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The possibility of Establishing a Multi-Agent System An exploratory study of the opinions of a sample of managers in the General Company for Iraqi Cement / Northern Cement Association Research extracted from the master's thesis Submitted by

Zainab Khalil Ibrahim

Zainab2020khalil2020@ntu.edu.iq

Northern Technical University / Administrative Technical College / Mosul,

Corresponding author: Zainab Khalil Ibrahim , e-mail: Zainab2020khalil2020@ntu.edu.iq

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Abstract : The current research aims to determine the possibility of establishing a multi-agent system in the Iraqi General Company for Cement / Northern Cement Association for the purpose of establishing a sophisticated industrial environment capable of providing products that meet the market needs in terms of quality and cost on the one hand, and securing a competitive advantage that secures it superiority over competing companies on the other hand. By relying on modern production systems that contribute to reducing costs and improving quality, including the Multi-Agent System (MAS), **The research problem started from the following questions:**

1. What is the extent of knowledge of the managers in the company under the study about the concept and applications of the Multi-Agent System?
2. Are the managers in the company under the study seeking to establish a Multi-Agent System?
3. Which applications are most suitable for the company under the study?

The research reached a set of conclusions, the most important of which are:

1. There is a willingness in the company under the study to establish a Multi-Agent System.
2. There is great importance for the applications of the Multi-Agent System in the company under the study.

In light of the previous conclusions, a number of proposals were presented, perhaps the most prominent of which are:

1. Increasing the interest of the management of the company under the study in the applications of the Multi-Agent System.
2. Determining a timetable for the tasks through which the products are manufactured in the company under the study.

Keywords: possibility of Establishing, Multi-Agent System, General Company for Cement.

1.Introduction

The rapid development of many administrative and technical concepts has led to fundamental changes in the reality of work and the way work is carried out and its style, and as a result of the intervention of the human element on the one hand and a great leap in the technology of executing tasks in a way that made

organizations compete among themselves in the way of carrying out their tasks and completing their work in a way that secures them Achieving cost and time savings and obtaining better quality, as all of this requires the organization to adopt modern production systems capable of interacting with reality in terms of providing products of appropriate quality at an acceptable cost, including the Multi-Agent System (MAS). Because of the limited studies that dealt with the issue of the possibility of establishing a multi-agent system in Iraq, the researchers have found A necessity to include their study of this variable and its application in the Iraqi General Cement Company / Northern Cement Associate. And The study included the following sections: (The first topic: the study methodology, the second topic: the theoretical side, the third topic: the field side, the fourth topic: conclusions and suggestions).

2.Study methodology

First: The problem of the study: The management of companies faces a set of variables that requires them to interact with them and come up with an actual understanding of them, and this embodies their ability to unique and then succeed in implementing production processes through the dynamic cooperation of fast-adapting devices capable of solving complex problems in an economic and effective manner, including the multi-agent system [1]. Through field visits to the company under the study and after conducting interviews with some of its managers , It turns out that the company includes some applications of the multi-agent system without knowing that it is within this concept. From here came this research attempt to test the possibility of establishing the multi-agent system in the company under the study by asking the following questions**: 1.** What is the extent of knowledge of the managers in the company under the study about the concept and applications of the multi-agent system? **2**. Do the managers of the company under the study seek to establish a multi-agent system? **3**. What are the most suitable applications for application in the company under the study?

Second: The importance of the study: The importance of the current study emerges from the importance of its variables and the reality of its consistency with the authors' proposals in the field of production and operations management. The study touched on the multi-agent system, after which it is one of the modern manufacturing systems, which contributes to achieving significant savings in time and cost. This study represents a scientific addition that deserves attention, especially if it is confirmed what the researchers found about the scarcity of reference to such a topic in the Iraqi writings in the field of production and operations management, according to what the researchers were able to see.

Third: Objectives of the study: The study aims to:1.Contribute to providing an intellectual framework on the main study variable and its sub-components. 2.Determining the impact of some applications of importance to establish the multi-agent system at the level of the company under the study.3.Attempting to develop the reality of the actual work in the company under the study and to keep it in line with the developments surrounding it in technologies and manufacturing systems.

Fourth: The hypothetical study scheme: The systematic treatment of the study problem requires the design of a hypothetical scheme as shown in Figure (1).

