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Innovative and Marketing Features of Agri-Food Supply Chain Development

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Abstract: The article emphasises that geopolitical instability (russian aggression in Ukraine, sanctions, tensions between the US and China, inflation, recession) has a negative impact on agri-food chains. In particular, the war in Ukraine is affecting Africa by increasing food prices, destabilising the situation and creating the threat of famine.

The article examines the export challenges faced by Ukraine during the war. Smart solutions provided in Ukraine and around the world in order to develop export opportunities are analysed. The specifics of investing in nearshoring production are investigated. The market of "digital logistics" as a set of services and tools for transportation is analysed.

The research studied digital platforms that can effectively manage cross-border transport in a single system and optimise the many business processes involved. Services that help to track real-time information on cargo, their location and transport conditions are analysed. They allow customers to reduce downtime costs, assess the efficiency of carriers, monitor cargo condition and quality.

This article focuses on the warehouse automation industry. In particular, it notes that robotic devices are already capable of sorting parcels, transporting them within warehouses and moving them from one shelf to another.

Particular attention is paid to the further transition to safer raw materials. The operators proposed to use green energy sources and support suppliers focused on renewable energy.

The main trends in 2023-2024 are expected to be the development of technology, flexibility, further transition to "green" solutions and other ways of developing the logistics market both in Ukraine and globally.

It is determined that Ukraine will be rebuild according to the principle of Build Back Better, in particular, it will build everything according to new rules and to the extent required, based on new realities.

Keywords: supply chains; export; logistics; economic instability; processing; agriculture; robotics.

JEL Classification: Q11; Q13; Q17; Q18; R11.

Introduction

The global logistics industry is constantly facing various challenges: the Covid pandemic, the russian invasion, and economic instability of global markets.

The problem of food security has been extremely relevant for Ukraine since the beginning of the full-scale invasion of Russia. The domestic agricultural sector provides food not only for Ukrainians but also for millions of people around the world. The year 2022 could have been a record export year for Ukraine in the history of its independence, if not for the russian invasion.

Now, in war, logistics chains are destroyed or changed in a completely unpredictable way, occupiers destroy storage and processing facilities, mine fields, steal crops and block the ports.

Food security remains an urgent issue, so it is essential to develop and implement startups that would accelerate victory and help improve logistics and export operations. The innovative technologies for the formation of agri-food supply chains will help to improve the efficiency of export and import operations.

1. Research Background

The transition of the agrarian economy to an innovative way of development is one of the most important and complex problems, the solution of which requires the systemic analysis of the main factors that can favor or, on the contrary, restrain this process. Innovation-oriented development of the agrarian production envisages the involvement of new technologies, creation of fundamentally new products and the use of modern innovative methods and techniques of management. In today's globalized world, the level of innovation development of the economy and society as a whole is not only one of the most important factors of success, but also the main resource of economic growth and geopolitical stability of states, which determines their place in the world politics and economy.

Innovative features of formation of agri-food supply chains have been studied by: V. Aranchiy (Aranchiy, 2019-2021), V. Povoroznyk (Agrarians and IT, 2023); O. Zoria (Zoria, 2022), L. Syhyda (Syhyda, 2023); N. Demianenko (Demianenko, 2020-2021), L. Sacher (Sacher, 2022), I. Yasnolob, (Yasnolob, 2018-2022) and others, but in a changing environment, new challenges arise that require adaptation and modification to the new realities of Ukraine and the world.

2. Methodology

The purpose of the article is to study the innovative features of the formation of agri-food supply chains.

The systemic and dialectical-cognitive methods were used during the study of scientific papers of Ukrainian and foreign scientists on approaches to ecologically and socially oriented development agri-food supply chains in the economy of Ukraine. The following methods were used while working on the article: abstract-logical (for carrying out theoretical generalizations and formulating conclusions), monographic (for retrospective analyzing and determining the peculiarities of agri-food supply chains in sustainable rural development), systemic-structural (for constructing a block-scheme of the system of analyzing); modeling (for developing the innovative model of environmentally and socially oriented economy), etc.

3. Results and Discussion

Global supply chains disrupted by aggression affect not just an individual country in Africa, but the entire world. The global challenges of 2019-2023 have affected supply chains (Table 1). And companies are trying to use smart technology to optimise processes.

