

ASERS

Journal of Environmental Management and Tourism

Quarterly

Volume XIII

Issue 7(63)

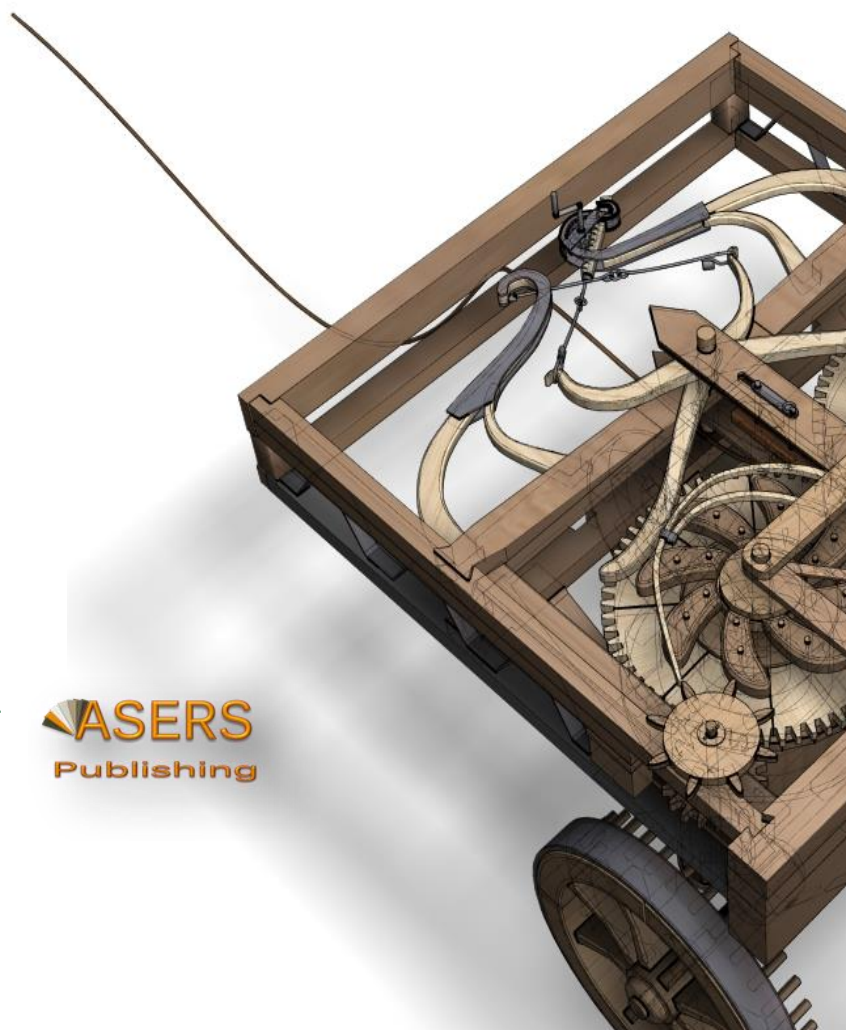
Winter 2022

ISSN 2068 – 7729

Journal DOI

<https://doi.org/10.14505/jemt>

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ISSN 2068 – 7729

Journal DOI: <https://doi.org/10.14505/jemt>

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ISSN 2068 – 7729

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DOI: [https://doi.org/10.14505/jemt.v13.7\(63\).01](https://doi.org/10.14505/jemt.v13.7(63).01)

Environmental Safety and Legal Regulation of Medical Waste Management: International Experience

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Suggested Citation:

Seilkassymova, R., *et al.* (2022). Environmental Safety and Legal Regulation of Medical Waste Management: International Experience. *Journal of Environmental Management and Tourism*, (Volume XIII, Winter), 7(63): 1817-1824. DOI:[10.14505/jemt.v13.7\(63\).01](https://doi.org/10.14505/jemt.v13.7(63).01)

Article's History:

Received 2nd of September 2022; Received in revised form 27th of September 2022; Accepted 31st of October 2022; Published 2nd of December 2022. Copyright © 2022 by ASERS® Publishing. All rights reserved.

