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Collaborative Governance for Management of Water and Air Pollution caused by Industrial Activities in Lamongan Regency, East Java

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Abstract:

This study aimed to 1) analyze water and air pollution caused by industrial activities, 2) investigate water and air pollution management carried out by government agencies, 3) examine the Collaborative Governance process in controlling water and air pollution. This study used a qualitative method with a phenomenological approach. The data were collected using data collection techniques through in-depth interviews, field observations, and document studies. The results showed that 1) industrial activities in Lamongan Regency generated water pollution with a percentage of 17%, namely in Sidoharjo River and Dapur River, as well as a decrease in air quality due to many industries that did not adhere to air pollution control regulations, hence increasing CO_2 gas emissions by (72%) or 3,712,849.07 Tons/Year, 2) reporting water and air pollution management done by submitting the related environmental documents through the SILILA Application (*Sistem Informasi Lingkungan Lamongan*), checking environmental documents, monitoring control, and socialization, 3) the execution of Collaborative Governance process in controlling water and air pollution is through five stages which include 1) public reports, 2) dialogue, 3) monitoring, 4) follow-up by governance, and 5) actions.

Keywords: collaborative governance; industrial activity; environmental pollution.

JEL Classification: Q52; Q53; G30.

Introduction

Industrial activities that do not adhere to environmental ethics can cause pollution. Many industries in Lamongan Regency use rivers as recipients of liquid waste, causing water and air pollution. Liquid waste that enters the river without prior processing can pollute the water and cause unpleasant odors. Environmental changes due to industrial activities force the government to deal with this problem. Henceforth, there is a need for collaboration

between stakeholders by involving the community, the private sector agents, and the government, which is called collaborative governance. If all policymakers carry out their respective roles and good collaboration are created, then water and air pollution management due to industrial activities can run well and sustainably.

1. Literature Review

Lamongan Regency supports the regional economy through industrial development. However, industrial development must follow the Lamongan Regency's potential by considering all the problems that might arise (Pratiwi 2018). Therefore, collaborative governance is needed, namely collaboration by involving the government, the private sector agents, and the community, which is a solution to public problems (Piani 2021). Gross regional domestic product data based on prevailing prices according to business fields in Lamongan Regency, in the first place, are agriculture, forestry, and fisheries. However, in regional economic development, the agricultural sector is replaced by the industrial sector, which aims to increase job opportunities (Widianingsih, Suryantini, and Irham 2016). The number of industries in Lamongan Regency refers to the Regional Regulation of the Province of East Java Number 5 of 2012 concerning the Provincial Spatial Planning of the Year 2011-2031. The government proposed Lamongan Regency to become an industrial area in East Java. According to the RTRW of Lamongan Regency, Regional Regulation Number 15 of 2011, there are two types of industry development in Lamongan Regency: the development of small and medium industries in the entire sub-district and development of large industries in the northern region of Lamongan Regency. Currently, the number of industries in Lamongan Regency has reached 1019 business activities with 84 UKL UPL, 14 DPLH, and 921 SPPL.

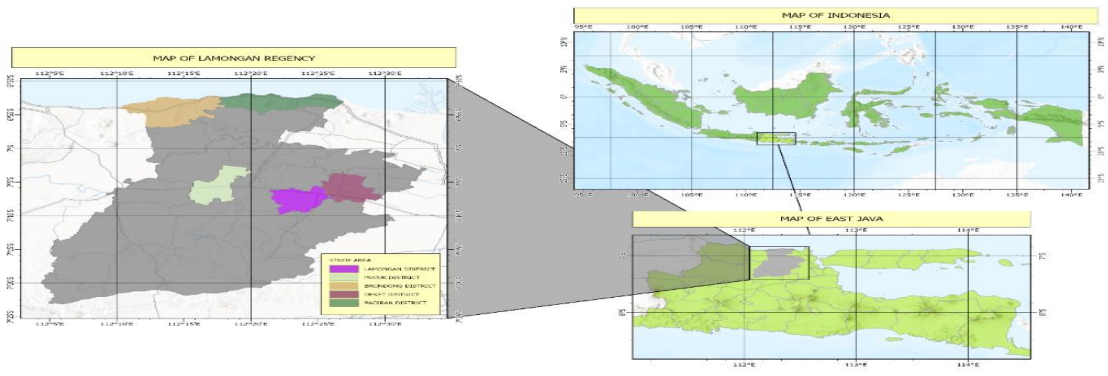
The government issued Government Regulation Number 24 of 2018 concerning electronically integrated business licensing services to facilitate the licensing process in Indonesia (Widodo 2020). This policy was issued to accelerate and increase investment and business to help investors set up Lamongan Regency factories easier (Baidawi 2020). Economic development based on regional comparative advantage will increase if regional development is precise on the objective (Ahsani 2017). On the other hand, a regional spatial plan that only emphasizes a few locations for planning specific sectors without considering the essential potential of the region will interfere with the region's development objectives.

