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Building and Environment 38 (2003) 853–860
BUILDING AND ENVIRONMENT
www.elsevier.com/locate/buildenv

JIT in developing countries—a case study of the Turkish prefabrication sector

Emel Laptali Oral[a,*], Gulgun Mıstıkoglu[b], Ercan Erdis[c]

[a] *Mustafa Kemal Üniversitesi, İnşaat Mühendisliği Bölümü, Mühendislik Mimarlık Fakültesi, Tayfur Sökmen Kampüsü, Antakya, Hatay, Turkey*
[b] *Mustafa Kemal Üniversitesi, Antakya Meslek Yüksekokulu, Antakya, Hatay, Turkey*
[c] *İnşaat Mühendisliği Bölümü, Çukurova Üniversitesi, Balcalı, Adana, Turkey*

Received 28 May 2002; received in revised form 11 December 2002; accepted 31 January 2003

Abstract

Just in Time (JIT) is a production management system, whose success depends on the fulfilment of a number of environmental conditions; which presents the problem related with its applicability in developing countries. The literature shows that the poor supply and demand conditions, and the unstable economic environments are the main obstacles for JIT application in developing countries. Other factors include; high costs of; imported technology, training, maintenance and the quality systems, low costs of labour and, the cultural values based on both high power distance and uncertainty avoidance.

The Turkish prefabrication sector was analysed as a case study. A questionnaire survey and a number of interviews were undertaken with Turkish prefabrication companies. Frequency, Thurstone's Paired Comparisons and correlation coefficient analysis were used to evaluate the questionnaire results.

The results unexpectedly showed that inflation was not an obstacle against implementation of JIT by Turkish prefabrication companies, as it had a trivial effect on the companies' supply-chain policies. Additionally, unlike in most developing countries material supply conditions were satisfactory. The financial difficulties and the demand uncertainties were determined to be the main obstacles for the implementation of JIT in the Turkish prefabrication sector.

Keywords: Prefabrication; Productivity; Quality; Developing countries; Just in Time (JIT); Turkish prefabrication sector

1. Introduction

Just in Time (JIT) applications have proved to be remarkably effective in achieving productivity and quality improvements in the manufacturing sector in developed countries [1–3].

The construction industry in developing countries (DCs), with substantial productivity and quality problems has an equal need to benefit from JIT. Due to its resemblance to manufacturing, the prefabrication sector is considered the most suitable to introduce any management approach into the industry [4]. Previous experiences show that success in the use of JIT applications requires the fulfilment of various environmental conditions; presenting the problem related with the applicability of JIT in the prefabrication sector in DCs. However, literature does not present any findings related to this problem. The aim of this article is to identify the likely effects of the environmental conditions in DCs to the success of JIT applications in the prefabrication sector. The prefabrication sector of the Turkish construction industry is then analysed as a case study. Turkey; accepted as a lower-middle income developing country in the World Bank classifications; is a good representative of DCs; with its; high inflationary economy, political instability, technological dependence on the developed world and its distinct cultural differences from developed countries.

2. Principles of JIT

The main objective of JIT is to achieve continuous quality and productivity improvements through production with 'zero defects' and 'no waste'. Successful implementation can be attained through the satisfaction of various organizational factors such as; top management support, determination of the basic production problems, participation of

* Corresponding author. Fax: (00) 903262455499.
E-mail address: emellaptalioral@yahoo.com (E.L. Oral).

