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Just-In-Time Implementation Status in the Middle East Industry

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***Abstract*—**The purpose of this study is to identify and evaluate the scale of implementation of Just-In-Time (JIT) in the different industrial sectors in the Middle East. This study analyzes the empirical data collected by a questionnaire survey distributed to companies in three main industrial sectors in the Middle East, which are: food, chemicals and fabrics. The following main hypotheses is formulated and tested: (The requirements of JIT application differ according to the type of industrial sector).Descriptive statistics and Box plot analysis were used to examine the hypotheses. This study indicates a reasonable evidence for accepting the main hypotheses. It reveals that there is no standard way to adopt JIT as a production system. But each industrial sector should concentrate in the investment on critical requirements that differ according to the nature and strategy of production followed in that sector.

***Keywords*—**Just-In-Time, JIT, Questionnaire, Types of Industrial Sectors.

I. Introduction

JIT is a very important and relevant topic to all operations managers today. It aims to meet demand instantaneously, with perfect quality and no waste [18]. It has become a major factor of competitiveness in the global environment [8]. JIT systems, which are designed to produce or deliver goods or services as needed and minimize inventories, require major changes in traditional operating practices [1] JIT originated in the 1950s at Toyota Motor Company in Japan, through continuous effort to solve manufacturing problems. JIT is often referred as the Toyota production system. Many definitions have been put forward for JIT. [5] Defined JIT as organizational philosophy that utilizes important procedures to maximize profit through minimizing inventory. [4] Defined JIT as an approach to minimize the waste. Whereas, [3] defined JIT as a production strategy with a new set of values to continuously improve quality and productivity.

JIT is characterized by reduced inventory, improved quality [14] reduced lead times, enhanced flexibility, worker empowerment, improved morale, minimum waste [16] and timely response to customer needs. JIT is based on two principles: elimination of waste; and respect and full utilization of human resources and capabilities. Potential waste is apparent at every stage of the production process [15]. The most important kind of waste to eliminate with JIT is the imbalance between customer demand and production. Inventory is generated by overproduction which leads to a waste of money. Operating with internal customers, this imbalance may exist at each stage in production, including the relation between supplier and producer. Waste may also arise during production for a number of other reasons, i.e. waiting, transporting, processing and producing defective goods. [2] Mentioned that after analyzing thirty eight articles published between 1982 and 1990, it is found that, in a total of 44 industrial companies, inventory was reduced by 68%, defect rates reduced from 6% to 0.5%, quality increased by 50%, and space reduced by 46%.

Questionnaires have been used and are still being used by many researchers to assess the JIT implementation benefits. Most of research has examined the effect of JIT philosophy in developed countries. [2] Used statistical analysis methods to examine the empirical data from a questionnaire survey to test the hypothesis that JIT has a positive impact on the quality of food. They used four quality measures; of these measures used, product quality, following USDA standards, and customer satisfaction score extremely high, with product safety scoring slightly lower. They concluded that most of the responding food companies considered themselves to be among the best quality-food producers. [13] Used a questionnaire survey run in manufacturing companies in the Nordic companies and East Asian companies, to evaluate to what degree the effects of TQM and JIT are to be expected. They found that JIT companies are very professional and facts-driven. They base their success on high quality of relationships with suppliers, employees and customers. [11] Identified and compared the scale of implementation of JIT activities in the UK by entirely British and American owned companies. He concluded that the British owned manufacturing companies are showing a high degree of interest in training programs, but they ; and the American owned companies; are still using the formal paper work for selecting their suppliers.

Not much attention has been paid to the study of the implementation of JIT in less developed countries. [12] examined the implementation of JIT production systems in Ghana. After He analyzed a survey questionnaire, he found that the Ghanaian manufacturing firms which implemented JIT invested in JIT production in terms of their efforts in employees training, setup time reduction, cellular manufacturing, continuous quality improvement, and supplier partnership.

The Middle East countries are recognized to be from the less developed countries. There is a crucial need to adopt the new technologies in the production management. The industrial sector in the Middle East suffers from many problems that can be cured by intelligent implementation of

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JIT system. The main four problems are: high inventory levels, high percentages of scrap and rework, high setup and lead times, and a huge shortage in the communication systems with the suppliers.

In this study, a questionnaire survey will be analyzed to evaluate the scale of implementation of JIT in the different types of industry in Middle East from the executive managers point view. It will bring out the critical JIT requirements and JIT elements essential to the successful incubation of JIT according to the type of industry.

