmer Monument Kileler – Achillio – Kalamaki - Paleoskala
2. Kalamaki – Elafos - Panagia Kampana
3. Elafos – Sklithro - Rakopotamos
4. Sklithro – Keramidi - Kanalia
5. Kanalia - Kerasia

6. Kanalia -Trail around lake Karla
7. Lake Karla - Stefanovikio - Panagia Armeniou - Panagia Petras Sotiriou
8. Armenio - Achillio-Kalamaki - Elafos-Sklithro - Dasos Polidendriou (former Royal estate)
9. Kileler greenhouses - Farmer Monument - VIOLAR-Achillio - Kalamaki reservoirs
10. Achillio – Kalamaki- Paleoskala - Lake Karla observatory - Ancient Oak Forest Park

Figure 2. Thematic map of the proposed enviromental and eco-cultural routes is presented



Baseline map source: Google Earth, Trakala *et al.* 2023).

The routes shown on the map (Figure 2), numbered 1-10, refer to various thematic fields, very useful for environmental education, while at the same time, they highlight the areas as environmental and cultural routes - paths, contributing to the achievement of sustainable development in the region. Some of the environmental education actions that can be implemented in the context of the planned environmental and cultural route are: activities for improving the knowledge concerning the biodiversity of terrestrial and aquatic ecosystems, activities for cultural heritage, presentations about the effects of agrochemicals on agricultural ecosystems, the importance of environmental protection, etc. Also, the mapping of soundscapes along the environmental and cultural path (trail) provides the framework for active listening, analysis and understanding of the environment. Overall, the proposed individual educational actions, as well as other related ones, aim to cultivate environmental sensitivity, environmental ethics and ecological consciousness.

3. Results

3.1. Reliability Analysis

The **reliability analysis** for the set of factors investigated, in terms of the main part of the analysis, as well as overall proved to be high (a=0.887). In fact, the greatest reliability was found in terms of personal experiences during the stay in the area, for the response to the information that existed about the area before the visit (Cronbach's Alpha a=0.887) (Table 2).

Table 2. Reliability Analysis

Reliability Statistics	
Cronbach's Alpha	**N of Items**
,880	32

3.2. Visitors' Profile

A total of 161 individuals participated in the study, of whom 84 were females (constituting 52.2% of the sample) and 77 were males (constituting 47.8% of the total sample) (Table 3).

Table 3. Demographic data

Male or Female					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	77	47,8	47,8	47,8
	Female	**84**	**52,2**	52,2	100,0
	Total	161	100,0	100,0	

In terms of age, most of participants were between 21-30 years old, making up 52.8% of the total. In addition, a proportion of participants belonged to the age group <20 years, representing 37.9% of the total sample, furthermore, only 7.5% of the sample responded from the age group above 40 years (Table 4).

Table 4. Demographic Data – Age

Age of participants					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<20	61	37,9	37,9	37,9
	21-30	**85**	**52,8**	52,8	90,7
	31-40	3	1,9	1,9	92,5
	41-50	12	7,5	7,5	100,0
	Total	161	100,0	100,0	

Regarding the level of education, most of participants have a university degree, accounting for approximately 62.1% of the total sample. A percentage of 20.5% represent participants with a High School education, while 17.4% representing participants with a Middle School education (Table 5).

Table 5. Demographic Data – Level of education.

Level of education.					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Middle School	33	20,5	20,5	20,5
	High school	28	17,4	17,4	37,9
	University	**100**	**62,1**	62,1	100,0
	Total	161	100,0	100,0	

In the present research, concerning the purpose of visiting in the area, participants offered diverse responses, with a notable predominance of answers associated with the natural environment, accounting approximately 19.3% of the total proportion (Table 6).

Table 6. Reason for visiting the area.

Reason for visiting the area					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Recreation	9	5,6	5,6	5,6
	Education	22	13,7	13,7	19,3
	Excursion	25	15,5	15,5	34,8
	Sport	4	2,5	2,5	37,3
	Walk	2	1,2	1,2	38,5
	Natural environment	**31**	**19,3**	19,3	57,8
	Bird Watching	5	3,1	3,1	60,9
	Hiking the Trails	11	6,8	6,8	67,7
	Ecotourism	8	5,0	5,0	72,7
	Excursion to the Lake	17	10,6	10,6	83,2
	Visit to the Management Body	4	2,5	2,5	85,7
	Investigation / Area Familiarity	18	11,2	11,2	96,9
	Sustainable Area Development	5	3,1	3,1	100,0
	Total	161	100,0	100,0	

Regarding the environmental quality, 70% of the participants perceive it as high or very high, 27% consider it moderate, and only 1.2% indicate that it is not of interest (Table 7).

Table 7. Degree of environmental interest

Degree of environmental interest					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Low	2	1,2	1,2	1,2
	Moderate	44	27,3	27,3	28,6
	High	**101**	**62,7**	62,7	91,3
	Very high	14	8,7	8,7	100,0
	Total	161	100,0	100,0	

3.3. Quantitative Analysis

No missing measurements were observed in both the demographics and the baseline part of the quantitative analysis. The demographics analyzed consisted of gender, age, education level, the reason for visiting the area and degree of environmental interest.

The reliability analysis for the set of factors that are investigated, in terms of the main part of the analysis, as well as overall proved to be high (a=0,887). In fact, the greatest reliability was found in terms of personal experiences during the stay in the area, for the response to the information that existed about the area before the visit (a=0,887).

3.4. Correlation of Variables

The **x^2 criterion** is used to investigate if some parameters are influenced by demographic characteristics. Therefore, considering a confidence level α=5%, it is examined if the questions under study are correlated or independent of gender, age or level of education, which is judged according to the corresponding tables and the value of the (two-sided) control with p. Based on the tables below, it is proven that the questions under consideration are independent of gender, because the p>0.05 condition applies. Thus, the answers of men or women are not the same, so they express different opinions. More specifically:

- ✓ p=0.721>0.05 (The Management Body contributes significantly to the protection, conservation and management of nature and the landscape in the wider area).
- ✓ p=0.61 >0.05 (Establishing environmental education at all levels contributes to achieving sustainable development and environmental awareness).
- ✓ p=0.375>0.05 (The region of Karla - Mavrovounio offers opportunities for environmental education through a local network of excellently organized pathways).
- ✓ p=0.721>0.05 (Students can approach the environmental dimension (of sustainable development) of walking pathways).
- ✓ p=0.972>0.05 (Walking pathways can be seen as an early level of development of ecological sensitivity).

On the other hand, the question concerning the reconstruction of Lake Karla in terms of providing opportunities for network development, certified at the European level of pathways in the wider area, depends on gender, because the condition p<0.05 applies (p=0.044<0.05). Therefore, the responses of the survey participants are identical, so women or men express the same opinions. At the same time, it was shown that the questions under consideration are independent of age, because the p>0.05 condition applies. That is, the answers of the participants are not identical, even if they belong to the same age range, so they express different opinions. More specifically:

- ✓ p=0.71>0.05 (The Management Body contributes significantly to the protection, conservation and management of nature and the landscape in the wider area).
- ✓ p=0.117>0.05 (The reconstruction of Lake Karla offers opportunities to develop a network of pathways certified at the European level in the wider area).
- ✓ p=0.986>0.05 (Establishing environmental education at all levels contributes to achieving sustainable development and environmental awareness).
- ✓ p=0.472>0.05 (The region of Karla - Mavrovounio offers opportunities for environmental education through a local network of excellently organized pathways).
- ✓ p=0.976>0.05 (Students can approach the environmental dimension (of sustainable development) of walking pathways).
- ✓ p=0.593>0.05 (Walking pathways can be seen as an early level of development of ecological sensitivity).

In parallel, it was shown that the questions under consideration are independent of the level of education, because the p>0.05 condition applies. That is, the answers of the participants are not identical, even if they belong to the same level of education, so they express different opinions. More specifically:

- ✓ p=0.814>0.05 (The Management Body contributes significantly to the protection, conservation and management of nature and the landscape in the wider area).
- ✓ p=0.874>0.05 (The reconstruction of Lake Karla offers opportunities to develop a network of pathways certified at the European level in the wider area).
- ✓ p=0.672 >0.05 (Establishing environmental education at all levels contributes to achieving sustainable development and environmental awareness).
- ✓ p=0.82>0.05 (The region of Karla - Mavrovounio offers opportunities for environmental education through a local network of excellently organized pathways).
- ✓ p=0.59>0.05 (Students can approach the environmental dimension (of sustainable development) of walking pathways).
- ✓ p=0.384>0.05 (Walking pathways can be seen as an early level of development of ecological sensitivity).

3.5. Effect of Demographic / Individual Characteristics on Questionnaire Variable

ANOVA analysis is applied to check if there is a significant difference between the variables, at a significance level of 5%. The simple analysis of variance (ANOVA), regarding the first research question, proved that age, as

well as education, are the important factors for the variable "to preserve the valuable ecosystems of a protected area, limits and restrictions on their use are required" (F= 4.276, p = 0.006), (F= 3.8, p = 0.024), respectively. At the same time, regarding the second research question, age was an important factor in the variable "in order to achieve the sustainable development of the region, radical changes must be made in the framework of local governance" (F= 2.699, p = 0.048). In all the other variables of the first two research questions, as well as in all the variables of the third research question, no significant difference was found between the average values, because the p>0.05 condition applies. Therefore, age and education level are not characterized as important influencing factors.

3.6. T-Test Analysis

The T-test method is applied with the aim of establishing if there are statistically significant differences, with gender as the independent variable. The t-test, regarding the first research question, proved that gender is an important factor for the variables "the restoration of Lake Karla offers opportunities for the development of a local network of European-certified pathways in the wider area" (t= -0.469, df=159, p = 0.007), "the wider area of Lake Karla - Mavrovounio, has important ecological features and a rich cultural heritage" (t= -0.239, df=159, p = 0.002). Women have a higher degree of perception regarding the opportunities to develop a local network of European-certified pathways in the wider area, through the reconstruction of the lake (M.A.= 3.99, S.D. = 0.63), compared to men (M.A.= 3.94, S.D. = 0.8). Accordingly, women have a higher degree of perception about the ecological features and rich heritage of the wider area (M.A. = 3.99, S.D. = 0.611), compared to men (M.A. = 3.96, S.D. = 0.818). At the same time, regarding the second research question, it was shown that gender is an important factor for the variables "in order to achieve sustainable development, both the local government and the state must contribute substantially" (t= 0.947, df=159, p = 0.009), "in order to achieve sustainable development, radical changes must be made in the context of local governance" (t= -0.534, df=159, p = 0.01), "in order to achieve sustainable development, radical interventions must be made for the protection of the natural and man-made environment" (t= -0.429, df=159, p = 0.009).

