

# CURRENT STATE OF TURKISH PREFABRICATION COMPANIES WITH RESPECT TO THE APPLICABILITY OF JUST IN TIME

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Just in Time (JIT) is a production system with main objectives of elimination of waste, and continuous improvement of quality and productivity. Literature findings show successful implementations of JIT in manufacturing, especially in repetitive and large quantity productions. Success in implementation depends on factors related with the companies' production, inventory and quality control/assurance systems, relationships with their clients and their suppliers, and top management support and employee participation.

Prefabrication has been determined as being the most suitable sector for the introduction of JIT into construction industry due to its closest resemblance to manufacturing. The aim of this paper is to present current state of Turkish prefabrication companies with respect to the applicability of JIT. A questionnaire survey has been undertaken with 31 companies registered to the Turkish Association of Prefabricators. Conclusions have been drawn in the light of frequency and Thurstone analysis of the questionnaire results, and Fisher's Exact Test for hypotheses testing. It is concluded that Turkish prefabrication companies mainly face three important problems related with the applicability of JIT. These are lack of clients' collaboration, suppliers' capability of JIT delivery, and inflation.

Keywords: ISO 9000, Just in Time, prefabrication, production system, quality assurance.

## INTRODUCTION

Just in time (JIT), in idealised terms, is a production system with the aim of zero defects and zero inventories. However, in practice JIT can be defined as "production of the right goods in the right amounts and at the right time." (Monden, 1983). The benefits of implementing JIT can be summarised in three main headings;

elimination of waste and all activities that do not add any value to the product or service,

production of the right goods at the first time,

achievement of continuous improvement.

While Lim and Low (1992), Kurt (1998), Akintoye (1993), discuss the implementation of JIT for building material management, Pheng and Meng (1997) point out that "any feasible application of JIT concept to improve productivity in the entire industry should first be applied to those sectors which exhibit characteristics most amenable for JIT application". The authors then recommend "off-site" prefabrication sector to be an appropriate start. Thus, the aim of this paper is to

present empirical analysis of the current state of the Turkish Prefabrication Sector with respect to the applicability of Just in Time.

## **FACTORS AFFECTING THE SUCCESS OF JIT IMPLEMENTATIONS**

The above stated benefits of JIT can be achieved only when some important factors are satisfied. These are factors related with;

the production system,  
total quality concept,  
relationships with the suppliers and the clients,  
inventory system,  
employee involvement in decision making and employee training,  
top management commitment.

### **Factors Related with the production system**

There are basically two systems of production. These are;

push system; where production is based on the forecasts of demand with stock taking;  
pull system; where production is based on demand without stock taking.

Utilisation of a pull system with JIT ensures that there is no overproduction, which not only reduces inventory but also increases labour idle time. Labour idle time can be used in favour of the company if labour is trained to gain multi functional skills and knowledge, especially to be able to switch from one machine to another and undertake preventive maintenance and set up of machinery. This, in turn, results in reduction of machinery breakdown and set up times, reducing buffer stocks and increasing production productivity.

Factory layout is another factor that affects the production productivity. Factory layout should be arranged mainly to prevent congestion and undesirable transportation waste. "The ideal layout is often U shaped flow line dedicated to a particular product family" (Pheng and Meng, 1997). U shaped layout also provides the workers' access to a number of machines, and eases communication between the workers in the same group.

### **Factors related with the total quality concept**

Production of the right goods in the right amounts and at the right time can only be achieved if required quality is guaranteed for each resource (man, machine, material) used during production. Implementation of a quality assurance system helps the company to achieve quality according to a set of standards which requires systematic actions for continuous improvement, and which provides adequate confidence that the product or service will satisfy given quality requirements. Total quality can be achieved by;

identifying the reasons behind any quality problems and finding long-term solutions to avoid the occurrence of the problem, and  
making quality the responsibility of every worker and not the responsibility of only quality control department.

