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The role of innovation in achieving green manufacturing the mediating role of cooperation / a descriptive study of the opinions of a sample of individuals working in the Iraqi Dhi Qar oil company

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Abstract
The current research seeks to identify the role played by innovation in achieving green manufacturing through the mediating role of cooperation. The research poses the following question (What is the role of innovation in achieving green manufacturing: the mediating role of cooperation?) In order to answer this question, a hypothetical diagram was assumed that explains the correlation and influence relationships between the research variables. The innovation variable was measured as an independent variable through its sub-dimensions (product innovation, process innovation, marketing innovation, organizational innovation), and the independent variable green manufacturing through its sub-dimensions (green tools and technologies, energy-saving technologies, recyclable manufacturing systems, life cycle management), and the mediating variable cooperation is one-dimensional. The practical aspects of the research was applied in Thi Qar Oil Company, the size of the community was (8000) working individuals, the questionnaire was distributed electronically using Google Form to (384) respondents, a set of ready-made statistical programs were also used, namely SPSS V.25, AMOS V.25, EXCEL V.2010, and a set of statistical tools were used, namely confirmatory factor analysis, Cronbach's alpha coefficient, Pearson's coefficient, and structural modeling analysis. The research reached a set of conclusions, the most important of which is that there is an indirect impact relationship for innovation in green manufacturing through cooperation, despite the presence of a direct relationship for innovation in green manufacturing, but the mediation of the cooperation variable positively enhances this effect, as well as a set of recommendations, the most important of which is urging the senior management of Thi Qar Oil Company to introduce new and developed products in an innovative manner and with high quality by supporting the innovative ideas of working individuals and supporting the research and development departments in a way that contributes to identifying market needs and requirements and meeting these needs.

Keywords: Innovation, green manufacturing, cooperation, product life cycle, product innovation, organizational innovation

Introduction
Green manufacturing is a manufacturing method that focuses on reducing the environmental impacts of manufacturing processes. The main goal of the concept is to focus on improving the efficiency of resource use, reducing waste, improving product quality, and reducing costs by reducing resources, reducing energy use, raw materials, reducing waste, improving product quality, and reducing costs. Therefore, it is considered one of the concepts of importance to organizations to improve profitability and compliance with legislation and laws related to environmental conservation. On the other hand, innovation is considered one of the biggest challenges facing modern organizations, especially with the rapid developments in technology and the negative effects that accompany this innovation on the environment. From this standpoint, the current research seeks to stand on the role that innovation plays in improving green manufacturing by achieving cooperation with others. The research includes four topics. The first topic was devoted to the methodology followed to achieve the goal, while the second topic included literary reviews of the research variables. The third and fourth topics were devoted to practical application, statistical analyses, conclusions, and recommendations, and concluded with a group of sources.

Methodology

First: The Research Problem

Global concerns about the scarcity of natural resources are one of the biggest challenges facing the world at the present time. These concerns affect all countries, regardless of their level of economic or social development. Therefore, the concept of green manufacturing supports these concerns and attempts to preserve natural resources from waste and make them as sustainable as possible. Based on this, the current research raises the question (What is the role of innovation in achieving green manufacturing: the mediating role of cooperation?).

Second: The importance of the Research

The importance of the current research stems from the importance of the variables it addresses, as these variables have received attention from most researchers. This is clear in light of the various research contributions in the variables (innovation, cooperation, and green manufacturing). This enhances the theoretical importance of the current research. On the other hand, the research has practical importance in light of the possibility of applying the research and its ease in various manufacturing fields. This supports reaching more objective results to answer the research problem.

Third: Research Objectives

The current research aims to identify the relationship of correlation and influence of the innovation variable in achieving green manufacturing, as well as identifying the mediating role of the cooperation variable between this relationships. A number of objectives emerge from this main objective, which are:

- Testing the relationship of influence and correlation of the innovation variable in cooperation at the level of Dhi Qar Oil Company, the research sample.
- Identifying the relationship of influence and correlation between the innovation variable and green manufacturing at the level of Dhi Qar Oil Company, the research sample.
- Identifying the relationship of influence and correlation between the cooperation variable and green manufacturing at the level of Dhi Qar Oil Company, the research sample.
- Identifying the indirect effects of the innovation variable in green manufacturing, in light of the mediation of the cooperation variable in this relationship.

Fourth: Formulating Research Hypotheses

1. Innovation and Cooperation

The concept of open innovation was introduced in 2003, which led to expanding the discussion beyond the boundaries of closed innovation (Bruhn & Ahlers, 2017:206) [37]. The basic idea here is to create a collaborative corporate innovation policy in its outlook and aims to integrate internal and external stakeholders into the innovation process with the aim of bridging the gaps between technology and the market (Prokopenko & Omelyanenko, 2018:43) [38]. Stated (Weber & Grauer, 2019:155) [39] that innovations ready for launch in the market are no longer developed only within the boundaries of the organization, but are the result of processes that overlap with internal and external processes. New external parties such as suppliers, competitors, end customers, online communities, and internal parties such as finance, marketing, and production departments join. In light of the above, the following hypotheses can be formulated:

- **H1:** (There is a statistically significant correlation between innovation and cooperation).
- **H2:** (There is a statistically significant effect of innovation on cooperation).