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doi:10.1016/S0360-1323(03)00021-0

Table 1
Common characteristics of DCs and their likely impact on the JIT Implementations

Characteristics of the DCs	Likely impact on the JIT implementation
1. High inflation rates	1. Tendency towards materials, sub-product, and product inventories.
2. High interest rates	2. No tendency towards any investment.
3. High costs of technology	3. Limited funds for R& D.
4. High costs of quality systems	4. Tendency not to utilise any QA system.
5. High maintenance costs	5. Limited preventive maintenance.
6. Low labour costs	6. No tendency to increase labour productivity.
7. High costs of training	7. Limited labour training within the company
8. State, the dominant client of the construction industry	8. Regulations and politics affect the demand and the rivalry conditions
9. High power distance culture	9. Top management avoid participative decision making
10. High uncertainty avoidance culture	10. Employees do not resist change
11. Few number of domestic suppliers	11.1. No bargaining power of the producers
	11.2. Tendency towards keeping materials inventories

the employees into decision-making, and utilization of both the appropriate production flow and the inventory systems. The fulfilment of these organizational factors depends on the various environmental conditions such as, the relationships with suppliers and clients, the culture, the regulations, and the economical and political state of the country. Some of these conditions are common for the construction work in most of DCs, and have been discussed by various authors like Ofori [5], Wahab [6], Okpala and Aniekwu [7], Abdelhalim and Duff [8], and Krajewski and Ritzman [1]. The likely effect of the environmental conditions in DCs on the implementation of JIT in prefabrication sector are examined in the following section. The findings are summarised in Table 1.

3. Common characteristics of DCs and their likely effects on JIT implementation

3.1. Implementation costs

Most authors identify top management to be the most important factor in achieving successful long-term and complete implementation of JIT [9–13]. Full acceptance of JIT by top management is required to empower middle management to overcome the barriers in the implementation process, and to get the full cooperation from suppliers.

It can be argued that top management support to JIT would be rather difficult in DCs; as the system requires utilising; quality systems, new technologies, preventive maintenance, and training programs that have high implementation costs, and that do not provide any competitive advantage to the companies [14]. Kaming et al. [15] state that the high costs of; new technologies and machinery due to the technological dependence of the developed world together with, the high interest rates charged by the banks for loans are some of the many problems that affect investments by construction companies in the DCs.

3.2. Costs of technology and maintenance

The waste elimination principle of JIT requires reduction in the set-up times. Excessive set-up times raise the inventory levels by reducing the machine efficiencies. Pheng and Meng [4] state that excessive set-up times are the main reason of the sub-product inventories in the Singaporean prefabrication sector. While recent machinery technologies decrease the set-up times, the present high costs of imported technologies represent a problem to DCs.

Preventive maintenance also reduces the inventory levels. Kaming et al. [15] state that companies in the DCs are not in favour of the preventive maintenance due to the high machinery maintenance costs. JIT applications solve the problem of high maintenance costs, supporting the principle that maintenance should be undertaken by the machine operators or by in-house workers.

3.3. Labour productivity and labour costs

The zero inventory principle of JIT requires the production flow to be a pull system and this increases labour idle time. Labour idle time, on the other hand, is prevented by the multifunctional working practices; labour carrying out tasks such as switching from one machine to another, undertaking the preventive maintenance, and setting up the machinery. Multi functional skills increase labour productivity, and these can be attained through training. However, any improvements in labour productivity through training may not be that attractive for companies in DCs, as the labour costs are dramatically low and the training costs are high [16].

3.4. Inflation and the supply conditions

Production with no waste requires elimination of the activities that do not add any value to the final product. Keeping inventories is one of these activities. The most important reason for keeping inventories in DCs is reported to be the high inflation rates; which is also the most important barrier for implementing JIT [17,18]. JIT implementation involves the risk of motivating inflation; as in cases of material shortages, the suppliers may tend to increase prices [19].

Another reason for keeping inventories is to avoid production delays, which are caused by problems both in the production line and in the supply chain. Scarce construction material suppliers present an important setback in the supply chain of DCs. This results in an increase in the levels of inventories to avoid problems related to quality, the quantity and, on time delivery of the materials [5–8].

3.5. The demand conditions

Success in JIT applications requires stability in both supply and demand. While long-term relationships with suppliers are important for the supply stability and quality, relationships with clients are equally important. Government policies have a dominant effect on the demand stability in DCs, as States are the most important clients of the construction industry. Kaming et al. [15] point out that the demand conditions for prefabrication are more disadvantageous than in situ construction in DCs, as the payment procedures for public works depend on the completed works on site.

