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Organizational modifications to support JIT implementation in manufacturing and service operations

Mahmoud M. Yasin[a,*], Michael H. Small[b], Marwan A. Wafa[c]

[a] Department of Management and Marketing, P.O. Box 70625, East Tennessee State University, Johnson City, TN 37614-0625, USA
[b] Department of Business Administration, University of Illinois at Springfield, P.O. Box 19243, Springfield, IL 62794-9243, USA
[c] Department of Business Administration, School of Business and Technology, University of Wisconsin-Parkside, 900 Wood Rd., Kenosha, WI 53141-2000, USA

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Abstract

This study investigates JIT implementation practices and performance in manufacturing and service organizations in the US. Literature related to JIT usage and performance in both sectors is reviewed. A field study is then conducted to investigate the actual implementation experiences of a selected group of service and manufacturing users of JIT. Our findings from the literature and the field study are used to develop four research hypotheses that are tested using survey data from 130 manufacturing and 61 service firms. Manufacturing and service firms that had engaged in modifications such as operator and management training and improving linkages with suppliers prior to implementing their JIT systems experienced less implementation problems and achieved higher levels of success than firms that placed less emphasis on these modifications. This paper details and discusses these and other results from our study. In addition, managerial implications of our findings are presented.

Keywords: JIT; Implementation; Performance

1. Introduction

The implementation and performance of JIT in the US manufacturing sector has been the subject of many investigations. Generally, findings from these studies support the contention that usage of JIT leads to improvements in operational efficiency and in performance. Significantly less research effort has been exerted on examining the usage and impact of JIT in the service sector. There are several reasons for this, foremost among which is the fact that some have questioned and continue to question the applicability of many components of JIT to service operations. Randall J. Benson's 1986 paper entitled "JIT: Not Just for the Factory" presented at the APICS 29th Annual International Conference represents one of the first serious attempts to report on JIT applications in service operations. Notwithstanding this and other early efforts, many service firms have been reluctant to get on the JIT bandwagon. For example, Duimering and Sajayeni [1] indicated that, up to the time of publication of their article, groups outside the production organization continued to show less enthusiasm for JIT systems. Indeed, it was only in the mid-1990s that many service providers began to embrace some aspects of the JIT philosophy.

In manufacturing, JIT has been credited with many holistic benefits. These benefits include reduced inventory levels; reduced investment in inventory; improved quality of incoming materials; and consistent high-quality products. Some additional benefits of JIT that have been achieved in manufacturing firms are: improved operational efficiency, uniform workstation loads; standardized components; standardized work methods; cooperative relationships with suppliers; closer collaboration with customers, and improved

* Corresponding author. Tel.: +1-423-439-5877; fax: +1-423-929-8297.
E-mail addresses: mmyasin@access.etsu.edu (M.M. Yasin), small.michael@uis.edu (M.H. Small), mwafa@uwp.edu (M.A. Wafa).

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customer satisfaction. Despite the delayed start in service applications of JIT, there have already been some success stories which indicate that many of these JIT benefits that have been achieved in manufacturing can be replicated in services, although sometimes in a slightly different form.

The service JIT literature, paltry though it might be, indicates that service providers in the healthcare, retail, distribution and transportation services have achieved some of the JIT benefits that have been attributed to JIT production (see, e.g. [2–5]). Hospitals and medical establishments, such as the Mayo Clinic, that have implemented some aspects of JIT have seen remarkable *reductions in inventory/supplies* and *improvements in operational efficiency and organizational effectiveness*. Distribution services such as Federal Express and UPS have reaped considerable benefits from *revision and standardization of work methods*.

Recent improvements in *information technology* have also enhanced the ability of services to benefit from JIT systems. For example, bar-code technology and point-of-sale (POS) systems have made it possible to create a *just-in-time replenishment system* between vendors and retailers which *improves customer service*. Wal-Mart utilizes the Wal-Mart Information System that incorporates a Retail Link (bar-coding technology, POS systems, and electronic data interchange (EDI)) and a satellite network to better *manage its inventory*, achieve better demand forecasts and build more *collaborative buyer-supplier relationships*. The introduction of automated teller machine (ATM) has also had a huge impact on improving and expanding banking services and *improving customer service* and *customer satisfaction*. Airlines and hotels use reservation systems and differential pricing to create *uniform facility loads*. Such successes have influenced many other service-oriented organizations, including government agencies, to adopt some aspects of JIT.