2. Innovation and Green Manufacturing

Upgrading the industry to green manufacturing needs to be based on innovation in the overall factors in order to achieve the green transformation of traditional manufacturing and the green development of new manufacturing (Jie, 2017:4) [43], and confirmed (Zhang *et al*., 2019:1701) [44] that the innovation system is a system that promotes economic development by combining several elements of interaction and interconnection. It is the key to achieving green manufacturing. (Hao *et al*., 2019:809) [45] Stated that according to the factors, the green manufacturing innovation system based on environmental and resource protection can be divided into two categories: the green transformation of the traditional manufacturing industry and the green development of the new manufacturing industry. Based on the above, the following hypotheses can be formulated :

- **H3:** (There is a statistically significant correlation between innovation and green manufacturing).
- **H4:** (There is a statistically significant effect of innovation in green manufacturing).

3. Cooperation and Green Manufacturing

Cooperation is one of the most important ways to implement effective cooperation between companies, and frequent exchange has become a natural part of organizational cooperation (Abualfaraa *et al*., 2020: 5) [42]. It was stated (Singh *et al*., 2021: 179) [41] that cooperation can contribute to manufacturing and effectively reduce the environmental impact of manufacturing, enhance convergence between goals, and explore new opportunities, so that organizational relations escalate and enter a new stage. Thus, more efficient manufacturing can be developed on the one hand, and on the other hand, contribute to effective environmental protection in manufacturing organizations (Pan *et al*., 2020: 257) [40]. Based on the above, the following hypotheses can be formulated:

- **H5:** (There is a statistically significant correlation between cooperation and green manufacturing
- **H6:** (There is a statistically significant effect of cooperation in green manufacturing). In light of the above discussions, the following hypothesis can be formulated.
- **H7:** (There is a direct and indirect effect of innovation in green manufacturing through cooperation).

Fifth: The hypothetical Scheme of the Research

In light of the above hypotheses and based on previous literature, Figure (1) shows the correlation relationships and direct and indirect effects of the research variables.

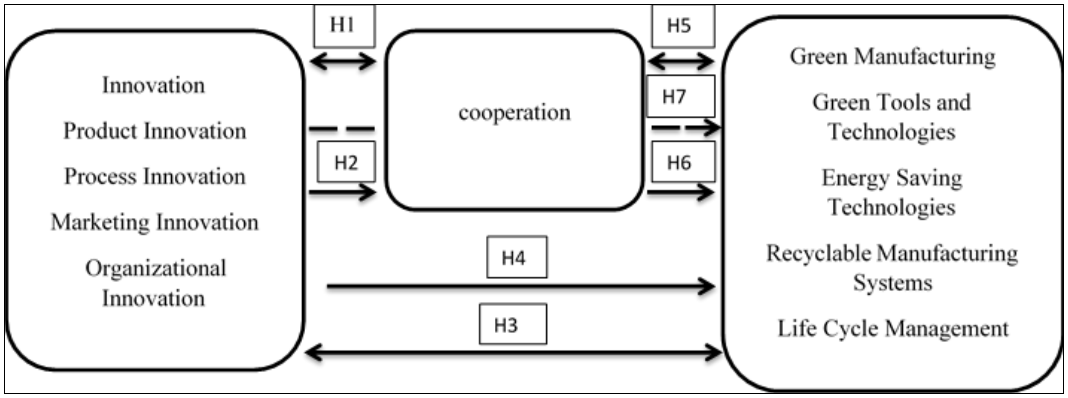


Fig 1: The hypothetical Scheme of the research

Sixth: The research community and its participants

The research community is represented by the individuals working in the Dhi Qar Oil Company, numbering (8000) working individuals. The random sample was selected, and its number was (384) working individuals. The questionnaire was distributed to them electronically using a Google forma for ease and speed and to ensure that all paragraphs are answered by the respondents and to ensure that no questionnaire is excluded.

Previous Literature

1. The concept of innovation

Is an idea, practice, or thing that is perceived as new by another individual or unit for adoption, or it is the adoption of an existing idea for the first time by a specific organization (De Vries *et al*., 2016: 152) [17], indicated (Kogabayev & Maziliauskas, 2017: 60) [18] that innovation consists of generating a new idea and implementing it in a new product, process, or service, which leads to dynamic market growth and increased job opportunities in addition to creating profit for innovative commercial organizations. According to (Frishammar *et al*., 2019: 156) [19], organizations seek innovation driven by three trends: towards more open innovation; towards increased services; towards a more digital world. These trends are changing innovation from being an inward-looking, product-centric, and largely analog activity to an outward-looking, service-oriented, and highly digital activity that goes beyond internal functions and involves customers, suppliers, and even competitors. Understood by academics, regulators, and practitioners that innovation is critical to a country's economic development on the one hand and to the long-term success of organizations on the other (He & Tian, 2020: 377) [20]. Regarding the dimensions of innovation, (Mabenge *et al*., 2022: 696) [21] mentioned four sub-dimensions of innovation, which are:

Product Innovation

Product innovation is about creating a new or improved product in terms of technical and functional features, components, materials, ease of use, or other functional features (Maier *et al*., 2019:819) [22] and confirmed (Heij *et al*., 2020:277) [23] that product innovation is the process of introducing new and improved products to the market that contribute mainly to the growth of organizations.

