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The effect of multiple performance criteria usage on the just in time production and total quality management implementation levels: Findings from Turkey

Zehra Berna Aydın
Department of Econometrics, Uludag University, Bursa 16059 Turkey
e-mail: berna@uludag.edu.tr

Selim Tüzüntürk
Department of Econometrics, Uludag University, Bursa 16059 Turkey
e-mail: selimtuzunturk@uludag.edu.tr

Mehmet Eymen Eryılmaz
Department of Management, Uludag University, Bursa 16059 Turkey
e-mail: mehmetery@uludag.edu.tr

Abstract

This article examines the effect of the multiple performance criteria usage on Just in Time Production (JIT) and Total Quality Management (TQM) implementation levels. Earlier studies have highlighted that JIT and TQM implementation levels play a major role in the success of organizational performance. Therefore the aim of this study was to determine the significant Balanced Scorecard (BSC) perspectives that may affect JIT and TQM using Logit regression analysis. The analysis process was executed on a sample of 117 industrial organizations from the top 500 large-scale industrial organizations of Turkey for 2004. Binary logistic regression models were estimated for the stated sample. Regression estimates showed that the two perspectives of "internal business" and "customer" enhanced the JIT implementation level in organizations. In addition, four perspectives, "innovation and learning", "customer", "sales" and "financial", were found to be significant in influencing the TQM implementation level in organizations. Finally, to the best of our knowledge, this study is the first empirical study that investigates the relationships between JIT, TQM and multiple performance measurement concepts.

Keywords: Multiple Performance Criteria, Just in Time Production, Total Quality Management, Balanced Scorecard, Logit Regression, Turkey.

1. Introduction

Due to their empirically supported positive effects on organizational performance (e.g., Brah *et al*., 2002; Claycomb *et al.*, 1999; Hasan and Kerr,

2003; Inman and Mehra, 1993; Sohail and Hong, 2003; Terziovski and Samson, 1999), "Just in Time (JIT) Production" and "Total Quality Management (TQM)" seem to have become two of the most attractive management techniques for organizations over the last three decades. However, there are some studies emphasizing the lack of TQM and JIT production in literature. For example, according to Ornek (2000), management techniques such as TQM, Reengineering and Activity Based Costing (ABC) are not successful at measuring intangible assets in an organization. Hoque (2005) also states that although TQM extols participative management and respect for people, it overlooks the issue of employee satisfaction. Also some of the studies announce the failure of these techniques (e.g., Cao *et al.,* 2000; Dar-El, 1997). On the other hand, some management innovations may compensate for deficiencies and increase the implementation levels of TQM and JIT when they are used together. A realization of a lack in this area in literature instituted this research.

The aim of this study was to determine the significant BSC perspectives that may affect JIT and TQM using Logit regression analysis method. This determination would enable managers to realize the significant factors which can be arranged and controlled in such a way as to lead to organizational improvement. In this context, BSC usage was considered as a tool that can increase the implementation level of TQM and JIT by compensating for deficits through the content of the BSC. Hence, multiple performance measurements as 20 items collected under five perspectives, were used to determine the stated relations as independent variables, for each regression equation.

In the second section, important studies in the literature relating to these management techniques are reviewed. The description of the data, measures and logit analysis method are given in section three. Research findings are presented in section four and the fifth section covers the conclusions and limitations of the study and also the future direction for the researchers.

2. Literature review

Performance measurement has already been described as a process of assessing progress towards achieving predetermined goals, including information on the efficiency with which resources are transformed into goods and services, the quality of those outputs and outcomes, and the effectiveness of organizational operations in terms of their specific contributions to organizational objectives (Amaratunga *et al.*, 2001: 181). Traditional performance measurement systems, which concentrate exclusively on financial measures, are no longer adequate to assess the performance of an organization. Dissatisfaction with financial measures to

evaluate organizations goes as far back as the 50s (Eccles, 1991: 132). Many performance measurement theories which have suggested the use of non-financial performance measures in addition to financial measures have emerged recently in the literature such as "Balanced Scorecard (BSC-Kaplan and Norton, 1992, 1993, 1996 and 2000)", "Systemic Scorecard (Leibold *et al.*, 2002; Voelpel *et al.*, 2006)", "Strategic Scorecard (Drew and Kaye, 2007)", and "Tableu de Bord (Bourguignon *et al.*, 2004; Epstein and Manzoni, 1997)". Extended performance measurement systems are important because the findings of various studies (e.g., Hogue and James, 2000; Strohhecker, 2007) indicate that there is a significant and strong positive relationship between the use of multiple performance measures and organizational performance. This study will focus on BSC which is accepted as one of the most popular innovative measurement systems. The term "Balanced Scorecard", developed by Kaplan and Norton, reflected the balance between short and long-term objectives, financial and non-financial measures, lagging and leading indicators and external and internal performance perspectives (Hepworth, 1998: 560). The BSC of an organization translates its vision into a set of performance indicators relating to the four perspectives of financial, customer, internal business process, innovation and learning. There are some causal relationships between these four perspectives (Othman, 2006; Sim and Koh, 2001). Strategy maps, one of the most important tools of BSC, enable these relationships to be depicted (Othman, 2006). Through BSC, the organization is also able to monitor both its past and future performance.