II. Research Methodologies

A. The JIT Hypothesis

Many researchers wrote about the main components of JIT. [6] Mentioned that JIT depends on the use of superior technology and electronic data interchange, which facilitates the development of technology skills and technologically advanced manufacturing equipment and facilities. [7] Used words like "mutual trust" and "partnership" to describe the buyer-supplier relationship in a JIT environment. [10] Argued that JIT is an efficient management system to cope with schedule fluctuations. [9] Considered kabana production control system as one of JIT major operational elements.

After a deep study of the previous researches, the survey questionnaire was designed to reflect the pilot pretest, and the JIT requirements were thus fine-tuned. According to [2] minimizing cost, establishing trust and providing reward are the three key considerations for a usable questionnaire. To minimize cost associated with manager's time, only the questions essential to the study was asked, which led to current questionnaire. To establish trust a covering letter explaining the purpose of the study and assuring confidentiality is included with the questionnaire. Finally the reward was an offer to present academic service and a promise to share the survey results.

Table I presents a questionnaire is designed to contain JIT requirements. The questionnaire will assess the executive manager's opinions about the critical JIT requirements, and how JIT components differ according to the type of industrial sector. In this study different JIT hypotheses will be tested: (The requirements of JIT differ according to the type of industrial sector)

B. The Survey Questionnaire

Through field interviews and pilot pretests, we modified the JIT requirements accordingly. We targeted the main three main types of industrial sectors in the Middle East, which are: the food, chemical and fabric. A pretest questionnaire, based on the JIT requirements listed in Table I. The pretest results indicated that although some large plants were willing to share information with us, small companies were defensive about their proprietary quality and safety data

TABLE I
Summary of JIT Elements and Requirements (A)

		Survey Question	Symbol
JIT requirements	Inventory level	Minimization of inventory levels	Q1
	Cultural change	Top management plays a pivotal role in spreading JIT understanding for the different levels of management	Q2
	Employee empowerment	Management support and understanding and employee empowerment	Q3
	Training	On-job training	Q4
	Communication systems	The use of integrated data interchange tools inside the company	Q5
		High degree of communication with the supplier	Q6
	Continuous improvement	Clear goals for continuous improvement	Q7
	Strategic planning	Strategic plans to implement JIT	Q8
		Let near benefits to gain JIT benefits	Q9

C. Statistical Analyses

The survey questionnaire consists of 34 various questions, 9 of these questions cover JIT requirements and the rest questions cover JIT elements. The scope of this paper is limited to JIT requirements only. A five-point Likert scale is used as follows: number 5 = strongly agree, 4 = agree, 3 = neutral, 2 = disagree, 1 = strongly disagree. The analysis, using Minitab, utilizes descriptive statistics and testing of hypothesis. The concentration of this research is on JIT requirements only for different types of industries and their type of production.

TABLE II
Managers' Response for JIT Requirements for Different Industries

Question No.	Food Co.	Chem. Co.	Fab. Co.	Average
Q1	3.80	3.93	4.25	**4.00**
Q2	3.93	3.60	4.00	**3.85**
Q3	4.13	4.13	4.25	**4.17**
Q4	4.07	3.60	3.81	**3.83**
Q5	4.33	3.87	4.00	**4.07**
Q6	3.73	4.00	3.75	**3.83**
Q7	3.73	3.20	4.00	**3.65**
Q8	3.27	3.13	3.69	**3.37**
Q9	4.33	4.40	4.50	**4.41**
Average	**3.92**	**3.76**	**4.03**	**3.91**
STD.	**0.34**	**0.42**	**0.27**	**0.30**

Table II shows the statistical data of the survey results for three types of industrial sectors. The mean and standard deviation were calculated for each JIT requirement and the difference in mean response to the different JIT requirements according to the type of industrial sector is analyzed and tested.