Process Innovation

Process innovation is an important element in enhancing the competitive advantage of the organization, as it can significantly impact performance improvement by reducing costs and increasing quality (Aliasghar *et al*., 2019:199) [24], and explained (Mooi & de Jong, 2020:741) [25] that process innovation is the extent to which a company introduces ideas or improvements in organizational processes or procedures, which is specific to each organization and is a major factor in determining performance.

Marketing Innovation

Is the process of thinking outside the box by developing new and/or different marketing strategies to meet consumer demands (Quaye & Mensah, 2019:1537) [26] and stated (Purchase & Volery, 2020:769) [27] that it is the creation of new and/or modified product packages and designs, promotional tactics, and pricing strategies, as well as exploring effective and efficient distribution networks.

Organizational innovation

It is a new method of production; a new market; a new source of supply; or a new organizational structure (Wang & Zatzick, 2019:105) [28]. And confirmed (Montalván-Burbano *et al*., 2020:2) [29] that organizational innovation is a key point in the growth of the organization and is considered a differentiation tool that creates competitive advantages.

The concept of green manufacturing

The concept of green manufacturing refers to any practice in manufacturing that does not harm the environment during any of the manufacturing stages, such as green product design, use of environmentally friendly raw materials, environmentally friendly packaging, distribution, and reuse after the end of the product's life (Rehman *et al*., 2016: 427) [1], and added (Shrivastava & RL, 2017: 69) [2] that green manufacturing is a manufacturing method that reduces waste and pollution for all industries. It slows down the depletion of natural resources as well as reduces the huge amounts of garbage entering landfills. It focuses on reducing parts, rationalizing materials, and reusing components to help build products more efficiently. Stated (Gandhi *et al*., 2018: 680) [3] that the rapid depletion of natural resources, the increasing demand for energy, and the increasing awareness of customers about environmentally friendly products and the need to comply with environmental legislation by developing green processes have led to the development of the green manufacturing model. According to (Mao *et al*., 2019: 998) [4], the green manufacturing

model helps reduce the environmental impact of manufacturing processes and ensures improvement in pollution control, reduction in natural resource consumption, and green brand image, and confirmed (Rajput & Datta, 2020: 2515) [5] that green manufacturing differs from traditional manufacturing in that it focuses on environmental impact, environmental arrangements set by governments, national and global environmental rules, and competitive weights. Legitimate environmental rules can lead to green developments that reduce costs, increase profitability, or make companies more competitive. According to (Ghadimi *et al*., 2021: 89) [7], environmental issues have rapidly increased as one of the most important issues in major manufacturing decisions. In 1996, the American Society of Manufacturing Engineers published a special blue book titled "Green Manufacturing," which introduced the concept of green manufacturing, along with its connotations and functions systematically explained. In line with what was mentioned, indicated (Pei *et al*., 2021: 309) [6] that the concept of green manufacturing was introduced to link traditional manufacturing and the environment, through a technique called environmentally conscious manufacturing, which includes developing and implementing manufacturing processes that can reduce or eliminate hazardous chemical waste, reduce scrap, and be safer operationally. As for the dimensions of green manufacturing, the dimensions mentioned by (Belhadi *et al*., 2020: 11) [8] were relied upon, which are:

Green tools and technologies

To enable more environmentally sustainable production, new green technologies and tools are being developed. For example, green chemicals are being developed from renewable raw materials which should contribute to a more sustainable chemical sector (Thomassen *et al*, 2019:4869) [9], and stated (Feng & Huang, 2020:733) [10] that these green chemical technologies can only contribute to a more sustainable society if their environmental impact is lower than that of their conventional counterparts.

Energy-saving technologies

Expectations indicate that global energy demand will increase, especially in developing countries, which requires sustainable strategies, as reliance on fossil fuels is insufficient, so the use of renewable energy sources such as solar and wind must be expanded. Governments and organizations must cooperate to develop a modern infrastructure that supports energy-saving technologies (Klemeš *et al*., 2019:5) [12]. According to (Tong *et al*., 2020:332) [22], the process of transitioning to sustainable and energy-saving energy systems requires collective commitment and international cooperation, as it can be considered an opportunity now to invest efforts and achieve tangible results that will change the future of energy in the world.

Recyclable manufacturing systems

This type of system allows organizations to adapt to rapid changes in market requirements, which contributes to improving production efficiency and reducing waste. In light of the use of advanced technologies such as artificial intelligence and data analysis, the recyclable manufacturing system can anticipate future needs and easily modify operations (Brunoe *et al*., 2019:1424) [13], and confirmed (Kingsley, 2020:848) [14] that there are multiple categories of recyclability, for example, flexibility, remanufacturability, and convertibility, which enable the ability to change manufacturing at different structural levels and in different ways.

Life cycle management

It is a systematic and controlled concept for managing product-related information throughout the entire product life cycle (Menon *et al*, 2019:1392) [15]. According to (Leng *et al*, 2020:5) [16], life cycle activities have become increasingly complex, in light of the involvement of more available resources, stakeholders, and advanced technologies in the product life cycle.