TQM is one of the three pillars this study is built on. Although no consensus exists on an exact definition of TQM (Raho and Mears, 1997), it is possible to define TQM as an approach to doing business that attempts to maximize the competitiveness of an organization through the continual improvement of the quality of its products, services, people, processes, and environments (Goetsch and Davis, 1997: 4). The concept of TQM, first cited in 1985 by Naval Air Systems Command (Bemowski, 1992), is generally accepted as the fourth era in the historical development process of the quality concept (Garvin, 1988; Kaye and Dyason, 1995; Raho and Mears, 1997). When the relevant literature is examined, it can be said that the majority of studies draw attention to the advantages. However, as is the case in other management philosophies, the success level of TQM depends on various factors. For example, Saraph *et al.* (1989), in their seminal study, developed an instrument that can be used to evaluate quality management efforts in organizations. The instrument consists of eight critical factors such as top management leadership, role of the quality department, training, product design, supplier quality management, process management, quality data reporting and finally employee relations. In another important study, Black and Porter (1996) identified ten factors critical to the success of a

TQM approach. This model includes some factors which are very similar to the factors in Saraph's model. It also covers three additional areas of customer satisfaction orientation, teamwork structures and communication of improvement information. Black and Porter (1996) explained the differences between their model and Saraph's with the evolution of body of the theory. Ahire *et al.* (1996) developed a TQM implementation scale, which includes twelve subconstructs and adds statistical process control usage as a new dimension to previous models. All the elements identified in these three important studies can be evaluated as critical success factors for TQM implementation. In addition to these, another study also indicates that the behavioral traits of employees have a significant impact on the effectiveness of quality management practices (Ahmad and Schroeder, 2002). Finally, research by Rad into hospitals in Iran (2006) shows that TQM success needs a more organic organizational structure and a medium organizational culture. On the other hand, it is certain that the content of the factors set to provide success in TQM implementation varies according to the operating conditions of the organization.

The third main concept of the study is JIT production. This is essentially more of a philosophy than a series of techniques, the basic tenet of which is to minimize cost by restricting the commitment to expenditure in any form, including manufacturing or ordering materials, components, etc, until the last possible moment (Sohal *et al.*, 1988: 15). If the related literature which started with the pioneering article by Sugimori *et al.*(1977) is examined, it can easily be seen that the concept of JIT is often used synonymously with numerous concepts such as "Inventory Production System", "Kanban Production", "Kaizen Production", "Lean Production", "Minimum Stockless Production", "Pull-Through Production", "Quick Response Inventory Systems", "Toyota Production System" and "Zero Inventory Production System" (Biggart and Gargeya, 2004; Ramarapu *et al.*, 1995; Shah and Ward, 2007; Sohal *et al.*, 1988). In the current study, the JIT concept as most commonly used in literature, was used. Nowadays, JIT appears to be in demand among practitioners and academicians because many empirical studies point out the benefits derived from implementation.. According to these studies, the appropriate implementation of JIT can lead to benefits for its users such as a more flexible work force, increased product simplification (Voss and Robinson, 1987) and flexibility of manufacturing systems (Kazazi and Keller, 1994), improvement in quality and reliability of products, productivity (Chong *et al.*, 2001; Kazazi and Keller, 1994), employees' job attitudes (Chong *et al.*, 2001; Groebner and Merz, 1994), positive market reaction (Howton *et al.*, 2000), significant reduction in inventory levels (Biggart and Gargeya, 2004; Chong *et al*., 2001), WIP (work in progress), space, set up and lead times, buffer stocks and the number of the suppliers (Kazazi and Keller, 1994). On the other hand, an

efficient implementation process requires effort and depends on several conditions such as appropriate organization culture (Ansari, 1986), supplier-buyer coordination and a shared computerized system supports this coordination (Manoochehri, 1984; Sohal *et al.*, 1988), plant size (Im and Lee, 1989), low turnover rates (Goyal and Deshmukh, 1992), a holistic understanding relating to JIT (Goyal and Deshmukh, 1992; Ramarapu *et al.*, 1995; Sakakibara *et al.*, 1997), adequate financial resources, management ability, compatible organization structure (Kazazi and Keller, 1994), strong organizational support (Biggart and Gargeya, 2004; Chong *et al.*, 2001; Goyal and Deshmukh, 1992; Im and Lee, 1989) and length of implementation history of JIT in the organization (Chong *et al.*, 2001).

