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ORIGINAL RESEARCH ARTICLE

Application of Knowledge in Integrated Lean-Green Production (Case Study: Model Presentation in the Food Industries)

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ABSTRACT

The aim of the research is to apply knowledge in the production of lean-green vegetables (case study: presentation of a model in the food industry). This research has been done in an applied and survey way. With Dematel's multi-criteria decision making expert method, the internal relationships of the variables have been examined. An expert questionnaire has been designed. The community of unit managers were the managers of food industry units. Validity based on the consistency rate of 0.656 was obtained and confirmed. The number of samples that included managers of food industry units in Azerbaijan province with at least 15 years of experience in the field of food industry and having at least a master's degree, which was determined to be 14 people, considering the acceptable sample size (10-25 people). The identified criteria include motivations and success factors related to human resource management, motivations and organizational success factors, systemic challenges and obstacles, managerial challenges and obstacles, challenges and obstacles related to human resources, methods, tools and techniques. Environmental processes, methods, tools and techniques, key factors of social-operational performance and key factors of environmental performance. Based on Dematel's analysis, motivations and success factors related to human resource management are the most effective. Systemic challenges and obstacles are in second place. The motivations and factors of organizational success are in the next level of influence. The key factors of socio-operational performance are the least effective. **©authors**.

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1. Introduction

Integrated lean-green production as a new approach in production management (Baas et al, 2024), by combining the principles of lean production and green production, pursues goals such as optimizing resources, reducing waste, and protecting the environment (Sadiku et al, 2023). In this regard, knowledge and innovation play a key role in successfully implementing this approach. On the one hand, lean production focuses on eliminating waste, increasing productivity, and optimizing processes; On the other hand, green production tries to reduce negative environmental effects and exploit renewable resources. For this reason, technical and managerial knowledge plays a key role in lean-green production and helps organizations achieve productivity and environmental sustainability at the same time (Rifqi et al, 2021). Knowledge of lean and green production plays an essential role in optimizing production processes and reducing waste. Focusing on eliminating waste and continuous improvement, lean manufacturing uses process engineering knowledge, data mining, and statistical analysis to optimize workflow and use resources more efficiently (Tardio et al, 2023). Knowledge related to tools such as "kaizen", "Six Sigma" and "value-added diagrams" help organizations to identify weak points in processes and improve them. This knowledge is also used in training employees and improving their skills to implement processes more accurately and efficiently, which leads to a reduction in waste and an increase in productivity (Díaz-Reza et al, 2022).

In green production, knowledge of clean technologies and environmental sustainability plays a key role (Ferrazzi et al, 2024). By taking advantage of knowledge in the fields of renewable energy, waste management, and product design according to the life cycle, organizations can optimize their production with the least environmental impact (Wu et al, 2012). For example, using recycled materials, optimizing energy consumption, and reducing greenhouse gas emissions are achieved with environmental and engineering knowledge. This knowledge also helps companies to fulfill their social responsibility to protect the environment and achieve long-term sustainability (Kumar et al, 2022) along with increasing productivity.

In the first step, the knowledge related to process engineering and production optimization is very critical in integrated lean-green production (Rossini et al, 2019). This knowledge allows organizations to design their production processes in a way that produces the least waste and optimal use of energy resources and raw materials. This knowledge includes the application of various tools such as material flow diagrams, value-added analysis and big data-based analyses that help organizations identify bottlenecks in the production process and correct them with minimal energy and material consumption (Kruse et al., 2023).

Second, knowledge of clean technologies and renewable energies plays an important role in green production (Bortolini et al, 2022). Using technologies that have the least environmental impact, such as solar, wind energy, or the use of recycled materials, can help reduce the carbon footprint of production (Mirzaagha et al, 2016). This type of knowledge not only includes the technical knowledge related to the application of green technologies but also knowing the methods of measuring and evaluating environmental effects is also a part of it. For example, the use of indicators such as product life cycle analysis helps organizations to evaluate the environmental impact of their products throughout the entire production cycle and to get closer to their environmental goals with improvements such as optimizing energy consumption and reducing waste. Third, sustainable supply chain management plays an essential role as one of the critical aspects in integrated clean-green production (Mekhum, 2020). Knowledge in this field helps organizations to optimize their supply chains based on sustainable and lean principles. This means employing suppliers with high environmental performance, reducing transportation routes, and using raw materials with lower environmental impacts