Third: Cooperation

With the increasing interest in the concept of cooperation between two or more organizations, it attracts increasing attention from theorists, the business community, and policy and decision-makers (Weber *et al*., 2017:233) [30] and confirmed (Le Pennec & Raufflet, 2018:819) [31] that any organization, regardless of its type, does not operate in isolation from the rest, so it must cooperate with other parties in order to survive and grow in a sustainable manner. Between organizations collaboration has become indispensable for many organizations (Berends & Sydow, 2019:4) [32]. Organizations may collaborate, for example, to develop innovations or address major challenges (Zahoor & Al-Tabbaa, 2020:105) [33], to streamline supply chains or to set standards (van der Schors *et al*., 2021:37) [34], to realize creative projects or to respond to emergencies (Lægreid & Rykkja, 2022:686) [35]. Between organizations collaboration enables organizations to pool resources and achieve goals that they cannot achieve alone (Rasool *et al*., 2023:565) [36].

The practical aspect

1. Examine research scale, coding, and reliability.

- The current research includes three variables as follows **:**
- The independent variable (innovation) was relied upon the scale mentioned by (Mabenge *et al*., 2022:695) [21], which consists of 20 items distributed over 4 sub-dimensions: product innovation (4 items), process innovation (4 items), marketing innovation (7 items), and organizational innovation (5 items)
- The mediating variable (cooperation) was relied upon the scale mentioned by (Shakir *et al*., 2023:896) [47], which consists of 7 items distributed over only one dimension **.**
- Dependent variable (green manufacturing) The scale mentioned by (Belhadi *et al*., 2020:11) [8] was relied upon, which consists of 12 items distributed over 4 sub-dimensions: green tools and technologies (3 items), energy-saving technologies (3 items), reconfigurable manufacturing systems (3 items), life cycle management (3 items), and as shown in the table (1) variables, dimensions, sources, and statistical coding, with Cronbach's alpha reliability coefficient for each variable.

Table 1: Research scale and Cronbach's alpha coefficient

Variable	Dimensions	Items	Source	Cronbach's alpha
Innovation	(PI product innovation)	4	(Mabenge *et al*, 2022 [21]:695)	0.964
	(PCI process innovation)	4		
	(MI marketing innovation)	7		
	(OI) organizational innovation	5		
cooperation	(CO) one dimension	7	(Shakir *et al*, 2023:896 [47])	0.805
Green Manufacturing	(GR) green tools and technologies	3	(elhadi *et al*, 2020:11[8])	0.948
	(EN) energy-saving technologies	3		
	(RM) reconfigurable manufacturing systems	3		
	(LC) life cycle management	3		

Source: Prepared by the researcher based on SPSS outputs and the mentioned sources.

2. Structural validity of variables

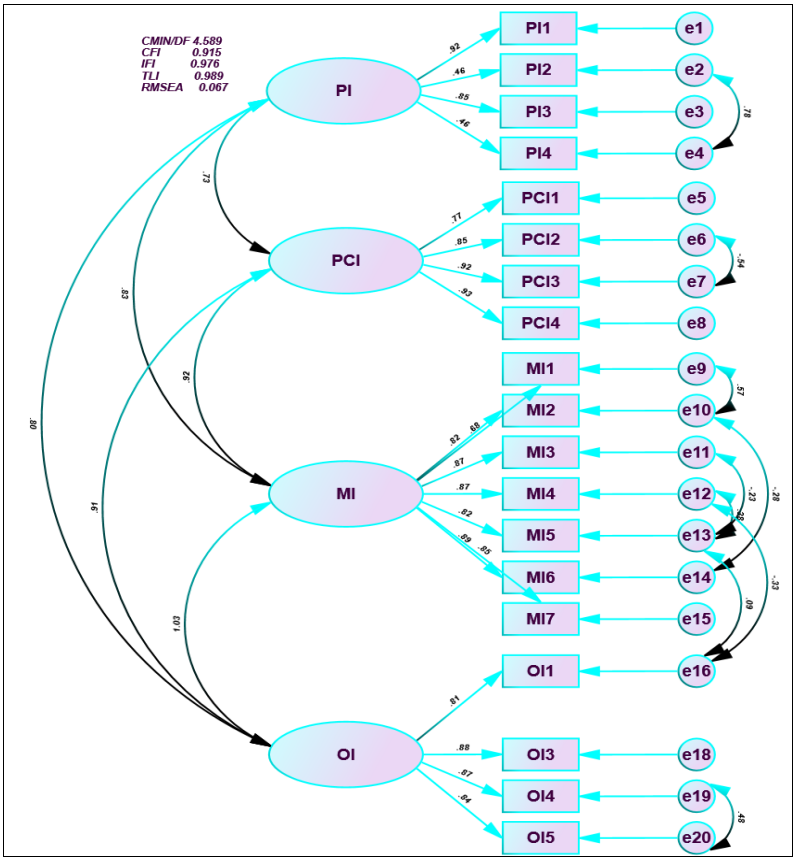
In order to verify the assumed structural validity of the variables with the data collected from the questionnaire, confirmatory factor analysis will suffice and exploratory factor analysis will not be conducted, considering that the scale used is ready and adapted by other researchers as it has been tested and applied in different fields in terms of environments and the nature of the work of organizations. When conducting confirmatory factor analysis, two things are considered (Afthanorhan, 2013: 199 [49]

A. Standard weights for paragraphs on dimensions, which must be greater than 0.40, and if the percentage is less, it is deleted, considering the poor representation of the paragraph for the dimension .