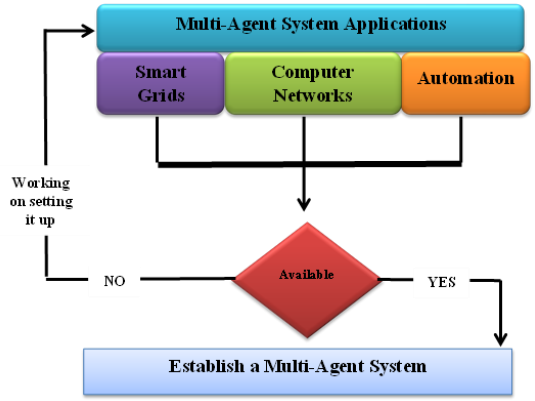

Figure (1) hypothetical study schematic

Fifth: The hypotheses of the study:

The first hypothesis: The company under the study has applications of the multi-agent system.

The second hypothesis: The company under the study responds to adopting the applications of the multi-agent system.

Sixth: Research Methodology: The researchers relied on the descriptive and analytical methods to complete this research.

Seventh: The limits of the study

a. **Spatial limits:** This study was conducted in the Iraqi General Cement Company / Northern Cement Associate, one of the formations of the Ministry of Industry and Minerals. The researchers chose it as one of the leading industrial companies that relies on modern systems in the implementation of its production processes, in addition to the need for the company under the study to achieve integration between its production processes by taking advantage of the advantages offered by the multi-agent system.
b. **Time limits**: The duration of the research was limited to the time period between 1/2/2021 and 20/6/2021.
c. **Human limits:** The current research was limited to the managers of the Iraqi General Cement Company / Northern Cement Associate, who are the assistant director of the company and his agents, heads of departments and managers of divisions and units.

Eighth: Methods of data and information collection: The following methods were relied on in collecting data and information related to the research:

1- Reliance on a group of Arab and foreign sources.

2- Direct meetings with some managers and heads of departments in the company under study.

3- Questionnaire form*: to obtain the data related to the individuals surveyed, as well as the data that contribute to determining the relative importance of establishing the multi-agent system and determining the extent of the company's response to the adoption of these applications. The statements related to the applications of the multi-agent system have been prepared based on the following sources: [2] [3] [4] [5]

Ninth: Statistical analysis methods: For the purpose of reaching objective indicators that express the nature of the study, its objectives and mechanisms for verifying its hypotheses, the ready-made software (SPSS 22) was adopted to conduct the required statistical analysis and reach the following: (frequencies, percentages, arithmetic mean, standard deviation, response measurement , (T) test.

Tenth: Testing the stability of the resolution: In order to determine the validity of the scale and the stability of the resolution, the Krumbach alpha scale was used. The value of the coefficient of the mentioned scale was (0.898), which is a significant value at the level of significance (0.05) and this result indicates the strength of the stability of the questionnaire used [6] .

The second topic / the theoretical side

This study includes the following topics:

First: The concept of (MAS): [7] indicated that the multi-agent system (MAS) consists of a group of independent elements known as agents and have the ability to perceive the surrounding environment with the help of special sensors be connected to it , and [8] showed that the Multiple Agent System (MAS) is characterized by independence and the ability to communicate with and adapt to its surroundings, as it has a high degree of flexibility, while[9] These features make (MAS) an ideal solution for complex tasks, where the complex tasks are divided into multiple sub-tasks, as each of the agents within (MAS) is given one of those sub-tasks in proportion to its characteristics and capabilities. This approach provides a solution Low cost compared to the old approach that relies on a single agent to solve the problem, it can be clarified the most important of what was addressed in the literature about the concept of the multi-agent system [10] ,confirmed that (MAS) is a special type of distributed intelligent systems that includes a group Independent agents on the

one hand and cooperating with each other on the other hand by communicating with each other to share knowledge and reach a solution to the existing problem, while [11] explained that (MAS) is a group of independent entities that have ability and knowledge that is not Enough to tackle a problem or accomplish a specific task, they work together In order to complete the tasks and achieve the desired goals, [12] showed that (MAS) is a computer system composed of several intelligent agents interacting with each other within a specific environment in addition to their interaction with their environment, while [5] see that (MAS) consists of a network of individual agents who share knowledge with each other and communicate in order to solve problems that are outside the power of a single.