Minister of Industry Regulation Number 35 of 2010 explained several criteria for determining industrial areas, such as the designation of industrial land, non-residential land, non-agricultural land, non-conservation land, and a minimum distance of 2 kilometers settlements. However, in reality, industrial area land in Lamongan Regency is used as agricultural land and aquaculture. Based on the social aspect, industry in rural areas has displaced agricultural life (Ayuningtias and Murdianto 2017). Aside from encouraging economic growth at the rural level, rural industrial activities also aimed to balance development. Meanwhile, based on the economic aspect, industry in rural areas can present business and job opportunities for the area around the industry. However, there is a contradiction between society and nature in modern times due to severe global environmental problems (Bagirov 2021). Environmental problems that occur in Lamongan Regency include water and air pollution due to industrial activities. Therefore, the government, the private sector agents, and the community must interact and collaborate to manage water and air pollution due to industrial activities.

2. Methodology

Geographically, Lamongan Regency is located at 6o51' - 7o23' South Latitude and 112o33' - 112o34 East Longitude. Its area is approximately 1,812.8 km^2 or ±3.78% of the total area of East Java Province (Figure 1).

Figure 1. Research Location



This study utilized a qualitative method because it examines the condition of natural objects where the researcher acted as the key instrument. Furthermore, this study employed a phenomenological approach because the interpretation of the data reveals phenomena and the relationship between each manifestation. The research location was in Lamongan Regency because many industries develop and can pollute the environment; therefore, collaborative governance is needed to manage water and air pollution due to industrial activities.

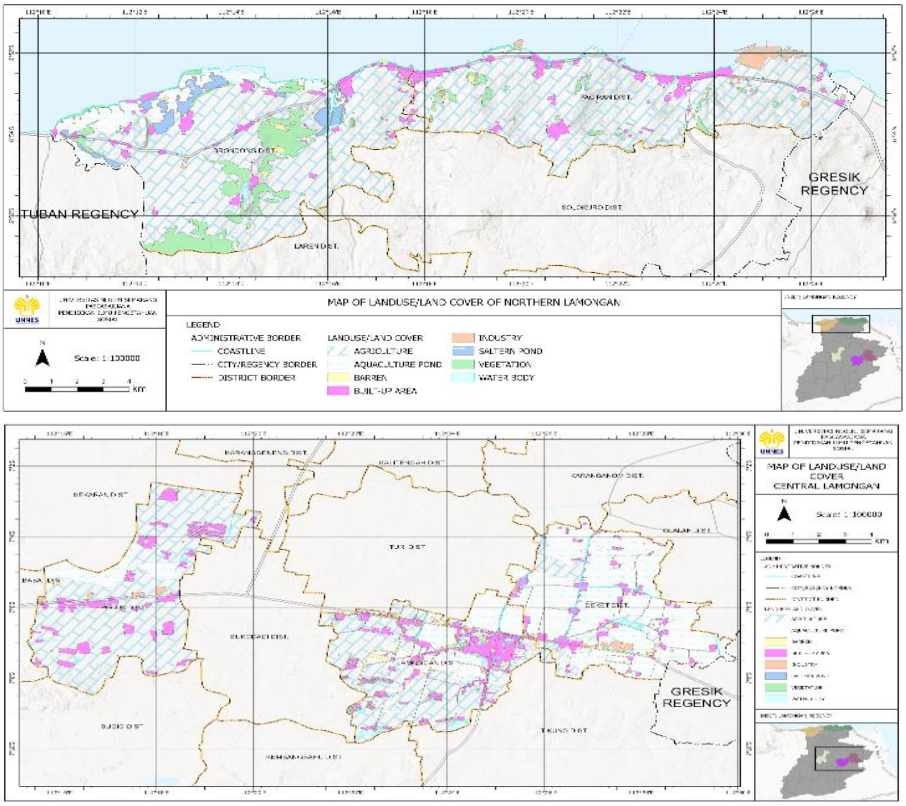
There are two data sources in this research, primary and secondary data. The primary data were from informants, such as DLH Lamongan Regency, the private sector, and the community. Meanwhile, the secondary data were environmental document reporting data, information documents on environmental management performance in the Lamongan Regency, research results, publication articles, newspapers, and relevant books. The data was collected through in-depth interviews to obtain information, field observations to research objects to see water and air pollution, and documentation from related agencies. The data analysis technique used was interactive analysis, which compares the data obtained through interviews with the data from observations, and documentation to strengthen the conclusions and test the validity of the data by examining the similarities, differences, or other possibilities. Comparative analysis was employed to compare field data of water quality standards according to Government Regulation no. 82 of 2001 and air quality standards according to East Java Governor Regulation No. 10 of 2009. In contrast, the descriptive analysis determined water and air management by government agencies and the collaborative governance process in managing water and air in Lamongan Regency.