We believe that the increasing number of implementations of many aspects of JIT in the service-sector and the increasing number of JIT success stories from this sector provide a great opportunity to review and compare JIT implementation practices and performance in manufacturing and services. This study seeks to provide answers to the following questions. (1) Do service and manufacturing firms make the same types of operational and organizational modifications to support their JIT implementations? (2) Does the level of effort exerted on these modifications have any impact on firm performance? (3) Is top management involvement critical to the success of JIT efforts in both service and manufacturing organizations? (4) What role should external partners, such as customers, suppliers and consultants play in the JIT implementation process?

This research was conducted in two stages. First, a literature review was performed to harness theoretical and practical information about past JIT implementations in both manufacturing and service facilities in the USA and about their subsequent performance. In the second stage, a two-phase empirical study was performed. In the first phase, a field study involving extensive interviews of manufacturing and service users of JIT was utilized to obtain more detailed information about actual implementations and about their perceptions of JIT impact on their firm's performance. The results from the field study were particularly important to this research since it provided additional information on JIT implementation and performance in the service sector that was not available in the literature. Based on the information gleaned from the literature review and from our field study, a conceptual framework consisting of four research hypotheses was developed.

In the second phase, a mail-administered survey was used to obtain the information required to test these hypotheses. Details of the development and administration of the field study and survey are provided. The hypothesis test results are presented and discussed. Managerial implications of the findings are also advanced. This study provides the following contributions to the JIT literature:

(1) It uses information from our field study and survey to report on the actual modifications being enacted by both service and manufacturing firms as they prepare for JIT implementation.
(2) It proposes measures to assess items such as the effectiveness of JIT implementation, the extent of organizational modifications and other related variables.
(3) It compares and contrasts JIT practices in manufacturing and service organizations. Such comparisons are rarely found in the JIT literature.

2. Relevant literature

Much has been written regarding the positive strategic influence of JIT on Japanese organizations [6,7]. However, the usefulness of JIT to US organizations is still the subject of great debates. It has been suggested that, in the USA, the JIT experience has been almost a total disaster [8]. Some also indicate that, in the USA, threats such as union strikes against suppliers to JIT producers make JIT enviornments unpredictable and potentially devastating [9]. However, the preponderance of the evidence from the literature indicates that JIT has, in most instances, had a significant and positive impact on US manufacturing businesses (see e.g. [10–13]).

While the literature on the utilization of JIT in US manufacturing organizations is substantial, the same is not true for service organizations. The experiences of K-mart [14] and Wal-Mart [15] are certainly two of the prime exceptions to this observation. However, there are also some examples of JIT effectiveness in non-retail services. The rising cost of healthcare delivery underscores the need for cost containment in healthcare facilities. One report indicates that about 35% of the budgets of most hospitals and medical establishments are spent on inventories and supplies and in remuneration for the personnel involved in managing this inventory [4]. Therefore, reduction in inventory cost has

been a primary target of healthcare administrators [16]. Converting to a JIT distribution system allowed Eisenhower Memorial Hospital of Palm Springs, California to reduce inventory and supplies by over 90% in 18 months [5]. Baxter Healthcare Corporation (a hospital supply firm) uses a JIT supply distribution system to ensure timely deliveries to hospitals that have converted to JIT [4].

2.1. Measuring JIT success

This investigation seeks to identify factors that lead to successful JIT implementation in manufacturing and service operational environments. We recognize, however, that JIT evaluations encompass activities and attitudes that were not previously subjected to objective measurement. Traditionally, evaluation methods focused on easily quantifiable metrics such as cost, price, quality, and delivery. However, recent performance evaluation systems place emphasis on a wider variety of measures including worker and management attitudes and buyer–supplier collaboration, thus, placing greater emphasis on data that is less easy to quantify [17–19]. We believe that firm performance on some of these less traditional measures must be gauged to enable a more holistic assessment of JIT performance.