Second: The importance of (MAS): [13] indicated that the importance of (MAS) lies in 1. (MAS) takes into account the constituent entities of the system and the nature of those entities in addition to the environment in which the system will be applied. 2. The possibility of using it in regulating interactions between agents in a way that prevents the occurrence of any conflict in the orders and tasks of each agent. 3. Works to address problems that may occur during complex work by organizing them in a sequential manner or by distributing tasks to system agents, especially design and calculation problems. 4. It provides a suitable solution for controlling distributed systems with multiple branches.

Third: Objectives of (MAS): [5] believes that the objectives of (MAS) are clear through: 1. Defining the characteristics and qualifications of each of agents within the (MAS) and specifying their specific objectives from To assign them tasks that are appropriate for that. 2. Divide the main problem into a number of sub-problems that can be controlled and distributed to the different agents in order to solve them in proportion to their own characteristics and goals. 3. Giving the agents present in (MAS) sufficient flexibility that enables the agent to perform his specific task in addition to the possibility of performing the task of one of the agents when he fails or stops. 4. Distributing the costs of processing operations to several agents in a way that contributes to a lower total cost compared to the method of solving the problem by one agent .

Fourth: MAS applications: [14] [9] [5] agreed that the applications of the multiple agent system were represented in:

1. Automation: Concept and Objectives

a. Concept: [15] mentioned that the term "automation" corresponds to the term "Automation" and its synonym in the Arabic language is the term mechanization, which is derived from the Latin word "machine" which means machine. Automated work, and [16] showed that automation is the process of developing the available tools in an attempt to develop new tools aimed at reducing the human effort that is exerted in daily work to the minimum possible .

b. Objectives of Automation: [2] indicated that the objectives of automation are manifested through: 1. Describing tasks and processes in a better and more clear manner, and contributing to increasing the effectiveness of achievement and improving quality levels. 2. High accuracy in completing the work and reducing the errors that may sometimes be produced by the human element. 3. Increasing speed and shortening time by abandoning unnecessary activities and storing information in a way that makes its retrieval processes faster and more accurate. 4. Enhancing the managers' ability to take rational and logical decisions based on scientific foundations and a realistic view resulting from their awareness of their.

2. Computer Networks: concept and objectives

a. Concept:[17] [18] mentioned that computer networks are a system of computers linked together for the purpose of sharing, analyzing and organizing digital information, and what contributed to the widespread use of computer networks on a large scale is that they Allows the possibility of sharing some devices such as printers and disk drives and is controlled by a main computer. Computer networks are divided according to the area they serve into four

sections: 1. Local Area Networks (LAN) 2. Wide Area Networks (WANs) 3. Metropolitan Area Networks (MANs) 4. Wireless networks(WNs).

b. Objectives:[3]clarified that the most important objectives of computer networks are as follows : 1. Sharing information, files and software by anyone within the network, in addition to sharing the use of some devices regardless of their geographical location. 2. Saving costs in general, whether related to the cost of purchasing devices and equipment attached to each computer, or the costs of sending some files by mail and other traditional methods. 3. Improving system performance by adding one or more processors at times when the workload increases. 4. Enhancing system reliability and access to files. In the event of a server failure or downtime, it is possible to obtain the same required files using another server.

3. Smart Grids: Concept and Objectives

a. Concept:[19] [20] indicated that smart Grids are the next generation networks as they integrate information technology with traditional energy networks, as they are a modern infrastructure for electric power networks that enhance their efficiency It improves its reliability and quality through automatic control of the network and providing it with sensor technologies and modern energy management techniques that enable it to communicate and interact intelligently with all connected to the network, whether they are power generation sources or energy consumers, and this contributes to providing sustainable, safe, and economical energy supplies.

b. Objectives:[4] Show that the objectives of smart grids are as follows: 1. Achieving optimal use of power plants and improving their reliability. 2. Enhancing the capacity of the current electric power networks and improving their quality. 3. Reducing wastage of energy by controlling the power generation process, especially during periods of maximum use. 4. Enable predictive maintenance and self-repair for problems that may occur in the system by automating maintenance and operation processes .