In management literature, it is possible to see studies that investigate or emphasize the relationships between different management techniques or philosophies. For example, Bartezagghi and Turqo (1989) claimed that the quality of conformance, one of the four dimensions of quality, is partially influenced by JIT. Harber *et al.* (1989) seem to consider the concept of continual gradual improvement as a common element for both TQM and JIT. Gilbert (1990) noted the relationship between TQM and JIT by emphasizing that total quality assurance is the one of the three thrusts which comprise JIT philosophy. Terziovski *et al.* (2000) examined the existence of mutual dependency between TQM and the "Learning Organizations (LO)". The findings point out a great deal of dependency between the two concepts. In another study, Bayazit (2003) found that 48 of 100 large Turkish TQM organizations were implementing the JIT technique. Also, if we look at the perspectives of the BSC, the relationships between BSC, TQM and JIT can be clearly seen. In this study, the idea that the employment of BSC in an organization will enhance the use of TQM and JIT is hypothesized. For example, continuous improvement, one of the main principles of TQM philosophy, is mainly affected by the intangible assets (human and information capital) of the organization (Gordon, 2006). In effect, Dabhilkar and Bengtsson (2004) illustrated how strategic continuous improvement capabilities were developed in three manufacturing BSC companies in Sweden. Therefore, intense emphasis on innovation and learning and customer perspectives in the BSC approach may enhance the implementation level of TQM. Also, especially internal business process and its measurements such as sales cycle times, production planning, engineering time studies (Gordon, 2006; Ishiyama, 2007), another perspective of the BSC technique, seem to support JIT implementation. Some authors seem to share similar ideas with the researchers. For example, according to Hernandez *et al.* (2003: 577), adaptation of TQM is important to establish a quality focused organization. Subsequently, this organization, by deciding to implement BSC, may translate these quality focused goals into action. Also, according to Hannula *et al.* (1999) and Wang (2006),

depending on the point of view selected, BSC can be regarded as one of several tools traditionally included in TQM. Hogue (2003: 556-558) suggests that BSC, with its emphasis of supplementing financial information with non-financial information, then supports TQM because quality is improved by non-financial factors such as product and process design, rework and on-time delivery. He also claims that BSC use contributes to TQMers' performance more than non-TQMers because of its ability to include employee satisfaction (Hoque, 2003: 560). For these reasons, in this study BSC is considered as a tool for TQM and JIT and it is predicted that BSC usage will enhance TQM and JIT implementation levels. An increase in the TQM or JIT implementation level is important because, as previously noted, many studies in literature have shown that accurate and high level adaptation of these techniques can bring some benefits such as stronger financial performance (Adam *et al.*, 1997; Forker *et al.*, 1996; Hansson and Eriksson, 2002), higher productivity (Chapman and Al-Khawaldeh, 2002; Khan, 2003) and innovativeness (Hoang and Igel, 2006), more positive work-related attitudes (Karia and Asaari, 2006) and so on.

Finally, the JIT system seems to have its own performance measuring systems. At this point, the question, "Why do we need to use a different performance measurement system?", may come to mind. However, JIT focuses on production based performance overwhelmingly. For example, indicators concerning employee satisfaction, collected under innovation and learning perspective of BSC, aren't clear adequately in JIT performance measurement system. Thus, it can be said that BSC brings in a holistic view to many previously separated fields of organizational performance such as finance, customer satisfaction, employee satisfaction, and innovativeness in addition to production. BSC also constructs a cluster of cause and effect relationships between these fields known as "strategy maps" (Kaplan and Norton, 1996) and link them to the vision of the organization. For that reason, BSC seems to create an added value in performance measurement activity in organizations. Also, it cannot be considered only a performance measurement system. After the evolution of the concept, it became accepted as a strategic management system (Anderson *et al.,* 2004; Hepworth, 1998; Kippenberger, 1996; Lawrie and Cobbold, 2004; Speckbacher *et al.,* 2003) comprising strategic planning, implementation and control (performance measurement) phases. Therefore, JIT cannot be accepted as a substitute management system for BSC.

3. Data, measures and methodology

3.1. Data

The data used in this study was collected from 117 industrial organizations from the top 500 large-scale industrial organizations of Turkey

in 2004. The Turkish economy faced a major economic crisis in February 2001 followed by an upturn in 2003. Productivity and profitability peaked in 2004 when 13.5% of the GDP was created by the top 500 large-scale industrial units of Turkey. Developments in the industrial sector affect the whole economy. The industrial sector is the most important sector of the Turkish economy, which is why for this study data was used from the top 500 large-scale industrial organizations of Turkey in 2004.

Questionnaires, together with an explanation of the study, were sent to the chief executive officers (CEO) of the top 500 large-scale industrial organizations of Turkey. There was a response rate of 23.4% (n=117). The sectorial distribution of the respondents is shown in Table 1.

Table 1
Sectorial Distribution

Sectors	Frequency	Percent
Beverage	1	0.9
Chemicals-Petrol	9	7.7
Construction	9	7.7
Electronic	6	5.1
Food	15	12.8
Glass	1	0.9
Metal Furniture-Machine	13	11.1
Mining	6	5.1
Plastic	6	5.1
Spare Part and Automotive	19	16.2
Textile and Clothing	25	21.4
Wood Products	7	6.0
N	117	100.0

Table 1 shows 21.4% of the total response from the Textile and Clothing sector, followed by 16.2% from Spare Parts and Automotive, then 12.8% from the Food sector.

