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RESEARCH ARTICLE

Providing a Green Value Stream Map to Improve Production Performance

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Abstract: Today, the cement industry has gone through a growing trend. Achieving the country's economic development, social development, and cultural development goals is essential. However, in line with these benefits, the environmental damage caused by cement factories is inevitable. In the present research, which was carried out to reduce environmental losses, value flow mapping and simulation by Arena software were used in two stages. It was determined in the first stage using the current simulated situation and the waste and environmental pollution created. Then by redrawing the future value flow map and using experts' opinions, the amount of reduced pollution caused by some measures was estimated. Then, in the second stage a new simulation was done to evaluate the reduced environmental pollution. The results of this research showed that by using the methods mentioned above in the primary production line process of the cement company, about 30% of waste and pollutions were reduced.

Keywords: value stream mapping, simulation, lean production, waste, cement industry, green approach

1. Introduction

Environmental effects are important for achieving sustainability and harmony in nature. Recently, there has been an increase in awareness among business communities about the significance of greening and the adoption of various environmental management techniques. Since environmental problems are threats to the sustainable development of human societies, it is essential that organizations, as the largest members of societies, recognize the effects of their behaviors on the environment and take steps to reduce the negative effects of these behaviors on natural ecosystems [1]. Today, most companies eliminate activities without added value using just-in-time or lean production techniques [2]. Its goal is to improve customer response time and reduce total costs [3]. Lean requires sustainability, change, and transformation in all stages of work and across organizational levels to enable the movement toward continuous improvement and achievement of perfection [4]. Lean goals simultaneously promote a culture that encourages continuous review and evaluation. Gradually, this stimulus is applied throughout the system, and the organization will periodically seek to evaluate how to implement lean principles in its internal processes. Thus, organizational readiness is one of the prerequisites for the beginning and continuation of lean goals [5].

A value stream is a set of value-creating and non-value-creating activities required to bring a product or group of products that use shared resources, through a central flow, from raw materials to the hands of the customer [6]. These activities include the flow of information and operations, which are the core and basis of any successful lean operation [7]. Value stream mapping is a lean technique that helps to depict all production processes and present the flow of materials and information [8]. This method aims to improve productivity while reducing waste and shortening work time [9]. This method has helped companies to eliminate activities that do not create added value and thus become more competitive [10]. Therefore, this method is a systematic method of identifying and eliminating all types of waste through continuous improvement and statistical information regarding product production in production lines and the direction of its evolution [11]. Today, one of the problems of industries is environmental pollution, which can be reduced by improving and harmonizing activities in the field of production with the cooperation of industries. A green design aims to reach high performance and minimize industrial environmental impacts [12]. The primary purpose of this research is to use value flow mapping to detect and reduce waste to improve the performance of the production process in a cement manufacturing company with an environmental approach.

2. Literature Review

With the rapid increase of population and change of life and consumption patterns, excessive use of non-renewable resources of nature, low level of production technology due to limitations such as difficult environmental conditions, limited agricultural land, lack of water resources, insufficient investment, and pollution entry industrial activities to the environment intensified

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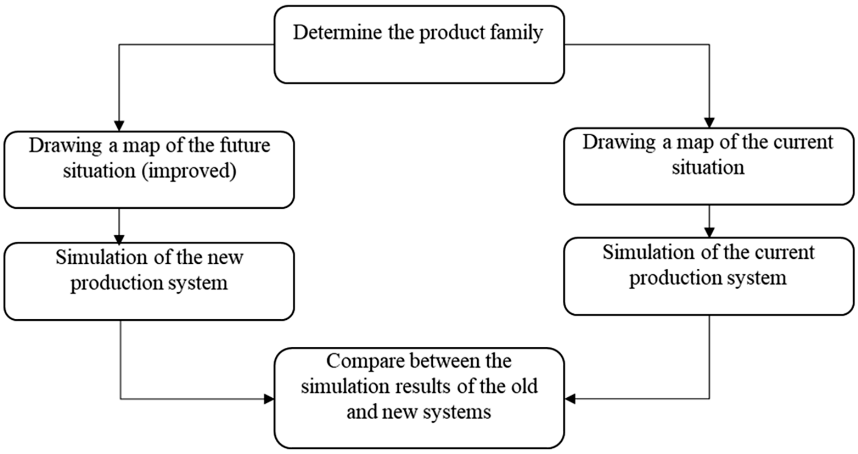
Figure 1
Research implementation process



the process of destruction and pollution of the environment [13, 14]. Every year, the cement production process produces a large amount of dust, toxic gases, and heavy metals, which will cause health respiratory risks and environmental pollution. Also, other harmful environmental effects in the physical part of the cement factory include soil pollution and erosion, air pollution, and noise pollution [15, 16].

Industrial production units, including cement factories, have harmful environmental effects by introducing various pollutants. By carefully examining the cement company studied in this research, it can be seen that in the production system of the factory, there is a lot of energy loss and environmental pollution, which causes the company's low efficiency [17]. Therefore, this issue reduces the loss and improves the production system's efficiency, making it necessary [18]. These losses include overproduction, losses related to transfers, losses related to the process, losses related to spare time, losses related to the production of defective products, and losses due to the maintenance and storage of inventories [19]. The use of value stream mapping is a suitable solution to overcome the problems and obstacles in the traditional production system [20, 21].

3. Research Methodology

The purpose of this research is to reduce waste to improve the performance of the cement company's production process with an environmental approach; the research method used in this research is descriptive action research. Figure 1 shows the stages of the research implementation.