3. the field side

The study includes the following topics:

First: Description and diagnosis of the study population and its sample: The study population and its sample can be described as follows:

a. Description of the study population: The company under the study was selected as a field for the purpose of research for the following reasons:

1. The extensive experience possessed by the company under study, as it is one of the leading companies in Nineveh Governorate.
2. The company's products cover the markets of Nineveh Governorate and the nearby governorates. Table (1) gives a simplified definition of the company under the study.

Table (1) A simplified definition of the company under the study

Company	company products
The General Company for Northern Cement was established in 1953 under the name of Rafidain Cement Company with two production lines that operate in the wet method to produce ordinary Portland cement. In 1957, a plant for the production of cement by the wet method was established in the village of Al-Arej, and its management was entrusted to the Hamam Al-Alil Cement Department. Mosul Cement in 1965, and several production lines were added to the Mosul Cement Company, such as concrete blocks, columns, Noura factory and lime brick factory, then the cement factories were expanded in Badush and Hammam Al-Alil to be the name after that of the General Aid for Building Materials in Mosul in 1975 and then the general facility For building materials in Mosul in 1978, and after dismantling the administrative link to the factories of concrete blocks, columns and bricks, and opening the way for the facility to focus on the cement industry only. Then the name was changed to the General Establishment for Cement in Nineveh, then a new phase began to expand the factories of Badush and Hammam Al-Alil with the establishment of the Sinjar plant with a high production capacity and with high technologies for operation and quality control, and the name of the company was changed to the General Company for Northern Cement.	1. Clinker. 2. Cement using the dry as well as the wet methods. 3. Paper bags for packing cement.

Source: Brochure of the company under the study

b- Description of the study sample: An intentional sample was chosen, represented by the individuals surveyed who have experience and know-how and are aware of the company's activity and tasks in order to ensure the benefit of accurate and useful information provided by them, as well as the possibility of obtaining ideas and proposals that enhance the importance of the study. The researchers distributed (80) forms, as this form included the assistant general manager of the company, his deputy, director of the new Badush laboratory, directors of departments, divisions and main formations. (71) forms were obtained valid for analysis, meaning that the response rate reached (88.75%). Table (2) shows the description of the respondents.

Table (2) Description of the individuals surveyed in the company under the study

Academic achievement									
Master's		Higher Diploma		Bachelor's		Technical Diploma		middle school	
%	No.	%	No.	%	No.	%	No.	%	No.
5.63	4	-	-	80.29	57	12.68	9	1.4	1

Years of service in the company (years)													
31 and more		26 – 30		21 – 25		16 – 20		11 – 15		6 – 10		1 – 5	
%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.
4.23	3	12.68	9	15.49	11	53.52	38	12.68	9	1.4	1	-	-

Age (year)							
50 and more		40 – 49		30 – 39		020 – 29	
%	No.	%	No.	%	No.	%	No.
40.85	29	45.07	32	14.08	10	-	-

Source: Table prepared by researchers based on the results of the questionnaire .

Table (2) indicates that the respondents have good qualifications that enable them to understand the components of the questionnaire and deal with them properly. The percentage of those who hold a technical diploma or above reached (98.6%) of them. It is also clear from Table (2) that the service period of the individuals surveyed in the company under study who have a service of no more than five years amounted to (100%), which are years during which managers obtain knowledge and experience in their field of work, which helps them take appropriate decisions to complete their work. . Table (2) indicates that (100%) of the respondents are over (30) years old and over, and this indicates the possibility of their understanding of the questionnaire more accurately and answering it correctly .

Second: Description and diagnosis of the study variables (*): The content of this aspect

includes a description of the nature of the study variables according to what the respondents in the company under the study realize, through the researchers' use of the (SPSS 22) program to infer arithmetic means, standard deviations, repetitions, their percentages and response rate To the scale area, as shown in Table (3):