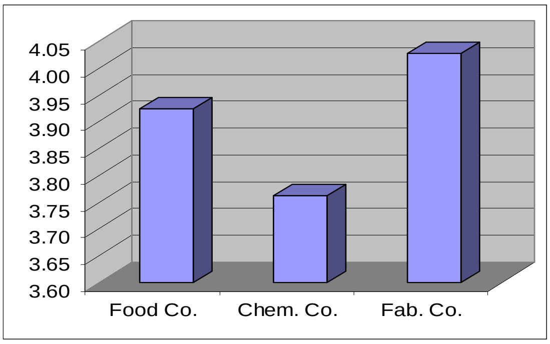

Fig. 1 Average responses for JIT Requirements

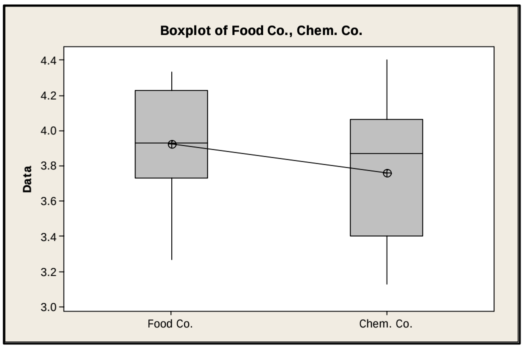

Fig. 2 Box Plot for Food and Chemical Industries

It is shown from Fig. 2, which the average response of managers for JIT requirements in Fabrication industry is higher than the one in the Food or Chemical industries, while the standard deviations are reversely set.

Hypothesis 1: The requirements of JIT differ according to the type of industrial sector

A) Food Industry vs. Chemical Industry

Ha0: The Average of Food industries = The Average of Chemical industries.

Ha1: The Average of Food industries ≠ The Average of Chemical industries

The t-test for this hypothesis is summarized as below:

Two-sample T for Food Co. vs Chem. Co.

	N	Mean	StDev	SE Mean
Food Co.	9	3.924	0.338	0.11
Chem. Co.	9	3.762	0.419	0.14

Difference = mu (Food Co.) - mu (Chem. Co.)
Estimate for difference: 0.162222
95% CI for difference: (-0.220267, 0.544712)
T-Test of difference = 0 (vs not =): T-Value = 0.90 P-Value = 0.380 DF = 15

The results of the t-test show that we cannot reject Ha0 and conclude that the average managers' response to JIT requirements for the food industry does not differ from the one in the chemical industry. The box plot in Fig. 2, illustrate the same results.

B) Food Industry vs. Fabrication Industry

Hb0: The Average of Food industries = The Average of Fabrication industries.

Hb1: The Average of Food industries ≠ The Average of Fabrication industries

The t-test for this hypothesis is summarized as below:

Two-sample T for Food Co. vs Fab. Co:

	N	Mean	StDev	SE Mean
Food Co.	9	3.924	0.338	0.11
Fab. Co.	9	4.028	0.265	0.088

Difference = mu (Food Co.) - mu (Fab. Co)
Estimate for difference: -0.103333
95% CI for difference: (-0.408363, 0.201697)
T-Test of difference = 0 (vs not =): T-Value = -0.72 P-Value = 0.481 DF = 15

The results of the t-test show that we cannot reject Hb0 and conclude that the average managers' response to JIT requirements for the food industry does not differ from the one in the fabrication industry. The box plot in Fig. 3, illustrate the same results.

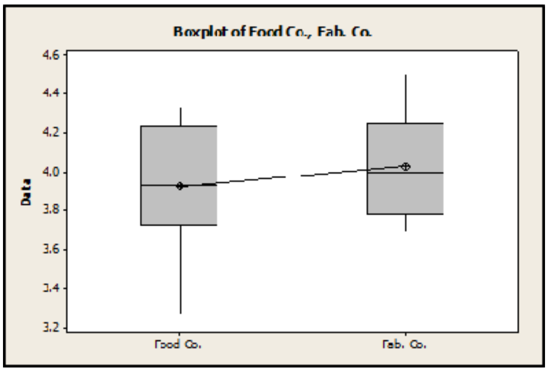

Fig. 3 Box Plot for Food and Fabrication Industries

C) Chemical Industry vs. Fabrication Industry

Hc0: The Average of Chemical industries = The Average of Fabrication industries.

Hc1: The Average of Chemical industries ≠ The Average of Fabrication industries

The t-test for this hypothesis is summarized as below:

Paired T for Chem. Co. - Fab. Co.

	N	Mean	StDev	SE Mean
Chem. Co.	9	3.76222	0.41934	0.13978
Fab. Co.	9	4.02778	0.26523	0.08841
Difference	9	-0.265556	0.301915	0.100638

95% CI for mean difference: (-0.497628, -0.033483)

T-Test of mean difference = 0 (vs not = 0): T-Value = -2.64 P-Value = 0.030

The results of the t-test show that Hc0 should be rejected and conclude that the average managers' response to JIT requirements for the chemical industry does differ from the one in the fabrication industry. The box plot in Fig. 4, illustrate the same results, and it is shown also that the confidence interval does not contain the zero value.