(Zhu et al, 2020). The use of advanced logistics models and smart technologies such as blockchain in tracking the supply chain enables organizations to ensure the transparency and sustainability of the entire process (Rakhmatullina et al, 2023). Human resource management and organizational culture play a central role in the success of integrated clean-green production. Knowledge of human resource management is essential to create a green and clean culture in the organization. This includes training employees to improve processes, promote environmental awareness, and promote innovation in energy and materials management. Organizations need to steer their culture in a direction where sustainability is seen as a core value and employees are encouraged to actively contribute to the continuous improvement of production processes. In today's era, for the company to remain competitive and progress in the long term, it must focus on its sustainable efforts to provide value to its customers (Figueroa et al, 2024).

This is achieved by timely delivery of products and services, at reasonable prices, that are highly useful and do not incur environmental responsibilities (Abreu et al., 2017). For this purpose, companies are encouraged to design, produce and present products that can be sustainable in the competitive world in addition to creating new value for customers, and customers are demanding sustainable products, and government restrictions for the production of environmentally friendly products are constantly increasing. It is increasing (Hashmi Sohi and Mansour, 2015) and companies not only need very high production and responsive production systems, but also environmentally friendly systems, that is, systems that provide more value with less environmental factors. They offer, they need. Nowadays, it can be seen that due to the legal and environmental restrictions, the demand for environmentally friendly products has increased greatly (Shokri et al, 2022). The aim of lean manufacturing techniques is to improve business processes (Saetta & Caldarelli, 2020). In the meantime, some companies have united to reduce the negative effects of their operations on the environment. The resulting "green" systems have sometimes led to a stunning reduction in energy consumption, waste production, and consumption of hazardous materials, and at the same time, the image of these companies has also been improved by organizations that They have become socially responsible (Bergmiller & McCright, 2009). So that many of the leading companies have implemented lean production programs that include increasing productivity, reducing costs and many other benefits, and with environmental concerns being raised, some other organizations have implemented green production programs. which results in reducing energy consumption, reducing waste production, and reducing the use of hazardous materials (Farias et al., 2019). With regard to the above content, there is no doubt that in today's era, achieving growth and progress in the industry requires the use of new methods and the use of new equipment and methods, which by using these methods, the circulation of products and productivity will increase, as well as time and cost. production decreases, in the meantime, the increase in population and lack of food has caused the use of new methods to improve productivity in the food industry, as one of the most influential and important industries in today's human life, more than ever before. should be taken into consideration and it is inevitable, because food security for the people of a society is realized when the people of the society can have access to healthy and sufficient food at any time, and improving food security, the need to increase the production of quality food, It is healthy and the price is reasonable, and besides this issue, the existence of a competitive market in the field of production, especially in the field of food industry, makes the use of new production methods in order to maintain and develop the market in this industry an unavoidable issue, so that the change of methods and approaches The production and application of new technologies and methods and the use of modern technologies in the food industry, in addition to improving the quality of

products and ensuring food safety, can play a significant role in the growth and development of business.

2. Literature Review

Pure-green production

Lean manufacturing is a management approach that focuses on reducing waste and optimizing production processes (Dave, 2020). The main goal of lean manufacturing is to increase productivity and reduce costs by eliminating unnecessary activities, reducing waiting times, improving quality, and minimizing waste. This method works with tools such as "Kaizen" (continuous improvement), "Just-in-time" (just-in-time production), and "Six Sigma" (reducing fluctuations) to optimize production processes and create more added value for customers.

Green production is an environmental approach in the production process that aims to reduce environmental impacts and optimal use of natural resources (Chen et al, 2020). This concept includes the use of renewable energy, reducing the consumption of raw materials, recycling waste, and reducing the emission of environmental pollution.

Green production, focusing on the sustainability and social responsibility of organizations, leads to the creation of production processes that ensure compatibility with the environment while maintaining product quality (Akbari et al, 2022). Green, Lean, Six Sigma are three distinct approaches, but they are synergistic because they jointly focus on waste reduction and effective use of resources (Figure 1).