Table (3) Summary of Frequency Distributions, Means, Standard Deviations, Response Ratio and Coefficient of Variation for the applications of the multi-agent system in the company under the study

variable name		variable symbol	response scale					Mean	Standard Deviation	% Response Rate	Variation Coefficient %
			Strongly Agree	Agree	Not Sure	Don't Agree	Don't Agree Strongly				
			%	%	%	%	%				
MAS Applications	Automation	X 1	28.37	55.34	11.67	4.42	0.2	4.06	0.74	81.34	18.28
	Computer Network	X 2	21.74	54.53	17.30	4.82	1.61	3.89	0.79	77.89	20.63
	Smart Grids	X 3	19.52	52.31	20.53	5.43	2.21	3.81	0.85	76.17	22.55
	General Average	-	23.21	54.06	16.5	4.89	1.34	3.92	0.79	78.47	20.49
	Total	-	77.27		16.5	6.23		-	-	-	-

N = 71 The table prepared by researchers based on the outputs of the program (SPSS 22)

The area of the scale is divided into five equal levels[21]:

The first level: between (20-39.99) represents a severe decline in the level of the perceived state.

The second level: between (40-59.99) represents the low level of the perceived state.

The third level: between (60 - 69.99) represents the average level of the perceived state.

Fourth level: between (70 - 89.99) represents the high level of the perceived state.

The fifth level: between (90-100) represents a sharp increase in the level of the perceived state.

It is inferred from the data of Table (3) that there is agreement between the opinions of the respondents regarding the paragraphs of the applications of the multi-agent system. The general consistency of the answers of the respondents in agreement reached **(strongly agree, agree)** (77.27%), and this indicates that there is a good degree of consistency of importance for the answers of the respondents. On the paragraphs of the applications of the multi-agent system, that is, the opinions of the respondents are heading towards the positive direction based on the (Likert) quintuple scale, and this arithmetic mean (3.92) which is higher than the default arithmetic mean of the scale (3) and a standard deviation (0.79) was reinforced. The degree of general inconsistency of the answers of the respondents to the paragraphs of the applications of the multi-agent system (6.23%) **(don't agree, don't agree strongly)**, which is a very small percentage. As for the percentage of answers **(not sure)**, it constituted (16.5%) of the total respondents. The value of the coefficient of variation was (20.49%), which means that the respondents agreed in a clear degree about these variables according to their personal point of view, while the ratio of the response to the scale area was (78.47%), and this indicates that the level of people's awareness .The response of the respondents has reached the fourth level of the scale space (the high level of the perceived state), which indicates the importance of the applications of the multi-agent system for the company under study. The component (X1), which represents the application of automation, had the largest and positive contribution to enriching the applications of the multi-agent system, as it obtained the highest agreement percentage (83.71%), arithmetic mean (4.06) standard deviation (0.74), which indicates homogeneity between the answers of the respondents, Depending on the values of the arithmetic means, the response ratio and the coefficient of variation, the importance of

adopting the applications of the multi-agent system in the company can be determined, as shown in Table (4).

Table (4) The relative importance of establishing a multi-agent system from the individuals surveyed in the company under the study

Variation Coefficient %	Response % Rate	Means	Activity symbol	Activities	
18.28	81.34	4.06	X 1	Automation	1
20.63	77.89	3.89	X 2	Computer Networks	2
22.55	76.17	3.81	X 3	Smart Grids	3

The table prepared by the researchers based on the product of the electronic calculator.

The data in Table (4) indicate that the managers in the company under the study are paying increasing attention to adopting the application of **(automation)** in the first place, then the application of **(computer networks)** in the second place, and then the application of **(smart grids)** in the third and last place. **In line with the foregoing, the first hypothesis is accepted at the level of the study.**

Third: Determining the response of the company under the study to establish (MAS) applications: In order to identify the response of the company under study to adopt (MAS) applications, the T-Test was used, as shown in Table (5).

Table (5) results of the statistical laboratory (T) for the respondents' answers to the study variables

Response Rate *	T-Test	Standard Deviation	Mean	Variable Symbol	Variable Name
7/7=100%	59.974	0.62	4.47	VAR 1	Automation
	45.819	0.76	4.14	VAR 2	
	43.250	0.75	3.87	VAR 3	
	38.876	0.87	4.01	VAR 4	
	51.170	0.65	3.97	VAR 5	
	37.475	0.88	3.92	VAR 6	
	52.483	0.65	4.09	VAR 7	
7/7=100%	32.920	0.91	3.5	VAR 8	Computer Networks
	47.811	0.71	4.0	VAR 9	
	50.763	0.68	4.1	VAR10	
	48.926	0.68	3.9	VAR 11	
	25.248	1.14	3.4	VAR12	
	50.215	0.66	3.9	VAR 13	
	46.081	0.75	4.1	VAR 14	
7/7=100%	33.360	0.92	3.66	VAR 15	Smart Grids
	37.971	0.77	3.47	VAR 16	
	40.994	0.81	3.98	VAR 17	
	33.519	1.03	4.09	VAR 18	
	35.020	0.88	3.69	VAR 19	
	38.180	0.86	3.92	VAR 20	
	43.795	0.74	3.85	VAR 21	