Porter [20] states that the presence of a number of independent buyers in a nation creates a better environment for innovation than in the case of where one or two customers dominate the market. The more sophisticated and demanding the clients, the more likely the firms in the industry are to create and sustain competitive advantage since such customers put pressure on the firms to upgrade and meet the high standards in the product quality [21].

3.6. Culture

Cultural values have a significant effect in attaining both top management support and employee participation into decision-making. The research undertaken by Hofstede [22] shows that there is a 'high power distance' cultural dimension in DCs like Turkey, Iraq, Argentina and Brazil, where the bosses take the decisions and act in a powerful manner. The relationship between the managers and the subordinates are characterized by low trust, with the latter avoiding disagreement and preferring to be directed by the manager. The findings of Kozan [23] also stress the fact that Turkey has a culture that can be characterized by; respect for authority, centralized administration, authoritarian leadership style and great differences in power between the organizational members. Yisa et al. [24] presents similar results for Iranian site managers. It can be argued that, under these cultural influences, top management of companies in DCs would not be keen on implementing any system which involved participative management. Should top management support the system; resistance from the employees would not be strong, as they would avoid taking risks. Hofstede [22] classifies this as 'high uncertainty avoidance' cultural dimension.

Training is a prerequisite to change the attitudes of the employees about new systems like JIT. However, the important point that should not to be missed out is that, most training practices have been developed in the West, and may not be appropriate for other cultural settings (Singh [25]). To get the best out of training, the programs should reflect the requirements of both the national and the organizational cultures, which may not necessarily match wholly with each other. Holness and Osborne [26], and Badiru [27] state that ISO 9000 implementations influence the organisational sub-cultures in such a way that, it becomes much easier to change the attitudes of the employees towards systems like JIT; irrespective of the national culture values.

4. The Turkish prefabrication sector

In Turkey, prefabrication started to take place after 1960s. Earlier applications were mainly one-storey industrial buildings. Recent applications include infrastructure, substructure and building construction.

In 1984, the Turkish Prefabrication Association (TPA) was established by organizations which produced concrete and reinforced concrete elements. The TPA aims to support industrial cooperation and development and became member of the Bureau Institute du Beton Manufacture — BIBM in 1993. TPA has currently 31 members. However, according to the unofficial figures, there are about 100 prefabrication companies in Turkey, which makes it difficult to have an accurate assessment on the state of the sector.

4.1. Production productivity and costs

According to the 2000 figures, total annual output of the sector is around 1 700 000 to 2 000 000 m^3. That is about 60% of the total capacity. Production productivity is around 40% and, is nearly half of the productivity in EU countries [28]. Productivity is affected from the level of the automation used. Low labour costs together with the high costs of the imported technology discourage investments towards automation. Labour costs account for approximately 28% of total production costs, while they are over 50% of the total production costs in countries like Holland, Belgium and Britain (DPT [28]).

4.2. The demand conditions

Housing and infrastructure projects dominate the Turkish construction market [27]. The government is the most important customer of the industry, and their policies affect construction quality and demand stability. Government policies focus on the division of funds into as many projects as possible. Thus, quality and on time completion do not provide any competitive advantage.

Demand uncertainty is stated to be the vital problem of the prefabrication sector [28]. The public and the private sectors

have 31% and 69% share of the prefabrication output, respectively. Seventy percent of the total demand comes from industrial building construction. The current financing system, which does not allow rapid financing required for prefabrication, presents the major obstacle for both the housing and the commercial building demand.

4.3. The materials supply conditions

The Turkish construction materials industry is an exception when compared to the similar industries in DCs. It is highly competitive both domestically and internationally. The Turkish iron and steel industry is one of the fastest growing amongst DCs. There are 24 producers with a total steel production capacity of 19.9 million tons (1999 figures). Eighty three percent of the total production contains long steel products [29]. One drawback, however, is that production is highly concentrated in some geographical areas. While not as competitive as the steel and iron industry, the cement industry contains about 28 producers with around 3–4% share of world exports [21].