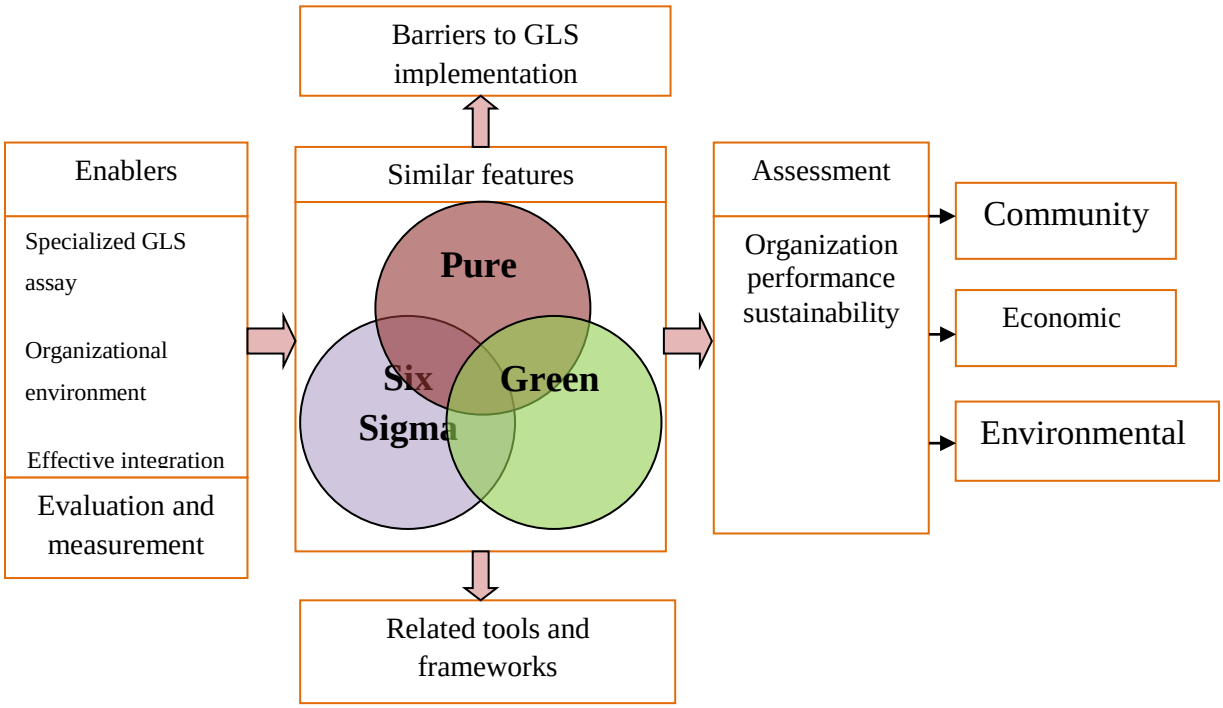

Figure 1. *GLS integration model (Kaswan & Rathi, 2020).*

3. Method

This research has been done in an applied and survey way. With Dimtel's multi-criteria decision making expert method, the internal relationships of the variables have been examined. An expert questionnaire has been designed. The community of unit managers were the managers of food industry units.

Validity based on the consistency rate of 0.656 was obtained and confirmed.

The number of samples that included managers of food industry units in Azerbaijan province with at least 15 years of experience in the field of food industry and having at least a master's degree, which was determined to be 14 people, considering the acceptable sample size

(10-25 people) The demographic characteristics of 14 experts in the Dematel analysis stage are given in Table 1.

Table 1. *Demographic characteristics of experts in Dematel analysis*

Frequency (Percentage)	Education	Frequency (Percentage)	Age	Frequency (Percentage)	Management history	Frequency (Percentage)	Gender
6	MA.	2 (14%)	30 to 40	7 (50%)	15-20	12(86%)	Man
(43%)	Ph.D.	8 (57%)	40 to 50	3 (21%)	20-25	2 (14%)	Woman
-	-	4 (29%)	Above 50	4(29%)	25-30	-	-
14(100%)							Total

First, the opinions of experts have been collected. Before that, it is necessary to mention that the components are coded as described in Table 2.