Table 1. Features of global supply chains in the face of new challenges

Years/Situation	Features of supply chains
2019-2021	
Pandemic and traditional supply chain disruption	Changing the geography of production (nearshoring). Warehouse automation
2022-2023	
Geopolitical instability: russian aggression in Ukraine, further sanctions and tensions between the US and China. Many industry players are paying attention to record inflation and possible recession	Changing the geography of production (nearshoring). Negative impact on supply chains. "China+1" principle: a policy that provides an alternative to the traditional supply chain

Source: Author's notes: based on data from (What the logistics, 2022)

In this way, classic logistics is being transformed. The players who create an environment of additional services for supply chain support will win. As a result, digital logistics is developing. According to Allied Market Research (Allied Market, 2023), the market, which covers a wide range of services and tools for transport, will grow by more than 20% by 2030. As a result, companies will increasingly focus on automation, IT solutions and cloud services. According to KPMG, about 60% of companies plan to increase investments in digitalisation. The aim is to improve the processes of data delivery, collection and analysis. The emphasis will be on logistics tools, such as planning, fulfilment centres, and tracking, rather than on the overall infrastructure and user interaction (What the logistics, 2022). Smart solutions of global companies are shown in Table 2.

Table 2. Smart solutions for forming supply chains from global companies

Smart solutions	Companies
Transparency in the Distribution Chain	Meest, ClearMetal, project44, FourKites, Descartes MacroPoint, Hapag-Lloyd
Warehouse Robotics	Amazon, GreyOrange and Locus Robotics
Transport Automation	Automobile: Uber, Convoy.Inc. Multimodal: UTEC Logistics
Artificial intelligence (AI)	Gartner, DataRobot and others
Digital twins	Boeing, Airbus, SpaceX
Green economy	Ford

Source: Author's notes: based on data from [(What the logistics, 2022; Jitplus, 2022; UTEC Logistics, 2023; Innovations, 2022)

These services help to track the cargo information, its location and transport conditions in real time. This allows the customer to reduce downtime costs, assess the carrier's performance, and monitor the condition and quality of the cargo. There are also a number of benefits for the carrier, such as a better understanding of how to ensure additional cargo security and optimise transportation. The companies involved in this area are developing rapidly due to the market demand (Zoria 2022). ClearMetal, for example, not only provides transparency in supply chains, but also helps to analyse and forecast the quantity and type of cargo for months ahead. Meest has a service called Meest World Logistics Platform. This is a single digital window for managing cross-border transport processes: from transport management to control of the quality and delivery time. This digital platform allows partners to effectively manage their cross-border deliveries in one system, which significantly optimises many related business processes (What the logistics, 2022). By 2022-2023, robotic devices will be able to sort parcels, transport them within warehouses, and move them from one shelf to another. By 2026, three out of four companies will use warehouse robotics.

Bill Gates has invested in a new Uber startup - Uber for trucks. The Uber Freight app is used for long-distance freight transport. The app solves the following problems: empty trucks on the way back, carrier employment and environmental pollution. The app also improves transport efficiency, reduces costs and reduces the environmental impact of trucks (Demianenko and Yasnolob 2021)

The US Company Convoy. Inc. has developed software that searches for carriers near a customer who are ready to accept a transport order on a map. So far, the service works locally, in Washington state (Jitplus 2022).

In Europe and the US, traffic is managed over the phone at a pre-agreed rate, and fares are paid online. This creates an environment of reasonable competition, where the service provided by the contractor is evaluated based on the results of the work performed (Jitplus 2022).

Artificial intelligence is likely to be used alongside augmented reality and augmented intelligence. Augmented intelligence combines human intelligence with automated artificial intelligence processes. For example, in logistics planning, the use of augmented intelligence may even outperform the use of artificial intelligence alone, as it combines human capabilities (experience, responsibility, customer focus, flexibility, common sense, etc.).

The potential uses of digital twins in logistics are enormous. Warehouses and businesses can also use this technology to create accurate 3D models of their centres and experiment with layout changes or the introduction of new equipment to see their effect (Innovations, 2022).