5. Research material and methodology

A questionnaire survey was undertaken with all (31) of the members of the TPA. The questionnaires were delivered to the companies by hand, and 26 out of 31 companies participated to the survey.

The questionnaire was divided into seven main sections, which included a total number of 47 questions. The questions mainly focused on the state of the companies with respect to the key issues of JIT implementation. These included general information about the companies, their production, inventory and quality systems, and the relationships with the suppliers and the clients. The questions were in the form of multiple-choice and scaling.

Three interviews were undertaken with the Secretariat of the TPA. Statistical data related with the current state of the sector, information about TPA, and information about the problems of the sector were provided by the Secretariat during the interviews. Site visits to three of the respondent companies were additionally carried out, to observe their production processes.

Data collected through the questionnaire survey was analysed by the use of frequency, correlation coefficient and Thurstone methods. Correlation coefficient (r) was used to determine the linear relationship between two variables. Value of 'r', being close to unity in magnitude implies a good correlation between the variables, while being near to zero indicates little or no correlation. Fisher Z transformation (Z) within 95% confidence interval was used to test if the calculated value of r was statistically meaningful. When a good correlation is determined between the variables, value of 'Z' are expected to be greater than 1.96 or smaller than -1.96, if 'r' is statistically meaningful within 95% confidence interval. In case of zero or little correlation, value of 'Z' is expected to be between -1.96 and 1.96 (Sydney and Castellon [30]).

The scaling questions were analysed by using Thurstone's Paired Comparisons Method. Respondents were asked to scale each choice by considering their relative importance. The scale scores of the choices were then compared through Thurstone coefficient (TC) values. TC calculations are based on the number of standard deviations of each choice from the calculated mean value of the set [31].

Table 2
Profile of the respondent companies

Size of the company	No. of employees	Frequency	% of respondents
Small	1–49	7	27
Medium	50–99	8	30
Large	100 <	11	43

Table 3
The environmental and organisational factors that affected top management decisions in the Turkish prefabrication sector

Factors	Frequency	% of respondents[a]
Economical state of the country	24	96
Rivals	19	76
Requirements of the clients	17	68
Technological developments	11	44
Regulations	7	28
Political state of the country	5	20
Requirements of the stakeholders	4	16
Requirements of the employees	1	4
Total no. of respondents	26	100

[a]Percentage of each category calculated from a total of 100%.

6. Results and discussion

6.1. Profile of the respondents

Table 2 presents the profile of the respondent companies according to their number of employees. The ranges for the number of employees are based on the classification for small, medium and large companies, as used by the Turkish Statistical Institute. The managing directors, the production managers and the quality assurance managers completed the questionnaires.

6.2. Financial difficulties and demand conditions

Table 3 shows the environmental and organizational factors that influenced the top management decisions in the Turkish prefabrication companies. The unstable macroeconomic environment with high inflation rates, high interest

Table 4
Relationship between the companies' approaches towards the technological developments and the size of the companies

	Size of the company		Total no. of respondents
	Small	Medium-large	
Consider the technological developments	3	8	11
Do not consider the technological developments	4	11	15
Total no. of respondents	7	19	26

Table 5
Relationship between implementing ISO 9000 and the size of the companies

	Size of the company		Frequency	% of respondents
	Small	Medium-large		
Implement ISO 9000	0	15	15	58
Do not implement ISO 9000	7	4	11	42
Total no. of respondents	7	19	26	100

rates and the fluctuating exchange rates pressured the managers to focus on the economical state of the country (96%) more than other factors. According to the figures provided by TPA, the economic crisis in Turkey resulted in about 20% shrinkage in the prefabrication sector between the years 2000 and 2001. Companies focused on the short-term returns to survive and were reluctant to invest in areas such as R&D or technology. The results of the questionnaire showed that only 44% of the respondents considered the technological developments during decision-making (Table 3). It was hypothesized that there was a relationship between the sizes of the companies and the companies' approach towards the technological developments, as small sized companies normally have limited resources to fund investments in new production concepts or technologies. However, no linear relationship was found (r=0.006, Z=0 in Table 4).