Table 2. *Coding of research components*

Key factors of environmental performance	Key factors of socio-operational performance	Environmental methods, tools and techniques	Process methods, tools and techniques	Challenges and obstacles related to human resources	Management challenges and obstacles	Systemic challenges and obstacles	Motivations and organizational success factors	Motivations and success factors related to human resource
C9	C8	C7	C6	C5	C4	C3	C2	C1
Ref: (Chen et al, 2020); (Kaswan & Rathi, 2020); (Figueroa et al, 2024).								

4. Findings

When the opinion of several experts is used, the simple arithmetic mean of the opinions is used and we form a direct correlation matrix. The direct correlation matrix of expert opinions is presented in Table 3.

Table 3. *Calculation of direct correlation matrix of components*

Component	C1	C2	C3	C4	C5	C6	C7	C8	C9	Total
C1	0.0	2.4	2.4	2.6	2.1	2.6	2.6	2.9	2.9	20.4
C2	1.5	0.0	1.2	2.9	1.3	3.4	3.1	3.0	3.0	19.4
C3	1.6	1.5	0.0	2.9	1.6	3.1	3.0	3.1	3.0	19.8
C4	1.8	1.7	1.8	0.0	2.0	2.1	1.7	2.4	2.4	15.8
C5	1.7	1.6	1.8	1.1	0.0	2.9	2.6	3.1	2.9	17.6
C6	1.9	1.9	1.7	1.6	2.4	0.0	2.3	2.0	2.3	16.1
C7	2.1	1.8	2.1	2.1	1.9	1.0	0.0	1.8	1.4	14
C8	1.2	1.6	1.5	1.6	1.6	1.9	1.9	0.0	1.9	13.3
C9	1.9	1.8	2.0	1.9	1.8	1.7	1.5	1.4	0.0	13.9

Calculation of normal direct correlation matrix First, the sum of all rows is calculated. The inverse of the largest sum of rows is k. According to Table 3, the largest number is 20.4, and all values in the table are multiplied by the inverse of this number to make the matrix normal (N = K*M). This matrix is presented in Table 4.

$$k = \frac{1}{\max \sum_{j=1}^{n} a_{ij}} = \frac{1}{20.4} = 0.049$$

⇨ N = 0.049*M

Table 4. *Normalized matrix (N) of components*

Component	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0.000	0.115	0.115	0.126	0.105	0.129	0.129	0.140	0.140
C2	0.073	0.000	0.059	0.143	0.063	0.164	0.154	0.147	0.147
C3	0.077	0.073	0.000	0.143	0.077	0.150	0.147	0.154	0.147
C4	0.087	0.084	0.087	0.000	0.098	0.101	0.084	0.115	0.115
C5	0.084	0.080	0.087	0.052	0.000	0.140	0.126	0.150	0.143
C6	0.091	0.094	0.084	0.080	0.119	0.000	0.112	0.098	0.112
C7	0.101	0.087	0.101	0.101	0.091	0.049	0.000	0.087	0.066

C8	0.059	0.080	0.073	0.080	0.080	0.091	0.091	0.000	0.094
C9	0.091	0.087	0.098	0.091	0.087	0.084	0.073	0.066	0.000

Calculation of the complete correlation matrix

To calculate the complete correlation matrix, the same matrix (I) is formed first. Then we subtract the same matrix from the normal matrix and invert the resulting matrix. Finally, we multiply the normal matrix by the inverse matrix. The complete correlation matrix is presented in Table 5.

$$T = N \times (I - N)^{-1}$$

Table 5. *Complete correlation matrix (T) of the components*

Component	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0.386	0.507	0.510	0.571	0.511	0.613	0.620	0.647	0.653
C2	0.430	0.378	0.437	0.554	0.450	0.604	0.604	0.615	0.621
C3	0.440	0.454	0.389	0.563	0.470	0.603	0.608	0.632	0.632
C4	0.385	0.397	0.402	0.362	0.418	0.486	0.477	0.518	0.523
C5	0.411	0.423	0.432	0.445	0.360	0.552	0.548	0.582	0.582
C6	0.396	0.413	0.407	0.445	0.443	0.404	0.510	0.514	0.530
C7	0.370	0.372	0.386	0.424	0.383	0.410	0.366	0.461	0.447
C8	0.317	0.346	0.342	0.383	0.355	0.419	0.424	0.353	0.443
C9	0.359	0.369	0.380	0.412	0.377	0.436	0.431	0.439	0.381