Logistics continues to be a major source of pollution: transport is responsible for 20% of global CO_2 emissions. Analysts emphasise that the supply chain would not be economically sustainable without environmental sustainability. The solution is to continue the transition to safer raw materials, encourage operators to use "green" energy sources, and support suppliers that emphasise renewable resource consumption (What the logistics, 2023). In addition, KPMG points out that in 2023, regulators and other stakeholders will focus on emissions of the third category - indirectly generated. Investors are likely to join this trend and require organisations to prove the low level of these indirect emissions (KPMG, 2023). Ukraine, the breadbasket of Europe, reduced its export potential in 2022. The factors that negatively affected supplies are shown in Table 3.

Table 3. Factors that negatively affected Ukrainian exports, 2022-2023

Factor	Reasons for the factor	Possible consequences
Decrease in venture capital investment in agricultural and food technology startups	Invasion of the russian federation	Rising capital costs, interest rates and questions about the business models of individual industry projects. Industry consolidation is likely and the number of acquisitions will increase
Economic crisis	Invasion of the russian federation	Hryvnia devaluation

Source: Author's notes: based on data from (In 2022, 2022)

Unfortunately, the technological development of the industry is slowing down because of decreasing investment and the economic crisis in Ukraine. However, the war has forced Ukrainian operators to switch to new, more flexible ways of operating. Meest has launched Meest Fulfilment, a service providing all logistics and postal services to companies entering the US market. The companies only deliver the goods to Meest's warehouses, while Meest handles the sorting, accounting, quality control and delivery to the end customers. Entrepreneurs who want to sell their product in the US market can ensure that local customers can get their goods quickly. This is highly important for gaining such a competitive edge (KPMG, 2023). Ukrainian exports are shown in Table 4.

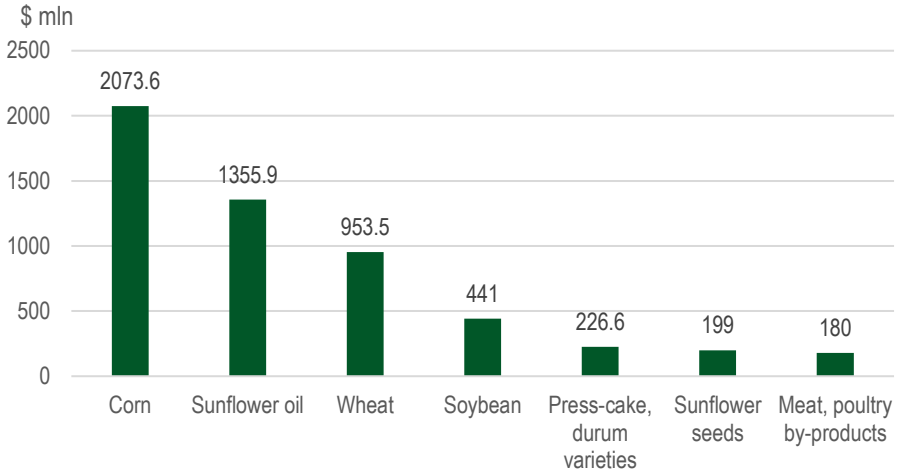
Table 4. Ukrainian exports, 2021-2022

Indicator	Years		2022 to 2021 %
	2021	2022	
Financing of technology companies in the agricultural and food sector of Ukraine, billion USD	53.6	30.0	56.0
Exports of all types of Ukrainian goods, billion USD	68.0	44.2	65.0

Source: Author's notes: based on data from (Ukraine's exports, 2022; In 2022, investment, 2022)

Agricultural and food products remain the most exported goods among sectors, accounting for 53% of total good exports in 2022 (Figure 1). Ukrainian products are exported to Poland (14.6% of total exports), Romania (9.7%), Germany (4.7%), Hungary (4.5%) and Spain (4.3%) (Syhyda, 2023).

Figure 1. Agricultural exports, first quarter of 2023



Source: the authors' development (Agrarians and IT, 2023)

Thus, grain crops (31%), fats and oils (14%), seeds and fruits of oilseeds (8%) accounted for the largest share in the export structure of the first quarter.

The year 2022 also revealed the benefits of domestic processing: companies focused on exporting raw materials were forced to reduce their activity or even stop it because of the blockade of ports on the Black Sea and the limited capacity of Ukrzaliznytsia. Instead, those who process their own products as feed or supply raw materials to the Ukrainian food industry ranked high in the rating (Aranchiy 2019). Oil and fat producers are the most resilient in terms of agribusiness sectors. However, they are reinforced by domestic contracts, or specialise in the production of bottled (more marginal products). Strong logistics, access to rail and proximity to the western borders meant production efficiency in 2022 (Rating of agricultural, 2023).