In general, it has been shown that JIT does promote efficient, effective and flexible utilization of productive resources. Many potential benefits of JIT, which are oftentimes just as relevant to service as they are to manufacturing, are cited in the literature. JIT tends to eliminate material waste and waste in production or in the delivery of services (see e.g. [20]). JIT also has the potential to reduce purchasing cost which is a major cost to both manufacturing and service organizations [21,22]. In addition, JIT is instrumental in reducing lead-time, decreasing throughput time, improving production or service quality, increasing productivity and enhancing responsiveness to customers [23–26].

Service operations have often been distinguished from manufacturing operations on the basis of the higher labor content of service jobs. As such, minimizing worker grievances and improving worker safety are of paramount importance to firms in the service sector. In this regard, JIT has also been credited with the ability to improve the practice of safety in service organizations [27]. Moreover, switching to JIT operations has encouraged some service firms to use their human resources more effectively. For example, Eisenhower Memorial Hospital has reorganized their materials management function by assigning their materials coordinators to user departments on a full-time basis. While these workers still perform their materials management duties, they are physically located in the user departments [5].

One of the purported advantages of adopting a JIT supplier relationship is the buyer's ability to decrease the supplier base to a more manageable size. Such action is expected to result in lower material overhead; fewer quality concerns; less inspection; and other benefits related to the potential for joint development projects utilizing the technology and technical expertise of the supplier [28]. Hospitals and other healthcare organizations work closely with suppliers and distributors to achieve some of these benefits [4]. Buyers are also finding it advantageous to involve suppliers in their internal decisions by establishing two-way customer/supplier electronic data interchange links (EDI) which expand the talent base, improve quality, reduce bottlenecks, and increase cost reduction opportunities [29,30]. Such systems also allow buyers to involve the supplier in operations decisions and in material and design changes at an early stage, hence reducing the likelihood of scheduling problems.

It has been shown that JIT, if properly implemented and supported, imbues an organization with the ability to foster improvements in organizational development. Ptak [31] indicated that JIT tends to foster organizational discipline and managerial involvement. JIT has also been credited with improving communications both internally—with the organization, and externally—between the organization and its customers and vendors [32]. Moreover, JIT can promote the integration of different functional areas of the organization. It especially has the tendency to bridge the gap between production and accounting [33–35,23].

2.2. Modifications to support JIT implementation

Research has shown, however, that the litany of potential JIT benefits listed above do not just happen [36,37]. Moreover, not all firms will reap, nor expect to reap all the purported benefits of their JIT systems. Before a manufacturing or service organization can enjoy the fruits of JIT, it has been suggested that the firm must accept JIT as an organizational philosophy. This may require the organization to change or modify its operating procedures, its production or service systems and in most cases its organizational culture. For example, plant or service layouts may have to be adjusted, relations with suppliers and customers usually have to be modified, quality circles may have to be implemented, and more accurate demand forecasts must be achieved and maintained [7,26,38–40]. Francis [41] underscored the importance of accurate data, especially demand forecasts, to the successful JIT effort. Among others, Vickey [42], Prasad [36], and Lee [43] stress that the existence of a logistics planning system is a prerequisite for successful implementation of JIT.

Prior research has also identified several other factors that could break or make the JIT implementation process. Some have stressed that top management involvement and proper employee training are essential for successful implementation of JIT [44,36,45–47]. Moreover, Billesbach and Schniederjans [48] and Zhu and Meredith [37] advocated training administrative as well as production (service) workers to ensure the successful implementation of JIT.

Since, in some industries, up to 75% of production cost can be allocated to outsourced materials, it is incumbent upon JIT users to take a proactive role in procurement

[28,49]. The preferred relationship between the JIT organization and its suppliers and customers has been described as mutually beneficial strategic partnerships [50,29,51]. The need for strong collaborative working relationships with vendors during and after the JIT installation has also been stressed [7,43,45,52,53]. The importance of maintaining collaborative supplier relationships after implementation appears to be an especially critical requirement for the success of JIT in both manufacturing and services [54–58,19,12,4].