Display the map of network relations

A threshold value must be calculated to determine the Network Relationship Map (NRM). With this method, partial relationships can be ignored and the network of significant relationships can be drawn. Only relations whose values in matrix T are greater than the threshold value will be displayed in NRM. To calculate the threshold value of relationships, it is enough to calculate the average values of the matrix T. After the intensity of the threshold is determined, all the values of the T matrix that are smaller than the threshold are zeroed, that is, the causal relationship is not considered. In this study, the threshold value is 0.462. Therefore, the pattern of significant relationships will be as shown in Table 6.

Table 6. *Pattern of significant relationships of components*

Component	C1	C2	C3	C4	C5	C6	C7	C8	C9
C1	0	1	1	1	1	1	1	1	1
C2	0	0	0	1	0	1	1	1	1
C3	0	0	0	1	1	1	1	1	1
C4	0	0	0	0	0	1	1	1	1
C5	0	0	0	0	0	1	1	1	1
C6	0	0	0	0	0	0	1	1	1
C7	0	0	0	0	0	0	0	0	0
C8	0	0	0	0	0	0	0	0	0
C9	0	0	0	0	0	0	0	0	0

As shown in Table 6, the number 1 means that the component has a causal relationship with another component. For example, C1 (engines and success factors related to human resource management) has a causal relationship with all components.