3.2. Measures

The measurements used were the multiple performance measurements covering twenty items (see Appendix 1) first described by Kaplan and Norton (1992) and later used by Hoque and Jones (2000) and Hoque *et al.* (2001). The respondents were asked to indicate on a five point Likert scale, ranging from 1 (not at all) to 5 (to a great extent). Descriptive statistics of the twenty items that were used in this study are presented in Table 2.

When the mean statistics are examined, it can be clearly seen that the operating income item has the greatest mean value of the performance

criteria, thus implying that the responding CEOs use the criterion of operating income criterion item most highly. Sales growth is the second most widely used performance criterion and the number of new patents is the least used.

Table 2
The Descriptive Statistics of the Performance Criteria

Items	N	Minimum	Maximum	Mean	St.Deviation
FINANCIAL PERSPECTIVE					
Operating income	117	2	5	4.53	.738
Sales growth	117	2	5	4.41	.800
Return-on-investment	117	2	5	3.91	.974
CUSTOMER PERSPECTIVE					
Market share	117	1	5	4.09	.952
Customer response time	115	1	5	4.17	.871
On-time delivery	117	1	5	4.01	.933
Number of customer complains	117	1	5	4.17	.994
Number of warranty claims	114	1	5	3.32	1.441
Survey of customer satisfaction	117	1	5	4.11	.926
SALES PERSPECTIVE					
Percentage of shipments returned due to poor quality	114	1	5	3.61	1.259
Number of overdue deliveries	115	1	5	3.27	1.216
INTERNAL BUSINESS PERSPECTIVE					
Materials efficiency variance	115	1	5	3.57	1.125
Ratio fo good output to total output at each production process	116	1	5	3.85	1.121
Manufacturing lead time	116	1	5	4.14	.913
Rate of material scrap loss	116	1	5	3.66	1.134
Labor efficiency variance	116	1	5	3.67	1.045
INNOVATION AND LEARNING PERSPECTIVE					
Number of new patents	113	1	5	2.58	1.342
Number of new product launches	116	1	5	3.25	1.179
Time-to-market new products	115	1	5	3.27	1.103
Employee satisfaction	117	1	5	3.62	1.136
Valid N	104				

In this study, the dependent variables were dichotomic. This means that every dependent variable had two categories, zero and one; where zero means the related management technique is not used and one that it is. According to the findings, 91 of the 117 organizations (77.8%) declared that they use JIT production. Also 101 of the 117 organizations (86.3%) announced that they are TQMers. The number of the organizations claiming

that they use both of the techniques, was 88 (75.2%) but, as emphasized before by the neo-institutional organization theorists (DiMaggio and Powell, 1983; Meyer and Rowan, 1977) repeatedly, organizations can give misinformation to their environments so as to be considered more innovative and to gain legitimacy. As a result, non-TQMers and non-JITers in this study might present themselves as TQMers and JITers to the researchers. Therefore this type of data collection process, where the organization is simply asked whether they are TQMers and JITers, may weaken the validity and the reliability of the research. To overcome this problem, the researchers adopted two main strategies. The first was to review related national literature, to try to find additional evidence of JIT and TQM implementation in the organizations claiming to be TQM and JIT users. The findings of a similar study indicate that 80% of Turkish machine production organizations benefited from advanced management and production techniques such as TQM, JIT and Computer Aided Design (CAD) (Bulbul and Gules, 2004: 7, cited from Ulusoy *et al.* 2002). Another research shows that organizations in the Turkish automotive industry utilize production technologies equivalent to international organizations (Bulbul and Gules: 2004: 7, cited from ISO, 2002). The second strategy was to examine the web sites of the organizations claiming to be TQM and/or JIT users. Any statement on the websites relating to the possession of a quality certificate was accepted as evidence of TQM and JIT implementation. Although quality certification isn't always an adequate indicator of TQM implementation, it is accepted as a good step towards TQM (Bradley, 1994; Gotzamani *et al.*, 2006; Meegan, 1997; Meegan and Taylor, 1997; Williams, 1997). Confirmation of data by diversifying the data collection methods (triangulation) is a common strategy in management and organization literature (e.g., Greenwood and Hinings, 1993; Oliver, 1997; Zbracki 1998). The examination of the websites of 40 randomly selected organizations from the total 117, showed that 27 organizations (68%) had a quality certificate. The websites of the remaining 13 organizations did not show any statements relating to the possession of a quality certificate but there was quite strong emphasis on quality and customer focus on the all websites. With this additional evidence, the statements of the organizations concerning implementation of TQM and JIT were accepted as true.

3.3. Method

Factor Analysis (FA) was executed on twenty items of the multiple performance measures (see Appendix 1). As is well known, FA is a statistical data reduction technique used to explain variability among observed random variables in terms of fewer unobserved random variables called factors. The observed variables are modeled as linear combinations of the factors and the error term. The proposed transformation can be presented

in matrix notation with $Z = AF + BU$. In this equation, Z is the matrix of the observed variables, A is the matrix that denotes the factor loadings, F symbolizes the factors, B is the coefficient of the error and U is the error term. The data that is derived from the FA is used in multivariate analyzing techniques such as linear regression, logit regression and so on.