B. Model fit indicators, which show the extent of the quality of the assumed model with the data drawn from the sample, and the most important of these indicators are (CMIN/DF < 5, CFI > 0.90, IFI > 0.90, TLI > 0.90, RMSEA < 0.08).

2.1. Confirmatory factor analysis of the innovation variable

It is clear from figure (2) of the confirmatory factor analysis of the innovation variable that all standard regression weights exceeded (0.40) except for one item, which is (O2), and this indicates its weak representation of the dimension to which it belongs, which requires its deletion from the scale. Also, the values of the structural fit quality indicators were good after resorting to Modification Indices proposed by the program to improve the level of these indicators, which contribute to increasing the level of consistency between the theoretical structure through which the scale was prepared and the answers of the sample members. Therefore, after deleting the above paragraph and implementing (9) of the necessary modification indicators, we note that the model has acquired the necessary level of conformity. Also, the structural validity parameters were all significant ratios through the values of the critical ratio (C.R.) shown in Table (2), which turned out to be greater than (2.56) at a significance level of (0.01), which indicates the feasibility and validity of these parameters and the possibility of relying on them in measuring the dimensions to which they belong.



Source: AMOS V.25 results

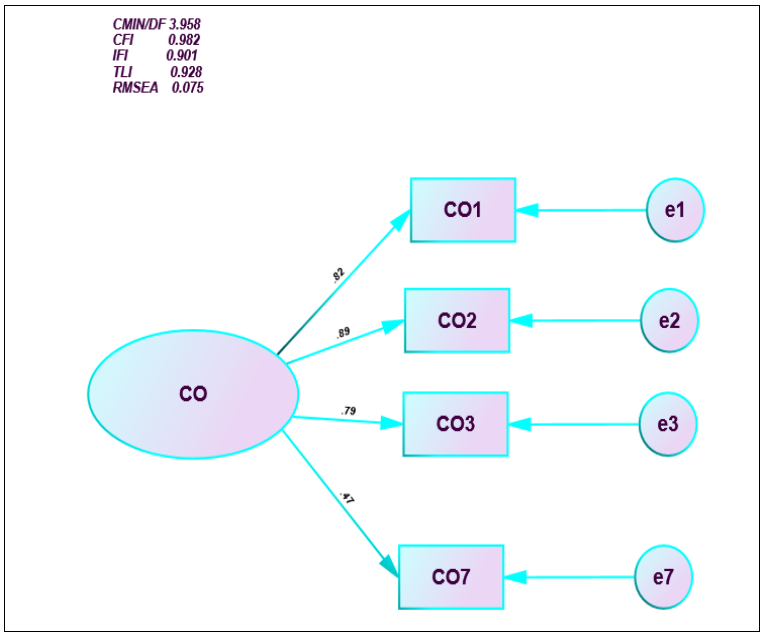
Fig 2: Confirmatory factor analysis of the innovation variable

Table 2: Construct validity parameters for the innovation variable

PATH			Estimate	S.E.	C.R.	P
PI1	<---	F1	1.000			
PI2	<---	F1	.489	.053	9.241	***
PI3	<---	F1	.872	.041	21.227	***
PI4	<---	F1	.570	.061	9.351	***
PCI1	<---	F2	1.000			
PCI2	<---	F2	1.038	.057	18.275	***
PCI3	<---	F2	1.047	.052	20.229	***
PCI4	<---	F2	1.160	.056	20.659	***
MI1	<---	F3	1.000			
MI2	<---	F3	1.189	.055	21.496	***
MI3	<---	F3	1.301	.083	15.703	***
MI4	<---	F3	1.162	.073	15.847	***
MI5	<---	F3	1.076	.072	15.001	***
MI6	<---	F3	1.150	.072	16.031	***
MI7	<---	F3	1.207	.078	15.448	***
OI1	<---	F4	1.000			
OI3	<---	F4	.923	.043	21.342	***
OI4	<---	F4	1.061	.051	20.928	***
OI5	<---	F4	.978	.049	20.066	***

Source: AMOS V.25 results

Confirmatory factor analysis of the cooperation variable: It is clear from the figure (3) of the confirmatory factor analysis of the cooperation variable that all standard regression weights exceeded (0.40) except for three items (CO4, CO5, CO6), which indicates their weak representation of the dimension to which they belong, which necessitates their deletion from the scale. Also, the values of the structural fit indicators were good. Therefore, after deleting the above paragraphs, we note that the model has acquired the necessary level of fit. Also, the structural validity parameters were all significant ratios through the values of the critical ratio (C.R.) shown in Table (3), which turned out to be greater than (2.56) at a significance level of (0.01), which indicates the feasibility and validity of these parameters and the possibility of relying on them in measuring the dimensions to which they belong. This indicates that the cooperation variable is measured by four items distributed over one dimension.