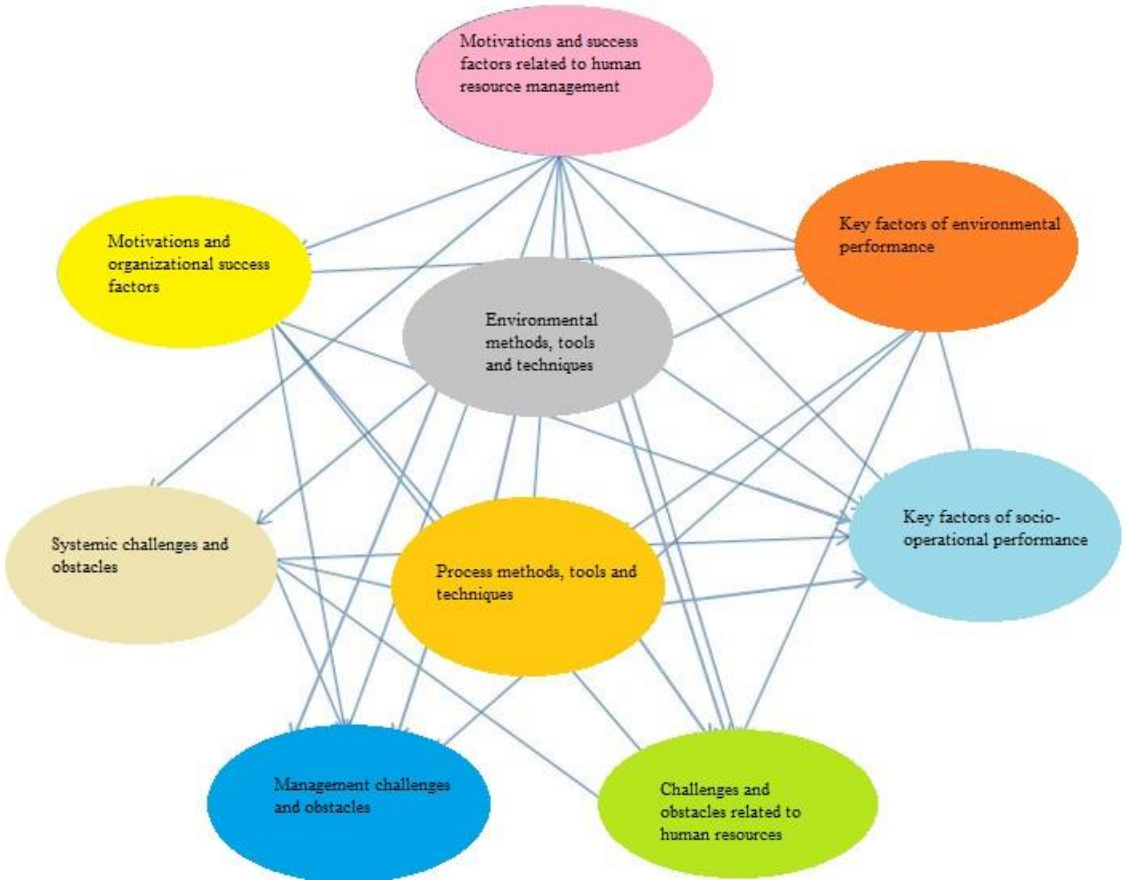

Figure 2. *Pattern of internal relations of model components*

According to the relationship pattern, the causal diagram can be drawn according to Figure 42 and based on Table 7.

The consistency index is 0.087 and it is confirmed

Table 7. *Pattern of causal relationships of components*

Components	D	R	D+R	D-R
Motivations and success factors related to human resource management	5.017	3.493	8.510	1.523
Motivations and organizational success factors	4.693	3.660	8.354	1.033
Systemic challenges and obstacles	4.790	3.686	8.476	1.105
Management challenges and obstacles	3.968	4.158	8.126	-0.190
Challenges and obstacles related to human resources	4.335	3.766	8.102	0.569
Process methods, tools and techniques	4.063	4.526	8.589	-0.463
Environmental methods, tools and techniques	3.619	4.588	8.207	-0.969
Key factors of socio-operational performance	3.382	4.761	8.143	-1.379
Key factors of environmental performance	3.585	4.813	8.398	-1.228

In Table 7, the sum of the elements of each row (D) indicates the influence of that factor on other factors of the system. Therefore, motivations and success factors related to human resource management are the most effective. Systemic challenges and obstacles are in second place. The motivations and factors of organizational success are in the next level of influence. The key factors of socio-operational performance are the least effective.

- The sum of the elements of the column (R) for each factor indicates the degree of influence of that factor on other factors of the system. Therefore, the key factors of environmental performance have a very high degree of influence. The key factors of social-operational performance are also in the next category. Motivations and success factors related to human resource management have the least influence from other criteria.

- The horizontal vector (D + R) is the degree of influence of the desired factor in the system. In other words, the higher the D + R value of an agent, the more interaction that agent has with other system agents. Therefore, methods, tools and process techniques have the most interactions with other studied criteria. Challenges and obstacles related to human resources have the least interaction with other variables.

- The vertical vector (D - R) shows the influence of each factor. In general, if D - R is positive, the variable is considered a causal variable, and if it is negative, it is considered an effect. In this model, motivations and factors of success related to human resources management, motivations and factors of organizational success, systemic challenges and obstacles, and challenges and obstacles related to human resources are the causal variables. Also, process methods, tools and techniques, management challenges and obstacles, environmental methods, tools and techniques, key factors of socio-operational performance and key factors of environmental performance are disabled variables. The results are presented in Figure 3 in Cartesian coordinates.