In the investigation and identification of the production system of the studied cement company, data collection will be done using observation and interviews with experts from different units, such as the industrial engineering unit, production planning, control management, warehouse management, and material supply management. Next, the value flow map of the current situation will be drawn using the knowledge obtained from library studies regarding value flow mapping and the review of case studies conducted in this field. In the next step, the future state's value flow map is drawn by answering eight questions designed to improve the system's state. Then, according to the data obtained through time measurement and documents available in the company, the current state of the production system will be simulated by Arena software. After, the improved state of the system, which was obtained by drawing the map of the future state, is simulated.

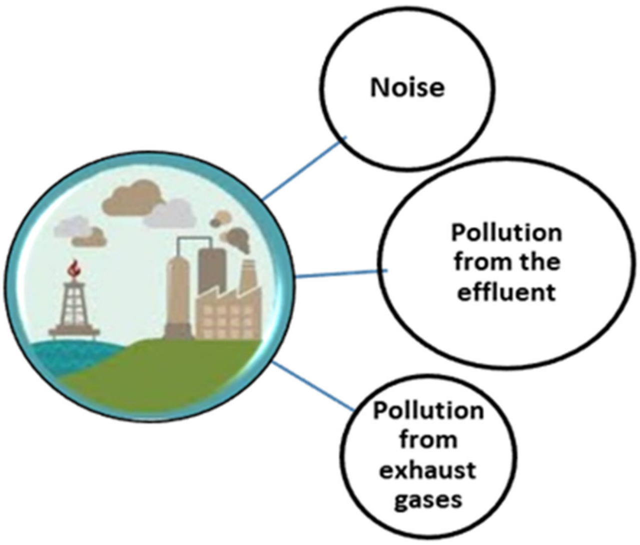
4. Analysis of Findings

This section is presented in two stages, the current state and the improved state. Figure 2 shows the types of pollution in the cement factory.

The pollution from the effluent is:

TDS: All organic and inorganic soluble substances in water

Figure 2
Pollution types



EC: Electrical conductivity of water
DO: dissolved oxygen
The pollution from exhaust gases is:
Co_2: carbon dioxide

4.1. Value flow map based on the current state

Figure 3 depicts the value flow of the current situation in the studied cement company, whose simulated model in Arena software is shown in Figure 4.

To check the level of pollution created in the flow map, the following formulas and indicators are as Equations (1)–(3):
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) + k \tag{1}$$

Vcar: the number of line components in cement production at each stage
d: the length of the study area

Figure 3
Value stream of the current status

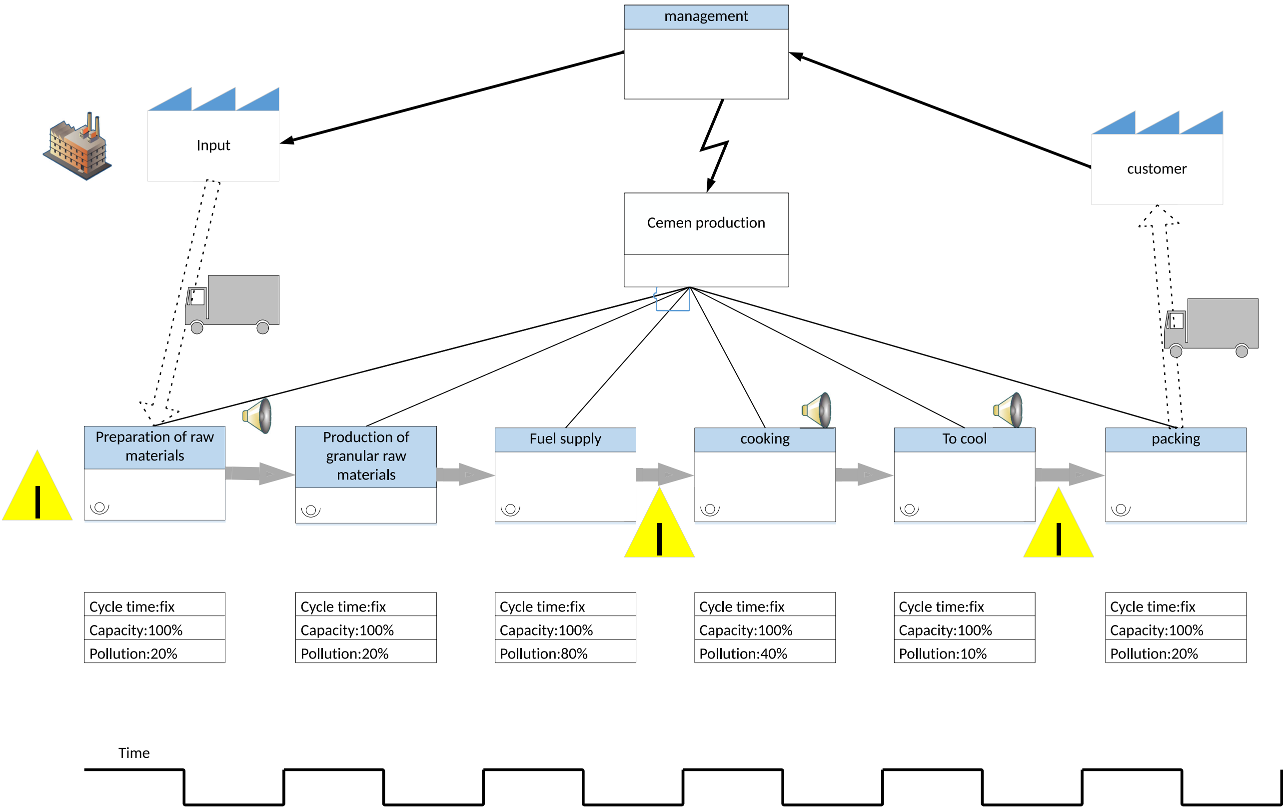
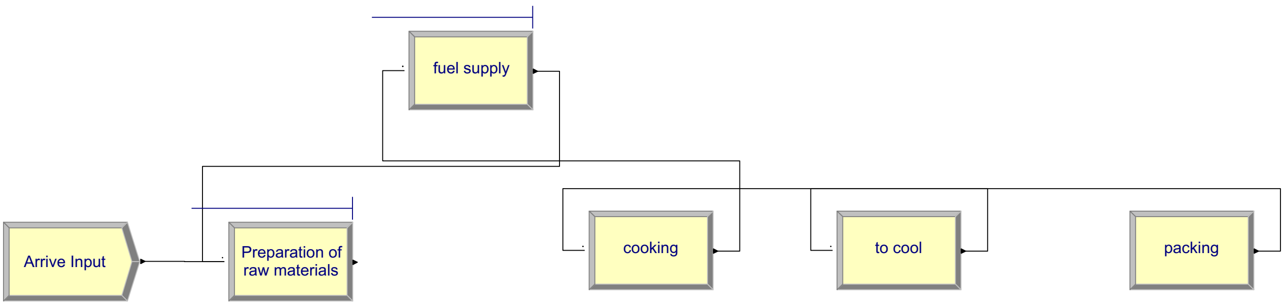