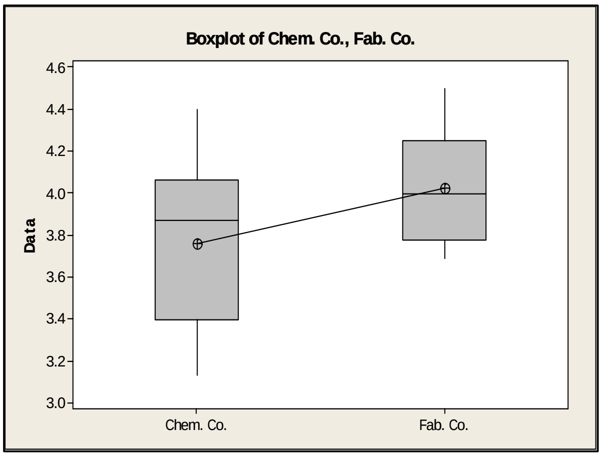

Fig. 4 Box Plot for Chemical and Fabrication Industries

Table III shows the statistical data of the survey results for the three types of productions. The mean and standard deviation were calculated for each JIT requirement and the difference in mean response to the different JIT requirements according to the type of production is analyzed and tested.

TABLE III
MANAGERS' RESPONSE FOR THE JIT REQUIREMENTS FOR DIFFERENT TYPES OF PRODUCTION

	Batch	Continuous	Mass	Average
Q1	4.06	4.07	4.00	**4.05**
Q2	3.94	3.85	4.11	**3.92**
Q3	4.19	4.26	3.89	**4.17**
Q4	3.81	3.93	3.89	**3.89**
Q5	4.13	4.22	3.56	**4.08**
Q6	3.69	3.93	3.89	**3.85**
Q7	3.50	3.81	3.89	**3.73**
Q8	3.25	3.44	3.78	**3.44**
Q9	4.44	4.48	4.33	**4.44**
Q10	3.75	3.52	3.78	**3.64**
Average	**3.88**	**3.95**	**3.91**	**3.92**
STD.	**0.35**	**0.32**	**0.21**	**0.29**

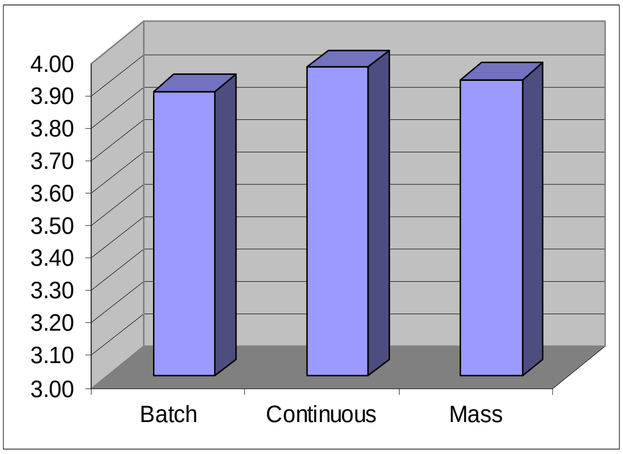

Fig. 5 Average responses for JIT Requirements

2. Hypothesis 2: The requirements of JIT differ according to the type of production

A) Batch Production vs. Continuous Production
Ha0: The Average of Batch production = The Average of Continuous production.
Ha1: The Average of Batch production ≠ The Average of Continuous production
B) Batch Production vs. Mass Production
Hb0: The Average of Batch production = The Average of Mass production.
Hb1: The Average of Batch production ≠ The Average of Mass production
C) Batch Production vs. Continuous Production
Hc0: The Average of Mass production = The Average of Continuous production.
Hc1: The Average of Mass Production ≠ the Average of Continuous Production
The t-test for theses hypothesis are summarized as below:
H0 P-Value Conclusion
a) Av. Of Batch production = Av. Of Continuous Production 0.625 Fail to Reject H0
b) Av. Of Batch production = Av. Of Mass Production 0.784 Fail to Reject H0
c) Av. Of Continuous Production = Av. Of Mass Production 0.752 Fail to Reject H0

The conclusion from these tests shows that there is no difference between the different types of production. The P-value for each hypothesis test is more than 0, 05. This means that whatever type of production there is no difference of the JIT requirements according to the managers' responses collected from the survey.

Table IV shows the statistical data of the survey results for the two types of manufacturing production; the Demand policy and the Storage & demand policy. The mean and standard deviation were calculated for each JIT requirement and the difference in mean response to the different JIT requirements according to the type of manufacturing production policies is analyzed and tested.