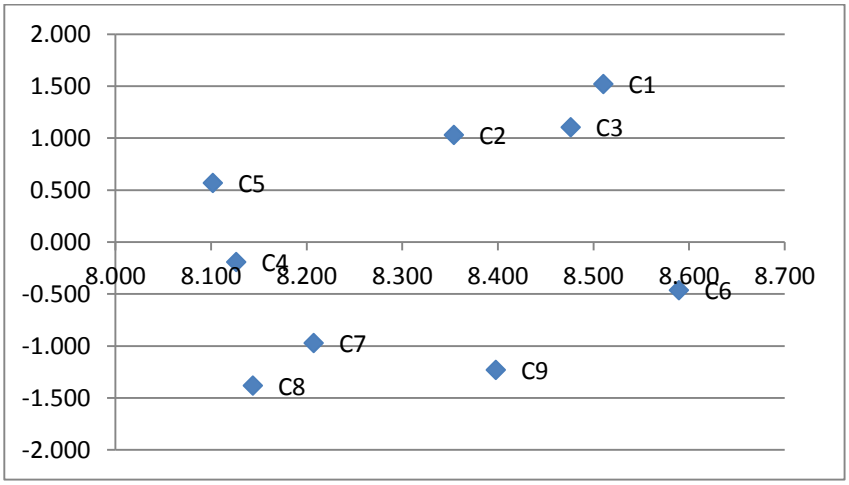

Figure 3. *Cartesian coordinates of DEMATEL output for components*

In integrated lean-green production within the food industry, the relationships among various criteria play a crucial role in the success and realization of this model. On one hand, the drivers and success factors related to human resource management, such as employee training and the creation of a green organizational culture, can enhance productivity and reduce waste. Alongside this, organizational success factors like effective leadership and managerial commitment to green production principles can foster an environment conducive to innovation and process improvement. However, systemic challenges and barriers, such as a lack of coordination between different organizational departments, along with managerial challenges like resistance to change, can significantly affect the implementation of this model.

Additionally, human-related challenges, including a shortage of necessary skills and employee motivation issues, may hinder

the achievement of environmental and operational goals.

On the other hand, methods, tools, and process techniques such as production line optimization and green supply chain management play a vital role in facilitating lean production processes. Furthermore, environmental methods and tools, such as life cycle assessment and environmental management standards, assist organizations in minimizing their environmental impacts and moving toward more sustainable production. Social-operational key performance indicators, such as customer satisfaction and corporate social responsibility, significantly influence the organization's reputation and success. Similarly, environmental key performance indicators, such as energy consumption reduction and the use of sustainable raw materials, are essential for creating a lean-green production system. Overall, the interaction between these criteria and attention to challenges and opportunities can contribute to achieving sustainable success in the food industry.

5. Discussion

Human resource management plays a vital role in the application of knowledge in integrated clean-green production. Drivers and success factors related to human resource management include continuous training of employees, empowerment and creation of green culture and productivity. Training employees in the field of lean and green production increases their knowledge and skills in improving processes and reducing waste. Also, empowering employees by giving them authority in environmental and process decisions increases their motivation and active participation in the implementation of green and lean approaches. Creating an organizational culture that reinforces values such as environmental responsibility and continuous improvement (Gholami et al, 2021) is another key success factor in human resource management. These actions make employees play a role as an active force in the pure-green production process. On the other hand, the drivers and factors of organizational success are also very important in the implementation of lean-green production. Senior managers' support for green and lean strategies, setting specific goals and creating stable organizational frameworks are among these drivers. Organizational success in this area is possible when structures (Tahmasebifard et al, 2018) and organizational processes are designed in such a way as to facilitate coordination between production and environmental goals (Terelak-Tymczyna et al, 2024). In addition, the use of advanced technologies, such as intelligent production and resource management systems (Farrukh et al, 2022) and attention to environmental innovations, are key factors in improving the organization's performance in lean-green production. These success factors enable organizations to make sustainable improvements in their operations and achieve competitive advantages in the market. In the application of knowledge in integrated lean-green production (Bai et al, 2018), systemic challenges and obstacles are one of the biggest implementation obstacles. These challenges can include infrastructure problems, the lack of harmonized standards for green processes, and the complexities of integrating traditional systems with new green and lean technologies. In the food industry, implementing lean-green production requires coordination between different parts of the supply chain, but existing systems may not be technologically and data-driven ready for such changes. The lack of suitable platforms for production data analysis and real-time monitoring of environmental processes is also one of the important system obstacles that slow down the implementation process of this approach. Management challenges and obstacles are

also significant in the implementation of clean-green production.

Organizational management may encounter resistance to change, especially in industries such as the food industry that have long relied on traditional methods of production. Managers may be concerned about the initial costs of implementing green and lean technologies and see these costs as a barrier to investing in environmental improvements.

In addition, the lack of specific strategies and long-term goals related to green and lean production can lead to managerial confusion and weakness in strategic planning. On the other hand, challenges and obstacles related to human resources also have a significant effect on the success of this approach. Many employees may lack sufficient training in areas related to lean and green production and their ability to adapt to new changes is limited. Also, cultural resistance to change and implementation of new processes can prevent the active participation of the workforce in environmental improvements and production productivity. Increasing the awareness and specialized training of human forces and encouraging them to cooperate in the implementation of these approaches is necessary to overcome these obstacles.