Figure 4
Simulation of the current status



q: the desired distance to measure noise pollution
leg: average sound produced in the study area
k: 1 dB correction factor for every 10 km increase or decrease
Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\,lo) + I\,lo \tag{2}$$

Ip: air quality index (AQI) for pollutant p
Cp: measured error (rounded) for pollutant p
BPhi: breaking point that is greater than or equal to Cp.
BPlo: breaking point that is less than or equal to Cp.
Ihi: AQI value corresponding to *BPhi*
Ilo AQI value corresponding to *Bplo*
Wastewater pollution

$$IRWQI\ sc = \left(\prod_{i=1}^{n} I\ wi_i\right) \tag{3}$$

$$y = \sum_{i=1}^{n} wi$$

Wi: weight of the *i*-th parameter
N: number of parameters
Ii: index value for the *i*-th parameter

This research carried out the obtained parameters during 365 in 4 seasons of the year and expressed in percentage form in flow mapping using formulas and Equations (4)–(17).

Preparation of Raw Materials
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) +\ k \tag{4}$$

$$Leg = 10\,log(10/2000) - 10\,log(10) + 1 = \ -64.027$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\,lo) + I\,lo \tag{5}$$

$$I_p = 150 - 101/300 - 170(300 - 170) + 101 = 83.95$$

$$84 - 64/100 = 20\%$$

Production of Granular Raw Materials
Noise

$$l = 10\ \log\left(\frac{\mathrm{vcar}}{\mathrm{d}}\right) - 10\ \log(q) +\ k \tag{6}$$

$$Leg = 10\,log(10/2000) - 10\,log(10) + 1 = -64.027$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\,lo) + I\,lo \tag{7}$$

$$I_p = 150 - 101/284 - 155(178 - 155) + 101 = 84$$

$$84 - 64/100 = 20\%$$

Fuel Supply
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) +\ k \tag{8}$$

$$Leg = 10\,log(15/2000) - 10\,log(10) + 1 = -69$$

Air Pollution

$$Ip = \frac{I}{BP}h - \frac{I}{BP}lo(C\,p - BP\,lo) + I\,lo \tag{9}$$

$$I_p = 150 - 101/254 - 155(210 - 155) + 101 = 128$$

Wastewater Pollution

$$IRWQI\ sc = \left(\prod_{i=1}^{n} I\ wi_i\right) \tag{10}$$

$$y = \sum_{i=1}^{n} wi$$

$$Y = 0.14 + 0.117 + 0.108 + 0.097 + 0.096 + 0.080 + 0.050 = 0.757$$

$$IRWQI_{sc} = (27^{0.14} * 95^{0.117} * 39^{0.108} * 96^{0.097} * 75^{0.096} * 99^{0.080} * 30^{0.050})^{1/0.757} = 21.01$$

$$-69 + 128 + 21/100 = 80\%$$

Cooking Ingredients
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) + \tag{11}$$

$$Leg = 10\,log(10/2000) - 10\,log(10) + 1 = -23$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\,lo) + I\,lo \tag{12}$$

$$I_p = 235 - 201/0.374 - 0.116(0.130 - 0.116) + 101 = 54$$

Wastewater Pollution

$$IRWQI\ sc = \left(\prod_{i=1}^{n} I\ wi_i\right) \tag{13}$$

$$y = \sum_{i=1}^{n} wi$$

$$Y = 0.151 + 0.134 + 0.129 + 0.103 + 0.088 + 0.085 + 0.050 + 0.074 + 0.067 = 0.911$$

$$IRWQI_{sc} = (99^{0.115} * 22^{0.134} * 87^{0.129} * 88^{0.103} * 26^{0.085} * 98^{0.080} * 100^{0.074} * 35^{0.067})^{1/0.911} = 56$$

$$-23 + 54 + 56 = 40\%$$

Material Cooling
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) +\ k \tag{14}$$

$$Leg = 10\,log(15/2000) - 10\,log(10) + 1 = -69$$

Wastewater Pollution

$$IRWQI\ sc = \left(\prod_{i=1}^{n} I\ wi_i\right) \tag{15}$$

$$y = \sum_{i=1}^{n} wi$$

$$\begin{aligned} Y &= 0.015 + 0.124 + 0.125 + 0.103 + 0.098 + 0.085 + 0.050 \\ &\quad + 0.074 + 0.058 \\ &= 1.168 \end{aligned}$$