3. Results and Discussion

3.1 Water and Air Pollution Caused by Industrial Activities

Industrial activities irresponsible for waste management obstructed the fulfillment of community rights to a healthy and clean environment (Sihombing 2020). The increase in environmental degradation is a global-scale problem, and henceforth there is a need for waste management according to regulations before being dumped into the environment (Różkowski and Rzętała 2021).

Figure 3. Distribution of Industry in Lamongan Regency



The community has a role in conveying information, social supervision, and complaints (Fatmawaty, Purnaweni, and Luqman 2020). Industrial activities become environmental problems if they ignore the principles of environmental ethics consisting of sustainability, proportionality, and responsibility. There are national and international policy gaps that allow a solid industry to gain profit by disregarding the environment. Therefore, it is

necessary to pursue an international movement for environmental justice and realize human rights for a clean and healthy environment (Wright *et al.* 2021). Industrial areas spread out in the northern region (north of Bengawan Solo to the north coast) for industry and marine fisheries, and the central area (north of the central axis road to the Bengawan Solo watershed), meant to be for agriculture and aquaculture (Figure 3).

Water pollution transpires due to the ineffective implementation of the Environmental Management Act so that many industrial owners pollute water by disposing of waste without prior management to gain profit (Subhi 2012). Even though there is a liquid waste disposal permit (IPCL), however, the function of the permit as a controller of activities in Indonesia is still far from expectations (Astriani and Adharani 2017). Consequently, it is necessary to calculate the strain of wastewater pollution in the industrial sector in the Lamongan Regency (Table 1) to control whether or not each industry treats its waste correctly. The burden of wastewater pollution due to the industrial sector increases and exceeds the capacity of water sources. If humans consume polluted water, it can cause health problems (Afroz et al. 2014).

Table 1. Total Wastewater Pollution Load in the Industrial Sector

No	Type of Industry	Production (Tons/Year)	BOD Waste Load (Tons/Year)	COD Waste Load (Tons/Year)	TSS Waste Load (Tons/Year)	Other Waste Load (Tons/Year)
1.	Fish Processing	125.4	45.80	75.20	9.50	1.56
2.	Textiles	1,603	36.60	32.50	12.56	0.89
3.	Food	1,020	2.50	6.20	1.47	0.04
4.	Fertilizer	12,100	21.50	47.30	39.74	13.51
5.	Tin	800	1.20	2.50	0.56	0.00
		15,648	107.60	163.70	63.83	16.00

Source: Data Analysis Results, 2021

Water quality monitoring has been conducted in 12 rivers to determine water quality in Lamongan Regency (Table 2). The parameter used is Government Regulation No. 82 of 2001, dated December 14, 2001, concerning Water Quality Management and Water Pollution Control.