In the application of integrated lean-green production knowledge, methods, tools and process techniques include approaches to optimize the production flow and reduce waste. In this regard, tools such as "Kaizen" (continuous improvement), "Just in Time" (JIT), and "5S" technique are used to organize the work environment. These techniques are used in the food industry with the aim of reducing waste, improving productivity and improving the quality of products. For example, just-in-time (JIT) manufacturing helps to produce food just when it is needed and prevents stockpiling and spoilage. Also, tools like "Six Sigma" help improve the quality of production processes and reduce defects and ensure that resources are used optimally.

Environmental practices, tools, and techniques include utilizing renewable resources, reducing energy consumption, and minimizing pollutant emissions.

For example, the use of low-energy technologies such as smart systems to manage energy consumption in food production is considered as one of the green solutions. Also, implementing recycling techniques and reusing waste materials as well as optimizing packaging processes to reduce the use of plastic and non-degradable materials are also other environmental measures. These techniques help reduce negative impacts on the environment and align production with sustainability requirements. The key factors of socio-operational performance in this model include promoting social responsibility and improving the working conditions of employees.

The implementation of lean-green production can increase employee satisfaction and strengthen their participation in continuous improvement processes by reducing pollutants and improving the working environment. Also, supporting local communities through job creation and meeting environmental standards helps to improve the organization's social image. Key environmental performance factors include reducing natural resource consumption, reducing carbon emissions and production waste, and improving resource efficiency.

The use of renewable energy, optimization of water and raw material consumption in the production process and intelligent management of resources are among the factors that guarantee the improvement of environmental performance.

The implementation of these factors reduces harmful environmental effects and increases business sustainability in the food industry.

6. Conclusion

In conclusion from the application of knowledge in lean-green production integrated with a case study of food industry, it can be said that combining these two approaches can significantly help to optimize performance and reduce waste in the production chain. The knowledge of process engineering and optimization in lean production provides the possibility of identifying and eliminating unnecessary and inefficient activities and increases productivity in different stages of production, from the preparation of raw materials to the distribution of the final product. In the food industry, this means reducing food waste, production time and energy consumption. Environmental knowledge and green technologies in integrated manufacturing also help to reduce environmental impacts. This is especially important in food industries that directly deal with natural resources and extensive energy consumption. Applying clean technologies and using renewable resources can not only help reduce energy consumption and carbon emissions, but also reduce the overall environmental impact of the production chain by optimizing packaging and transportation processes. In addition to preserving natural resources, these changes help promote social responsibility and improve the image of organizations in domestic and international markets. The use of lean-green management models in the food industry by supporting innovation, sustainable organizational culture and continuous training of employees can lead to a sustainable and efficient production system. Increasing environmental awareness and employee participation in improving processes will not only lead to increasing product quality and reducing costs, but will also help to build trust in customers and the long-term growth of organizations in the food industry. In order to apply knowledge in integrated pure-green production in the food industry and provide an effective model, the following 10 practical suggestions can be presented:

- Implementing continuous improvement processes using lean manufacturing methods, such as kaizen, to reduce waste in food production lines and optimize the use of resources.
- Using clean energy sources such as solar and wind to reduce dependence on fossil fuels and reduce energy costs in the production process.
- Using lean production optimization methods to reduce the waste of raw materials in different stages of production and better productivity of raw materials.
- Using recycled materials and reducing the volume and weight of food packaging, which helps to optimize the consumption of resources and reduce environmental impacts.
- Using smart technologies such as the Internet of Things (IoT) for accurate monitoring of energy and water consumption in food production and reducing resource wastage.
- Conducting life cycle analysis to evaluate the environmental effects of food products from the raw material production stage to the end of the product life, and implementing environmental improvement strategies at each stage.
- Selecting suppliers of raw materials with high environmental performance and integrating green criteria in the supply chain to improve the overall sustainability of the production system. - Training employees on the principles and methods of green and lean production in order to promote environmental awareness and increase their participation in improving processes.
- Implementation of recycling systems to reuse production waste and packaging materials, which helps to reduce costs and improve environmental sustainability.
- Encouraging an organizational culture that emphasizes continuous improvement

and preservation of natural resources, and leads employees and managers to implement environmental and productivity policies.

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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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