$$\begin{aligned} &IRWQI_{sc} \\ &= (79^{0.015} * 32^{0.124} * 87^{0.125} * 87^{0.103} * 24^{0.098} * 95^{0.050} * 95^{0.074} * 35^{0.058})^{1/0.911} \\ &= 79 \end{aligned}$$

$$-69 + 79/100 = 10\%$$

Packaging and Shipping
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) + k \tag{16}$$

$$Leg = 10\,log(10/2000) - 10\,log(10) + 1 = -23$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\ lo) + I\ lo \tag{17}$$

$$I_p = 155 - 101/0.374 - 0.116(0.130 - 0.116) + 101 = 43$$

$$-23 + 43/100 = 20\%$$

Table 1 shows the type of environmental pollution created in each stage. According to Figure 5, most pollution is related to the fuel supply stage.

Table 1
Pollution created in the cement production process by the current model

Row	Process	Moderate noise pollution	Moderate pollution of the effluent	Moderate pollution of exhaust gases and dust
1	Preparation of raw materials	✓	✓	✓
2	Production of granular raw materials	✓	–	✓
3	Fuel supply	✓	✓	✓
4	Cooking ingredients	✓	✓	✓
5	Cooling the material	✓	✓	–
6	Packaging and shipping	✓	–	✓

4.2. Value stream map based on the corrective status

Based on the investigations, the debatable issue in cement production is the issue of waste, which includes several parts. One of the parts that can be examined in cement production is the information available on the transportation time, which includes the time of arrival of raw materials, their conversion into raw materials, and the transfer of materials to the baking section, as well as the output of materials after packaging.

In this section, according to the methods and suggestions presented in the previous sections and by reviewing the available information, the suggestions are summarized, and the company's future value is drawn. Among the measures taken to improve it, the following can be mentioned:

1) Replacement of appropriate and new means of transportation to reduce noise pollution and speed up transportation between stages
2) Reducing transportation operations to eliminate noise pollution
3) Increasing the level of awareness of human resources in critical stages, such as the baking process to reduce hidden and obvious waste
4) Optimizing cooking operations by using suitable fuel replacement in this process and using up-to-date devices to reduce hidden and obvious waste and reduce many environmental pollutions.

Figure 6 shows the improved value flow map, and Figure 7 shows the simulation of the improved value flow map.

To check the level of pollution created in the flow map, the following formulas and indicators are used as Equations (18)–(31).

Preparation of Raw Materials

Sometimes waste cannot be eliminated, but by reducing it, the pollution in this sector will be maximized

Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) + k \tag{18}$$

$$Leg = 10\,log(10/2000) - 10\,log(10) + 1 = -64.027$$

$$I_{p=}150 - 101/202 - 155(178 - 155) + 101 = 79$$

$$79 - 64/100 = 15\%$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\ lo) + I\ lo \tag{19}$$

Production of Granular Raw Materials
Noise

$$Leg = 10\,log(10/2000) - 10\,log(10) + 1 = -64.027 \tag{20}$$

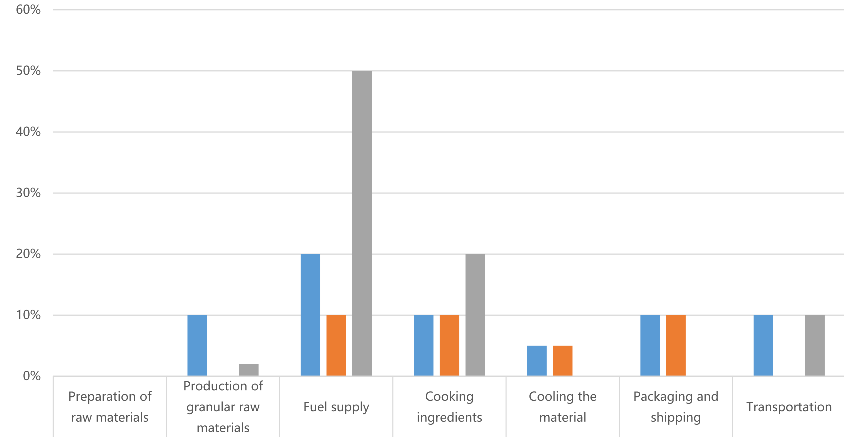
Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\ lo) + I\ lo \tag{21}$$

$$I_p = 150 - 101/284 - 155(178 - 155) + 101 = 79$$

$$79 - 64/100 = 15\%$$

Figure 5
The level of environmental pollution in the cement production process



	Preparation of raw materials	Production of granular raw materials	Fuel supply	Cooking ingredients	Cooling the material	Packaging and shipping	Transportation
Noise pollution	0%	10%	20%	10%	5%	10%	10%
Effluent pollution	0%	0%	10%	10%	5%	10%	0%
Exhaust gases and dust pollution	0%	2%	50%	20%	0%	0%	10%