As a result, total quality approach directs the production system towards zero defects and in turn towards zero inventories. As Badiru (1995) states “JIT is a concept that complements the ideas of total quality management (TQM ) and facilitates the objectives of ISO 9000”.

**Factors related with the relationships with the suppliers and the clients**

In a JIT environment, suppliers are important not only for the achievement of quality but also for the reduction of inventory. Delivery of high quality materials in small quantities on time is an essential factor for the success of JIT that may result in long-term agreements of the manufacturer with a single (or a few) reliable supplier. Such a relationship, in turn, leads to better quality, lower cost production for the manufacturer and income stability for the supplier.

Client relationships are also important firstly in getting feedback about the product quality and secondly in easing the manufacturer’s efforts in implementation of JIT by assuring as few variations as possible in their orders.

**Factors related with the top management and employee commitment**

JIT implementation cannot be successful, or even be started, if top management does not support it. Top management support will be in the form of convincing the employees and top management of the suppliers about the benefits of JIT, and financing the implementation.

Employee commitment can be achieved through training, and giving opportunity for participation in the decision-making.

**RESEARCH METHODOLOGY**

A questionnaire survey has been undertaken with the prefabrication firms that are members of Turkish Prefabrication Association (TPB). From a total number of 31 members, 23 of them responded to the survey as 8 firms had very busy schedules due to the extra demand after the earthquake in the Marmara Region of Turkey in August 1999. The questionnaires were delivered by hand to the 23 firms.

The questionnaire was divided into sections related with the factors affecting the success of JIT implementation. The questions were mainly in the form of multiple choice and ranking.

Results were analysed by using Frequency Analysis for the multiple-choice questions, Thurstone Analysis for the ranking questions and some hypotheses testing by using Fisher’s Exact Test.

**PRESENTATION AND DISCUSSION OF RESULTS**

**Profile of the respondents**

Profile of the respondents are presented in Table 1

**Table 1:** Profile of the respondents

Type of work (pre-cast concrete products)	Number of companies	Number of employees	Variety of Products
Only manufacture	4 (17 %)	60-218	5-90
Manufacture and assemble on site	19 (83 %)	25-200	6-50

The questionnaires were answered by project managers, quality managers and production planners.

**Production systems**

The questionnaire contains two questions related with the production system. The first question categorises the production planning systems as materials requirement planning (MRP), optimum production planning (OPT), flexible manufacturing system (FMS), and just in time manufacturing (JIT). The definitions for each system are given by one sentence. The second question is related with the production flow, and that is presented either being a pull system or a push system. Each of these two systems is also explained with one sentence. In spite of these explanations, possibility of managers’ lack of knowledge related with the different types of the production systems could have resulted in misleading conclusions. Therefore a one-tailed hypothesis was proposed with;

H<sub>0</sub>: There is not a relationship between JIT implementation and implementation of a pull system during production.

H<sub>1</sub>: Companies that implement JIT employ push system rather than a pull system.

By analysing the results presented in Table2 using Fisher’s Exact Test, it was found that there was not enough evidence to reject H<sub>0</sub> and H<sub>1</sub> was rejected.

Two more hypotheses were also tested to support the above hypothesis. These were about the relationship between implementation of JIT and materials inventory, and also relationship between employing a pull system and sub product inventory. The results show that there is not any relationship between keeping the material inventory and implementing JIT, and that there is not a relationship between employing a pull system and keeping sub product inventory.

The above discussion raises the question about the validity of the managers’ answers related with their companies’ production systems. Therefore, 61% of JIT implementation through Turkish prefabrication sector is not a reliable result and will be ignored during the analysis of other results.

**Table 2:** Production Systems Employed by the Prefabrication Companies

	MRP	OPT	FMS	JIT
No of Respondents	5 (24 %)	1 (5 %)	2 (10 %)	13 (62 %)
Push system	1	1	1	3
Pull system	4	0	1	9

Note: 1 of the JIT implementing companies did not choose any of the production flow systems.