In this study, our approach was to conduct an FA and then use the derived data in a binary logit regression model. There are binary and multinomial types of logit regression models. When the dependent variable has more than two categories, the regression model is called multinomial logit regression (Leech, *et al.*, 2004). Binary[1] logit regression is a form of regression which is used when the dependent variable is dichotomous and the independent variables are of any type[2]. The dependent variable should diverge into two categories, zero and one which means in the former case the circumstance does not occur and in the latter case the circumstance occurs (Walker and Duncan, 1967). The aim of the usage of logit regression method is the same as any model that is used in statistical model foundation techniques, that is to find the most proper model in the characterization of the relation between the dependent and the independent variable(s) (Hosmer and Lemeshow, 2000). The distribution function that

$$P_i = E(Y = 1|X_i) = \frac{1}{1 + e^{-(\alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_K X_K)}} \quad (1)$$

is expressed by Equation 1 is utilized to characterize the binary logistic regression model. P_i denotes the probability of the particular choice of the i^{th} individual, the Y's probability of taking zero or one. The cumulative distribution function is an "S" shaped curve (Horowitz and Savin, 2001). X is in an unlimited range between $-\infty$ and $+\infty$, but P_i is in a limited range between zero and one (Harrel, 2001). The nonlinear form of the logit regression model (Equation 1) can be transformed into linear

$$L_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_K X_K \quad (2)$$

form by proper transformation steps[3]. Equation 2 expresses that the explanatory variable and parameters are all linear. L is called *"Logit"* in this specification. Therefore this kind of model is called *"Logit Model"* (Gujarati, 2003). When the error term is written into the model specification, we have the short form of the binary logit regression model:

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[1] In this study, binary logit regression model is estimated for the proposed relations.

[2] While the dependent variable is categorical, the independent variables can be categorical or continuous in logit regression models.

[3] For the ease of exposition the transformation process is not given. See Gujarati (2003) for details.

$$Y = P_i + \varepsilon \tag{3}$$

According to this model, the "Ordinary Least Square (OLS)" parameter estimates of the logit model will be unbiased but will not be "Best Linear Unbiased Estimator (BLUE)" any more. Because of the non-linearity of the explanatory variable(s) and parameters in the population regression function, the LS estimation also cannot be performed (Stock and Watson, 2007). When the explanatory variables have continuous variables, as in this study, the "Maximum Likelihood (ML) estimation technique" (Morgan and Teachman, 1988) should be used to produce consistent and efficient estimators.

The significance of the parameters can be tested in a number of ways in logistic regression analysis. The parameters can be tested individually by the Wald test. The hypotheses that are going to be tested in this test are:

$$\begin{aligned} H_0 &: \beta_i = 0 \\ H_1 &: \beta_i \neq 0 \end{aligned} \tag{4}$$

Wald statistics show standard normal distribution (Hosmer and Lemeshow, 2000). This is computed by dividing the ML estimation of the parameter $(\hat{\beta}_i)$ with its standard deviation $S\hat{h}(\hat{\beta}_i)$.

The other popular statistical test is well known as the Hosmer-Lemeshow test. A statistic that shows Ki-Square distribution is computed in this test. When the probability value of Hosmer-Lemeshow statistic is found to be more than 0.05, it is said that the goodness of fit of the model is well organized. The Hosmer-Lemeshow statistic reflects the goodness of the fit of the explanatory variables.

4. Research findings

The Kaiser-Mayer-Olkin (KMO) measure of sampling adequacy statistic (0.82) shows that the data is proper to conduct FA. Then, the reliability analysis was conducted on twenty items for the satisfaction of the internal consistency of the answers. The Cronbach Alpha coefficient $(\alpha = 0.90)$ shows that the internal consistency of the items is satisfied. The FA results are shown in Table 3.

The items in Table 2 are numbered from 1 to 20. The first column of Table 3 shows the numbers of the related items. Principle components technique was used in the derivation of the proper factors. We also executed FA using a varimax rotation method. The results show that the five factor solution is the most significant one for the sample of 117 organization answers. The first four factors are similar to Kaplan and Norton (1992) and Hoque *et al.* (2001) factors but, last factor is not. We renamed this factor

(items 19 and 20) as "Sales Perspective". Hence, the findings of the FA show the factors as:

1. Financial perspective.
2. Customer perspective.
3. Internal business perspective.
4. Innovation and learning perspective.
5. Sales perspective.

This construction including five perspectives, is not abnormal. BSC is an organization-specific tool as Kaplan and Norton often emphasize in their studies. Therefore, the organizations sometimes may feel a need to employ additional perspectives reflecting a specific strategic focus (Speckbacher, *et al.*, 2003: 370). Some examples for this situation can be found in Gordon (2006) and Speckbacher *et al.* (2003). One possible explanation of the construct with five perspectives is that organizations might feel a need to separate the measures relating to sales from the customer perspective to observe sales performance better.