Abstract

The article deals with the issues of protecting the population and the environment from the harmful effects of medical waste. Medical waste is dangerous, as the biomaterial carrying the virus accumulates. The list of medicines used in the activities of medical institutions, along with the risk of waste, is also extensive. In the world practice, the issues of neutralization and processing of medical waste are considered. In addition, the analysis of sanitary requirements and legal regulations for the disposal of medical waste was carried out. The hazard class of medical waste is considered depending on the degree of their epidemiological, toxicological and radiation hazard, as well as negative impact on the habitat.

Keywords: medical waste; hazardous waste; radioactive substances; environmental safety; state regulation; treatment of medical waste; radioactive waste.

JEL Classification: Q53; I18.

Introduction

One of the most acute global problems of our time is to ensure the safe handling of waste, which everywhere surrounds a person and can negatively affect her/his living conditions and health. Waste is constantly generated in everyday conditions, accumulated in production, dumped into the oceans, and gets to Earth in the form of space waste from human activities. The unfavorable situation in the world in the field of waste management of production and consumption leads to environmental degradation and poses a real threat to public health. According to the UN, in 18% of cases, the cause of premature death is unfavorable environmental conditions, of

which 1% is due to the negative impact of industrial, medical and household waste (Blizetskaya and Vasilenko 2018, 131).

The problems of collection, disposal, neutralization and disposal of various types of waste, protection of the population and the environment from their harmful effects should occupy one of the most important areas in the strategic development plans of any locality, especially cities. In addition to household and industrial waste, this fully concerns the waste of healthcare institutions, the management of which remains a rather imperfect sphere of urban economy, especially in countries with economies in transition, which includes the Republic of Kazakhstan (Bekezhanov and Yerkinbayeva 2017, 754).

Among the above list, medical waste requires special attention, they are dangerous epidemiologically, because they contain pathogenic microorganisms of varying degrees of virulence and danger and helminth eggs, and can also be contaminated with toxic and radioactive substances.

The problem of medical waste management in modern conditions is considered as an important epidemiological and environmental component of the safety of the country's population. Since 1979, the World Health Organization has classified medical waste as hazardous and recommended that countries create special services for their processing. Neither in the USSR nor in Russia at that time such services were created. Assessing the actual practice of medical waste management in our country, we have to state that due to moral, social and other reasons, their dangers are clearly underestimated, which is largely due to the lack of serious scientific research and justification (Rusakov *et al.* 2018, 4).

The relevance and social diversity of the problem of medical waste management is confirmed by the experience and dynamics of its study in developed countries, which, of course, should be taken into account along with local features and opportunities in domestic practice. Interesting, in particular, is the experience of the USA, where the peak of discussions about the problem of medical waste occurred in the late 80s - early 90s of the last century, when special and periodic public printing turned out to be filled with materials about the problems in this area. Public attention to the problem was actively attracted, which greatly stimulated the activities of government structures. This was reflected in the fact that all states have developed and adopted legislative acts regulating the rules of work with medical waste, while until the end of the 1980s such acts were available only in some states. In parallel with the legislative activity of the government, the American Environmental Protection Agency has developed a document entitled "Control over the waste of medicine and the medical industry", which has acquired the character of a legislative act that applies to all states (Grossman 2020, 153). Meanwhile, the problem of medical waste management has a distinct hygienic, epidemiological, environmental and social character due to their extreme polymorphism, as well as such factors of potential but very real danger as infection, toxicity and radioactivity. Therefore, the organization of such waste management system at all its stages, especially during transportation and disposal, assumes compliance with the requirements of not only sanitary, but also environmental legislation.

The documents of the World Health Organization (WHO), which pays serious attention to hospital epidemiology and hygiene, emphasize that "every clinic, regardless of size, should be a place designed to heal a sick person, which is the main goal of the health system (Prüss *et al.* 1999).