Innovative technologies for supply chain development are being introduced and developed in Ukraine (Table 5).

The government project eRobota provides Ukrainians with grants for starting a business, developing entrepreneurship and training. It aims to boost entrepreneurship and stimulate job creation. The development of the agro-processing industry significantly increases added value and reduces the burden on the capacity of export routes.

Since 2021, agri-tech and food startups have been booming, driven by global investors and entrepreneurs' awareness of the environmental impact of agriculture and meat production, as well as concerns about food security (Despite the war, 2023).

Grant support for export alliances will strengthen the potential of Ukrainian enterprises and encourage them to unite for a common goal of conquering new markets. The programme will provide about 15 grants ranging from $35,000 to $150,000. The grant program is aimed at supporting enterprises that seek to jointly promote their products in international markets. The initiative is implemented in partnership with the Office for Entrepreneurship and Export Development and the national project Diia. Business (USAID provides, 2022).

Group of Companies "Grain Capital" implemented a project to build a transshipment hub from 1520 mm gauge to 1435 mm European gauge on the border in Romania. The new facility was commissioned by one of the Ukrainian grain traders (Freight transport, 2022).

Nestlé has started construction of a new production site in Ukraine, which will be located in Volyn region. The new factory will be built near the distribution centre of Nestlé, which has been operating for over 10 years. Production is expected to start in the first quarter of 2024. The production network in Volyn together with the factory in Torchyn will become the European regional centre of the company in the category of culinary products.

The hub will employ 1,500 people at the production facility, which will supply products to the Ukrainian market and other European markets (Nestlé started, 2022). The new facilities will be equipped with state-of-the-art production technology and will meet the high domestic demand for food products, particularly instant noodles and condiments. Ukraine will remain the only European centre for instant noodles production for Nestlé, and the Volyn production hub will certainly play a huge role in exporting this fast-growing segment to European countries (Zoria, 2022).

Table 5. Innovative technologies for the development of a closed production cycle and supply chains from Ukraine, 2022-2026

Areas of development	Features
Development of agricultural and food technologies	Development of precision farming, improved agri-business management, irrigation and weather forecasting; B2B agri-business markets; improved food waste management; development of farm-to-table concept. Incentives - grants from eRobota State (garden grant, greenhouse grant, self-employment grant, grant for veterans and their families), various grants from USAD.
Development of the agro-processing industry	The government's grant project eRobota (grant for processing plant), from USAD. Transitioning from raw material exports to external sales of deeply processed products.
Support for startups	Development of biological fertilisers, vertical farms, agricultural robotics and alternative proteins, including plant-based and laboratory-grown meat
Grant support for export alliances	Support for businesses aiming to jointly promote their products on international markets
Hubs	A railway transshipment hub for Ukrainian grain was built in Romania. Nestlé in Ukraine will become the company's European regional hub for the culinary products. Coordination of IT solution providers, transport companies, warehousing, supply chain, foreign trade and distribution
Development of engineering and hardware programmes	Tracking and visibility of products. Development of digital logistics (JIT+ service for grain logistics in Ukraine). Improving customs logistics, the delivery market, and the use of drones for parcel delivery. Creation of robotic vehicle fleets, improvement of supply chain management, freight forwarding, warehouse automation, improvement of e-commerce logistics, creation of smart pallets and containers, and on-demand storage
Community autonomy	Each community should ensure maximum autonomy in the supply of agricultural products to its residents. Promote the cultivation, production and storage of as much food of plant and animal origin as possible
Human resources work	Outsourcing of logistics business processes
Export of niche high-margin cultures and products	Change in crop specialisation. Increase the area under peas, berries, mustard, etc., which are more variable in terms of transportation. Launching a line of unique Ukrainian types of honey directly from beekeepers, indicating the name of the beekeeper and honey terroir on a fair trade basis
Customs European Integration and Customs visa-free access for Ukraine	Obtaining European customs facilitation and benefits. Extension of zero duty on exports from Ukraine
Packaging design and functionality	In 2022, Syngenta purchased specialised bulk containers to export grain by rail. Important innovative solutions from technologists and branding agencies