Source: AMOS V.25 results

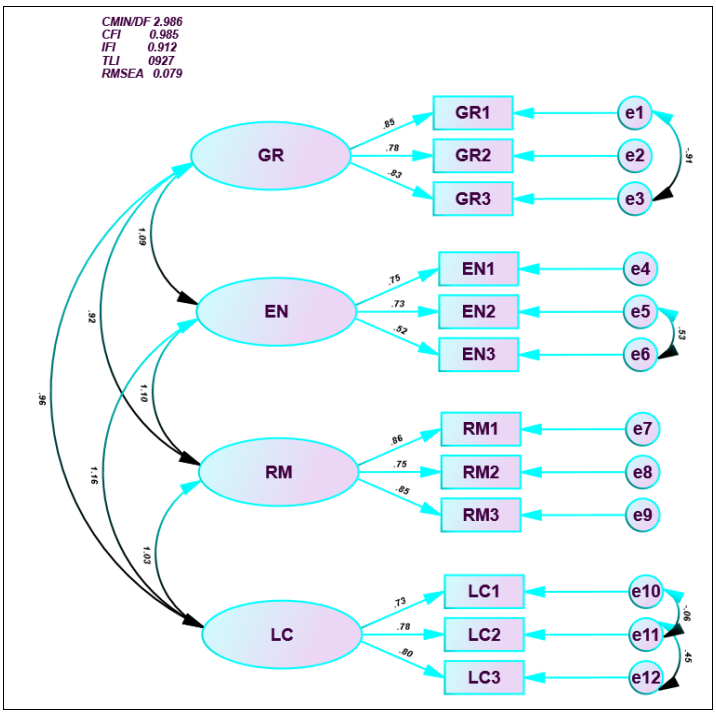
Fig 3: Confirmatory factor analysis of the cooperation variable

Table 3: Construct validity parameters for the cooperation variable

PATH			Estimate	S.E.	C.R.	P
CO1	<---	F1	1.000			
CO2	<---	F1	1.129	.074	15.224	***
CO7	<---	F1	.363	.042	8.563	***
CO3	<---	F1	1.128	.077	14.590	***

Source: AMOS V.25 results

Confirmatory factor analysis of the green manufacturing variable It is clear from the figure (4) of the confirmatory factor analysis of the green manufacturing variable that all standard regression weights exceeded (0.40), which indicates that they represent the dimensions to which they belong. Also, the values of the structural fit indicators were good after resorting to the Modification Indices proposed by the program to improve the level of these indicators, which contribute to increasing the level of consistency between the theoretical structure through which the scale was prepared and the answers of the sample members. Therefore, after performing (4) of the necessary modification indicators, we note that the model has acquired the necessary level of conformity. Also, the structural validity parameters were all significant ratios through the values of the critical ratio (C.R.) shown in Table (4), which turned out to be greater than (2.56) at a significance level of (0.01), which indicates the feasibility and validity of these parameters and the possibility of relying on them in measuring the dimensions to which they belong.



Source: AMOS V.25 results

Fig 4: Confirmatory factor analysis of the green manufacturing variable

Table 4: of the structural validity parameters of the green manufacturing variable

PATH			Estimate	S.E.	C.R.	P
GR1	<---	F1	1.000			
GR2	<---	F1	.877	.048	18.232	***
GR3	<---	F1	.877	.060	14.733	***
EN1	<---	F2	1.000			
EN2	<---	F2	1.048	.063	16.756	***
EN3	<---	F2	.808	.068	11.857	***
RM1	<---	F3	1.000			
RM2	<---	F3	.747	.042	17.615	***
RM3	<---	F3	.885	.041	21.804	***
LC1	<---	F4	1.000			
LC2	<---	F4	1.056	.068	15.553	***
LC3	<---	F4	1.098	.067	16.455	***

Source: AMOS V.25 results

Testing Hypotheses

Testing the correlation hypotheses

Pearson's correlation coefficient will be used to judge the existence or absence of a correlation between the research variables and to test the following hypotheses:

- H1 (There is a statistically significant correlation between innovation and cooperation)
- H3 (There is a statistically significant correlation between innovation and green manufacturing)
- H5 (There is a statistically significant correlation between cooperation and green manufacturing)

It is clear to us from the table (5) that there is a correlation between the independent variable innovation and the dependent variable cooperation, which is a strong positive and statistically significant relationship based on the significance of the test and the Sig value of (0.01), as the correlation value reached (0.792**). Table () also shows us the existence of a correlation between the innovation variable and the green manufacturing variable as a dependent variable, as the value of the correlation coefficient reached (0.899**), which is a strong positive relationship with statistical significance at a significance

level, as the value of Sig reached (0.01). The aforementioned table shows the existence of a correlation between cooperation and green manufacturing, as the value of the Pearson coefficient test reached (0.857**), which is a positive and strong relationship with statistical significance at a significance level of (0.01).

Based on the above discussion, the result of the decision is to accept the association hypotheses (H1, H3, H5). This means that the presence of a certain percentage of the innovation variable necessitates the appearance of the green manufacturing and cooperation variable with it, and also the presence of a certain percentage of the cooperation variable necessitates the appearance of the green manufacturing variable with it at the level of the Dhi Qar Oil Company under study.