■ Noise pollution ■ Effluent pollution ■ Exhaust gases and dust pollution

Figure 6
Value stream of the improved status

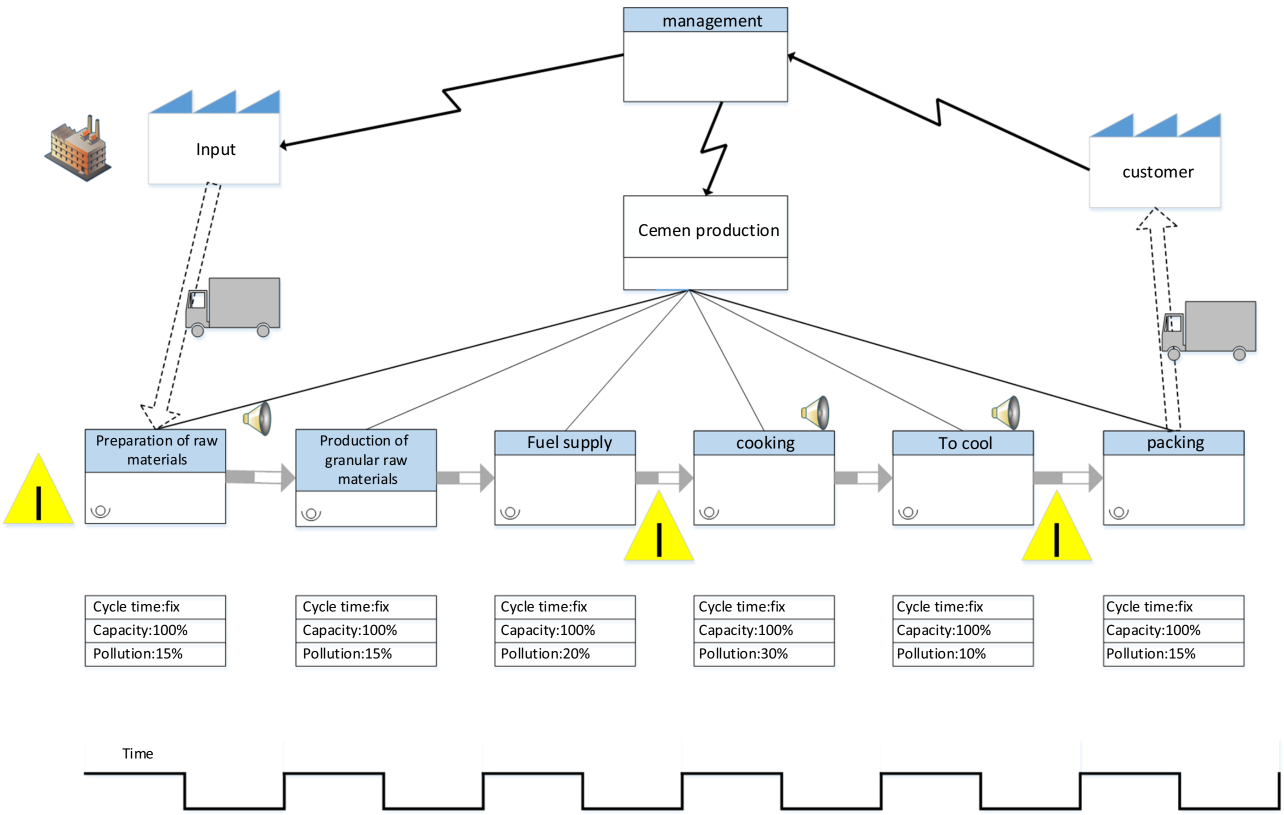
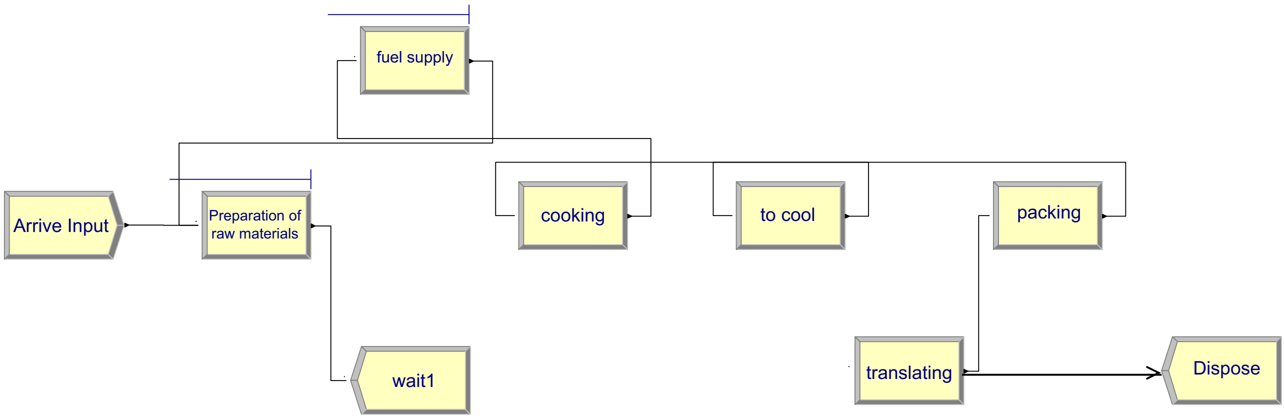