Source: Author's notes: based on data from (Jitplus, 2023; Nestlé started, 2022; TA Ventures, 2023; USAID provides, 2022; Agricultural production, 2023; Freight transport, 2022; Exhibition, 2022; Window to Europe, 2021; Logistician's Day, 2023; Ukrainian brand, 2021; National Forum, 2022; Agriculture during, 2023; In 2022, 2023)

JIT+ specialises in building efficient grain transportation logistics in Ukraine. We have adopted effective European logistics principles and developed a unique service that allows us to track grain transportation online. With online tracking, the communication is two-way, and the cargo owner has the opportunity to contact the driver in real time, adjust movements, optimise routes and reduce downtime at loading and unloading points. A single information space allows customers, shippers, consignees and carriers to negotiate directly. Statistical data and carrier ratings help to find reliable partners and build long-term forecasts for the development of their business (Jitplus, 2023).

The main trends in 2023-2024 should be the development of technologies, flexibility, further transition to "green" solutions and other ways of developing the logistics market both in Ukraine and in the world. Ukraine will be rebuilt according to the principle of Build Back Better, in particular, it will build everything according to new rules and to the extent necessary, based on new realities (Agriculture during, 2023).

New export opportunities are emerging. African countries that have long been out of Ukraine's focus have now become important because of the russian federation's armed aggression against our country. The economic circumstances of the russian-Ukrainian war, with the blocking of our exports abroad, have a bigger impact on Africa (The forgotten, 2022).

Alongside intergovernmental negotiations and the creation of post-war reconstruction plans for Ukraine (infrastructure development), there is growing interest from private invest (Despite the war, 2023). International organisations and governments of the Western countries strongly support such initiatives of Ukraine and provide organisational, resource and financial support. But the main burden falls on the community leaders and domestic farmers and entrepreneurs. Significant results in production and exports can only be achieved with close cooperation of all stakeholders, active dialogue and coordination of efforts (National Forum, 2023). Ukraine will rebuild according to the principle of Build Back Better, in particular, it will build everything according to new rules and to the extent necessary, based on new realities.

The domestic market will quickly recover and new horizons will open up for Ukraine as an important player on the global agri-food map with the end of the war. As the population of the world is growing and diets are changing, the world will need to produce 50% more food by 2050 in order to meet the needs of humanity. According to the Food and Agriculture Organization of the United Nations (FAO), this demand will be met through sustainable agriculture (One step, 2023). International investors are waiting for the war to end so they can actively invest in Ukraine. Investments in logistics, transshipment terminals, and vehicles are still ongoing even today (Investment, 2022).

Conclusions

Global supply chains, which are disrupted by aggression, affect countries all over the world. And, smart solutions are being made in logistics tools: planning, the operation of fulfilment centres, tracking and so on.

In Ukraine, agricultural and food products are still the most exported goods among sectors, accounting for 53% of total goods exports in 2022. Modelling and optimisation of business processes, digital transformation of supply chains, management of big data and digital platforms, IT startups and the future of smart logistics, as well as further transition to green solutions, should be major trends in Ukrainian supply chains in 2023-2024. The Ukrainian logistics industry needs to integrate into the global digital logistics ecosystem.

Some of the statements and conclusions of the research paper are of scientific and practical value, in particular, the research paper analyses the innovative technologies for the formation of a closed production cycle and supply chains from Ukraine during the period of martial law and suggests the main development trends in 2024. In the context of global challenges, the development of agricultural enterprises is of utmost importance. In the war time, the agricultural sector is the second front in the struggle of the Ukrainian people for food and financial independence, and the exports of products. Moreover, Ukrainian grain and other agricultural products are a significant link in the chain of global food security, which points to the importance of developing agricultural enterprises.