Table 2. Water Quality in Lamongan Regency

No	Name of River	Temperature (°C)	pH	DHL (µS/cm	TDS (mg/L)	TSS (mg/L)	DO (mg/L)	BOD (mg/L)	COD (mg/L)	NO2 (mg/L)	NO3 (mg/L)
1	Plalangan River	29.5	7	25	56	55	4,4	2,5	16.2	0.002	4.76
2	Deket River	28	8	32	47	56	6,6	2.9	24.5	0.0011	3.46
3	Malang River	28.5	7.2	64	32	41	5,9	3	22.4	0.01	8.32
4	Dinoyo River	28.5	8	22	75	37	6,5	3	25	0.054	5.75
5	Sidoharjo River	27	8.3	75	32	39	6,4	10	32.3	0.0034	3.34
6	Dapur River	29	7.6	43	93	33	4,5	8	22.6	0.0056	7.43
7	Glugu River	29	8	45	27	15	5,2	2.9	22.5	0.0043	3.65
8	Lamong River	28.5	8.4	23	87	23	6,4	2.9	16.2	0.0053	4.94
9	Kuro River	27	7.8	36	34	41	6,8	3	12.5	0.0065	8.32
10	Deket River	27.5	7.5	64	63	37	6,6	3	24.5	0.031	4.43
11	Kentong River	27.5	7.2	22	82	33	6,2	2.5	25.8	0.0064	6.98
12	Laras Liris River	29	7.2	75	45	29	6,7	2.8	16.5	0.0011	8.32
	Water Quality Standard	**20-30**	**6-9**	**250**	**1000**	**50**	**6**	**2**	**10**	**0.06**	**10**

Source: Data Analysis Results, 2021

The measurement showed that nine rivers have DO content above the quality standard, and three rivers have DO content below the specified quality standard (Plalangan River 4.4 mg/L, Dapur River 4.5 mg/L, and Glugu River 5.2 mg/L). The measurement results of COD values were above the predetermined quality standards, while the measurement results that showed the highest BOD value were Sidoharjo River (Sidoharjo Market Bridge), which was 10 mg/L. The estimation of the water quality index is from on the Decree of the State Minister of the Environment No. 115 of 2013 concerning Determination of Water Quality Status using the pollution index method, tabulated in Table 3.

Table 3. Calculation of Water Quality Index

Status	Total	Percent	Coefficient	Score
Pass the Standard	10	83%	70	58.33
Light Polluted	2	17%	50	8.33
Medium Polluted	0	0%	30	0
Heavily Polluted	0	0%	10	0
	12			
	Water Pollution Index Score			66.67

Source: Data Analysis Results, 2021

Based on the results of river water quality tests at 12 sampling points in Lamongan Regency, there were two rivers with a lightly polluted status, with a percentage of 17%, and the calculation of the water quality index 66.67% discovered, which was Sidoharjo River and Dapur River. If not controlled, the waste that causes pollution will decrease water quality, disrupting the river ecosystem (Pohan, Budiyono and Syafrudin 2017). The polluted status triggered the anxiety of the farming community (Figure 4).

Figure 4. Fish died due to water pollution

One of the causes of dead fish was heavy metals from factory waste that harmed fish (Polat *et al.* 2016). The results showed that the tapioca industry owners had not managed liquid waste independently due to the large number of dead fish caused by tidal inundation mixed with industrial wastewater (Banowati, Indriyanti and Juhadi 2018).

The increasing industrial activities induced air pollution in Lamongan Regency. Even though large-scale industries have air pollution control devices, they have not yet fully adhered to the emission air quality standards. Air pollution emissions by industry are highly dependent on industrial equipment and utilities and the type of industry and its processes (Pramudi, Nadiroh and Samadi 2020). Moreover, industrial activities have the potential

to produce emissions from product mobilization activities. The phenomenon of air pollution in the Lamongan Regency will be presented in table 4 as follows.