Source: prepared by researchers N = 71
Tabular value (T) = 1.990
(*) Response ratio = number of variables for each dimension / sum of variables for one dimension

The results of the table can be described as follows:

a. **The results of the statistical test (T) for the variables (X1-X7):** Table (5) showed the results of the statistical laboratory (T) for the respondents' answers that all the sub-variables had achieved compatibility within the application of (Automation), as the value of (T) calculated for these variables was greater than Its tabular value is (1.990) at a significant level (0.05), and the agreement of the company under consideration with this component is (100%), and this result is consistent with the study [22], which confirmed that automation if Applied in the manufacturing industries, it will give the company the necessary flexibility to respond to customers' demands and provide an economic environment, which enhances the company's competitiveness and earns it a privileged position.
b. **The results of the statistical test (T) for the variables (X8-X14**): Table (5) showed the results of the statistical laboratory (T) for the respondents' answers that all the sub-variables had achieved compatibility within the application of (computer networks), as the value of (T) calculated for these variables was greater From its tabular value of (1.990) at a significant level (0.05), and the compatibility of the company under consideration with this component reached (100%), and this result is consistent with the study[23] , which confirmed that computer networks It plays an important role in saving the time needed to share information between departments and

branches of the company, as well as saving the costs that result from purchasing a large number of devices attached to a computer.

c. **The results of the statistical test (T) for the variables (X15-X21):** Table (5) showed the results of the statistical laboratory (T) for the respondents' answers that all the sub-variables had achieved compatibility within the application of (smart grids), as the value of (T) calculated for these variables was greater From its tabular value of (1.990) at a significant level (0.05), and the compatibility of the company under consideration with this component reached (100%), and this result is consistent with the study [24], which confirmed that smart networks It can contribute to enhancing the independence and reliability of the system through interaction with energy users , due to its advanced technologies that emanate from distributed artificial intelligence systems and communication and information technologies. **In line with what was presented, the second hypothesis was accepted at the level of the study.**

4. Conclusions and Suggestions

First: the conclusions

1. There is an agreement between the opinions of the surveyed managers about the variables of the research, as their opinions tended towards the positive pole according to the five-point Likert scale, which indicates the possibility of establishing a multi-agent system in the company under study.

2. The results of the test proved the existence of great importance for the applications of the multi-agent system in the company under study, as the response rate of the surveyed managers reached the fourth level of the scale used (high level of the perceived state), which reflects the managers' awareness of the importance of establishing such applications in the company under research.

3. The application of automation ranked first in terms of the relative importance of adopting the multi-agent system applications from the respondents' point of view, then the application of computer networks ranked second, and finally the application of smart networks ranked third.

4. The results of the statistical analysis proved that the company under the study obtained an excellent response rate for the establishment of all applications of the multi-agent system. The application of automation came first in terms of response rates, then the application of computer networks ranked second, and finally the application of smart networks ranked third.

Second, the suggestions

1. Increasing the interest of the management of the company under discussion in the applications of the multi-agent system, such as automation, computer networks and smart networks, in an effort to provide products that meet the needs of its customers in terms of appropriate quality and cost, in addition to the economic benefits that the company reaps as a result of its application.

2. Determining a timetable for the tasks through which the products are manufactured in the company in question.

3. Increasing the interest of the management of the company under discussion with the necessity of securing the basic components to initiate the application of the multi-agent system in the future in terms of machines and equipment, as well as the tools and software for that.

4. Expanding the relationship between the management of the company under discussion and the specialists in Iraqi universities such as the Northern Technical University and other Iraqi universities by continuing to hold training courses in production and operations management in general, and initiating the application of the multi-agent system in particular.

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