A significant force for the adoption of modernized technologies to increase efficiency is the quality and the productivity demands of the clients. During the interviews, it was stressed that government policies did not encourage improvements in quality and productivity in construction. Competitive advantage was based on unrealistic price cuts. Consequently, as the results in Table 3 show, the rivalry conditions (76%) were more important for the prefabrication companies than the clients' requirements (68%). Nevertheless, a majority of respondents still considered the clients' requirements during decision-making. This together with the fact that 58% of the respondents implemented ISO 9000 (Table 5) reflected the significant role of private clients who seek quality in construction. The important effect of the

Table 6
Relationship between the companies' approaches towards clients' quality requirements and ISO 9000 implementations

	Implement ISO 9000	Do not implement implement ISO 9000	Total no. of respondents
Consider clients' requirements	15	2	17
Do not consider clients' requirements	0	9	9
Total no. of respondents	15	11	26

clients' quality requirements was supported by the good correlation between giving priority to the clients' requirements and implementing ISO 9000 ($r = 0.85$, $Z = 6.02$ by using the data in Table 6). Implementing ISO 9000 was also determined to be strongly related with the size of the companies ($r = 0.71$, $Z = 4.14$ by using the data in Table 5). None of the small sized companies could afford to implement the system. The results in Table 7 show that, for 90% of the companies that did not have ISO 9000, costs of initiating and implementing the system was the main obstacle.

A strong relationship was also determined between the size of the companies and the extent of the companies' training programs ($r = 0.75$, $Z = 4.63$ by using the data in Table 8). While the results in Table 9 show that 92% of the companies undertook some kind of training program, none of the small sized companies provided training to all of their employees.

Company' policies related with the preventive maintenance were unexpectedly promising. Nearly all of the respondents (97%) undertook preventive maintenance irrespective of the size or their quality system.

6.3. Inventories and the supply conditions

According to the DPT [28] report, demand uncertainty is the most important problem in prefabrication production in Turkey. This is also supported by the questionnaire results; 73% of the managers stated that demand uncertainty had an adverse effect on their production planning efforts.

While none of the respondent companies kept product inventories due to the project-based production; 34% kept sub-product and a majority (88%) kept materials inventories (Table 10). Table 11 presents the results related with the reasons of keeping sub-product inventories. TC values show that the demand uncertainties were the primary reason. Unlike the arguments in the literature, the risk of production delays due to problems caused by; the set-up times, the machinery breakdowns or the uneducated labour had trivial importance (TC = −0.42) on the sub-product inventory policies of the Turkish prefabrication companies.

TC values in Table 12 show that inflation (TC = −0.79) did not have a strong effect on the companies' inventory

Table 7
Reasons of not Implementing ISO 9000

	Frequency		% of all of the respondents*	% of the respondents without ISO 9000*
	With ISO 9000	Without ISO 9000		
No disadvantages	15	1	62	9
High costs of implementation	—	10	38	91
Increases production time	—	1	4	9
Decreases labour productivity	—	1	4	9
Increases paperwork	—	1	4	9
Total no. of respondents	15	11	100	100

*Percentage of each category calculated from a total of 100%.

Table 8
Relationship between the extent of the companies' training programs and the size of the companies

	Size of the company		Total no. of respondents
	Small	Medium-large	
Training program included every employee	0	15	15
Training program included some of the employees	6	3	9
Total no. of respondents	6	18	24

Table 9
Training programs of the respondent companies

Training programs for:	Frequency	% of respondents
New employed and labour	1	3.9
Only new employed	2	7.7
Only labour	3	11.5
Administrative staff and managers	3	11.5
All of the employees	15	57.7
None of the employees	2	7.7
Total no. of respondents	26	100

Table 10
Inventory policies of the respondent companies

	Frequency	% of respondents[a]
Keep product inventories	0	0
Keep sub-product inventories	10	38
Keep materials inventories	23	88
Total no. of respondents	26	100

[a]Percentage of each category calculated from a total of 100%.