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Credit Authorship Contribution Statement

Ilona Yasnolob: analysed innovative technologies for the creation of a closed production cycle and supply chains in Ukraine during the period of martial law.
Nataliia Demianenko: conducted a formal analysis and delineated the main trends in the development of supply chains from Ukraine during martial law in 2024.
Oleg Gorb: researched and analyzed the export challenges encountered by Ukraine during the war.
Yurii Tiutiunnyk: conceptualized innovative solutions both within Ukraine and on a global scale to enhance export opportunities.
Svitlana Tiutiunnyk: the specifics of investing in nearshoring production are investigated.
Lyudmyla Shulga: the market of “digital logistics” as a set of services and tools for transportation is analysed.
Tetiana Dugar: researched digital platforms capable of effectively managing cross-border transport within a unified system and optimizing numerous business processes.
Olena Maiboroda: analyzed services that assist in tracking real-time information regarding cargo, its location, and transportation conditions

Svitlana Pysarenko: researched the methodology, administered the project, and oversaw its software and support.
Yuliia Pomaz: supervised, curated data, verified and edited it, and was responsible for data visualization.

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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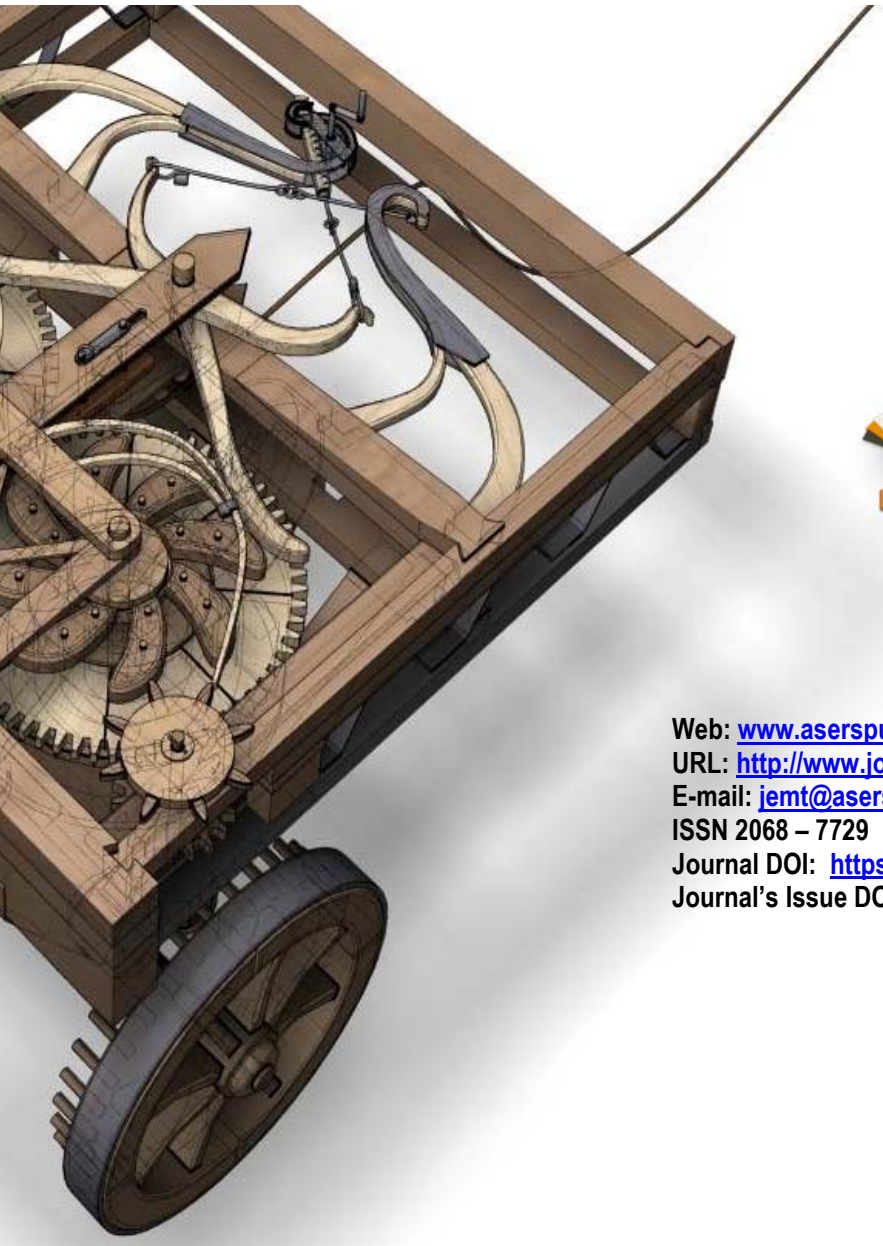

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