This mission, as noted further, can be seriously undermined if a high level of hygiene and a minimal risk of in-hospital infections caused, among other things, by medical waste are not provided in a medical institution.

1. Methodology

The article uses comparative legal methods of analysis and synthesis. The methods of analysis were used to analyze the works of scientists to identify certain types of medical waste, in which medical waste is considered as a circulating system. Research was carried out on the use of synthesis methods of individual parts of medical waste, its elements and general theory. Methods of research of medical waste on environmental harm to human health, classification and systematization of medical waste; study of the internal structure of the legal system, comparative legal analysis of environmental harm laws were used.

2. Results and Discussion

2.1 The Effects of Medical Waste on the Environment

To ensure environmental safety, the main part of the waste generated at the enterprise is not subject to burial, due to their toxicity. This is especially true of institutions that generate medical waste as a result of their activities. It is impossible to reduce the formation of medical waste, because reusable instruments, syringes and many other items are prohibited in medical institutions. To date, it is allowed to use only disposable tools, which are collected in containers after use and are subject to various disposal methods. The choice of disposal method is diverse

both in terms of the quality of neutralization and in terms of price category. Medical waste — waste from hospitals and health-improving institutions — are complex substrates of heterogeneous quality, which pose a serious danger from an epidemiological point of view. The disposal of medical waste is one of the most important areas of environmental protection in all developed countries of the world (Alexandrov 2011, 34).

Medical waste is a rather serious danger, both for the environment and for humans, and this danger is becoming more serious due to the progressive trend of increasing their quantity. The problem of medical waste is extremely acute all over the world. In some countries, cases of HIV infection of children have already been reported after they played with disposable syringes and blood transfusion systems thrown into landfill. The main reasons for the danger of medical waste are: 1. They often contain pathogens of various infectious diseases. 2. The presence of toxic and radioactive substances is possible. 3. Contains a large number of pathogenic microorganisms. 4. There is a risk of reuse of injection needles and syringes in case of improper handling after use (Teltsova and Gaisin 2017, 129). The cause of most infections that occur on the territory of medical institutions is the ventilation system. Burning infected medical waste in an open area provokes the spread of infection over distances of several tens of kilometers. When such garbage is buried, pathogens of dangerous diseases subsequently enter reservoirs together with groundwater or infect the air through the release of gases during rotting. On the territory of the Russian Federation, such an occupation as the processing of medical waste is often practiced. But, this type of activity is not safe for human life. The only possible way out today is their complete destruction. This is done in almost all civilized countries of the world. Therefore, no matter how economically profitable it is to buy used X-ray films, syringes and other medical waste to obtain plastics and precious metals, such an occupation is too dangerous for both parties interested in the transaction.

2.2 Problems of Legal Regulation of Medical Waste Treatment

Any legal mechanism, as you know, should be enshrined in the legislation of the state. The main legal act that enshrines the dominant principles and guiding ideas that form the mechanism under consideration in Kazakhstan is the Constitution of the Republic of Kazakhstan. The Constitution of the Republic of Kazakhstan defines that the generally recognized principles and norms of international law and international treaties of the Republic of Kazakhstan are an integral part of its legal system. If an international treaty of the Republic of Kazakhstan establishes rules other than those provided for by law, the rules of the international treaty shall apply. In particular, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was ratified by the Law of February 10, 2003 (Law of the Republic of Kazakhstan 2003).

Kazakhstan has also signed a number of international agreements aimed at reducing the negative impact on the environment, including the replacement of outdated equipment and the use of "the best available technologies". An example is the Stockholm Convention on Persistent Organic Pollutants of June 7, 2007, the Law of the Republic of Kazakhstan on Ratification of the Stockholm Convention on Persistent Organic Pollutants (Law of the Republic of Kazakhstan 2007).