Men have a higher level of perception regarding the achievement of sustainable development through local government and the state (M.A.= 4.23, S.D. = 0.759), compared to women (M.A.= 4.13, S.D. = 0.617). On the other hand, women possess a higher degree of understanding regarding the achievement of sustainable development, through radical changes in the local governance framework (M.A.= 3.88, S.D.= 0.648), compared to men (M.A. = 3.82, S.D. = 0.839), as well as through radical interventions to protect the natural and man-made environment (M.A.=3.85, S.D.=0.685), in relation to men (M.A.= 3.79, S.D.=0.879). In all the other variables of the two questions, as well as all the variables of the third research question, no significant difference was found between the mean values, because the p>0.05 condition applies. Therefore, gender is not characterized as an important influencing factor.

3.7. Summary Results of Statistical Analysis

The reliability of the research analysis was proved quite satisfactory, both overall and individually of all the factors under study, as the Cronbach's alpha coefficient approached unity. At the same time, regarding the correlations of the variables, all the questions under consideration are independent of the demographic characteristics, as the p>0.05 condition applies.

In the first research question, visitors answer that Lake Karla and the wider region of Mavrovouni constitute an attractive destination. Most respondents agree and fully agree, with a percentage of 80.1%. Regarding the importance of the ecological characteristics and the rich cultural heritage, the majority (>80%) responded that they agree or fully agree. Regarding the conservation and protection of ecosystems, visitors state that limits should be set on their use, with a percentage of 92%.

When asked if visitors believe that measures should be taken for the sustainable development of the area, many participants answered that they agree (55.3%) or strongly agree (32.3%). At the same time, it states that radical changes should be made in the framework of local governance, with particular emphasis on the seventeen (17) sustainability goals. 54% responded that they agree, while 17.4% responded that they fully agree. Environmental education plays a crucial role in achieving sustainability goals and shaping environmental consciousness. Most participants responded that they agree, with a percentage of 46.6%, while a high percentage of 44.1% fully agrees.

In the third research question, regarding whether the protected area of Lake Karla is a suitable space for environmental education and interpretation activities, most participants responded that they agree, with a percentage of 55.3%, while 25.5% stated that they fully agree. Additionally, regarding the ability of students to

approach the environmental dimension (sustainable development) of walking trails, the majority of participants responded that they agree, with a percentage of approximately 57.8%, and another large percentage of approximately 26.1% fully agrees. Conversely, a small percentage (2.5%) answered that they disagree. Similarly, regarding the design of environmental and cultural routes for promoting sustainable development through citizen education, many participants responded that they agree, with a percentage of approximately 54.7%, and concurrently, a percentage of 21.7% expressed full agreement. Conversely, a relatively small percentage (3.1%) answered that they disagree. Additionally, regarding the characterization of walking trails as an early stage of developing ecological sensitivity, the majority of participants responded that they agree, with a percentage of approximately 56.5%. Furthermore, a significant percentage of 23.6% fully agrees. Regarding the contribution of walking trails to conducting excursions through areas of significant aesthetic, environmental, and cultural value, most of participants responded that they agree (54.7%), with an additional 22.4% expressing full agreement.

3.8. Statistical Comparison

An exception was the question concerning the reconstruction of Lake Karla in terms of providing opportunities for the development of a network of pathways certified at the European level in the wider area, which depends on gender because the condition $p<0.05$ ($p=0.044<0.05$) applies. Through the ANOVA method, it was shown that age and level of education are not characterized as significant influencing factors in the variables of the three research questions, because the $p>0.05$ condition applies, and no significant difference was found between the mean values. An exception was the variable "limits and restrictions on their use are required to preserve the valuable ecosystems of a protected area", respectively, regarding the first research question, where important influencing factors are judged. Accordingly, about the second research question, age was an important factor in the variable "in order to achieve the sustainable development of the region, radical changes must be made in the operating framework of local governance". At the same time, with the application of the T-test method, it was shown that gender is an important factor for the variables "the restoration of Lake Karla offers opportunities for the development of a local network of pathways certified at the European level in the wider area" ($p=0,007$) and the question "the wider area of the lake Karla – Mavrovounio, has important ecological characteristics and a rich cultural heritage" ($p=0,002$), regarding the first research question.

Accordingly, with regard to the second research question, it was shown that gender is an important factor for the variables "in order to achieve sustainable development both the local government and the state must contribute substantially", "in order to achieve sustainable development it must radical changes should be made in the framework of local governance", "in order to achieve sustainable development, radical interventions must be made to protect the natural and man-made environment". In all the other variables of the two questions, as well as all the variables of the third research question, no significant difference was found between the mean values, because the $p>0.05$ condition applies, therefore gender is not characterized as an important influencing factor. In addition, the research has some limitations, such as the sample of participants, which is considered satisfactory, but not very large. Accordingly, another limitation that exists in the study is that the questions concerning the second research question are more compared to the rest, so there is no uniformity in the number of questions, among the research questions. Therefore, a future study may include a larger sample of participants to be more reliable. In addition, future research may include inquiries about pathways from different regions of the country or even abroad, to observe the differences or similarities between the research questions under consideration.

4. Discussion

From the analysis of this study, it appears that the restoration of Lake Karla can support various types of ecosystem services and benefits, providing opportunities for sustainable development in the wider area, while restoring the degraded rural environment in the Region of Thessaly. In addition to the restoration of a wetland ecosystem, which will simultaneously restore biodiversity and abiotic parameters, it will also contribute to sustainable development, giving possibilities for alternative forms, which will be linked to the highlighting of the natural and cultural wealth of the area. At the same time, the perspective of a stable business opportunity including agriculture and tourism/services related to the lake environment. The restoration of the lake may also contribute to the return from the cities to their place, a large part of the population that has left the rural areas.

The restoration of the lake not only has ecological benefits but also provides opportunities for sustainable tourism. It is an ecosystem with rich biodiversity, attracting many different species of birdlife (Zalidis *et al.* 1999). At the same time, the terrestrial forest and agro-forest ecosystems offer shelter and food to many species, creating a healthy ecosystem, ecologically balanced. International recognition of the importance of Lake Karla is

evident through its designation as a Natura 2000 site (GR1430007). The wealth of biodiversity of species and habitats are a major attraction for tourists (Dodouras, Lyratzaki and Papayannis 2014).

Lake Karla and its surrounding areas offer not only ecological benefits but also great cultural services. The environment is perfect for recreational activities and raising environmental awareness. The existing infrastructure includes info-kiosks, observation posts for bird watching, a tourist information center, and a natural history and folklore museum. Visitors can engage in various activities, such as tree planting along the lake's perimeter and embankments, visiting environmental education sites, as well as enjoying horse riding, cycling, and hiking routes. These activities can be further complemented in the future with water sports facilities and accommodation services. Greek studies conducted in the touristic area of Rethymno, Crete, investigated visitors' perceptions of a significant nesting ground for sea turtles. The study indicated a positive attitude towards the implementation of two policy instruments: an entrance fee to the beach and a tax on local accommodation costs, which could secure funding for environmental management improvements in the area (Jones *et al*. 2011; Panagopoulos and Dimitriou 2020). have shown support for the development of such activities in Lake Karla. Another study concerning the Prefecture of Pella in Northern Greece surveyed visitors of thermal springs and found that the development of an educational center and ecotourism leisure activities, including hiking and water sports at Lake Vegoritida, were highly appealing to almost half of the respondents (Apostolidis 2017). These policy instruments could also be applicable to Lake Karla's case. Understanding the opinions and preferences of visitors is one of the fundamental requirements when setting up an appropriate tourism management plan in a few protected areas (Banaš and Zahradník 2012). In a study on the management of a protected area, she investigated the views and perceptions of visitors to a sensitive area of Crete on the nesting of the *Caretta-Caretta* sea turtle. The study showed a positive attitude among visitors about protecting and securing funding for such environmentally sensitive areas, with the acceptance of a beach entry ticket to enhance environmental stewardship (Jones *et al.* 2011). The above studies show the positive response of visitors to the effective protection of the environment and the taking of measures for the sustainable development of the areas. From this research where it was carried out, some current questions were studied, which must be considered by the competent management bodies of the area under study, with the aim of improving the provision of quality services and infrastructure to visitors.

Conclusions

The design of new sustainable infrastructures and activities will improve the satisfaction of visitors and will simultaneously contribute to the protection of the Park and to the sustainable development of the wider region (thematic routes, guided tours, cave visits, camping, summer and winter schools etc.

The analysis of the questionnaires showed that the newly reconstructed Karla Lake can support several types of benefits (some quantifiable in monetary terms and some not), offering multiple recreational and environmental education opportunities to visitors, while ensuring sustainable development and ecosystem services to society and in the country (Lukas *et al.* 2008).

The very positive situation above will be the precondition ensuring the maintenance of the agricultural population in the region. The perspective of a stable business opportunity including agriculture and tourism/services related to the lake environment can even motivate a population return to the countryside from the cities that have suffered more during the last years from the economic crisis and austerity.

The ecological advantages, which include rich biodiversity in and around Karla, have the potential to create opportunities for sustainable tourism. The lake is an ideal habitat for many species of migratory birds. It offers safe shelter, rich food and suitable breeding ground. The international importance of Lake Karlas is further documented by its designation as a Natura 2000 site (GR1430007), which is mainly attributed to the abundance of birdlife present in the area (Dodouras *et al.* 2014). People will obtain several kinds of benefits through ecosystem services from the restored Lake Karla.

Karla Lake and the surrounding lakeside and mountain areas, apart from the rich biodiversity, have additional important values, while offering the possibility of a variety of cultural services, making the area an attractive destination for leisure activities and environmental awareness. Today there is already a basic infrastructure which includes information kiosks, birdwatching sites, a tourist information center, a natural history museum and other infrastructure for easy and safe visitor access [Management authority]. All of the above should be enriched, including new actions (horse riding, cycling, hiking, guided tours, environmental information, environmental interpretation and awareness) using new technologies and audio-visual media, with the possibility of equal access and information for all without exception, including of course of people with problems (movement, vision, hearing, etc.).

In general, the results of this research show that the utilization of the natural and cultural heritage of the Karla area, *i.e.* biodiversity, history and cultural and cultural values can contribute to the emergence of the area as an attractive destination, for the benefit of visitors, of local society and the sustainable development of the area (Panagopoylos and Dimitriaou 2020). A necessary condition must be the preparation of a special study for the carrying capacity of the area, to avoid phenomena of degradation of the environment and the destination. alongside information and awareness programs for visitors (švajda *et al.* 2018; Trakala, Tsiroukis, Martinis 2023).