Table 11
Reasons of keeping sub-product inventories

Reasons	Thurstone coefficient (TC)
Demand uncertainty	+0.42
Inflation	0.0
Risk of production delays	−0.42

Table 12
Reasons of keeping materials inventories

Reasons	Thurstone coefficient (TC)
Risk of production delays	+0.93
Demand uncertainty	−0.16
Inflation	−0.79

Table 13
Priorities of the respondent companies in choosing their suppliers

Priority	Thurstone coefficient (TC)
Quality	+1.00
Reliability	+0.16
On time delivery	+0.08
Price	−0.03
Distance	−1.23

decisions, as stated in the literature. The risk of production delays due to the possibilities of late deliveries by suppliers was the primary reason for keeping material inventories (TC = +0.93). Such an approach played an important role in the priorities of companies while choosing their suppliers. On-time delivery was the respondents' third priority in choosing their suppliers (Table 13). Quality was their first priority (TC = +1.00 in Table 13).

The quality provisions of the prefabrication companies was demonstrated as; all of them worked with the suppliers that had both TSE (Turkish Standards Institute) certificates for the materials quality standards and ISO 9000 certificates. The majority (82%) had long-term relationships (over 2 years) with their main suppliers (concrete, steel and aggregate) and did not have any substantial problems.

6.4. Culture

The effects of both the high power distance and the high uncertainty avoidance cultural dimensions are experienced strongly not only in the business environment but also in everyday life in Turkey. Although it was beyond the scope of this research to undertake an in depth study of the effects of the cultural values on human behaviour; the findings in Table 3 ironically presents the meaning of the employees to the managers; showing that the requirements of the employees were not reflected in management decisions at all. Employee resistance towards change, on the other hand, was not stated to be a problem by 17 (65%) of the managers, should JIT be implemented. This was supported by the fact that although some discomfort had been felt during the initiation of ISO 9000 implementations, none of the companies actually faced any significant employee resistance.

7. Conclusions

The aim of this article was to examine the applicability of JIT in the prefabrication sector of DCs. In order to achieve the aim; the literature related to the environmental requirements of JIT and the environmental conditions in DCs were discussed. The empirical part of the study was based on the analysis of the Turkish prefabrication sector.

The literature showed that high inflation rates, high costs of imported technology, maintenance, training and the quality systems; few number of suppliers, low costs of labour, the governments' inadequate approach towards quality, high power distance/uncertainty avoidance culture were the main obstacles for the applicability of JIT in prefabrication in DCs. The case of the Turkish prefabrication sector indicated that uncertainties in both the demand and the macroeconomic conditions were the two primary barriers for both quality and productivity improvements. The companies were reluctant to invest in areas like new technologies to improve both the process quality/ productivity. Low labour costs were the key obstacle for the automation.

While public demand did not encourage improvements in quality/productivity, the private clients' quality requirements were constructive.

The demand conditions were not the only determinant in shaping the company policies. The financial strength of the companies were important for both ISO 9000 implementation and the training programs. The advantages of preventive maintenance, on the other hand, were accepted throughout the sector, irrespective of the financial strengths of the companies.

Unlike most DCs the Turkish construction materials sector is competitive both domestically and internationally. The supply conditions related to the quality of the materials were satisfactory for the prefabrication companies. However, the high probability of late deliveries by suppliers was the main reason of keeping materials inventories. Unlike the arguments in the literature, inflation had a trivial effect on the companies' inventory policies.

High power distance and high-risk avoidance are the dominant cultural values that affect the organizational sub-cultures in DCs. Thus, to have a significant move towards the implementation of advanced systems like JIT, training programs should fit with both the national and the organizational cultural values.

Acknowledgements

The authors would like to thank to Ass. Prof. Mustafa Oral for his invaluable support throughout the preparation of this article.

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