This law considers waste incineration plants, including jointly household, hazardous or medical waste, as a dangerous source of atmospheric air pollution and indicates the need to stop open incineration and search for alternative technologies to reduce waste generation, involving them in circulation.

On the basis of the Basel Convention of April 12, 1996, an Agreement was signed between the CIS countries "On the control of transboundary movement of hazardous and other wastes". These acts regulate the procedures for the import (export) and transit through the territory of the participating countries of hazardous waste. In the CIS countries, there are relevant laws on the sanitary welfare of the population, on waste, and sanitary rules on the treatment of medical waste have been adopted, similar in their main accents to the Russian legislative framework.

The sources of civil law regulation of medical waste management in Russia, on the one hand, are legislative acts regulating the rights and obligations, responsibilities of the parties between whom a contract for the treatment of medical waste has been concluded, and on the other hand, legislative acts establishing environmental and sanitary-epidemiological requirements for safe waste management.

The paid provision of services is the realization of the freedom of economic activity guaranteed in the Russian Federation, the movement of services, the right of everyone to freely use their abilities and property for entrepreneurial and other economic activities not prohibited by law. At the same time, this activity must be carried out in compliance with human rights to health protection and a favorable environment, enshrined in articles 41 and 42 of the Basic Law (The Constitution of the Russian Federation 1993).

The concept of a contract concluded for the purpose of transportation and disposal of waste, the principles of civil law regulation of emerging legal relations are laid down in the Civil Code of the Russian Federation (1994).

In foreign countries, contractual relations are also regulated to a greater or lesser extent by laws. Civil codes in the countries of continental Europe contain detailed rules governing both general provisions of the law of obligations and relations arising in connection with certain types of contracts. In England, which is a country of case law, the law on the supply of goods and the provision of services was adopted in 1982, a little earlier, in 1977, the law on unfair contract terms was adopted. In the USA, issues of contract law are regulated by the Uniform Commercial Code and the Code of Contract Law (Adjei *et al.* 2015, 237).

In 2021, the Law of the Republic of Kazakhstan on Biological Safety of the Republic of Kazakhstan established that ensuring chemical and biological safety is one of the most important areas of strengthening the national security of the Republic of Kazakhstan (Law of the Republic of Kazakhstan 2021).

The norms ensuring environmental and sanitary-epidemiological safety of waste management are established by laws. There is no special law regulating the treatment of medical waste in Kazakhstan, therefore, the basic principles are regulated by the law of January 2, 2021 "Environmental Code" (Ecological code of the Republic of Kazakhstan 2021).

The mechanism for implementing the norms laid down in federal legislation is defined in subordinate regulatory legal acts. In accordance with the law of December 30, 2020 "On Technical regulation", the process of developing general and special technical regulations is underway (Law of the Republic of Kazakhstan 2020).

The main subordinate legal acts of a regulatory nature are sanitary norms and Rules of sanitary and epidemiological requirements for the collection, use, application, neutralization, transportation, storage and disposal of production and consumption waste approved by the Order of the Minister of Health of the Republic of Kazakhstan (Order of the Acting Minister of Health 2020).

In Kazakhstan, since 2004, a qualitatively new system of waste management of medical and preventive institutions has been created, close in basic provisions to international standards. Prior to that, waste disposal from medical institutions was carried out on the basis of normative legal acts of household waste management and acts regulating the medical activities of institutions.

In the Northeastern United States, the massive release of hospital waste in 1988 prevented citizens from using beaches and ocean resources, the peak of discussions about the problem of medical waste occurred just in the late 80s – early 90s. As a result, all states have developed and adopted legislative acts regulating the rules of work with medical waste (Corrigan *et al.* 2021).

The Center for Disease Control, as well as organizations related to occupational hygiene and occupational safety, relevant state institutions during this period adopted numerous documents related to the disinfection of hospital waste (regulations on blood-borne pathogenic agents, various classifiers of waste and methods of their disposal, etc.). In the UK, the concept of hospital waste and the procedure for handling The Waste Management Rules were determined with them (The Collection and Disposal of Waste Regulations 1988).