Table 4. Air Pollution due to Industrial Activities

No	Air Pollution	Additional Information
1	Source of air pollution	a. Fuel Oil 1,596 Liters; b. Gas 6.0 MMSCF; c. Coal 4,723 Tons; d. LPG 458,584 Kg; e. Diesel 42,124 Liters
2	PPU compliance level	a. Obedient 1 company (2%), b. Less obedient 13 companies (26%), c. Disobedient 36 companies (72%).
3	Air pollution case	a. A letter from the NGO JALAK concerning the tin burning activities in Warukulon Village, Pucuk District, which did not adhere to the licensing provisions. b. The demonstration event in six villages related to air pollution due to waste from PT. BMI that caused a foul odor, especially during the rainy season.
4	Total CO_2 emissions from the industrial sector	3.712.849,07 Tons/Year
5	The impact of air pollution	a. Climate change, b. The increasing greenhouse gas (CO_2) emissions, c. Public discomfort.

Source: Data Analysis Results, 2021

The problem of air pollution kept increasing in industrial cities when the fuel industry for coal used oil and natural gas to which impacted public health (Soto-Coloballes 2020). The burning of coal and oil from industry is one of the sources of carbon monoxide (CO). High concentrations of CO gas can cause health problems, even death (Diken, Wardhana and Sutrisno 2017). The study results by (Setyowati, Astuti, Hardati, Subiyanto and Amin 2020) showed that trees have an emission absorption function of 42% or 2,646,253.41 kg/year. On the other hand, one of the impacts of air evaluation is the increase in CO2 gas emissions from the industrial sector, and approximately around 3,712,849.07 Tons/Year came from LPG, Solar, and Coal. Air pollution can raise greenhouse gas emissions that harm the climate. Therefore, all levels of society need to be aware of the urgency of this problem (Setyowati *et al.* 2019).

3.2 Forms of Water and Air Pollution Management

The Environment Agency of Lamongan Regency, as the implementing agency for regional autonomy, has the fundamental task and function to carry out environmental supervision and control. There are similarities between the case in Lamongan Regency and China, which also suffer environmental damage due to industrial activities. China proposed a series of environmental protection policies to restrict industrial pollution emissions (Ye and Wang 2019). The Lamongan Regency Government's policies in managing water and air pollution due to industrial activities are presented in table 5.

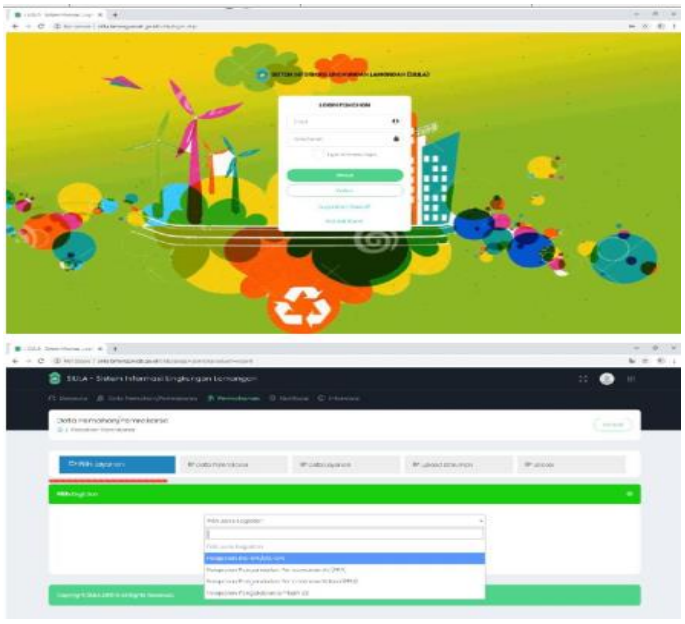
Table 5. Water and air pollution management

No	Policy	Description
1	Reporting through SILILA Application (*Sistem Informasi Lingkungan Lamongan*)	The reporting through the SILILA application (*Sistem Informasi Lingkungan Lamongan*) is an effort to provide access to information and environmental quality to the public.
	Obliging industry to submit Environmental Document Reporting to the Environmental Agency	a. Submit Water Pollution Control Reporting (PPA) every 3 months b. Submit Air Pollution Control Reporting (PPU) every 6 months c. Reporting RKL (Environmental Management Plan), RPL (Environmental Monitoring Plan), and B3 every 3 months
2	Report checking by DLH	The Environment Agency conducts indirect supervision by checking reports or documents sent by the industry, whether the reports match the site's conditions (environment).
3	Control supervision	Monitoring water and air quality regularly and continuously every month.
4	Socialization	Conducting socialization and guidance on controlling water and air pollution to industrial factories.