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Credit Authorship Contribution Statement

Georgia Trakala: Conceptualization, Investigation, Methodology, Project administration, Software, Formal analysis, Writing - original draft, Supervision, Data curation, Validation, Writing – review and editing, Visualization, Funding acquisition.
Aristotelis Martinis: Conceptualization, Methodology, Project administration, Data curation, Validation, Writing – review and editing, Visualization, Funding acquisition.
Georgios Karris: Validation, Writing – review and editing, Visualization, Funding acquisition.
Charicleia Minotou: Validation, Writing – review and editing, Visualization, Funding acquisition.
Achilleas Tsiroukis: Data curation, Validation, Writing – review and editing, Visualization, Funding acquisition.
All authors have read and agreed to the published version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Post-COVID-19 Community-Based Tourism Sustainable Development in China. Study Case of Hebian Village

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Abstract: China's tourism sector has seen the effects of the worldwide COVID-19 outbreak. Community-based tourism has arisen as a sustainable alternative to mass tourism, benefiting local communities economically while preserving the environment and cultural heritage. Using Hebian Village as a case study, this study investigates the post-COVID-19 sustainable development of CBT in China. The study employs a qualitative methodology, including field observation and semi-structured interviews with community members, tourists, and tourism experts. The findings of this study indicate that Hebian Village has the potential for the sustainable development of CBT, as it possesses unique natural and cultural resources, and its residents are ardent about promoting tourism while maintaining their traditional way of life. Inadequate crisis management, a lack of marketing and managerial skills, and restricted access to funds are all preventing the expansion of CBT in Hebian Village. The study proposes some suggestions for the development of CBT that include the crisis of COVID-19, community participation, market orientation, and government support. CBT has the potential to contribute to the sustainable development of rural regions in China, but it requires a concerted effort on the part of all stakeholders, including the government, local communities, and tourism industry actors.

Keywords: sustainable development; community-based tourism; post-COVID-19.

JEL Classification: Q01; Z32; R11.

Introduction

The global tourism industry has been significantly disrupted by the COVID-19 pandemic. Tourism is a vital source of income and employment in numerous regions, particularly in developing nations. One of China's most important industries, tourism eventually drives national and regional development. Even so, the pandemic has revealed the tourism industry's vulnerability, necessitating a reconsideration of the industry's development model. Community-based tourism (CBT) is a type of tourism that is owned and managed by the local community, with travelers participating in the cultural, social, and commercial activities of the community. CBT focuses on the conservation of natural and cultural resources, the promotion of local cultural and traditional practices, and the empowerment of local communities. This study examines the sustainable development of CBT in China after COVID-19, using Hebian Village as a case study. Yunnan Province, renowned for its ethnic diversity, natural attractiveness, and cultural heritage, is the location of Hebian Village. Miao and Yi ethnic minority groups have maintained their traditional manner of life and culture in Hebian Village. Hebian Village possesses unique natural and cultural resources, such as traditional Miao and Yi attire, regional cuisine, and breathtaking natural scenery. As a representative example of CBT, Hebian Village provides guidance for the sustainable growth of rural community tourism in China following the COVID-19 era.

1. Literature Review

1.1 The COVID-19 Crisis and Tourism

There is no denying the importance of tourism throughout the world because of the (in)direct cooperation and development contributions made by the tourist industry to more than 50 different industries. The tourism business will be affected by the pandemic regardless of location or country (Wen *et al.* 2021). According to Zhong, Guo, and Chen (2020), the COVID-19 pandemic first appeared in the last month of 2019 in the Chinese town of Wuhan, Hubei Province, and rapidly spread from individual to individual. Wuhan is a major Chinese transportation hub because the river Yangtze, which runs between Chongqing and Shanghai, and the Beijing-Guangzhou railway intersect there. Despite the Chinese New Year being the most important time for families to get together in China (Bogoch *et al.* 2020), the Chinese government locked down Wuhan on the 24th of January in 2020 in response to the rapid spread of COVID-19 within Hubei Province. Destinations all around the world are competing to attract wealthy Chinese tourists in an effort to boost their economies, and governments and businesses everywhere are keeping their sights on China's booming tourism sector (Wen *et al.* 2021). A loss of US$22 billion in Chinese outbound expenditure and a decrease of 9 million in incoming visitors are predicted as a result of COVID-19, according to a study. Depending on the severity of the epidemic's effects, 7-25 million decreased Chinese exits are possible by 2020 (Dass and McDermott 2020). The academic community is continually working to undertake appropriate studies on the rehabilitation of the tourism industry after the pandemic in the face of the virus's devastation. According to certain academics, some conditions may exist where an extended tourist season might result in higher economic development. Global crises may aid nations who successfully manage them in evolving and expanding their seasonality, coupled with special actions done by local governments to revive tourism and promote it even more (Beirman 2020; Kyriakakis and Tzirakis 2020). After the outbreak, several academics are worried about how transportation would affect the growth of sustainable tourism (Więckowski 2021). Numerous academics have directed their research towards forecasting the trajectory of the tourism and leisure industries subsequent to the outbreak (Nurbayani and Asyahidda 2021; Tiwari and Sanjeev 2021; Majumdar 2021; Gupta and Sahu 2021; Bharwani and Mathews 2021). Scholars are also interested in how virtual tourism is developing in the post-pandemic age (Permana, Permana, and Wijaya 2021; Chakravarty, Chand, and Singh 2021). The emergence of health tourism and medical tourism in the aftermath of the epidemic has piqued the interest of academic researchers (Hekmat *et al.* 2022; Chhabra *et al.* 2021). Researchers also prioritize the examination of small and medium-sized tourism-related enterprises in the months following the outbreak of the pandemic (Gaffar *et al.* 2022; H.-M. Liu 2021; Zhao *et al.* 2021). Scholars have conducted a comprehensive analysis of literature pertaining to crisis management in the tourism industry spanning from 2008 to 2022 (Qiao *et al.* 2023). In contrast to these researches, this perspective paper aims to investigate the prospects for the long-term growth of CBT in the Chinese village of Hebian following the COVID-19 epidemic. The study also aims to assess the current state of CBT in Hebian Village and the prospects for its future growth. This study concludes by putting up suggestions for the long-term growth of CBT in China's Hebian Village.

1.2 The Philosophy of Community-Based Tourism

Community-based tourism (CBT) was first advocated by the United Nations and the World Bank, among other multinational donors. To that end, CBT was envisaged as a complement to both mass tourism and rural tourism in underdeveloped and developed countries, respectively (Zielinski *et al.* 2020). CBT was viewed as a viable technique for reducing poverty in the developing countries (Dangi and Jamal 2016), and it would help with conservation efforts and the expansion of rural businesses. Many nations have adopted community-based tourism (CBT) due to its proven economic benefits to local communities. Thus, communities with a history of subsistence agriculture, fishing, or as an indigenous people might benefit from implementing CBT to boost their economies (Teh and Cabanban 2007; Lepp 2007; Lee 2013; Thompson, Johnson, and Hanes 2016; Reggers *et al.* 2016; Wang, Cater, and Low 2016; Dodds, Ali, and Galaski 2018). Mtapuri and Giampiccoli (2016) argued that beneficial environmental and societal effects have been facilitated through CBT programs. As a result, several development organizations have adopted this strategy as a tool for community development, especially in areas with few options for economic growth. Economic effect on families, social and economic advancements, and sustainable lifestyle diversity are the most obvious advantages of CBT (López-Guzmán, Sánchez-Cañizares, and Pavón 2011). Moreover, it improves the standard living within neighborhoods by increasing the number of utilities, roadways, green spaces, and leisure and cultural venues. Natural resource use, scenic locations, and rare species of wildlife and plants all play a role in raising people's and tourists' consciousness about the need of protecting the natural environment (Brunt and Courtney 1999; Lee and Jan 2019). Employment opportunities,

stakeholder revenue, community empowerment, conservation promotion, and poverty alleviation are just some of the positive impacts that CBT has on the tourist sector (Eom and Han 2019). There are a lot of people living in rural areas in China. China's rural regions are home to a sizable population. In 2021, China assisted more over 100 million people out of poverty (Office 2021). This marked the beginning of a new age of rural development. Therefore, the development of community-based tourism will play a positive role in consolidating the achievements of poverty alleviation, revitalizing the rural economy, and increasing the income of local people in China.

1.3. Crisis Management and Community-Based Tourism Sustainable Development

Mikušová and Horváthová (2019) mentioned that managing crises effectively requires anticipating potential problems before they arise. Efficient crisis and catastrophe management is essential for mitigating losses and speeding up recoveries on both the local and global scales. Risk management and preparedness for natural disasters also have a role in determining a destination's attractiveness to tourists (Y. Liu, Cheng, and OuYang 2019). To add complexity, crisis management is a continuous process encompassing a wide range of stakeholders whose responses to risks are influenced by variables that involve their location and their ties to others in the industry (Miguel *et al.* 2022). Scheduling and preparation efforts beforehand a disaster or crisis hits, coping techniques in the event of a crisis or disaster, and assessment and enhancement following a crisis or disaster are the three pillars of successful crisis and disaster management, as proposed by Ritchie (2009). Healthy tourist growth is intrinsically linked to effective crisis management (Qiao *et al.* 2023). Research from Roe, Hrymak, and Dimanche (2014) devised a framework for risk assessment consisting of three phases—assessment, evaluation, and management—to examine the tourist industry's impact on the environment. Economic, social-cultural, environmental, and life-satisfaction sustainability issues have all been tackled in attempts to determine the long-term viability of CBT. Distribution of economic advantages to citizens should be equitable (Lee and Jan 2019; Woo, Kim, and Uysal 2015; Choi and Sirakaya 2006). Economic growth that benefits locals and conserves natural resources is a goal of CBT. In addition, the CBT administrators could offer educational opportunities and agricultural activities that will boost visitor pleasure and develop new revenue streams in certain rural areas, so promoting sustainability in the economy (Lee 2013; Ohe 2008; Ohe and Ohe 2020; Ohe and Kurihara 2013; Lee and Jan 2019). Choi and Sirakaya (2006) stated that community-based tourism (CBT) allows locals to strengthen their social or traditional cultural identities while also improving social cohesion in the neighborhood. CBT will increase awareness, appreciation, and protection of the planet's natural resources. Woo, Kim, and Uysal (2015) proposed that the provision of material well-being, communal wellness, psychological wellness, and physical and mental wellness to locals is essential to the long-term success of CBT. The sustainability of CBT may be improved by the use of life satisfaction surveys to get insight into locals' views on how tourism has affected their lives in terms of their material, social, emotional, and physical security (Kim, Uysal, and Sirgy 2013). Environmental conservation, cultural preservation, fairness, revenue generation, and satisfying human needs are all goals of sustainable tourism. Both the economic and social benefits of tourism, as well as the conservation of natural resources, are emphasized (C.-H. Liu *et al.* 2013; Qiao *et al.* 2023). A key obstacle for CBT sustainable development in the post-COVID-19 age is striking a balance between community economic development and tourist growth.