Figure 7
Simulation of improved status



Fuel Supply
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) + \ k \tag{22}$$

$$Leg = 10\,log(15/2000) - 10\,log(10) + 1 = -69$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\ p - BP\ lo) + I\ lo \tag{23}$$

$$I_p = 150 - 101/254 - 155(210 - 155) + 101 = 128$$

Wastewater Pollution

$$IRWQI\ sc = \left(\prod\nolimits_{i=1}^{n} I\ wi_i\right) \tag{24}$$

$$y = \sum\nolimits_{i=1}^{n} wi$$

$$Y = 0.14 + 0.117 + 0.108 + 0.097 + 0.096 + 0.080 + 0.050$$
$$= 0.757$$

$$IRWQI_{sc}$$
$$= (98^{0.14} * 95^{0.117} * 39^{0.108} * 102^{0.097} * 99^{0.096} * 99^{0.080} * 100^{0.050})^{1/0.757}$$
$$= 38.98$$

$$-\ 69 + 128 + 39/100 = 20\%$$

Cooking Ingredients
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) + \ k \tag{25}$$

$$Leg = 10log(10/2000) - 10log(10) + 1 = -23$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\ p - BP\ lo) + I\ lo \tag{26}$$

$$Ip = 235 - 201/0.374 - 0.116(0.130 - 0.116) + 101 = 54$$

Wastewater Pollution

$$IRWQI\ sc = \left(\prod\nolimits_{i=1}^{n} I\ wi_i\right) \tag{27}$$

$$y = \sum\nolimits_{i=1}^{n} wi$$

$$Y = 0.151 + 0.134 + 0.129 + 0.103 + 0.088 + 0.085 + 0.050$$
$$+ 0.074 + 0.067$$
$$= 0.911$$

$$IRWQI_{sc}$$
$$= (99^{0.115} * 22^{0.134} * 87^{0.129} * 88^{0.103} * 26^{0.085} * 98^{0.080} * 100^{0.074} * 35^{0.067})^{1/0.911}$$
$$= 56$$

$$-\ 23 + 54 + 56 = 40\%$$

Material Cooling
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) + \ k \tag{28}$$

$$Leg = 10log(15/2000) - 10log(10) + 1 = -69$$

Wastewater Pollution

$$IRWQI\ sc = \left(\prod\nolimits_{i=1}^{n} I\ wi_i\right) \tag{29}$$

$$y = \sum\nolimits_{i=1}^{n} wi$$

$$Y = 0.015 + 0.124 + 0.125 + 0.103 + 0.098 + 0.085 + 0.050$$
$$+ 0.074 + 0.058$$
$$= 1.168$$

Table 2
Pollution created in the cement production process after applying the improved model

Row	Process	Moderate noise pollution	Moderate pollution of the effluent	Moderate pollution of exhaust gases and dust
1	Preparation of raw materials	–	–	–
2	Production of granular raw materials	✓	–	✓
3	Fuel supply	–	–	✓
4	Cooking ingredients	✓	✓	✓
5	Cooling the material	–	✓	–
6	Packaging and shipping	–	–	✓

$$IRWQI_{sc} = (79^{0.015} * 32^{0.124} * 87^{0.125} * 87^{0.103} * 24^{0.098} * 95^{0.050} * 95^{0.074} * 35^{0.058})^{1/0.911} = 79$$

$$-69 + 79/100 = 10\%$$

Packaging and Shipping
Noise

$$leg = 10\ \log\left(\frac{vcar}{d}\right) - 10\ \log(q) +\ k \tag{30}$$

$$Leg = 10\,log(10/2000) - 10\,log(10) + 1 = -23$$

Air Pollution

$$Ip = \frac{I}{BP}hi - \frac{I}{BP}lo(C\,p - BP\,lo) + I\,lo \tag{31}$$

$$I_p = 155 - 101/0.274 - 0.116(0.103 - 0.116) + 101 = 38$$

$$23 + 38/100 = 15\%$$

After checking the simulation model, the improved situation is presented according to Table 2. It should be noted that pollution caused by cement production can never be eliminated, and it can only be reduced by using modern methods.

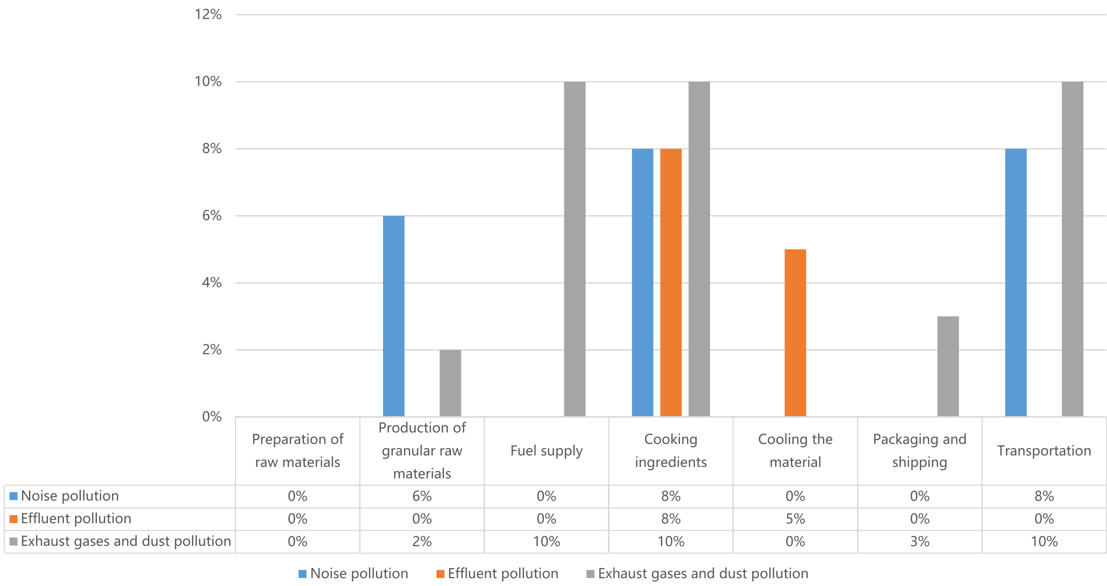
Figure 8 shows the estimation of the reduction of environmental pollution in the stages of cement production.