At the regional level, it is also possible to adopt laws and bylaws. In the Volgograd Region, the order of the Health Committee of the Administration of the Volgograd Region No. 282 of February 11, 2009 "On the management of hazardous waste in healthcare institutions of the Volgograd region" is in effect (Order of the Health Committee 2009). At the municipal level, the adoption of legal acts on the improvement of measures in municipal institutions is not excluded.

Thus, the sources of regulation of legal relations in the field of medical waste management are:

- Constitution of the Republic of Kazakhstan,
- international treaties,
- laws,
- subordinate regulatory legal acts of the republican level, including sanitary norms and rules,
- laws of the subjects of the Republic of Kazakhstan and subordinate regulatory legal acts of the regional level,
- local regulations.

It should be borne in mind that legal acts of regional levels can regulate the analyzed legal relations only in terms of duplication of concepts and classification of medical waste established at the federal level, as well as in terms of determining the waste flow pattern.

Issues of civil law regulation are determined exclusively at the regional level, because civil legislation, by virtue of article 71 of the Basic Law of the country, is under the jurisdiction of the Republic of Kazakhstan.

2.3 Digitalization Trends in Waste Management in Europe

The available sources of information revealing the trends of digitalization of waste management in Germany are mainly focused on describing future digital technologies. These include the concepts of digital waste management

in sustainable cities (Ulaschik *et al.* 2020, 199), process modeling for dispatching and routing, creation of prototypes of intelligent containers (Rzabay *et al.* 2022, 633), digital classification of images for waste sorting (Bekezhanov *et al.* 2020, 186) and others. In addition to the intentions of companies in the field of digitalization, the current level of use of digital technologies is being investigated, taking into account the level of implementation and stages of the waste management value chain (meaning such stages as customer management, sales, dispatching, logistics, weighing and sorting, recycling, disposal).

European researchers confirm "the growing importance of digitalization in waste management (López-Portillo *et al.* 2021). Publications on studying the goals of companies in the field of digitalization of waste management deserve special attention (Bekezhanov *et al.* 2022, 656). The expected goals of digitalization of the activities of such companies are to increase the transparency of processes, increase efficiency and improve quality, as well as focus on cost leadership strategies through optimization of internal processes.

Hazard class	Characteristics of the morphological composition
Class A. Epidemiologically safe waste, similar in composition to solid household waste	- Waste that does not have contact with biological fluids of patients, infectious patients. - Stationery, packaging, furniture, inventory that have lost their consumer properties. Estimates from the cleaning of the territory and so on. - Food waste from central food units, as well as from all departments of the organization engaged in medical and/or pharmaceutical activities, except for infectious, including phthisiological.
Class B. Epidemiologically hazardous waste	Infected and potentially infected waste. Materials and tools, objects contaminated with blood and/or other biological fluids. Pathoanatomic waste. Organic operational waste (organs, tissues, and so on). Food waste from infectious departments. Waste from microbiological, clinical diagnostic laboratories, pharmaceutical, immunobiological industries working with microorganisms of 3-4 pathogenicity groups. Biological waste of vivariums. Live vaccines unsuitable for use.
Class B. Extremely epidemiologically hazardous waste	Materials that have come into contact with patients with infectious diseases that can lead to emergencies in the field of sanitary and epidemiological welfare of the population and require measures for sanitary protection of the territory. Waste from laboratories, pharmaceutical and immunobiological industries working with microorganisms of 1-2 pathogenicity groups. Waste of medical and diagnostic units of phthisiological hospitals (dispensaries) contaminated with sputum of patients, waste of microbiological laboratories working with tuberculosis pathogens.
Class G. Toxicologically hazardous waste 1-4* hazard classes	Medicinal (including cytostatics), diagnostic, disinfectants that are not subject to use. Mercury-containing objects, devices and equipment. Waste of raw materials and products of pharmaceutical industries. Waste from the operation of equipment, transport, lighting systems and others.
Class D. Radioactive waste	All types of waste, in any aggregate state, in which the content of radionuclides exceeds the permissible levels established by radiation safety standards.