2. Methodology

Multi-method, interpretative, and naturalistic approaches characterize qualitative research. This implies that qualitative researchers look at occurrences from the perspective of the meanings that individuals give them in their everyday lives. The researcher may acquire empirical materials in a number of ways, including via interviews, direct observation, document and artifact analysis, visual materials, and first-hand experience (Pathak, Jena, and Kalra 2013; Sandelowski 2004; Denzin and Lincoln 2011). Based on Rosenthal (2016), when applied to big qualitative data sets, these methodologies may provide light on the "why" behind people's behaviors. In order to get relevant and usable findings from this analysis, it must be carried out in a thorough and systematic approach. Cause and effect are not the focus of qualitative research. Instead, it investigates how people interpret and respond to events (Attride-Stirling 2001). According to Atkinson (2007), the data collection method of field observation is employed to comprehend the interactions and behaviors of groups of individuals within a specific context.

2.1 Research Sample

Within the context of qualitative research, the significance of sample size is deemed to be relatively diminished, as the comprehensive and intricate nature of the research can be effectively captured through the examination of a limited number of sample size traits that are typical of the qualitative category (Alam 2021; Wolor *et al.* 2023). Notwithstanding, there have been proposed general guidelines regarding the sample size in qualitative research that are distinguished by particular frameworks. The aforementioned sources (Njie and Asimiran 2014; Palinkas *et al.* 2015) identify the presence of at least one participant in the case study. Moser and Korstjens (2018) argued that the qualitative research typically employs a limited sample size, which is contingent upon various factors such as the extent of data depth, participant variety, scope of research inquiries, data collection techniques, and sampling approach. The process of picking respondents is contingent upon the researcher's evaluation of which prospective participants possess the most instructive and comprehensive insights that align with the researcher's research objectives.

The unit of analysis in this particular research was the sustainable development of CBT (Community-Based Tourism) in Hebian Village, China. The sample size for this investigation comprised 12 individuals. The process of determining the location was conducted with a deliberate purpose of assessing the potential of the CBT to contribute to sustainable development in the post-COVID-19 era. The investigation was conducted during the period spanning from September to November of the year 2022.

Figure 1. Sketch Map of Hebian Village

2.2 Data Collection Process

The current investigation employed field observation and interviews as the primary data collection methods. The process of gathering data by means of the active involvement and observation of individuals or groups is known as field observation. Interviews are a data collection technique where the interviewer presents inquiries to participants either in person, over the phone, or via the internet. The objective of the qualitative research interview was to elucidate the significance of the central theme within the world of life of the participants. According to Moser and Korstjens (2018), the primary objective during an interview is to comprehend the significance of the responses provided by the participants.

In order to present a comprehensive analysis of the present circumstances, obstacles encountered by the village, and recommendations for sustainable development through Community-Based Tourism (CBT) in Hebian village in the aftermath of the COVID-19 pandemic, the investigators employed observational techniques and conducted interviews utilizing semi-structured questioning, with an emphasis on allowing participants to offer unrestricted responses.

The inquiry posed the following research queries:

a) What is the potential for the sustainable development of CBT in Hebian Village?

b) What are the challenges of CBT-sustainable development that the Hebian village faces?

c) What are the barriers must be overcome for Hebian Village's CBT sustainable development after the COVID-19 era?

The participants were twelve people who are tourism stakeholders in Hebian village.

Table 1. Details on Participants, Length of Interviews, and Survey Remarks

Materials	Types	Interviewee Characterization	Length of Interview (mins)/no. of reports
Interviewee A	Community Members	Head of Village	65 mins
Interviewee B	Community Members	Village Committee Member	55 mins
Interviewee C	Community Members	Village Committee Member	57 mins
Interviewee D	Community Members	Farmer	61 mins
Interviewee E	Community Members	Farmer	66 mins
Interviewee F	Community Members	Housewife	40 mins
Interviewee G	Community Members	Homestay Owner	60 mins
Interviewee H	Community Members	Tea House Owner	58 mins
Interviewee I	Community Members	Grocery Store Owner	59 mins
Interviewee J	Tourists	Visitor	38 mins
Interviewee K	Tourists	Visitor	33 mins
Interviewee L	Tourism Expert	Professor of University	62 mins
Field Observation Reports	Researcher		31 reports

In September 2022, the initial visit was occurred, and the conversation with head of village and village committee member was also conducted. The researcher was given an hour-long community tour by a village committee member. Locational specifics, facilities, historical and cultural landmarks, and alternative lifestyles were presented. The gathering in the Hebian Village Administration Office eventually included unofficial discussions with community officials, committees, and a few locals. During the interview, we spoke about the prospects for CBT growth in the village, the major difficulties locals had encountered and overcome during the pandemic, and the locals' attitudes and opinions on the topic of CBT's sustainable growth in the wake of the COVID-19 epidemic.

The follow-up visit happened at the beginning of November. The study employed field observations that spanned a duration of 15 days, specifically from November 12th to November 27th. During this period, 31 substantial notes were generated. The aforementioned reports focused on three primary themes, including potential, challenges associated with the development of CBT throughout the pandemic, and recommendations to mitigate the identified deficiencies for the sustainable development of CBT post-COVID-19. Conversely, a total of 12 interviews were done with the community members, tourists, and tourism experts. The community members include the village head, village committee members, homestay owners, teahouse owners, grocery store owners, and local resident representatives. The tourists include domestic tourists who have visited Hebian Village. The tourism experts include academics and professionals in the tourism industry who have experience in community-based tourism development.

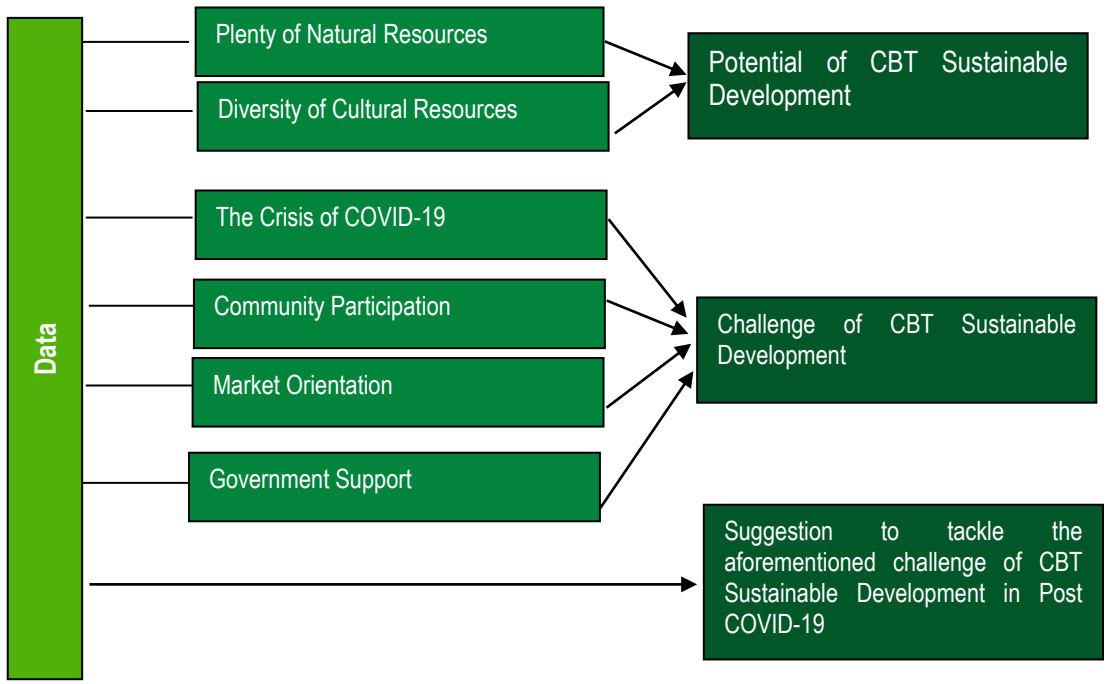
As noted in Table 1, the informants' occupations are varied and include a head of village, two members of the village committee, two farmers, a housewife, an owner of a homestay, a tea house, an owner of a grocery shop, two tourists, and a university professor. Prior to interviews, the interviewee was told of the objective of the interview and the topic the researcher had developed that would be covered (both of which were often the same). Participants were contacted and requested for their consent to be voice recorded during an open interview in order to be transcribed and analyzed. The vast majority of interviewees were approached at their own homes or places of work, in which they seemed most cozy answering questions and providing helpful feedback to the

researcher. The interviews ranged among 30 minutes to 1 hour, and since Chinese is a language that is often used in everyday life, the interviewees opted to talk in that language. A 312-page discourse in Chinese was taken down from the interviews and converted into English. The interviews took a total of 10 hours and 54 minutes.

2.3 Data Analysis

The present investigation employs the thematic analysis approach, which consists of six distinct phases, to examine the unprocessed data and transform it into meaningful outcomes. Because of its evolution and the seamless transitions between its stages, the six-stage process is best described as gradual and suggestive. The mentioned methodology entails a process of reviewing previously gathered data, creating codes, identifying themes, re-evaluating themes, defining stated themes, coding, and ultimately, presenting the findings (Braun and Clarke 2006). The findings of this study provide guidelines for applying CBT to the process of achieving sustainable growth. These suggestions are based on a thorough review of the relevant literature, as well as interviews and field observations conducted by the researcher. The target of these recommendations is to effectively address the challenges that have been identified in this area.

Figure 1. Thematic Network



Source: Author

3. Research Finding and Discussion

As represented in Figure 1, interviews and field observation revealed three prominent themes in Hebian Village and indicated that the village have obstacles related to tourism sustainable development need to face in the post COVID-19 era. These include Potentials, Challenges, and Suggestions. Undoubtedly, Hebian Village with the aid of the targeted poverty alleviation policy proposed by the central government of China, Hebian Village has overcome extreme poverty. Rural tourism is developing rapidly in the area, and how to utilize its own advantages to increase the income of local people and achieve sustainable development of tourism and economy has become a focus of attention. However, with the Covid-19 pandemic, it has become a big challenge for tourism sustainable development of Hebian Village. Despite the limited scope of this study, the data sources delivered a diverse and intriguing range of results. These findings are related to the research question.