Source: Data Analysis Results, 2021

The government agencies indirectly conducted water and air pollution management by checking the environmental document reports on the SILILA application (*Sistem Informasi Lingkungan Lamongan*) (Figure 5). The assistance provided by the application is in the form of online services for RKL-RPL Reporting, Water Pollution Control Reporting (PPA), Air Pollution Control Reporting (PPU), and Hazardous Waste Management Reporting by accessing silila.lamongankab.go.id.

Figure 5. SILILA Website Page Views

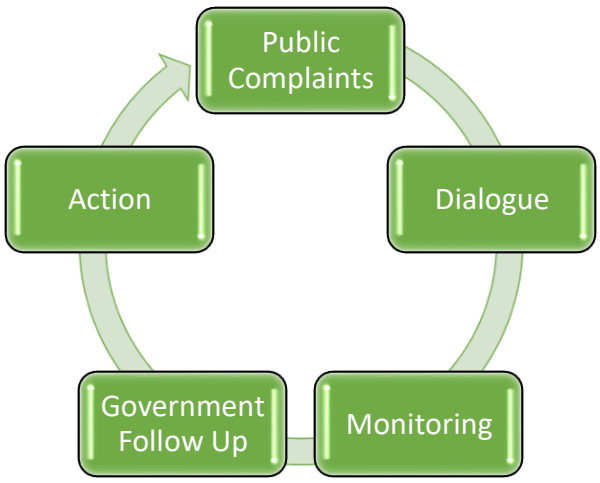


The Lamongan Regency Government monitors and overwatches water quality regularly and continuously through water patrol every month while air quality once every six months. In addition, socialization plays a significant role in controlling pollution concerning public awareness, especially industry owners.

3.3 Collaborative Governance for Water and Air Pollution Management Caused by Industrial Activities in Lamongan Regency

Ansell, C.dan Alison (2007) explained that Collaborative Governance is a new strategy from the government involving various stakeholders and government officials simultaneously in a forum to reach decisions. The government as the regulator has a cooperative relationship with the private sector as the executor (Donahue, J. 2011). Ratner (2012) established three stages in the Collaborative Governance process: Identifying Obstacles and Opportunities, Debating Strategies for Influence, and Planning Collaborative Actions. The process of Collaborative Governance in controlling water and air pollution is in Figure 6.

Figure 6. Collaborative Governance Process



The people of Lamongan Regency play an active role in managing water and air pollution through submitting complaints. Complaints regarding the environment are made verbally or in writing submitted to the responsible authority. All the parties involved then identify the community's complaints, and solutions are sought together through dialogue. This phase involves listening to each party regarding the existing problems and seeking solutions from each stakeholder (Cahya and Nasution 2020). Stakeholders then discuss the practical steps to solve these problems. Government and non-governmental agencies conduct dialogue before implementing program activities to avoid clash between each stakeholder – conducted in formal and non-formal manner (Nopriono and Suswanta 2019).

The government conducts indirect monitoring by inspecting environmental report documents on the SILILA application (*Sistem Informasi Lingkungan Lamongan*). On the other hand, the government conducts direct monitoring to inspect water and air pollution. If the government detects violations committed by industry actors during monitoring, the stakeholders then plan to implement any feasible strategies. Each stakeholder cooperates well and supports each other.Furthermore, the Environment Agency will provide evaluation letters, warning letters, and sanctions to industrial actors who violate the regulations. Consequently, stakeholders will follow up in mediation and field verification until the status of the complaint is complete. Building a safe and orderly situation in an environment involves various kinds of stakeholders as part of collaborative governance and not only on one party. Collaborative governance itself is the development of knowledge and the capacity of institutions to generate security and order (Zadek 2020).

The existence of trust in a group is one of the success factors to reach successful collaboration (Dyo 2019). Meanwhile, there are clear, firm, and acceptable rules for each stakeholder to play a role following their jurisdiction in the authority's aspect. The excellent collaboration will be unachievable if it has not fulfilled the aspects of government clarity, and there exists sector ego, lack of public awareness, limited human and technical resources, and shortage of financial resources (Mutiarawati and Sudarmo 2021).