The researchers note that the choice of digital technologies and platforms themselves is limited, while the most advanced digital technologies (for example, tracking orders in real time using sensors) remain unclaimed due to the high cost. According to the report on digitalization trends in waste management in European countries (Castillo-Giménez *et al.* 2019, 222) "the increased use of digital technologies is crucial for shifting waste management in Europe towards more sustainable materials management." According to the authors of the report, these technologies contribute to the improvement of waste recycling processes, facilitating the use of recycled materials by manufacturers, and give consumers the opportunity to make more informed decisions about procurement and sorting. Also, the information generated by digital technologies makes it possible to optimize waste search options for processors. If we talk about the level of digital transformation, then, according to researchers, most companies are in the innovation phase. Also, more modern business models are appearing on the market, for example, electronic waste trading platforms (Bekezhanov *et al.* 2021, 1941).

There is a tendency to expand the range of software for waste management and business intelligence in the field under study. It follows from the report that elements of digitalization are available at different stages of

the waste management process, but the effects of their use are heterogeneous: different technologies are used at different scales. This brief overview of trends allows us to conclude that the information support of companies in the field of waste management in Europe is focused on the use of digital technologies that prove their high importance. In line with these trends, we will focus on the information (statistical) support of waste management processes in Kazakhstan.

Medical waste, depending on the degree of its epidemiological, toxicological and radiation hazard, as well as negative impact on the environment, is divided into five hazard classes (Table 1):

- Class A – epidemiologically safe waste, close in composition to solid household waste (hereinafter referred to as MSW).
- Class B – epidemiologically hazardous waste.
- Class B – extremely epidemiologically hazardous waste.
- Class G – toxicologically hazardous waste of hazard classes 1-4.
- Class D – radioactive waste.

Conclusion

The proposed system is able to provide an independent data source for all interested users of digital information. The main results of the implementation of such a system can be called:

- departure from a multi-stage paper system for generating statistical information;
- determination of the actual volumes of waste generated based on independently collected data in automatic mode;
- formation of an open database in the field of waste management in Kazakhstan;
- automatic accounting of the amount of waste aimed at disposal and neutralization;
- formation of an idea of the actual morphological composition of the resulting MSW;
- calculation of waste generation standards based on real data;
- automatic calculation of indicators characterizing the achievement of the goals of national projects in the field of ecology and sustainable development;
- availability of real, independently collected, statistical data necessary for making informed management decisions by entities involved in the waste management process.

The treatment and disposal of medical waste requires increased attention and care to avoid the significant burden of disease associated with poor practices, including exposure to infectious agents and toxic substances. The key elements of waste treatment and disposal organization are:

- promotion of practical techniques aimed at reducing waste and ensuring proper waste sorting;
- development of strategies and systems, along with appropriate supervision and regulation, for the gradual improvement of practical methods for sorting, destruction and disposal of waste, with the ultimate goal of meeting national and international standards;
- if possible, the preferred choice of safe and environmentally sound treatment of hazardous medical waste (for example, by autoclaving, microwave treatment, steam treatment in combination with internal mixing and chemical treatment) instead of incineration;
- creating a comprehensive system that takes into account responsibilities, resource allocation, processing and disposal; this process is lengthy and supported by incremental improvements;
- raising awareness of the risks associated with medical waste and safe practices;
- selection of safe and environmentally acceptable waste management options to protect people from hazards during collection, sorting, transportation, storage, treatment or disposal of waste.
- raising awareness of the risks associated with medical waste and safe practices;
- selection of safe and environmentally acceptable waste management options to protect people from hazards during collection, sorting, transportation, storage, treatment or disposal of waste.

Government commitment and support are needed to ensure universal and long-term improvements, although immediate action can also be taken at the local level.