**Production Problems:**

**Machinery breakdown and preventive maintenance (PM):** While 76% of the respondents stated that machinery breakdown was affecting their production productivity, only 57% of the companies undertook periodical preventive maintenance where periods depended on the type of the machinery.

**Variations in orders:** 62 % of the managers stated that their main problem during production was client related; that was variations or cancellations in orders.

**Layout:** Problems of long travel distances of material between two processes, and crowded and insufficient roadways due to the factory layout affected productivity in 50% of the prefabrication companies.

**Uneducated labour:** Only 3 managers stated that their companies’ production was affected due to the uneducated labour.

Set up times: Machinery set up times affected productivity only for 10% of the companies.

**Inventory**

Questions related with inventory were divided into 3 main sections; materials, sub product, and final product inventories.

Materials Inventory: 87% of the companies kept materials inventory due to the reasons presented in Table 3. The most important reason is to avoid risk of production delays if suppliers could not supply the required materials on time. Other reasons, although not as important as the first one, are demand uncertainty (mainly due to the variations in orders) and inflation.

**Table 3:** Reasons For Keeping Materials Inventory

Importance Rank	Reason	Thurstone Coefficient
1	Risk of production delays	+ 0,93
2	Demand uncertainty	-16
3	Inflation	-79

Sub Product Inventory: Sub product inventory was kept by 35% of the manufacturers due to the demand variations, inflation and the risk of production delays (see Table 4).

**Table 4:** Reasons For Keeping Sub Product Inventory

Importance Rank	Reason	Thurstone Coefficient
1	Demand uncertainty	+ 0,42
2	Inflation	0
3	Risk of production delays	-0,42

Final Product Inventory: 20 of 23 managers stated that they had to keep the final product for a certain period of time for curing of concrete. However, 7 out of 23 also stated that final product inventory was kept due to the clients not being ready for the handling.

**Quality systems**

The questionnaire results show that 91% of the prefabrication companies implement at least one quality assurance (QA) system and only 3 of them (13%) utilise total quality management (see Table 5). Two of the companies whom employ Turkish Standards QA stated that they were at the stage of applying for ISO 9000.

**Table 5:** Quality Assurance Systems Employed by the Companies

Quality Assurance System Employed	Number of Respondents	Respondent %
Turkish Prefabrication Association (TPB) QA	21	91
Turkish Standards (TS) QA	18	78
ISO 9000 QA (9001 or 9002)	12	52
Total Quality Management	3	13

It is a well-known fact that employment of ISO 9000 QA standards requires more strict procedures than Turkish QA systems. Thus, ability of a company for any improvements in the former would be much stronger than in the later, and one of the factors that is a good indicator of continuous improvement is the decrease in product defects through years. Thus a hypothesis was developed saying that;

H<sub>0</sub>: There is not a relationship between the different standard types of quality assurance systems implemented and decrease in product defects.

H<sub>1</sub>: The decrease in product defects is less if the companies employ Turkish QA systems rather than ISO 9000 QA system.

H<sub>0</sub> was rejected and H<sub>1</sub> was accepted by using Fisher’s Exact Test.

Additionally, as presented before machine breakdown was stated to be the most common reason for the productivity loss during production. However, only 60 % of the companies undertake preventive maintenance. When the company profiles are examined, the results show that all of the companies with ISO 9000 QA employ preventive maintenance where only 2 of the companies with Turkish QA standards undertake preventive maintenance.

**Suppliers**

While all of the prefabrication companies undertake quality control (QC) for incoming materials, it was stated by the managers that suppliers undertaking QC were advantageous for them in terms of time and cost savings as it resulted in the decrease of the number of samples during their quality control procedures.