Table 5: Pearson correlation test between research variables

		Innovation	CO	Green Manufacturing
Innovation	Pearson Correlation	1	.792**	.899**
	Sig. (2-tailed)		.000	.000
	N	384	248	384
CO	Pearson Correlation	.792**	1	.857**
	Sig. (2-tailed)	.000		.000
	N	248	248	248
Green Manufacturing	Pearson Correlation	.899**	.857**	1
	Sig. (2-tailed)	.000	.000	
	N	384	248	384
**. Correlation is significant at the 0.01 level (2-tailed).				

Source: SPSS V.25 results

Testing the impact hypotheses

Testing the impact hypothesis (H2), which states: (There is a statistically significant impact of innovation on cooperation).

The table (6) shows that the significance of F is (0.000) and its value reached (413.540), which is a smaller value than the significance value of (0.01), and this indicates the presence of an effect of the innovation variable on the cooperation variable. Also, the value of (R^2) reached (0.627), which explains the variance that occurs in the cooperation variable through the innovation variable, i.e. innovation explains 62% of the changes that occur in the cooperation variable, and the remaining percentage is due to factors that were not included in the research model. The value of (α=2.175), which indicates that when the innovation value is zero, this means that the cooperation variable will not be less than this value. The table also shows the value of (β=0.792), i.e. any deviation of one value for the innovation variable will have a deviation of the same value for the cooperation variable, whether it is an increase or decrease. The calculated value of (T) reached (20.336), which is a value greater than the standard value of (1.96), which is a value with statistical significance in terms of the significance level. The value (0.000). Referring to the above discussion, the simple linear regression equation for the effect of innovation on cooperation can be deduced as follows:

Cooperation = 2.175 + 0.792 (innovation) this indicates the acceptance of the influence hypothesis H2

Table 6: The impact of innovation on collaboration

Dependent variable cooperation							Independent variable
Sig	F	R^2	Sig	(t) calculated	Model parameters		
0.000	413.540	0.627	0.000	33.589	2.175	α	
			0.000	20.336	0.792	B	Innovation

Source: SPSS V.25 results

Testing the impact hypothesis (H4), which states: (There is a statistically significant impact of innovation in green manufacturing).

The table (7) shows that the significance of F is (0.000) and its value reached (160.753), which is a smaller value than the significance value of (0.01), which indicates the presence of an effect of the innovation variable on the green manufacturing variable. Also, the value of (R^2) reached (0.808), which explains the variance that occurs in the green manufacturing variable through the innovation variable, i.e., innovation explains 80% of the changes that occur in the green manufacturing variable, and the remaining percentage is due to factors that were not included in the research model. The value of (α=2.145), which indicates that when the innovation value is zero, this means that the green manufacturing variable will not be less than this value. The table also shows the value of (β=0.899), i.e., any deviation of one value for the innovation variable will have a deviation of the same value for the green manufacturing variable, whether it is an increase or decrease. The calculated value of (T) reached (40.059), which is a value greater than the standard value of (1.96), which is a significant value. Significant statistic with significance level of (0.000). Referring to the above discussion, the simple linear regression equation for the impact of innovation on green manufacturing can be deduced as follows:

Green manufacturing = 2.145 + 0.899 (innovation) this indicates the acceptance of the influence hypothesis H4

Table 7: Impact of innovation in green manufacturing

Dependent variable green manufacturing							independent variable
Sig	F	R^2	Sig	(t) calculated	Model parameters		
0.000	160.753	0.808	0.000	5.834	2.145	α	
			0.000	40.059	0.899	B	Innovation

Source: SPSS V.25 results

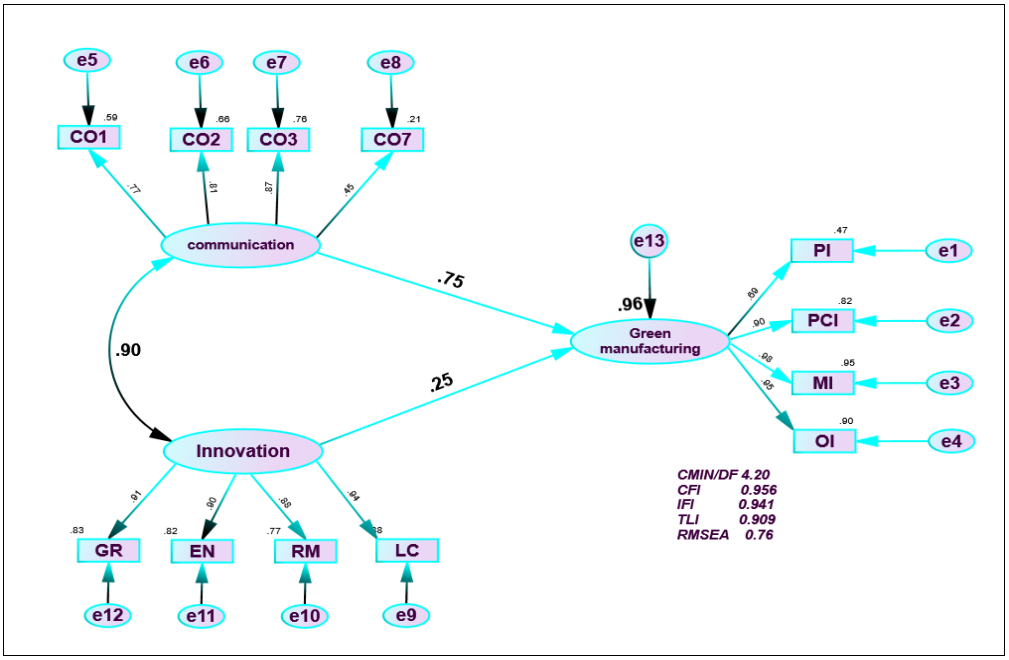
Testing the effect hypothesis (H6) which states (There is a statistically significant effect of communication in green manufacturing). And testing the hypothesis (H7) which states (There is a direct and indirect effect of innovation in green manufacturing through cooperation).

