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Provide a model based on the dimensions of circular economy, clean production and the fourth generation industrial revolution to improve the sustainable productivity of manufacturing industries

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EXTENDED ABSTRACT

INTRODUCTION

In the age of globalization, awareness of sustainability issues is rapidly increasing among organizations, which creates a greater need to implement sustainable actions in supply chains to reduce social, economic and environmental problems. Sustainability is defined by the World Environment Commission as a development that meets the needs of the current generation with an awareness of natural resource scarcity. Over time, the relative importance of social, economic, and environmental dimensions to sustainability has varied. Managing all aspects of sustainability in an organization has become challenging due to the need for its overall restructuring with a focus on adopting fourth-generation industrial technologies, clean production, and circular economy measures. To address the challenges of changing the paradigm to sustainable, the concept of circular economics has received a great deal of attention around the world and has increasingly emerged as a new approach to creating sustainable business. A circular economy is a model that reduces waste production and emissions. Achieving economic benefits, minimizing environmental impacts and increasing resource efficiency are the main goals of the circular economy. This concept has emerged as a new industrial model and as a solution to reduce the negative effects of linear economics. This type of economic system is a good opportunity to reduce the use of raw materials, protect material resources and also reduce the impact of carbon. Its main purpose is to distinguish economic growth from the constraints of natural resources and social effects. Clean production is one of the new concepts that integrates several environmental design strategies and can be considered as a potential factor in a circular economy. Clean production emphasizes the integration of the relationship between the environment and management. In the age of industrial digitalization, the connection between fourth generation industries and the circular economy has made it possible to discover different ways in which environmental sustainability goals can be achieved. In this interaction, the digitalization of industries is increasingly playing the role of facilitator in clean production. This revolution is playing an important role in the sustainability of businesses. These technologies can enable real-time resource allocation programs and coordination with suppliers in sustainable production by gathering the information needed in real time from the intelligent manufacturing system. In view of the above, industries must increase their efforts to achieve sustainability goals and adopt innovative approaches during the action. Therefore, the main question of the research is: what are the factors of circular economy, clean production and fourth generation industrial revolution effective in evaluating sustainable performance in food industry and improving its productivity? And what is the relative importance of each of them? The present study is innovative in terms of combining and simultaneously paying attention to the components of circular economy, clean production and the fourth generation industrial revolution in the era of digitalization of industries to evaluate their performance.

METHODOLOGY

The present research is applied in terms of purpose and descriptive-survey in terms of method and nature. The research area is the active manufacturing industries in the food sector of Bushehr province. At first, dimensions and indicators were identified by library method and based on the study and content analysis of theoretical and experimental foundations of research.

The statistical population of this research consisted of experts and industrial and academic experts who were familiar with the subject empirically and theoretically. Eight of them were selected as sample members by non-randomized purposive judgmental method. In this section, the criteria for selecting experts were their theoretical familiarity and expertise in the fields of environmentalism, sustainable management, the 4.0 generation industrial revolution, and circular economics. The data collection tool is a researcher-made questionnaire. The validity of this questionnaire was confirmed by face content analysis approach and its reliability was confirmed by Cronbach's alpha method with a value of 0.705. In order to analyze the data, the stepwise or equilibrium evaluation ratio analysis approach was used in fuzzy environment. This approach is one of the multi-criteria decision making methods for weighting the indicators. The main feature of this method compared to other similar methods is its ability to evaluate the accuracy of experts' opinions about the weight indicators given during the method process, ease of implementation and no need for high comparisons. In addition, in this method, experts can consult with each other, which makes the results more accurate than other methods.

FINDINGS

In order to analyze the data, the stepwise or equilibrium evaluation ratio analysis approach was used in fuzzy environment. After identifying the indicators, a questionnaire was designed and provided to the experts in absentia to receive comments.

	first expert			second expert			Third expert		
	Down	medium	Top	Down	medium	Top	Down	medium	Top
Clean production	1	1	1	1	1	1	1	1	1
Circular economy	0.67	1	1.5	0.4	0.5	0.67	0.4	0.5	0.67
۴.۰Industries	0.4	0.5	0.67	0.4	0.5	0.67	0.29	0.33	0.4
	fourth expert			fifth expert			sixth expert		
Clean production	1	1	1	1	1	1	1	1	1
Circular economy	1	1	1.5	0.29	0.33	0.4۰	1	1	1
۴.۰Industries	0.4	0.5	0.67	1	1	1	0.29	0.33	0.4
	seventh expert			eighth expert					
Clean production	1	1	1	1	1	1			
Circular economy	1	1	1.5	0.29	0.33	0.4			
۴.۰Industries	0.4	0.5	0.67	0.4	0.5	0.67			

The final weight of dimensions and indicators of sustainable performance of industries were calculated.

Dimensions	Final weight	Indicator	**Final weight**
۴.۰Industries	0.23	Internet of Things	0.014
		Big data technology	0.058
		Smart factory and cloud production	0.023
		D printing technology۳	0.099
		Robotic system	0.035
Clean production	0.39	Top management support	0.168
		Management of energy consumption and resources	0.117
		Green design and packaging	0.047
		Buy green	0.074
Circular economy	0.3	Investment	0.033
		Waste recycling	0.138
		Reuse of second-hand materials	0.081
		Sales of recyclable materials	0.051

CONCLUSION

The results showed that clean production and circular economy have the highest relative importance of improving the sustainable performance of manufacturing industries, respectively. Gupta et al. (2021), in their study, stated that circular economy and clean production have the most prominent role in the sustainable performance of organizations, which is consistent with the results of this study. Also, among the indicators; Excellent management support, waste recycling, energy and resource management and 3D printing have the highest weight. Therefore, more attention should be paid to these factors. However, it should be noted that the implementation of each of the indicators is likely to have many obstacles and contradictions; Therefore, researchers can explore these problems in future studies.

This can be due to the lack of access to technology transfer and learning channels (including imitation through observation of fourth generation industries, import of equipment and technical knowledge, scientific and technological relations with leading countries). Strengthen the infrastructure and prerequisites needed for the country's industries to implement the developments of the Fourth Industrial Revolution. One of the limitations of this research can be in collecting data with a researcher-made questionnaire in the form of new dimensions and concepts based on the opinions of experts.

The basic premise of this method is the equality of experts in terms of knowledge. Since there is a knowledge gap between experts in terms of familiarity with the concepts of these dimensions, this can lead to bias. Therefore, it is hoped that this limitation will be removed in other research by taking the necessary measures.

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