5. Discussion

In order to fulfill the standards to achieve sustainable development, one of the industries that is given a lot of attention is the cement industry. In this research, by drawing the value flow and simulating the current and future by Arena software, the effects of environmental pollution in the cement production process have been investigated. According to the steps of the value stream mapping, there are requirements that cannot be removed. Also, by examining the current and future flow map and the simulations, there is a difference between the waiting time, which is the result of the elimination and reduction of some losses. But the inventory has not changed, and besides, by eliminating and reducing unnecessary transportation, losses can be minimized. It should be noted that pollution caused by cement production can never be eliminated, and it can only be reduced by using modern methods. The results of the new simulation showed a 30% reduction in pollution after applying the suggestions of experts to reduce waste and eliminate pollution.

Many mineral resources are used in the production of cement. Nowadays, most of the power plants are supplied with fossil fuel,

Figure 8
Prediction of the environmental pollution level in the cement production process



which has many disadvantages, including the reduction of fossil fuel resources, the emission of pollution, etc. For this reason, it is necessary to move toward the production of electricity from renewable energy sources such as biomass. Fuel supply is one of the wastes of modern cement production systems. In developing countries, agricultural waste materials are used as animal feed and even as fuel in rice factories, brick factories, and even cement factories, and this is due to their cheapness and ease of access. These materials play a significant role in reducing environmental pollution.

Agricultural waste is significant. Sugarcane plant waste is the most important source of fuel, which consists of different parts such as stalks, peat, and bagasse. A significant part of this waste is incinerated after reuse and accumulation. However, this produces fine dust in the air. Researchers have developed a system with essential knowledge that reverses this cycle and uses the starting point of waste from another industry. Instead of consuming energy, it also receives energy from this process and uses sugarcane waste to generate electricity and use it to produce quality cement. This is considered a new system in cement production, which, in addition to reducing costs, also plays a vital role in saving resources.

6. Conclusion

The cement production industry is one of the energy-intensive industries and also causes environmental pollution, such as dust particles, carbonaceous compounds, sulfur oxides, and nitrogen, in cement production as the main factor in the production of carbon dioxide factory gas [22, 23].

Considering the role of the cement industry in the sustainable development green approach, this research has tried to provide suitable solutions for the essential efficiency of resources and compliance with environmental principles in different stages of cement. The main question in this research was how to use value stream mapping to identify and reduce waste in order to improve the performance of the cement company's production process with an environmental approach. In this research, using value stream mapping and simulation by Arena software, the losses have been identified, and by redrawing the future value flow map and simulating it, and considering the environmental pollution created in cement production, the losses and pollutions have been reduced.

In order to help the organization pay attention to lean techniques, a possible tool for value stream mapping is needed so that it can determine the benefits obtained during the planning and evaluation stages. This simulation tool has a dynamic performance and is flexible to the organization's details. Simulation can reduce uncertainty and create a dynamic view of inventory levels, delivery times, and machine performance percentages in the future state map. Also, with the help of simulation, it is possible to identify the results obtained from implementing lean production principles and check its effects on the whole system. In addition, the simulation can evaluate the maps of the future state of the successor, which are created through different answers to the designed questions according to the information obtained after drawing the map of the future value flow and simulating it to evaluate. The pollution created in cement production has been evaluated in the future, and the improved state in cement production has been investigated.

There are limitations in every research, and this research also includes limitations. The main limitation of the current research is the unavailability of long-term data for simulation. This paper offers some suggestions for cement managers:

1) It is suggested that some people be employed in the factory as those responsible for measuring environmental standards next to each main activity so that they act strongly toward implementing environmental requirements and monthly and continuous reports along with the definitions of strategic themes regarding the improvement of environmental performance. Deliver an environment with a green approach.
2) Using various systems to reduce pollution caused by exhaust gases, such as filtration systems.
3) Using new systems to reduce environmental pollution, especially greenhouse gases, such as replacing suitable fuel and using renewable resources.
4) Modeling foreign companies that have been successful in the green approach model.

Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

Data available on request from the corresponding author upon reasonable request.

Author Contribution Statement

Somaieh Alavi: Conceptualization, Methodology, Validation, Investigation, Data curation, Writing – original draft, Supervision, Project administration. **Parisa Siamaki:** Software, Formal analysis, Investigation, Data curation, Writing – review & editing, Visualization. **Seyedmehdi Mirmohammadsadeghi:** Conceptualization, Methodology, Validation, Investigation, Writing – original draft, Supervision.

References

[1] Singh, A., Philip, D., Ramkumar, J., & Das, M. (2018). A simulation based approach to realize green factory from unit green manufacturing processes. *Journal of Cleaner Production*, *182*, 67–81. https://doi.org/10.1016/j.jclepro.2018.02.025

[2] Balkhi, B., Alshahrani, A., & Khan, A. (2022). Just-in-time approach in healthcare inventory management: Does it really work? *Saudi Pharmaceutical Journal*, *30*(12), 1830–1835. https://doi.org/10.1016/j.jsps.2022.10.013

[3] Mohan, J., Rathi, R., Kaswan, M. S., & Nain, S. S. (2022). Green lean six sigma journey: Conceptualization and realization. *Materials Today: Proceedings*, *50*, 1991–1998. https://doi.org/10.1016/j.matpr.2021.09.338

[4] Jum'a, L., Zimon, D., Ikram, M., & Madzík, P. (2022). Towards a sustainability paradigm; the nexus between lean green practices, sustainability-oriented innovation and Triple Bottom Line. *International Journal of Production Economics*, *245*, 108393. https://doi.org/10.1016/j.ijpe.2021.108393