However, maintaining the benefits of these partnerships relies on the continuous flow of materials and information along the supply chain. It is felt that such collaboration can only be successful if there is effective communication between partners in the supply chain. Suppliers must have easy access to the buyers' demand and real time operational information and the supplier must share critical scheduling information with the buyer. Sharing of such information helps to reduce problems related to the timing, quality and quantities of deliveries [5,50,59,4,29,30,60]. Some studies have also espoused the collaborative benefits of dealing with geographically proximate suppliers. This promotes the idea that buyers should, whenever and wherever possible, choose certified nearby suppliers or encourage suppliers to locate near the manufacturing facility [61,62].

3. Research methodology

The literature review presented above outlines several benefits of JIT. It also addresses some desirable organizational and operational modifications to support JIT implementation. Some common barriers to effective JIT implementation were also identified. The information gleaned in this first stage of the study was harnessed to provide a basis for the second stage of this study—the empirical component.

The empirical stage of the study consisted of two phases. In the first-phase a field study was carried out to gather information on actual JIT implementation practices in manufacturing and service firms. Given the dearth of literature on JIT in services, this phase was especially critical in filling in the gaps of our understanding about JIT implementation in service firms. Of particular interest was the identification of JIT benefits as well as the barriers to successful JIT implementation in service environments. In the second phase, a mail-administered survey was used to test several hypotheses that were developed from an analysis of our literature review findings and our field study results.

3.1. Field study

A field study of 25 firms that had been utilizing JIT in their daily operations for at least 3 years was undertaken. The field study participants consisted of 15 large manufacturing firms (consumer and industrial products) and 10 large service organizations (health care, commercial and retail service) located in the Midwestern and Southern USA. The manufacturing organizations had between 5 and 16 years of experience with JIT systems, while the service firms experience with JIT systems ranged from 3 to 10 years. The authors interviewed managers that had oversight of the implementation and/or operation of the JIT system, and other company officers that were cognizant with the entire history of the JIT planning and installation process at each of the field study sites. In some cases we were referred to past officers of the company who had more detailed historical information about the initiation of the JIT project. The management titles of our field study respondents were general managers, plant managers, directors of purchasing, operations managers, senior vice-presidents and comptrollers.

Structured and unstructured interviews were utilized to gain insights into the JIT implementation process and information about the current status and performance of JIT in the selected firms. In particular, respondents were asked to identify their firm's reason(s) for implementing JIT and to describe any organizational or process modifications that they had entered into in preparation for their JIT implementation. The managers were also asked to indicate some of the critical problems that they had encountered during JIT implementation. Finally, there were asked to outline some of the benefits that they had achieved from JIT operations.

The site visits and interviews conducted during this phase provided insights into JIT implementation requirements, hindering factors, and benefits as seen by these manufacturing and service firms that were currently utilizing JIT in their daily operations. A listing of the items mentioned most frequently by our field study respondents is presented in summary form in Table 1. This table indicates that there were some differences among manufacturing and service firms with respect to the level of emphasis on specific activities and outcomes. However, it appears that the manufacturing and service firms had reasonably similar expectations from their systems and had, indeed, sought to make the types of organizational and operational modifications that have been reported in the literature, prior to fully implementing their JIT systems.

One interesting observation from this phase of the study is that all of the participants from service firms indicated that their initial JIT efforts were primarily aimed at reducing supplies or inventory. They also indicated that the JIT efforts were continued after the initial effort revealed other potential areas for improving efficiency or reducing costs. Our health-care respondents indicated that their JIT efforts were strongly supported and sometimes initiated by hospital supply firms that had converted to JIT production and/or distribution.

The majority of our field study participants (both manufacturing and service) indicated that their firms' thrust towards JIT had been initiated by either top-managers, the accounting function or purchasing. The actual JIT installations, however, appeared to have been spearheaded and managed by various groups, including in-house personnel