Analysis shows that 78 % of the companies work with the suppliers who employ either ISO 9001 or ISO 9002. That was also supported by the managers’ answers related with their priorities in choosing their suppliers. Their priorities are quality, price, reliability, on time delivery and, finally, distance of the supplier from their company (see Table 6 below). However, it can be observed from the table that quality has a prominent importance for the prefabricators. Additionally, 80% of the managers stated that they had been working with their suppliers more than two years time.

**Table 6:** Thurstone Analysis Results for Supplier Selection

Importance Rank	Factor	Thurstone coefficient
1	Quality	2,10
2	Price	0,01
3	Reliability	-0,1
4	On time	-0,2
5	Distance	-2,50

The number of suppliers that the companies are working with varies depending on the material types. Table 7 shows the relationship between the number of suppliers and the three main types of materials used. The table also shows the varying distances of the suppliers from the prefabricators. The difference between values of the minimum and maximum distances show that prefabrication companies do not give any importance to the suppliers’ distance from their companies that is also the result of Thurstone Analysis (see Table 6).

**Table 7:** Number of Suppliers and Their Distances From the Prefabricators

Material type	Number of suppliers (n)			Total	Distance from the prefabricator (km)	
	n ≤2	2 ≤n≤ 4	n > 4		Min	Max
Cement	18 (82%)	3 (14%)	1 (5%)	22	10	550
Reinforcement Bars	10 (45%)	10 (45%)	2 (10%)	22	60	1000
Aggregate	13 (68%)	4 (21%)	2 (11%)	19	5	85

**Training and employee participation**

88% of the managers stated that their companies provided training to their employees. However only 34% of them gave training to all of the employees about various subjects that could be related or unrelated with the employees’ responsibilities (see Table8).

**Table 8:** Type of Training Provided by the Prefabrication Companies

Participants	Type of Training	Companies (%)
All of the employees	In various subjects	34
All of the employees	In subjects related with their responsibilities	14
Managers only	In various subjects	14
Laborers only	In subjects related with their responsibilities	14
New employees	-	10

Finally, the questionnaire results show that none of the companies have employee participation in decisions undertaken by the top management. Decisions are mainly undertaken by considering information related with the rivals and/or clients.

## **CONCLUSIONS**

JIT is a production system with the aim of production of the right goods in the right amounts at the right time through elimination of waste and continuous improvement. Turkish Prefabrication companies would benefit from JIT implementation in elimination of waste that is caused by the machinery breakdowns, material inventories and, unsuitable factory layouts. However, the following are the main factors to be considered for the success of any JIT implementation in Turkish prefabrication sector.

While nearly all of the prefabrication companies employ a quality assurance system, employment of ISO 9000 QA systems would form a much stronger foundation than the Turkish QA systems for the achievement of continuous improvement during JIT implementation.

Quality is the vital factor for Turkish prefabrication companies in choosing their suppliers. Most of them are satisfied with the quality provided by their suppliers and consequently have long-term relationships with them. However, suppliers' not having enough knowledge about JIT and not being ready for the delivery of required amounts of materials at the requested time is an important barrier for the success of JIT implementation.

Currently clients' variations affect the level of material, sub-product and final product inventories of the prefabrication companies. However, success in JIT implementation cannot be achieved unless there is both suppliers' and clients' collaboration.

Although prefabrication companies undertake training to their employees, the companies can benefit from provision of training in different disciplines that would result in multi functional workers. However, training should also be provided to the companies' top management related with the benefits of employee participation in company decisions.

Inflation is also one of the main factors that would affect the introduction of JIT in Turkey as it creates tendency for keeping buffer inventories.

It can finally be concluded that, there are three main obstacles; lack of clients' collaboration, suppliers' capability of JIT delivery, and inflation, affecting the applicability of JIT in the current state of Turkish prefabrication sector.

## **ACKNOWLEDGEMENTS**

The authors would like to thank to Professor Cemal Yükselen for his invaluable guidance throughout this research.

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