3.1 What is the Potential for the Sustainable Development of Community-Based Tourism in Hebian Village?

Hebian Village shown the potentials it acquired toward own plenty of natural resources and also possess diversity of cultural resources, including the following:

1) Plenty of Natural Resources

The data gathered from interviews conducted between researchers and participants suggests that the prosperous growth of tourism in the region is predominantly dependent on the availability of sufficient natural resources such as tropical rainforests, rivers, and the like. For example, *"The main reason we come here for tourism is to be deeply attracted by the natural scenery here. We feel very relaxed here, which is a pleasant feeling that is difficult to describe."* (Interviewees J and K)

On top of that, all respondents are convinced that the local population has developed a strong awareness of the need of environmental protection. For example, "*Our community not only lifted itself out of poverty through the government's targeted poverty alleviation policies but also helped local people establish a strong environmental awareness*." (Interviewees A, B, and C)

2) Diversity of Cultural Resources

All respondents, by means of interviews and field observations, confirmed the researchers' conclusions that the local culture is diverse. For example, *"My homestay's ability to consistently draw visitors stems from its distinctive architectural design and the incorporation of genuine ethnic minority culture. Our whole neighborhood has done a wonderful job of keeping our local minority culture alive and strong."* (Interviewee G)

Lee (2013) noted that tourists may see demonstrations of the local customs and culture that have been revitalized in indigenous communities. The specific situation of Hebian Village clearly confirms this point. Moreover, locals' increased awareness of to environmental issues is a direct result of the region's abundance of natural assets, diverse topography, stunning landscapes, and endemic biodiversity (Lee 2013; Lee and Jan 2019). Since CBT promotes in community development and therefore helps ensure the long-term sustainability of communities, it plays a crucial role in poverty reduction (Lee and Jan 2019). Based on the above viewpoints, combined with interview and field observation in Hebian Village, it can be seen that the village is located in a beautiful natural setting, with lush forests, rice paddies, and tea plantations. The village also possesses unique cultural resources, such as the Miao and Yi traditional costumes, the local food, and the handicrafts. The community members are aware of the importance of resource conservation and are taking measures to protect the environment and cultural heritage. The findings show that the residents of Hebian Village have developed a keen understanding of their responsibility for preserving their environment, and that the area is blessed with a wealth of natural resources and cultural diversity. The potential for growth and sustainability in community-based tourism is substantial in Hebian Village.

3.2 What are the Challenges of Community-Based Tourism Sustainable Development that the Hebian Village Faces?

Hebian Village is an excellent instance of rural tourism growth in the region, although it has various issues related to CBT sustainable development.

1) The Crisis of COVID-19

Researchers have found through on-the-ground observations that the effects of the epidemic have had a catastrophic impact on tourism in the entire riverside village. Very few domestic tourists now visit, and most tourism-related facilities, such as restaurants and homestays, are either closed or operating at lower levels. For example, *"Since the beginning of the pandemic, the number of visitors visiting our town has dropped dramatically. I truly wish the outbreak will end soon because business at my tea house has dried up."* (Interviewee H)

It was pointed out in the interview that since the outbreak, locals have lost their main source of income from tourism and must now depend on traditional agricultural revenue and government assistance to sustain their livelihoods. For example, "*The epidemic has completely changed my life, without tourism income. Traditional farming and livestock raising provide the majority of our income. We hope that the epidemic will end soon."* (Interviewees D, E and F)

According to Qiao *et al.* (2023), the tourist industry's crisis management literature was analyzed in depth from 2008 to 2022. As can be seen, the tourist sector worldwide has taken a major hit, and Hebian Village is definitely no exception. The Hebian Village pandemic is a microcosm of much larger societal issues, and they merit contemplation. Ritchie (2009) argued that the three pillars of effective crisis and disaster management are planning and preparation before a crisis or disaster happens, using response strategies during a crisis or disaster, and reviewing and strengthening after a crisis or catastrophe. To ensure a speedy recovery, decrease the impact of catastrophes, and maintain long-term growth in the community tourism industry, preventative steps are essential.

2) Community Participation

It has been determined via interviews that all the residents questioned feel some responsibility for contributing to the growth of community tourism. One of the interviewees mentioned that *"Since our village began*

to develop tourism, the entire village has been involved. Young people can serve as tour guides and sometimes take tourists on foot to the forest. Elder people, some of whom operate homestays and others operate restaurants, can say that after developing tourism, our income has increased and our living standards have greatly improved." (Interviewee F)

While locals increase their income through tourism development, respondents also raise some of their concerns. For example, *"We feel that the current development of community tourism is very fragile, especially after the outbreak of the epidemic, and we have lost our tourism income. We are concerned that even if the epidemic ends, tourism will find it difficult to recover from before."* (Interviewees B and C) The interviewed tourism experts also expressed their views on this, "believing that villagers have a high enthusiasm for tourism development but lack professional knowledge such as tourism-related skills, an understanding of the tourism market, and the promotion of tourism products." (Interviewee L)

The research results show that the community members have strong attachment to their cultural heritage and natural environment and are enthusiastic about developing tourism while preserving their traditional way of life. Also, the community members are involved in various aspects of tourism development, such as providing homestay accommodation, guiding tours, and selling local products. However, the community members face challenges in terms of skills and capacity building, marketing and promotion. These challenges contradict line with López-Guzmán, Sánchez-Cañizares, and Pavón (2011) claim that the most obvious advantage of CBT is its economic impact on family, social, and economic progress, as well as sustainable lifestyle diversity.

3) Market Orientation

The findings of interviews between interviewees and researchers indicated that the village offers a unique cultural and natural experience for tourists, but the tourism products and services need to meet the expectations and preferences of the target market. For example, *"Nearly all the prerequisites are established in our hometown for the growth of tourism, but we are unsure about the market's demands—especially once the epidemic has gone and consumer habits and behavior have undoubtedly changed. Regarding the future growth of tourism, we are quite concerned."* (Interviewees D, E, F, and I) Additionally, the visitors who were questioned said that "We came here for tourism since it was one of the few gorgeous areas that had remained open during the pandemic, and the local natural environment is quite stunning. After the pandemic, we are uncertain if we will return for tourism." (Interviewees J and K)

The research findings reveal that there is a need for market research and analysis, product and service innovation, and quality control and assurance. The community members face challenges in terms of accessing market information, meeting the standards and expectations of the target market, and competing with other destinations. Lee (2013), Ohe (2008), Ohe and Ohe (2020), Ohe and Kurihara (2013), Lee and Jan (2019), and others have argued that by providing educational opportunities and agricultural activities, CBT executives can increase visitor satisfaction and develop novel sources of income in particular rural areas, thus encouraging economic sustainability. This shows that local communities, in order to keep their tourist industries thriving, need to be aware of consumer preferences. In order to stay competitive, tourist businesses must respond to changing consumer preferences and demands.

4) Government Support

The research findings evident that government support is necessary for the development of CBT in Hebian Village. The government plays a crucial role in providing policy, regulatory, and financial support for tourism development. For example, *"We need government assistance to continue living here. We were able to get out of poverty with the aid of the government a few years ago, and they have since helped us expand our rural tourist industry. Our level of life has risen dramatically."* (Interviewees C, D, E, F, and I) Alterations to community facilities were cited by other responders as well. He said that *"the government's efforts to alleviate poverty in certain areas had resulted in new asphalt roads, upgraded water infrastructure, and updated public restrooms. All of these have helped pave the way for the growth of the tourist industry."* (Interviewee B) Some respondents expressed their thoughts on the government's actions, of course. For instance, *"Our household contributes to the growth of community tourism, but our earnings from this endeavor are modest because of our restricted means. It does not seem that the government's current initiatives will address our concerns."* (Interviewee F) Some have even hypothesized that "*we lost all tourist revenue while the outbreak was going on. I'm concerned that, despite the government's subsidies, we won't have enough to see us through the pandemic."* (Interviewee E)

The research findings promote that the government has recognized the potential of CBT in Hebian Village and has provided policy and financial support for tourism development. The government has also provided infrastructure and facilities, such as roads, water supply, and public toilets, to support tourism development. It is perfect match with Brunt and Courtney (1999) stated, the CBT improves the quality of life in communities by

bolstering infrastructure including public services, transportation, landscaping, and entertainment options. Local people and visitors become more aware of the need of maintaining the natural environment as a result of the exploitation of natural resources, the presence of scenic areas, and the presence of rare species of animals and flora. Woo, Kim, and Uysal (2015), and Choi and Sirakaya (2006) state that they have examined at economic, social-cultural, environmental, and life-satisfaction sustainability to determine whether or not CBT will be there in the future. There has to be fairness in the distribution of the country's economic benefits (Lee and Jan 2019). However, the government faces challenges in terms of balancing tourism development with promoting sustainable tourism and ensuring the equitable distribution of benefits among the community members.

3.3 What are the Barriers Must be Overcome for Hebian Village's Community-Based Tourism Sustainable Development after the COVID-19 Era?

Answering this question, it should be collaborating research question 1 and 2. The research recommends several suggestions to tackle the challenge of CBT sustainable development in Post COVID-19 in Hebian Village and other rural communities in China. These suggestions include:

1) Establishing and improving crisis handling and management mechanisms, so that when a crisis occurs, it can be safely overcome and quickly recovered after the crisis.
2) Strengthening community capacity building, including skills training, leadership development, and networking and collaboration. Give the locals the chance to keep learning new things so that they can understand the latest changes in the market. Especially in the post-pandemic period, staying ahead of the competition requires pooling individual strengths to produce tourist products that customers desire.
3) Improving marketing and promotion, including market research and analysis, product and service innovation, and quality control and assurance. Changes in consumer behavior and habits are inevitable in the wake of an epidemic. The locals may be fearful of tourist growth due to their lack of tourism knowledge and vulnerability. Expertise from the tourist sector and support from the government will be crucial.
4) Providing equitable and effective government support, including policy and regulatory support, financial support, and infrastructure and facilities development. The administration has obviously put forth a lot of effort into boosting tourism and the local economy, with positive results. However, advantages are still not equally distributed. To guarantee a somewhat transparent and equal distribution of benefits in the post-pandemic period, the government should increase regulatory efforts while giving financial assistance. Government efforts should be redirected from post-epidemic rehabilitation to ideological work for locals to calm their fears about the outbreak.
5) Fostering partnership and collaboration among stakeholders, including the government, the private sector, NGOs, and the community, to promote sustainable and inclusive CBT development.

Conclusion

The research concludes that CBT can be a sustainable and inclusive development approach for rural communities in China, particularly in the post COVID-19 era. With its COVID-19 crisis, community involvement, market orientation, and government assistance, Hebian Village is a model of effective CBT development. The research findings suggest that CBT development in Hebian Village has brought economic benefits, improved infrastructure, and enhanced cultural preservation and environmental protection. However, the research also identifies challenges and limitations in terms of crisis management, skills and capacity building, marketing and promotion, and government support. The research has several limitations, which provide opportunities for future research. First, the research is based on a case study of Hebian Village, which may not be representative of other rural communities in China. Further research is needed to compare and generalize the findings to other contexts. Second, the research uses qualitative methods, which may be subject to researcher bias and limited generalizability. Further research is needed to use quantitative methods to validate the findings and enhance the reliability and validity of the research. Third, the research focuses on the domestic tourists, without considering the perspective of international visitors. Further research is needed to include the perspectives of both international and national tourists to assess their satisfaction and impact on the community and the environment.