Figure (5) and Table (8) show the effect of the innovation variable on the green manufacturing variable, as it appears that it has a direct effect of (0.25). There is also an indirect effect of the independent variable innovation on the dependent variable green manufacturing through the mediating variable cooperation, with a value close to (0.675), which is the result of multiplying the value of the correlation between the cooperation and innovation variable by the amount of the effect of the cooperation variable in green manufacturing, a value of (0.90*0.75). Therefore, if innovation increases by (1), this will lead to a direct change of (0.25) on green manufacturing, and the total direct and indirect effect of innovation in green manufacturing mediated by the cooperation variable is approximately (0.925). The value of interpretation (R2) is (0.96), which means that the innovation and cooperation variables explain (96%) of the changes that occur in the green manufacturing variable, while the remaining percentage, which is (4%), is due to other variables that were not included in the current research model. These results prove hypotheses (H6, H7) at the level of the Dhi Qar Oil Company under study.

Table 8: Path test of direct and indirect effects of research variables

R^2	Total Effect	Indirect Effect	Direct Effect	Path
0.96	0.925	(0.75 × 0.90) (0.675)	0.25	Innovation → Green Manufacturing
				Innovation → Communication → Green Manufacturing

Source: Prepared by the researcher based on the results of the AMOS V.25 program.



Source: AMOS V.25 results

Fig 5: Direct and indirect effect between variables.

Conclusion and Recommendations

In light of the results of the statistical analysis, the researcher reached a set of conclusions and recommendations, which are:

Conclusion

- The concept of innovation helps organizations and their employees to create a competitive environment that contributes to achieving organizational strategic goals and expanding their market share, which is positively reflected in achieving profits for the organization and individuals .
- The concept of cooperation seeks to improve the morale of employees inside and outside the organization and enhance the internal and external relations of the organization, which enhances the positive work environment, which is reflected in the participation of individuals in the decision-making process and bearing responsibility and benefiting from the different opinions and ideas of employees .
- Adopting green manufacturing contributes to enhancing the social and environmental responsibility of organizations and individuals, which creates a clean

environment and is greatly reflected in improving the organization's image and increasing its acceptance in society .

- There is a significant correlation and influence of innovation in cooperation, which concludes from this relationship that the Dhi Qar Oil Company under investigation, if it seeks to improve cooperation and collaboration among its employees and spread the culture of bearing responsibility, organizational innovation can contribute significantly to achieving this .
- There is a positive correlation and impact relationship for cooperation in green manufacturing, which indicates that if the company under study wants to assume its environmental and social responsibilities and adhere to environmental laws in manufacturing processes, this can be improved in light of adopting the concept of cooperation between its employees .
- There is a correlation and impact relationship for innovation in green manufacturing, which indicates that the company under study can achieve environmental responsibility by adhering to government laws and regulations related to preserving the environment by introducing new environmentally friendly products and building innovative manufacturing processes that contribute to reducing waste in time and materials, as well as adopting modern marketing ideas to market products and building organizational structures that encourage teamwork .
- There is an indirect impact relationship for innovation in green manufacturing through cooperation; despite the existence of a direct relationship for innovation in green manufacturing, the mediation of the cooperation variable contributes to increasing this impact, which is positively reflected in enhancing green manufacturing for the Dhi Qar Oil Company under study.

Recommendations

- Urging the senior management of Dhi Qar Oil Company to introduce new and developed products in an innovative way and with high quality by supporting the innovative ideas of the working individuals and supporting the research and development departments in a way that contributes to identifying the market needs and requirements and meeting these needs .
- Introducing modern methods and machines in the manufacturing process and stopping the waste of resources and time by reducing the manufacturing time of products and spreading the culture of time management at work and paying attention to quality and reducing waste .
- The senior management of Dhi Qar Oil Company should adopt modern and innovative marketing methods to promote its products as well as pay attention to attractive packaging and design, and choose more effective promotional methods that keep pace with technological developments such as various means of social cooperation and advertisements on screens spread in public areas .
- The senior management of Dhi Qar Oil Company should modify its organizational structure and make it more flexible and keep pace with environmental and technological changes to facilitate the exchange of information between different departments such as production, marketing, research and development, etc., by adopting the reduction of functional boundaries between departments .
- Organizing courses and conferences that encourage the dissemination of the culture of green practices and concepts that are keen to preserve the environment and disseminating this culture across the company's various departments and encouraging the use of renewable resources in manufacturing processes .
- Adopting the concept of the product life cycle and making greater efforts to enhance the design of more environmentally friendly products by extending their lifespan and making them less impactful on the environment .
- Enhancing the spirit of cooperation and participation among employees and supporting work teams to share important information to perform tasks .

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