[5] Aalavi, S., & Janatyan, N. (2021). Identifying and prioritizing activities of green project management based on lean-sustainable principles in Isfahan Parks and Green Space Organization. *Research in Production and Operations Management*, *11*(4), 1–25. http://doi.org/10.22108/JPOM.2021.126382.1316

[6] Huang, Z., Kim, J., Sadri, A., Dowey, S., & Dargusch, M. S. (2019). Industry 4.0: Development of a multi-agent system for dynamic value stream mapping in SMEs. *Journal of Manufacturing Systems*, *52*, 1–12. https://doi.org/10.1016/j.jmsy.2019.05.001

[7] Silvestri, L., Gallo, T., & Silvestri, C. (2022). Which tools are needed to implement Lean Production in an Industry 4.0 environment? A literature review. *Procedia Computer Science*, *200*, 1766–1777. https://doi.org/10.1016/j.procs.2022.01.377

[8] Galvão, G. D. A., Homrich, A. S., Geissdoerfer, M., Evans, S., Ferrer, P. S. S., & Carvalho, M. M. (2020). Towards a value stream perspective of circular business models. *Resources, Conservation and Recycling*, *162*, 105060. https://doi.org/10.1016/j.resconrec.2020.105060

[9] de Oliveira, J. A., Devos Ganga, G. M., Godinho Filho, M., Silva, D. A. L., dos Santos, M. P., Aldaya Garde, I. A., . . . , & Ometto, A. R. (2022). Environmental and operational performance is not always achieved when combined with cleaner production and lean production: An overview for emerging economies. *Journal of Environmental Planning and Management*, *65*(8), 1530–1559. https://doi.org/10.1080/09640568.2021.1940888

[10] Orisaremi, K. K., Chan, F. T., Chung, S. H., & Fu, X. (2022). A sustainable lean production framework based on inverse DEA for mitigating gas flaring. *Expert Systems with Applications*, *206*, 117856. https://doi.org/10.1016/j.eswa.2022.117856

[11] Mofolasayo, A., Young, S., Martinez, P., & Ahmad, R. (2022). How to adapt lean practices in SMEs to support Industry 4.0 in manufacturing. *Procedia Computer Science*, *200*, 934–943. https://doi.org/10.1016/j.procs.2022.01.291

[12] Kong, L., Wang, L., Li, F., & Guo, J. (2022). Toward product green design of modeling, assessment, optimization, and tools: A comprehensive review. *The International Journal of Advanced Manufacturing Technology*, *122*(5), 2217–2234. https://doi.org/10.1007/s00170-022-10021-9

[13] Agyabeng-Mensah, Y., Tang, L., Afum, E., Baah, C., & Dacosta, E. (2021). Organisational identity and circular economy: Are inter and intra organisational learning, lean management and zero waste practices worth pursuing? *Sustainable Production and Consumption*, *28*, 648–662. https://doi.org/10.1016/j.spc.2021.06.018

[14] Benhelal, E., Shamsaei, E., & Rashid, M. I. (2021). Challenges against CO_2 abatement strategies in cement industry: A review. *Journal of Environmental Sciences*, *104*, 84–101. https://doi.org/10.1016/j.jes.2020.11.020

[15] Alavi, S., Peivandzani, S., & Mirmohammadsadeghi, S. (2021). Risk assessment and prioritization of ERP implementation based on BSC. *Journal of Human, Earth, and Future*, *2*(1), 16–23. https://doi.org/10.28991/HEF-2021-02-01-02

[16] Mishra, U. C., Sarsaiya, S., & Gupta, A. (2022). A systematic review on the impact of cement industries on the natural environment. *Environmental Science and Pollution Research*, *29*(13), 18440–18451. https://doi.org/10.1007/s11356-022-18672-7

[17] Ighalo, J. O., & Adeniyi, A. G. (2020). A perspective on environmental sustainability in the cement industry. *Waste Disposal & Sustainable Energy*, *2*(3), 161–164. https://doi.org/10.1007/s42768-020-00043-y

[18] Alavi, S., Arbab Shirani, B., & Esfandiari, E. (2014). Investigation about the relationship between organizational learning and innovation from system dynamic view in Isfahan engineering research center. *Research in Production and Operations Management*, *5*(1), 71–92. https://jpom.ui.ac.ir/article_19807_en.html

[19] Kumar, N., Hasan, S. S., Srivastava, K., Akhtar, R., Yadav, R. K., & Choubey, V. K. (2022). Lean manufacturing techniques and its implementation: A review. *Materials Today: Proceedings*, *64*, 1188–1192. https://doi.org/10.1016/j.matpr.2022.03.481

[20] Mirmohammadsadeghi, S., Ahmed, S., & Nadirah, E. (2014). Application of memetic algorithm to solve truck and trailer routing problems. In *Proceedings of the 2014 International Conference on Industrial Engineering and Operations Management*, 747–755.

[21] Poudyal, L., & Adhikari, K. (2021). Environmental sustainability in cement industry: An integrated approach for green and economical cement production. *Resources, Environment and Sustainability*, *4*, 100024. https://doi.org/10.1016/j.resenv.2021.100024

[22] Dinga, C. D., & Wen, Z. (2022). China's green deal: Can China's cement industry achieve carbon neutral emissions by 2060? *Renewable and Sustainable Energy Reviews*, *155*, 111931. https://doi.org/10.1016/j.rser.2021.111931

[23] Schneider, M. (2019). The cement industry on the way to a low-carbon future. *Cement and Concrete Research*, *124*, 105792. https://doi.org/10.1016/j.cemconres.2019.105792

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