In conclusion, the research contributes to the literature on CBT sustainable development in China, especially in the post COVID-19 era. The research provides insights into the key elements of sustainable CBT development and the challenges and potentials of tourism development in rural communities. The study recommends suggestions to promote sustainable and inclusive CBT development and identifies limitations and opportunities for future research.

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Credit Authorship Contribution Statement

Mingjing Qu: As the corresponding author, Mr. Qu, played a pivotal role in the research and drafting of the manuscript. His contributions included Conceptualization, Investigation, Methodology, Software, Formal analysis, Data curation, and Writing – original draft. He also contributed to the Validation, Visualization, and Writing – review and editing processes, ensuring the accuracy and credibility of the findings.

Wong Ming Wong: He actively shared thoughts and refined the Methodology to achieve strong trial design. He selected and optimized project software for exact data analysis using his knowledge. Mr. Wong was passionate about Data curation, ensuring high-quality, well-organized data. He engaged himself in Validation, ensuring the study's legitimacy and replicability.

Declaration of Competing Interest

The authors of this work declare possible conflicts of interest: **Financial Interests:** None of the authors have financial interests that potentially conflict with this study. **Personal Relationships:** None of the authors have personal ties or affiliations that might bias this paper's conclusions. Accordingly, we confirm that no known conflicting financial interests or personal relationships might have influenced this paper's work.

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Predicting the Intention to Implement Green Practices by Small and Medium Sized Hotels in South Africa

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Abstract: The study examined the intention to implement green practices by small and medium sized hotels in South Africa by extending the Theory of Planned Behaviour (TPB). Three personal factors namely moral norms, response efficacy and environmental concern were used to extend the TPB. In addition, the study examined if intention predicted the implementation of green practices. A quantitative approach was utilised, and a self-administered questionnaire was used for the collection of data from hotel managers and owners. The Partial Least Square Structural Equation Modelling (PLS SEM) was utilised for the analysis of data and testing of hypotheses. The results of the empirical study indicated that attitude, moral norms and response efficacy have significant positive relationships with green practice intention. In addition, intention is a predictor of the implementation of green practices. The implication of the study is that the extended TPB can help to improve the understanding of the intention to implement green practices by small and medium sized hotels. From a theoretical perspective, the study developed a model on the intention to implement green practices by extending the TPB by three individual factors namely moral norms, response efficacy and environmental concern. Empirically, the study provides a clear understanding of the predictors of the intention to implement green practices.

Keywords: green practices; hotels; theory of planned behaviour; individual factors.

JEL Classification: Q01; Q57; M10; R11.

Introduction

There are serious environmental related problems that the universe is currently facing, and these include air pollution, global warming, acid rain, waste disposal and water pollution (Steg *et al.* 2014). According to Nheta and Tondani (2016), the key causes of global warming are known to be carbon dioxide and other greenhouse gases (GHGs). Even though hotels have positive benefits, they are also linked to extensive natural resource use, significant waste creation, and high greenhouse gas emissions, all which have negative environmental consequences (Alipour *et al.* 2019). Due to rising stakeholder pressure, particularly from governments and customers, hospitality firms have begun to consider issues related to the environment. As a result, hotels are increasingly implementing green measures to decrease their undesirable environmental effects in order attract and retain guests, maintain a competitive advantage, and improve financial performance (Huang *et al.* 2015; Nheta and Tondani 2016). However, many small and medium-sized hotels and lodges, mainly in developing countries, have not taken any initiative to decrease the damage they cause to the environment, regardless of the efforts done by certain parts of the industry (Nheta and Tondani 2016). Although a single small firm does not have the same environmental impact compared to a large firm, their combined effects are bigger than for large firms (Cantele *et al.* 2020). However, some small hotels have started to incorporate environment management into their operation and strategy (Alipour *et al.* 2019).

Green practices have become an important part of environmental research in recent years. According to Alipour *et al.* (2019), currently green practices and sustainability are being considered by many businesses and

industries when running their daily operations. Smith and Perks (2010) assert that the ways to utilise methods, processes and products that will not negatively affect the environment by weakening the natural resources or through pollution are referred to as green practices. Awaysheh and Klassen (2010) describe green practices as the strategies or activities executed by businesses to alleviate the impact of the operation and activities on the environment. There is a need to create a zero net release of carbon dioxide into the atmosphere and for the hospitality sector to go green (Mbasera *et al.* 2016). Therefore, it is essential to explore the antecedents intention to implement green practices by small and medium-sized hotels. Theoretical models such as the Norm Activation Model (NAM), the Value Belief Norm (VBN) and the Theory of Reasoned Action (TRA) have been used by researchers to examine intentions to carry out green practices in hotels. However, the Theory of Planned Behaviour (TPB) by Ajzen (1991) is the most utilised theory for predicting green behavioural intentions and behaviours (Wang *et al.* 2016). The TPB proposes that an individual's intention to perform a specific behaviour determines whether or not that behaviour is performed. An individual's intention to behave in a certain way is influenced by three elements and these are (1) attitude towards the behaviour (2) subjective norms (3) perceived behavioural control. The TPB argues that intention is a significant indicator in predicting the implementation of sustainable practices (Ajzen 1991; Huang and Ge 2019). Even though the TPB is widely used to explain green behaviour, several studies have improved the theory's explanatory power through additional relevant variables or factors (Chen and Tung 2014). This study extends the TPB by adding three individual factors (moral norms, response efficacy and environmental concern) to develop a predictive model of intention to implement green practices by small and medium sized hotels.

1. Literature Review

1.1. Theory of Planned Behaviour (TPB)

The TPB by Ajzen (1991) is an extension of the Theory of Reasoned Action (TRA) by Ajzen and Fishbein (1980). The TRA argues that intention is a predictor of behaviour. Intention is determined by two factors namely attitude and subjective norms. The TPB shows that an individual's performance of a specific behaviour is determined by his/her behavioural intention to perform the behaviour. An individual's attitude, subjective norms, and perceived behavioural control are the three components linked to behavioural intention (Ajzen 1991). Although TPB has been broadly used to explain green behaviour, numerous studies have improved the theory's explanatory power through additional relevant variables or factors (Chen and Tung 2014).

1.1.1. Attitude and Green Practice Intention

Attitude is the first determinant of behavioural intention. Ajzen (1991) describes attitude as the way that a person makes a positive or negative appraisal of the behaviour in question. Individuals that have a positive attitude as the outcomes of behaviour are favourably appraised and as a result, are expected to take part in a particular behaviour (Yilmaz 2014). Numerous researchers have discovered that attitude is a vital precursor of behavioural intention in different settings like the implementation of the consumption of green products (Yadav and Pathak 2016) and sustainable automobiles (Wang *et al.* 2016). Chan and Hawkins (2010) discovered that attitude positively impacts the intention to implement green practice. However, the study by Chen and Chai (2010) found that attitude is not positively related to green practice intention. This study proposes that (H1): Attitude towards green practices and intention to implement green practices are significantly positively related.

1.1.2. Subjective Norms and Green Practice Intention

Subjective norms (SN) evaluate the chance that significant reference groups or persons, for example, family and friends will disapprove or approve of a specific behaviour (Ajzen 1991). Individuals are not influenced by people around them only, but they are also influenced by the groups or individuals that they consult regarding beliefs, behaviours, attitudes, and opinions (Wang and Ritchie 2012). Numerous researchers assert that there is a favourable link between SN and people's intention to conduct a behaviour (Han 2015; Paul *et al.* 2016; Ko and Jin 2017). In addition, prior ecological research proved that there is a positive link amongst SN and the intention to stay in ecological hotels (Suki and Suki 2015), the intention to recycle (Tih and Zainol 2012) and the intention to consume green products (Moser 2015). Conversely, empirical studies by Chen and Peng (2012) and Verma and Chandra (2018) did not find a positive correlation between SN and green practice intention. This means that the results of empirical studies on the relationship between SN and ecological practice intention are inconclusive. Thus, this study proposes that (H2): SN and intention to implement green practices are significantly positively related.

1.1.3 Perceived Behavioural Control and Green Practice Intention

The apparent ease or difficulty of carrying out a behaviour is known as perceived behavioural control (PBC) (Ajzen 1991). In the context of green consumers, Wang *et al.* (2014) conducted a study in China about factors influencing sustainable consumption behaviours and established that the association between PBC and sustainable consumption behaviour is significant and positive. Conversely, Ko and Jin (2017) showed that strong PBC often leads to a greater favourable green clothing products purchase intention. In contrast, Arvola *et al.* (2008) conducted an empirical study and found that there is no association between PBC and the intention to buy sustainable products. This phenomenon can be extended to sustainable hospitality firms. In the context of green hotels, empirical studies by (Chen and Peng 2012; Chen and Tung 2014; Verma and Chandra 2018) found that PBC has a significant positive relationship with the intention to implement ecological practices. It is hypothesised that (H3): PBC and intention to implement green practices are significantly positively related.

1.2 Extension of the TP

The TPB can be broadened by the inclusion of different constructs that can improve the model's predictive power (Ajzen 1991). Chen and Tung (2014) used environmental concern and perceived moral obligation to extend the TPB in a study on consumers' intention to visit green hotels. De Freitas (2018) in a study on consumers' intended behaviour towards selecting green hotels extended the TPB by adding perceived moral obligation, anticipated regret, environmental knowledge, and environmental concern. Wang *et al.* (2018) added two constructs namely environmental concern and perceived consumer effectiveness to the TPB. This study will use three constructs namely moral norms, response efficacy and environment concern to extend the TPB.

1.2.1 Moral Norms and Green Practice Intention

The rules of morality that individuals should follow are known as moral norms (MN) (Machura 2013). Furthermore, based on studies conducted in the context of greening, MN can be described as an individual's desire with regards to their own duties concerning the performance of a particular ecological behaviour as well as the argument that the conduct is morally correct (Ru *et al.* 2019). Various researchers have done empirical reviews regarding the influence of moral norms, and they found a positive association between MN and a person's intention to exhibit ecological behaviour (Han 2015; Bertoldo and Castro 2016; Wang *et al.* 2020). Shalender and Sharma (2021) found that people who have greater personal moral norms have favourable intentions concerning the purchase of electronic vehicles compared to those who do not. It is hypothesised that (H4): there is a significant association between MN and intention to implement green practices.