Conclusion

Industrial activity in Lamongan Regency caused a drop in water and air quality. The disposal of wastewater into river bodies caused water pollution. In addition, industrial fuel sources can induce air pollution that has an impact on health. Collaborative governance is a strategy in controlling water and air pollution applicable in other industrial areas. Each stakeholder cooperates well and supports each other. Moreover, the industry has a good awareness of waste management before disposing it into the environment. Consequently, the government explicitly accommodates alternative solutions in anticipating environmental damage caused by polluters. The community also has the awareness to preserve the environment and balance the ecosystem; henceforth, all components can experience environmentally friendly development.

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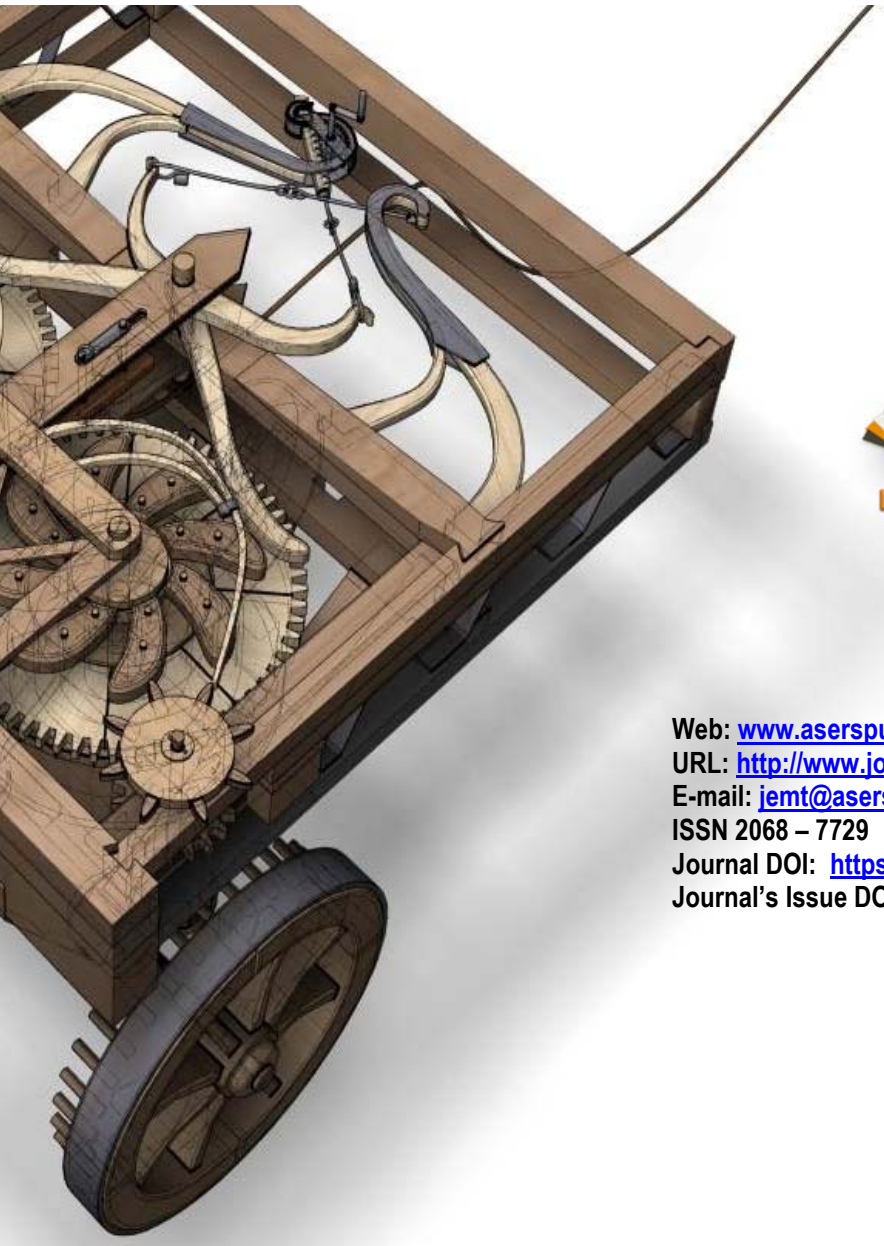

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