Table 3
Varimax Rotated Factor Analysis Results

	Component				
	1	2	3	4	5
1				.813	
2				.867	
3					
4	.654				
5	.794				
6	.551				
7	.865				
8	.639				
9		.751			
10		.783			
11		.810			
12		.570			
13			.503		
14			.768		
15			.723		
16			.640		
17			.651		
18			.562		
19					.761
20					.732

The reliability analysis was conducted for each of the five factors. Cronbach Alpha coefficients (Cronbach, 1951) are respectively 0.76 for three items of financial perspective, 0.85 for the following five items of customer perspective, 0.81 for the following four items of internal business perspective, 0.79 for the following six items of innovation and learning perspective and 0.85 for the following two items of sales perspective. The internal consistency of the items is separately satisfied well.

Afterwards, the factor charges (quantities) of these five factors are used as explanatory variables of the binary logit regression models for modeling separately JIT and TQM. A stepwise regression model was used in the estimation of the binary logit regression model to enable the management of the multicollinearity problem by determining the best explanatory variable set. Consequently, we were able to test the aim of this study, that is to research the effects of performance criteria on JIT and TQM.

Firstly, we modeled JIT. The explanatory variables are the financial perspective (FIN), customer perspective (CUST), internal business perspective (INT), innovation and learning perspective (IL) and sales perspective (S). The specification of this logistic regression model with these variables can be written in the following form:

$$P_i = E(Y = 1 | X_i) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 FIN + \beta_3 CUST + \beta_4 INT + \beta_5 IL + \beta_6 S)}} \quad (5)$$

In this model the dependent variable Y_i expresses the i^{th} organization's JIT production propensity. If the i^{th} organization implements JIT production Y_i takes 1, otherwise 0. All the explanatory variables are continuous variables. When JIT production is taken in hand, binary logistic regression model is modeled in two steps. Table 4 summarizes the estimation results.

In Table 4, B denotes the estimated coefficients. The stepwise logit regression analysis was completed in two steps. In modeling JIT two factors were found to be significant that affected JIT production implementation. These are internal business perspective and customer perspective. The P values of these two coefficients show that they are statistically significant at 5% level (See Table 4, 0.023<0.05 and 0.015<0.05).

The interpretations of the coefficients are different in logistic regression. The Exp (B)'s are interpreted in logit regression, not the coefficients (B's). If the Exp (B) is bigger than one (Exp (B) >1) as here, then the value of Exp (B) is directly interpreted. The estimation results show that the internal business perspective increases the probability of JIT implementation 1.918 times and customer perspective increases the probability of JIT implementation 1.882 times.

Table 4
Stepwise Logistic Regression Analysis for Just in Time Production

		B	Standard error	Wald	df	P values	Exp (B)	95% significance limits of Exp (B)	
								Lower	Upper
Step 1(a)	CUST	.651	.266	5.964	1	.015**	1.917	1.137	3.232
	Interception	1.471	.269	29.861	1	.000	4.353		
Step 2(b)	INT	.651	.287	5.146	1	.023**	1.918	1.093	3.365
	CUST	.632	.260	5.896	1	.015**	1.882	1.130	3.135
	Interception	1.546	.285	29.398	1	.000*	4.692		

Notes: * denotes that the parameter is significant at 1% level.
** denotes that the parameter is significant at 5% level.
*** denotes that the parameter is significant at 10% level.

The Hosmer-Lemeshow statistic was found to be 9.239 and its probability value 0.323>0.05. This finding implies that the goodness of fit of the model is well organized. In addition to this, Nagelkerke R^2 was found to be 0.18; 18% of the total variation in JIT is explained by the two variables, INT and CUST.

Secondly, we modeled TQM. The explanatory variables are same as the JIT model, the financial perspective (FIN), customer perspective (CUST), internal business perspective (INT), innovation and learning perspective (IL) and sales perspective (S). The specification of this logistic regression model with these variables can be in written the following form:

$$P_i = E(Y = 1 | X_i) = \frac{1}{1 + e^{-(\beta_1 + \beta_2 FIN + \beta_3 CUST + \beta_4 INT + \beta_5 IL + \beta_6 S)}} \quad (6)$$

In this model the dependent variable Y_i expresses the i^{th} organization's TQM propensity. If the i^{th} organization implements TQM, Y_i takes 1, otherwise 0. When TQM is taken in hand, the binary logistic regression model is modeled in four steps. Table 5 summarizes the estimation results:

The stepwise logistic regression analysis was completed in four steps. Four factors were found to be statistically significant that affected TQM implementation (See Sig. column step 4 in Table 5). These are innovation and learning, customer, financial and sales perspectives. In Table 5, P values of Step 4 show that IL and S are statistically significant at 5% level and FIN, CUST are statistically significant at 10% level (See Table 5, 0.010<0.05, 0.020<0.05, 0.056<0.10 and 0.051<0.10). As is mentioned Exp (B)'s are interpreted in logistic regression analysis. The estimation results show that the IL, 2.437 times; the CUST, 1.775; the FIN, 1.705 times, the S, 2.030 times increase the probability of TQM implementation.