1.2.2 Response Efficacy and Green Practice Intention

Response efficacy (RE) is the extent of an individual's beliefs about how effective a response is in preventing a threat (Popova 2012). RE refers to situations in which a person is of the opinion that a specific change in response will help to protect them and other people from the threat. The person's belief that an anticipated behaviour will succeed in eliminating threat is referred to as response efficacy (Almarshad, 2017). RE as a cognitive construct is a useful extension of the TPB. According to Ng *et al.* (2018), RE affects the intention to buy electronic vehicles positively and customers tend to reflect about consuming ecological products if they think their behaviour is going to help protect the environment (White *et al.* 2019). Moreover, Pang *et al.* (2021) have discovered that the association between RE and customers intention to purchase organic foods is positive. It is hypothesised that (H5): RE and intention to implement green practices are significantly positively related.

1.2.3 Environmental Concern and Green Practice Intention

Schuitema *et al.* (2013) define environmental concern (EC) as a common understanding and consciousness concerning issues in the environment. Chan and Hsu (2016) indicate that environmental concern has encouraged an increasing niche market, specifically the pro-environmental hotel industry. EC is the result of the hotel industry's attempts to reduce the extreme use of non-renewable resources while also limiting emissions (Ogbeide 2012; Chen and Tung 2014). As a result, hotels have gradually started to accept worldwide environmental initiatives to become more sustainable (Kang *et al.* 2012; Rahman *et al.* 2015). Sang and Bekhet (2015). Paul *et al.* (2016) and Yadav and Pathak (2017) showed that the link between EC and intention to buy certain ecological products is positive. Ii s hypothesised that (6): EC and green purchase intention are significantly positively related.

1.3 Intention and Actual Green Practices

In the TPB, the determinants of intention are perceived behavioural control, attitude and subjective norms (Ajzen 1991). Behaviour is mainly dependent on intention, and they have a positive relationship (Ajzen 1991). Intention is an important indicator in predicting the implementation of green practices (Yilmaz 2014; Wang *et al.* 2016; Huang and Ge 2019). Thus, it is hypothesised that (H7): intention is significantly positively related to actual green practices.

2. Methodology

The research used the cross-sectional survey method in a quantitative study. The survey method used to obtain data from the respondents was the self-administered questionnaire. The survey was conducted in the Capricorn District Municipality of Limpopo Province, South Africa. The sample frame consisted of all managers and owners of small and medium sized hotels selected from the databases of TripAdvisor, Trivago, and Hotel Grading of South Africa. The owners or managers of the identified hotels were contacted through emails to explain the purpose of the study. Five hundred and seventy hotel owners and managers were contacted, only four hundred and three hotel owners and managers granted permission to conduct the survey. Before the actual data collection, a pilot study was carried out with twelve hotel owners and managers who did not participate in the main survey. Four hundred and three participants who took part in the survey were made up of one hundred and fifteen from micro hotels, two hundred and twenty-nine from small hotels and fifty-nine from medium hotels. Based on the quantitative definition of small, medium, and micro enterprises by the National Small Business Act, 2019, micro hotels have been 0 and 10 employees, small hotels between 11 and 50 employees and medium-sized hotels between 51 and 250 employees. Each participant in the survey was give two weeks to complete the questionnaire. The participants were reminded every week through emails to complete the questionnaire. This process was repeated for two months. The Partial Least Square Structural Equation Modelling (PLS SEM) on the SmartPLS software version 3.0 was used to analyse the data collected in the survey. The question items were developed from prior studies and depicted in appendix one. The items were anchored on the five-point Likert scale with "1" strongly disagree and "5" strongly agree. Appendix one depicts the items used to measure the constructs.

3. Results

3.1 Biographical Details

Five hundred and seventy (570) questionnaires were distributed in the main survey to the respondents and four hundred and three (403) questionnaires returned were found to be usable, whereas 12 were not usable. Therefore, 403 (70.7%) questionnaires were analysed. Table 1 depicts the respondents' bibliographical details.

Table 1. Respondents' biographical details

Biographical Details	Frequency	Percentage
Gender		
Male	218	54
Female	185	46
Age		
Below 20	0	0
21-30	83	21
31-40	91	22
41-50	169	42
51-60	49	12
Above 60	11	3
Level of education		
Pre matric	44	11
Matric	129	32
Post matric	230	57
Level of business status		
Sole proprietor	0	0
Partnership	127	32
Close corporation	145	36
Private	131	32

Biographical Details	Frequency	Percentage
Number of employees		
0-10	115	28
11-50	229	57
51-250	59	15
Years of operation		
Below 5	54	14
6 to 10	126	31
11 to 15	150	37
Above 15	73	18
Position		
Owner	258	64
Manager	145	36

Source: (authors' data analysis)

Table 1 illustrates the respondents' details as follows: gender, male (218), female (185). Age, no respondent was below 20 years, 21-30 (83), 31-40 (91), 41-50 (169), 51-60 (49), above 60 (11). The level of education, pre matric (44), matric (129), post matric (230). Level of business status, sole proprietor (0), partnership (127), close corporation (145), private (131). Number of employees, 0-10 (115), 11-50 (229), 51-250 (59). Years of operation, below 5 (54), 6 to 10 (126), 11 to 15 (150), above 15 (73). Position, owner (258), manager (145).

3.2 Partial Least Square Structural Equation Modelling

Hair *et al.* (2019) indicates that to assess the outcomes in PLS-SEM, it is important to evaluate the measurement and structural models.

3.3.1 Measurement Model Assessment

The study follows the requirements for the evaluation of the measurement model with respect to the factor loading, composite reliability, Cronbach's alpha and the average variance extracted (Hair *et al.* 2019). The outcomes shown in table 2 indicate that the loadings have a value more than the required threshold of 0.708. The item loading for all the different variables range from the lowest value of 0.710 to the highest value of 0.966. The Cronbach's alpha value for all the latent variables ranges from 0.740 to 0.947. Composite reliability values are more than 0.80 as shown below in the table. The findings presented in Table 3 also reveal that GPI, GPB, ATGPI, SN, PBC, PEOC, LB, MN, RE and EC have an AVE value of 0.729, 0.904, 0.627, 0.688, 0.789, 0.814, 0.830, 0.655, 0.615 and 0.654, respectively. In addition, each construct's square root of AVE is larger compared to the values in the same column with it as shown by table 3.

Table 2. Measurement model assessment

Constructs	Item	Loading	Cronbach's alpha	Composite reliability	AVE
Green practice intention (GPI)			0.812	0.889	0.729
	GPI1	0.768			
	GPI2	0.902			
	GPI3	0.884			
Green practice behaviour (GPB)			0.947	0.966	0.904
	GPB1	0.931			
	GPB2	0.966			
	GPB3	0.955			
Attitude towards green practice (ATT)			0.902	0.922	0.627
	ATTI1	0.803			

Constructs	Item	Loading	Cronbach's alpha	Composite reliability	AVE
	ATT2	0.821			
	ATT3	0.827			
	ATT4	0.746			
	ATT5	0.759			
	ATTI6	0.754			
	ATT7	0.830			
Subjective norms (SN)			0.853	0.898	0.688
	SN1	0.869			
	SN2	0.817			
	SN3	0.878			
	SN4	0.747			
Perceived behavioural control (PBC)			0.867	0.918	0.789
	PBC1	0.879			
	PBC2	0.895			
	PBC3	0.890			
Moral norms (MN)			0.740	0.851	0.655
	MN1	0.837			
	MN2	0.745			
	MN3	0.842			
Response efficacy (RE)			0.822	0.864	0.615
	RE1	0.717			
	RE2	0.903			
	RE3	0.793			
	RE4	0.709			
Environmental concern			0.914	0.930	0.654
	EC1	0.816			
	EC2	0.846			
	EC3	0.798			
	EC4	0.795			
	EC5	0.801			
	EC6	0.801			
	EC7	0.804			

Table 3. Discriminant validity

	ATT	EC	GPB	GPI	MN	PBC	RE	SN
ATT	**0,792**							
EC	0,147	**0,809**						
GPB	0,248	0,058	**0,951**					
GPI	0,317	0,179	0,385	**0,854**				
MN	0,299	0,137	0,231	0,340	**0,810**			
PBC	0,303	0,147	0,494	0,255	0,392	**0,888**		
RE	0,124	-0,007	0,052	0,057	0,154	0,046	**0,784**	
SN	0,312	0,105	0,418	0,252	0,227	0,384	0,070	**0,830**

The square root of the AVE is represented by the diagonals.
Source: (authors' data analysis)

3.3.2 Structural Model Assessment

Hair *et al.* (2017) suggest that the structural model can only be measured when the required criteria are met. The requirements of the structural model such as common method bias, the R^2, the f^2, the Q^2 and model fit by Hair *et al.* (2019) were met. The model (R^2) explained 41.9% of the variance of GPI. The f^2 obtained in the study ranges from 0.000 to 0.029. The Q^2 obtained in the study is 0.146, and the standardised root mean residual (SRMR) obtained in the study is 0.05. Dijkstra and Henseler (2015) point out that the significance of a hypothesis is tested through bootstrapping. In addition, the value of standardised beta is also utilised to assess the significance of every estimation. Demir *et al.* (2021) indicate that the larger the value of the standardised beta, the larger the effect on the endogenous variable.

Table 4. Structural model

Path	Standardised Beta	T-statistics	Decision
H1 ATT →GPI	0.167	3.070**	Accepted
H2 SN→GPI	0.082	1.429	Rejected
H3 PBC→GPI	0.012	0.231	Rejected
H4 MN→GPI	0.172	3.326**	Accepted
H5 RE→GPI	0.204	2.983*	Accepted
H6 EC→GPI	0.088	1.751	Rejected
H7 GPI→GPB	0.385	4.801*	Accepted

*P<0.01, **P<0.05

Source: (authors' data analysis)

The results of the structural model are represented in table 4. Four hypotheses are accepted. Hypothesis one shows that proposes that attitude towards green practices and intention to implement green practices are significantly positively related is accepted. Hypothesis four that proposes that moral norms and intention to implement green practices are significantly positively related is accepted. Hypothesis five that proposes that proposes that response efficacy and intention to implement green practices are significantly positively related is accepted. Hypothesis seven that proposes that there is a significant positive relationship between green purchase intention and green purchase behaviour is accepted. Three hypotheses are rejected. Hypothesis two that proposes that subjective norms and intention to implement green practices are significantly positively related is rejected. Hypothesis three that proposes that perceived behavioural control and intention to implement green

practices are significantly positively related is rejected. Hypothesis six that proposes that environmental concern and intention to implement green practices are significantly positively related is rejected.