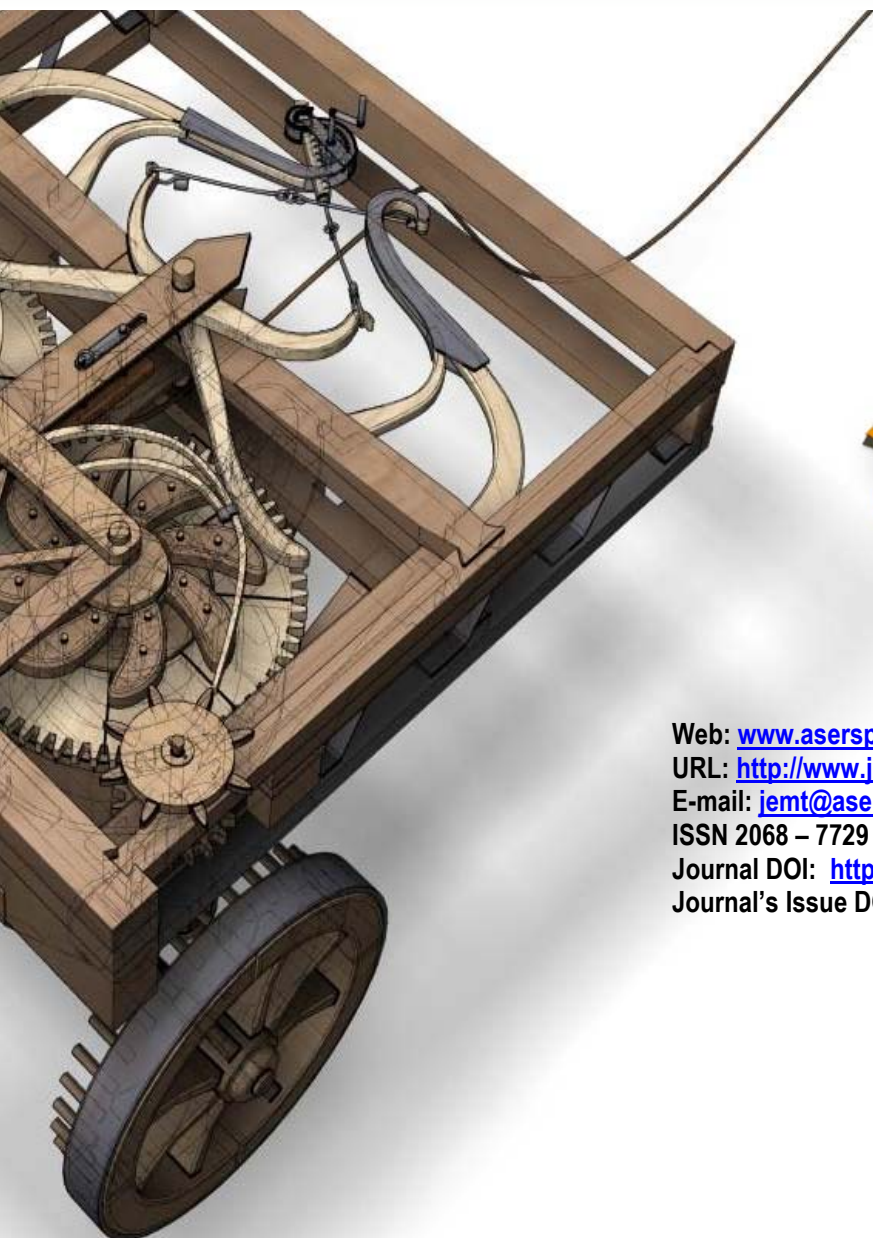
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ISSN 2068 – 7729

Journal DOI: <https://doi.org/10.14505/jemt>

Journal's Issue DOI: [https://doi.org/10.14505/jemt.v13.7\(63\).00](https://doi.org/10.14505/jemt.v13.7(63).00)