TABLE IV
RESULTS OF JIT REQUIREMENT FOR MANUFACTURING ACCORDING TO DEMAND PRODUCTION POLICY AND STORAGE & DEMAND POLICY

Question No.	Demand Policy	Storage & Demand Policy	Average
Q1	4.56	3.82	**4.08**
Q2	4.00	3.85	**3.90**
Q3	4.28	4.15	**4.20**
Q4	3.89	3.67	**3.75**
Q5	4.28	4.00	**4.10**
Q6	4.00	3.76	**3.84**
Q7	3.83	3.67	**3.73**
Q8	3.50	3.42	**3.45**
Q9	4.39	3.42	**3.76**
Average	**4.08**	**3.75**	**3.87**
STD.	**0.33**	**0.24**	**0.23**

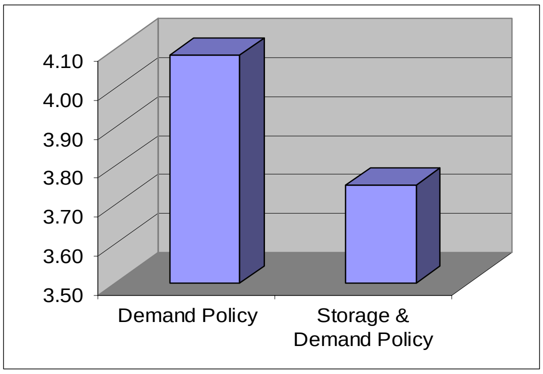

Fig. 6 Average responses for JIT Requirements

3. Hypothesis 3: The requirements of JIT according to the manufacturing policies

A) Demand Manufacturing Policy vs. Storage & Demand Policy

Ha0: The Average of Demand Manufacturing policy = The Average of Storage & Demand Policy.

Ha1: The Average of Demand Manufacturing policy ≠ The Average of Storage & Demand Policy.

The t-test for this hypothesis is summarized as below:

Paired T for Demand prod. - Stocked & Demand Production Policy

	N	Mean	StDev	SE Mean
Demond prod.	9	4.08111	0.32678	0.10893
Stocked Demand	9	3.75111	0.24189	0.08063
Difference	9	0.330000	0.309071	0.10302

95% CI for mean difference: (0.092427, 0.567573)

T-Test of mean difference = 0 (vs not = 0): T-Value = 3.20 P-Value = 0.013

The results of the t-test show that Ha0 should be rejected because the P-value < 0.05 and conclude that the average managers' response to JIT requirements for demand manufacturing policy does differ from the one for the storage & demand policy. The box plot in Fig. 8, illustrate the same results as shown below, and it is shown also that the confidence interval does not contain the zero value.

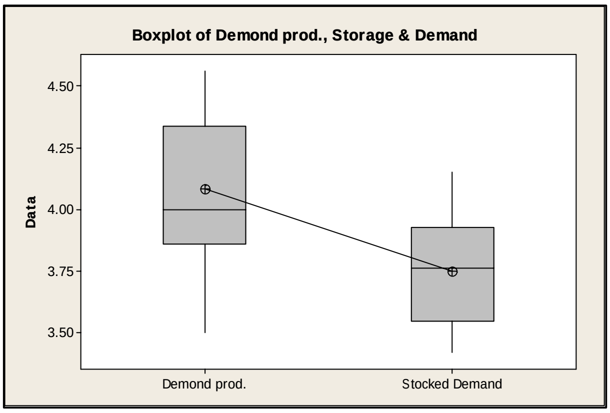

Fig. 7 Box Plot for Demand and Storage & Demand Policies

III. CONCLUSION

The theme of this study was to identify and evaluate the scale of implementation of JIT in three different types of industrial sectors in the Middle East. A questionnaire was designed to assess the executive managers' opinions about the critical JIT, and how these JIT components differ according to the type of the industrial sector. There were significant differences between the chemical and fabrication sectors from one side, while there were no significant differences on the other sectors in the survey. The differences rise from the fact that not all sectors can adopt JIT on the same scale. The different sectors differ in the production nature and strategy.

The results of the analysis showed that the average managers' response to JIT requirements for the food industry does not differ from the one in the chemical industry. On the other hand it is concluded that the average managers' response to JIT requirements for the chemical industry does differ from the one in the fabrication industry. It is concluded that the average managers' response to JIT requirements for the food industry does not differ from the one in the fabrication industry.

Regarding the production type it is concluded that there is no difference between the different types of production. Therefore, the JIT requirements are the same for different types of production. It is also concluded that the JIT requirements for demand manufacturing policy does differ from the one for the storage & demand policy.

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