Table 5
Stepwise Logistic Regression Analysis for the Total Quality Management

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for Exp(B)	
								Lower	Upper
Step 1	IL	.719	.300	5.748	1	.017	2.052	1.140	3.692
	Interception	1.947	.321	36.703	1	.000	7.009		
Step 2	IL	.763	.315	5.862	1	.015	2.145	1.156	3.979
	FIN	.540	.249	4.686	1	.030	1.715	1.052	2.795
	Interception	2.059	.344	35.735	1	.000	7.835		
Step 3	IL	.742	.316	5.502	1	.019	2.100	1.130	3.902
	FIN	.540	.261	4.275	1	.039	1.716	1.029	2.862
	S	.563	.283	3.945	1	.047	1.756	1.007	3.059
	Interception	2.145	.361	35.231	1	.000	8.539		
Step 4	IL	.891	.345	6.659	1	.010**	2.437	1.239	4.795
	CUST	.574	.300	3.653	1	.056***	1.775	.986	3.196
	FIN	.534	.273	3.813	1	.051***	1.705	.998	2.913
	S	.708	.305	5.378	1	.020**	2.030	1.116	3.693
	Interception	2.337	.417	31.395	1	.000*	10.347		

Notes: * denotes that the parameter is significant at 1% level.
** denotes that the parameter is significant at 5% level.
*** denotes that the parameter is significant at 10% level.

The Hosmer-Lemeshow statistic was found to be 7.33 and its probability value 0.495>0.05. This finding implies that the goodness of fit of the model is well organized. In addition to this Nagelkerke R^2 was found to be 0.30; 30% of the total variation in TQM is explained by four variables, IL, CUST, FIN and S.

To summarize the research findings, internal business and customer perspectives (only two out of five) enhanced the JIT implementation level in organizations. Innovation and learning, customer, sales and financial perspectives (only four out of five) were found to be significant in influencing the TQM implementation level in organizations.

5. Conclusion

The main aim of this study was to measure the effect of multiple performance criteria usage on JIT and TQM implementation level in organizations. The logit regression analysis of these relationships suggested that measures relating to internal business and customer perspectives enhance the JIT implementation level in the organizations. There may be several reasons behind the findings that only INT and CUST perspectives enhance JIT. For example, it is claimed in the literature that long-term and intensive relationships between organizations may cause some decrease in

the efforts concerning innovation. Thus, as long-term relationships are intrinsic to the nature of JIT philosophy, it seems to be normal that no relationships were found between the innovation and learning perspective of BSC and JIT implementation. Secondly, in this study, measurements relating to innovation and learning were accepted as independent variables. However, according to the literature, JIT philosophy seems to affect innovation capacity. Finally, another reason for unrelatedness between innovation and learning and financial perspectives of BSC and JIT may be that JIT can be interpreted differently in various cultures and the relationships between some variables and JIT can vary depending on the culture. For example, Billesbach *et al.* (1991) revealed that managerial practices and perceptions in the implementation of JIT principles and concepts are significantly different in the United Kingdom compared to the United States. Also, the results show that TQM implementation level was influenced by measurements relating to innovation and learning, customer, sales and financial perspectives. These results are consistent with the expectations of the researchers generally. These findings contain some benefits for organizations and their managers. For example, top managers of organizations who wish to enhance the efficiency of TQM and JIT implementations in their organizations, can add BSC technique to their management tool boxes. In the literature, there are a limited number of studies (e.g., Hannula *et al.,* 1999; Hoque, 2003) discussing the relationships between these management techniques conceptually. To the best of our knowledge this is the first study investigating the relationships empirically. Another interesting finding was the multiple performance measures construct with the five perspectives. One possible explanation is that organizations operating in Turkey may prefer to separate sales related measurements from customer measurements to be able to observe them better.

This study has several limitations. The first limitation stems from the fact that there are quite different opinions as to the defining characteristics of the BSC concept (Speckbacher *et al.*, 2003: 362). In this study, the usage of multiple performance measurements was accepted as an adequate condition of BSC implementation. This is consistent with some BSC literature. For example Speckbacher *et al.* (2003: 363) define the usage of combined measurements (financial and non-financial) without a cause and effect relationship as *"Type I BSC"*. Their point of view is consistent with Malmi (2001). However, according to other authors, cause and effect relationships between these measurements have to be understood and specified well for real BSC use (Bhagwat and Sharma, 2007; Hoque and James, 2000: 13; Othman, 2006). The researchers adopted the perspective of the first group of authors and did not collect information about organizations have a strategy map to depict the relationships between measurements. The

second problem of the study is that BSC should be a company-specific tool but BSC implementation levels of the organizations were measured with common scales such as Hoque and James (2000) for all organizations predominant in the related literature. However, organizations may use their own measurements instead of employing those in the BSC implementation level scales. This measurement style can give misleading signals and lead to labelling of organizations using BSC in the most appropriate ways as in fact "weak BSC users". The final limitation of the study was related to the measurement of TQM and JIT implementation in the organizations. To measure these variables, nominal data was collected. There are several tools in literature to measure TQM and JIT use but the previous experience of the researchers showed that top managers, especially CEOs, consider these tools to be time consuming. For that reason, the researchers collected nominal data at this point. On the other hand, there are disadvantages to this type of data collection of only asking CEOs whether their organization uses TQM and/or JIT. For example non-TQMers or non-JITers may present themselves as TQM and JIT users. To overcome this limitation, the researchers followed the previously outlined two main strategies.