4. Discussion

The study examined the intention to implement green practices by small and medium sized hotels in South Africa through the extension of the TPB. Three constructs namely moral norms, response efficacy and environmental concern. The findings indicated that attitude towards green practices and intention to implement green practices are significantly positively related. This suggests that a favourable attitude towards green practices by owner/manager of a small hotel can affect the intention to implement green practices. The findings are supported by prior empirical studies. Chan and Hawkins (2010) discovered that attitude positively impacts green purchase intention. In addition, empirical findings by Kim and Han (2010) and Chen and Peng (2012) find that attitude and intention to implement green practices are significantly positively related. The findings indicate an insignificant relationship between subjective norms and intention to implement green practices. The findings suggest that the opinions of significant reference groups or persons such as family and friends do not influence managers/owners to implement green practices. The findings are supported by prior empirical studies. Chen and Peng (2012) and Verma and Chandra (2018) find an insignificant relationship between SN and the intention to implement green practices. The findings indicate that the relationship between perceived behavioural control and intention to implement green practices is positive but insignificant. The findings suggest that owners/managers of small hotels may not have the understanding, skills, competence, and resources to implement green practices. The findings of the study by Arvola *et al.* (2008) found no association between PBC and the intention to buy sustainable products. The findings indicate that moral norms and intention to implement green practices are significantly positively related. The findings are supported by prior empirical studies by (Han 2015; Bertoldo and Castro, 2016; Wang *et al.* 2020). Shalender and Sharma (2021) indicate that moral norms positively influence intention to adopt green behaviour. The findings indicate that response efficacy is positively related to intention to implement green practices. The findings are supported by the results of prior empirical studies. Ng *et al.* (2018) find that response efficacy positively affects the intention to purchase electric cars in Hong Kong. Pang *et al.* (2021) find that the association between response efficacy and customers intention to purchase organic foods is positive. The findings indicate that the relationship between environmental concern and intention to implement green practices is positive but insignificant. The findings of studies by Mainieri *et al.* (1997) and Bamberg (2003) also find that the relationship between environmental concern and intention to purchase green products is insignificant. The results indicate that intention to implement green practices is a predictor of actual green practices. According to the TPB by Ajzen (1991), intention is the predictor of behaviour. The findings are supported by prior studies on the implementation of green practices (Chen and Tung 2014; Yilmaz 2014; Wang *et al.* 2016; Huang and Ge 2019).

Conclusions and Further Research

The study explored the determinants of intention to implement green practices by small and medium-sized hospitality firms in South Africa by using moral norms, response efficacy and environmental concern to extend the TPB. The findings showed that the effects of attitude, moral norms and response efficacy are significant. The effects of subjective norms, perceived behavioural control, and environmental concern are insignificant. The findings also indicated that intention is an important predictor of actual implementation of green practices. The study makes theoretical, empirical and policy contributions to the research on green practices in hotels. Theoretically, the study demonstrated that personal factors can be used to extend the TPB in the context of the intention to implement green practices by small hospitality firms. Empirically, the study contributes to the body of knowledge on green practices in small hotels. The study suggests some recommendations to improve the implementation of green practices by hotels. To improve attitude, moral norms and response efficacy, hotel owners or managers must have half-yearly workshops so that they can be taught about the importance of living in harmony with the environment and taking care of it. Therefore, it is suggested that green practice should be incorporated as a course in entrepreneurial programmes at institutions of higher learning so that these managers or owners can take them as their subjects or modules, which will prepare them to take care of the environment when running their day-to-day operations. The study had some limitations. The research focused on 403 hotel managers and/or owners in a single province, which limited the findings' generalisability. The study depended on self-reported data owners and managers rather than objective observations. This may lead to bias. The study's cross-sectional survey method cannot be utilised to examine behaviour over a longer period. The study's ability to determine cause and effect is hindered as a result of this limitation. Longitudinal studies focusing on the same concepts will assist in determining the cause-and-effect relationship. New studies should focus on the perception

of employees about the green practices in their firms. An examination of the moderating effects of gender and level of education of hotel managers/owners will add to the knowledge on green practices.

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Credit Authorship Contribution Statement

Proceed Lerato Masebe was involved in the conceptualisation, investigation, methodology, software formal analysis, writing of original draft of the study.
Olawale Fatoki was involved in the conceptualisation, administration, supervision, validation, review, editing, visualisation and funding of the study.

Declaration of Competing Interest

The authors declare that they have no competing financial interests or personal relationships that could have appeared to influence the work reported in the paper.

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Appendix: Measures of Constructs

Variable	Survey	Response category	Adapted from
Green practice intention	1. We are willing to implement green practices in our hotel/lodge in the future 2. We intend to implement green practices in our hotel/lodge in the future. 3. We plan to implement green practices in our hotel/lodge in the future.	Five-point Likert scale 1= strongly disagree 5= strongly agree	Ajzen 1991. Chen and Tung (2014)
Green practice behaviour	1. We have implemented green practices in our hotel/lodge in the past six months. 2. We have implemented green practices in our hotel/lodge in our daily operation. 3. We have implemented green practices in our hotel/lodge on a regular basis.	Five-point Likert scale 1 strongly disagree. 5 strongly agree	Chen and Tung 2014
Attitude towards green practices	1. I think that implementing green practice in my hotel/lodge is useful to protect the environment. 2. I think that implementing green practice in my hotel/lodge is significant to reduce greenhouse gas emissions. 3. I think that implementing green practice in my hotel/lodge is valuable to reduce pollution. 4. I think that implementing green practice in my hotel/lodge is a wise decision. 5. I think that the implementation of green practice in my hotel/lodge is desirable. 6. I think that the implementation of green practice in my hotel/lodge is pleasant 7. I think that the implementation of green practice in my hotel/lodge will make a positive impact on the environment	Five-point Likert scale 1= strongly disagree 5= strongly agree	Hua and Wang (2019)
Subjective norm	1. Most people who are important to me think I should implement green practices. 2. Most people who are important to me would want me to implement green practice. 3. People whose opinions I value would prefer that I implement green practices. 4. My friend's positive opinion influences me to implement green practice.	Five-point Likert scale 1= strongly disagree 5= strongly agree	Chen and Tung (2014)
Perceived behavioural control	1. I think that I am capable of implementing green practice in my hotel/lodge. 2. I have the knowledge and skill to implement green practice in my hotel/lodge. 3. Whether or not I implement green practice in my hotel/lodge is completely up to me.	Five-point Likert scale 1 strongly disagree. 5 strongly agree	Chen and Tung (2014)

Variable	Survey	Response category	Adapted from
Moral norm	1. I believe it is my moral responsibility to reduce environmental pollution and greenhouse gases emissions. 2. I feel morally obliged to implement green practices irrespective of what others think of me. 3. I take into account environment consequences while I implement a practice.	Five-point Likert scale 1 strongly disagree. 5 strongly agree	Shalender and Sharma (2021)
Response efficacy	1. I am sure that green practice is effective in preventing, conserving and preserving physical and cultural resources. 2. I am sure that green practice will help prevent depletion of animal and plant species. 3. I am sure that green practice will help protect the environment. 4. I am sure that green practice will help prevent threat to safety of present and future human generations	Five-point Likert scale 1 strongly disagree. 5 strongly agree.	Fatoki (2021)
Environmental concern	1. I am extremely worried about the state of the world's environment and what it means for the future 2. Mankind is severely abusing the environment 3. When mankind interferes with nature, it often produces disastrous consequences 4. The balance of nature is delicate and easily upset 5. Human must live in harmony with nature in order to survive 6. I think that environmental problems are important 7. I think that we should care about environmental problems.	Five-point Likert scale 1 strongly disagree. 5 strongly agree.	Chen and Tung (2014) Yadav and Pathak (2015)

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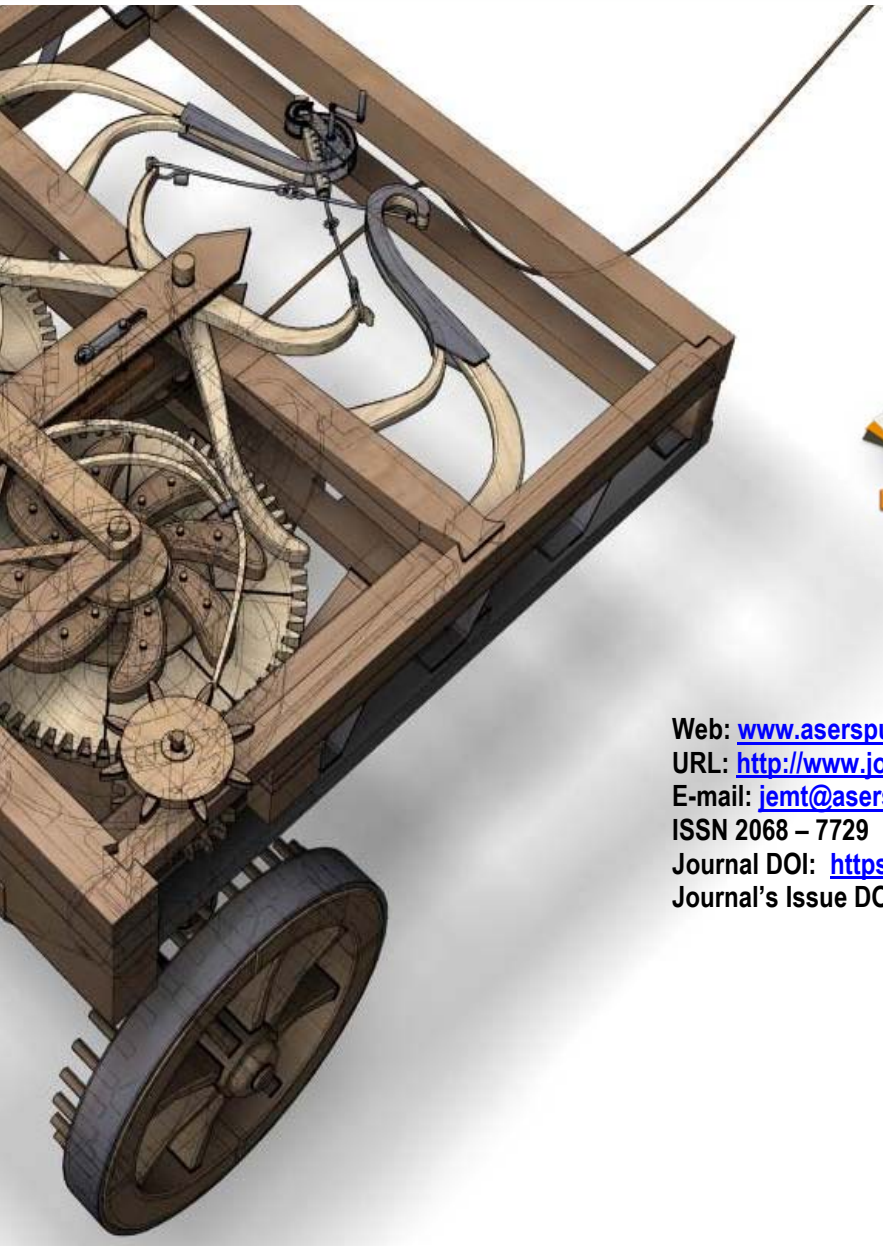

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