The relationships between TQM, JIT and BSC concepts have important potential for future research. For example, previous studies have examined the effect of TQM, JIT and BSC implementation on organizational performance separately from each other. Researchers, in subsequent studies can investigate the concurrent effect of these techniques on organizational performance. For example, when they are employed together, what are their effects on performance? Do they create a synergy or neutralize the others's positive effect on organizational performance? Another research question may be whether one of them can be a mediator variable between the other techniques and organizational performance BSC, for instance, may affect organizational performance both directly and through TQM implementation so would be a partial mediator variable between BSC and performance. Also, as Hannula *et al.* (1999) stressed, TQM can be seen as a tool for BSC as well, so the existence of a mutual relationship between these two techniques can be examined. In addition, researchers may investigate TQM and JIT elements individually that are affected from a BSC perspective, such as. how teamwork effectiveness, one of the elements of TQM, is affected by BSC implementation. Finally, this study may be replicated in different cultures to test the generalization of the findings.

Appendix
Measurement Used

Just In Time Production

Please indicate below, by circling the appropriate number, to what extent is the just in time production technique used in your factory's manufacturing processes.

1. Not at all
2. to a little extent
3. to some extent
4. to a considerable extent
5. to a very great extent

Total Quality Management

Please indicate below, by circling the appropriate number, to what extent is the total quality management technique used in your factory's manufacturing processes.

1. Not at all
2. to a little extent
3. to some extent
4. to a considerable extent
5. to a very great extent

Multiple Performance Measures Usage

Please rate the extent to which each of the following measures is used for performance evaluation of your business unit: (scale: 1=not at all and 5=to a very great extent).

Performance measures	*Usage rate*
FINANCIAL MEASURES	
Operating income	1 2 3 4 5
Sales growth	1 2 3 4 5
Return-on-investment	1 2 3 4 5
INTERNAL BUSINESS PROCESSES MEASURES	
Materials efficiency variance	1 2 3 4 5
Ratio of good output to total output at each production process	1 2 3 4 5
Manufacturing lead time	1 2 3 4 5
Rate of material scrap loss	1 2 3 4 5
Labour efficiency variance	1 2 3 4 5
INNOVATION AND LEARNING MEASURES	
Number of new patents	1 2 3 4 5
Number of new product launches	1 2 3 4 5

Time-to-market new products	1 2 3 4 5
Employee satisfaction	1 2 3 4 5
CUSTOMER MEASURES	
Market share	1 2 3 4 5
Customer response time	1 2 3 4 5
On-time delivery	1 2 3 4 5
Number of customer complains	1 2 3 4 5
Number of warranty claims	1 2 3 4 5
Survey of customer satisfaction	1 2 3 4 5
SALES MEASURES	
Percentage of shipments returned due to poor quality	1 2 3 4 5
Number of overdue deliveries	1 2 3 4 5

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Özet

Çoklu performans kıstası kullanımının tam zamanında üretim ve toplam kalite yönetimi uygulama düzeyine etkisi: Türkiye'den bulgular

Bu makale çoklu performans kıstası kullanımının Tam Zamanında Üretim (TZÜ) ve Toplam Kalite Yönetimi (TKY) üzerindeki etkisini incelemektedir. Daha önceki çalışmalar TZÜ ve TKY uygulama düzeylerinin örgüt performansının başarısı üzerinde büyük bir rol oynadığını vurgulamaktadır. Bu nedenle, bu çalışmanın amacı Logit regresyon analizini kullanarak TZÜ ve TKY'yi etkileyebilecek anlamlı Dengeli Ölçüm Kartı (DÖK) perspektiflerinin belirlenmesidir. Analiz süreci Türkiye'nin 2004'de en üstteki 500 büyük ölçekli endüstri örgütünden 117 endüsti örgütü örneklemi üzerinde uygulanmıştır. Belirtilen örneklem için ikili lojistik regresyon modelleri tahmin edilmiştir. Regresyon tahminleri örgütlerde iki perspektifin, firma içi ve müşteri perspektiflerinin TZÜ kullanım düzeyini arttırdığını göstermiştir. İlave olarak, dört perspektifin, yenilik ve öğrenme, müşteri, satış ve finansal perspektiflerinin örgütlerdeki TKY uygulama düzeyini etkilemede önemli olduğu bulunmuştur. Sonuç olarak, bildiğimiz kadarıyla bu çalışma TZÜ, TKY ve çoklu performans ölçüm kavramları arasındaki ilişkileri araştıran ilk deneysel çalışmadır.

Anahtar kelimeler: Çoklu Performans Kıstası, Tam Zamanında Üretim, Toplam Kalite Yönetimi, Dengeli Ölçüm Kartı, Logit Regresyon, Türkiye.