Table 1
A summary of most frequent response by field study participants

	Manufacturing firms		Service firms		All participants	
	Number	(%)	Number	(%)	Number	(%)
Reasons for implementing JIT						
Reducing inventory levels	15	100.0	10	100.0	25	100.0
Increase the efficiency of operations	13	86.7	7	70.0	20	80.0
Gain a competitive strategic advantage	12	80.0	5	50.0	17	68.0
Increase customer satisfaction	11	73.3	5	50.0	16	64.0
Reduce storage space requirements	11	73.3	4	40.0	15	60.0
Improve product quality/quality of service	8	53.3	4	40.0	12	48.0
Modifications initiated prior to JIT implementation						
Training to improve job skills	10	66.7	6	60.0	16	64.0
Training to improve decision making	9	60.0	6	60.0	15	60.0
Initiation of quality circles/quality control programs	10	66.7	4	40.0	14	56.0
Simplification of operations	8	53.3	5	50.0	13	52.0
Improving facility layout	6	40.0	6	60.0	12	48.0
Reducing the number of active vendors	8	53.3	2	20.0	10	40.0
Purchasing automated equipment	6	40.0	1	10.0	7	28.0
Problems encountered during JIT implementation						
Inconsistent timing and quantities of deliveries	7	46.7	6	60.0	13	52.0
Inconsistent quality of incoming materials	5	33.3	5	50.0	10	40.0
Worker resistance	7	46.7	3	30.0	10	40.0
Lack of top management support	5	33.3	4	40.0	9	36.0
Lack of communications between management and workers	6	40.0	3	30.0	9	36.0
Unwillingness of workers to perform multiple tasks*	5	33.3	2	20.0	7	28.0
Benefits derived from JIT implementation						
Reduction of supplies/work-in-process inventories	13	86.7	9	90.0	22	88.0
Reductions in inventory	12	80.0	8	80.0	20	80.0
Improved relationships with suppliers	11	73.3	8	80.0	19	76.0
Improvements in on-time deliveries from suppliers	11	73.3	7	70.0	18	72.0
Improvement in operational efficiency	12	80.0	6	60.0	18	72.0
Reduced variability in workforce levels	8	53.3	5	50.0	13	52.0
Reductions in setup times	10	66.7	2	20.0	12	48.0
Improvements in worker satisfaction	5	33.3	5	50.0	10	40.0
Reduction in grievances filed by workers	7	46.7	1	10.0	8	32.0
Total respondents	15	100.0	10	100.0	25	100.0

and outside consultants. In several cases, suppliers and major customers had been proactive both in promoting the idea of JIT implementation and in assisting these firms with their implementation efforts.

The results from our field study were correlated with the information gleaned from the literature review to facilitate the formulation of our research hypotheses and the development of a survey instrument to gather the data required for testing these hypotheses.

3.2. Theoretical framework and research hypotheses

This research has several objectives. First, to determine if service and manufacturing firms make the same types of organizational modifications to support their JIT implementation and if the level of effort exerted on these modifications influence firm performance. Second, to determine to what extent differences in JIT performance can be associated with differences in the persons or groups that had initiated the JIT project or in the persons or groups that had spearheaded the JIT installation effort. These research questions generated the four research hypotheses presented below:

H_1: Firms that exert higher levels of effort in modifying their organizations in preparation for JIT implementation will tend to encounter less implementation problems.

Table 2
Job profiles of survey respondents

Job title of respondent	Manufacturing firms		Service firms		All respondents	
	Number	(%)	Number	(%)	Number	(%)
Owner	13	10	4	6.6	17	8.9
President	45	34.6	24	39.3	69	36.1
Vice president	24	18.5	10	16.4	34	17.8
Operations manager	37	28.5	20	32.8	57	29.8
Other	11	8.5	3	4.9	14	7.3
Total	130	100	61	100	191	100

Note: Respondents were encouraged to share the survey with others who could provide the required information.

H_2: Firms that exert higher levels of effort in modifying their organizations in preparation for JIT implementation will tend to achieve higher levels of success with JIT.

H_3: JIT projects that are initiated by top management will reap higher levels of success.

H_4: JIT projects that involve suppliers in the implementation process will reap higher levels of success.

Each hypothesis will be tested for its applicability in both manufacturing and service firms. Where plausible, comparisons between manufacturing and service firms will also be provided.

3.3. Survey instrument

The survey instrument consisted of 51 questions of which 39 requested responses on a ten-point Likert-type scale. The questions covered such items as the modifications undertaken prior to JIT implementation, the problems encountered during JIT implementation and the results (both successes and failures) of the JIT program. Most of the questions had sub-classifications, resulting in a total of 110 individual questions. The questionnaire was validated (face validity) by 15 business executives from firms that had implemented JIT and 14 APICS members. They all commented positively on the extensive coverage of the JIT implementation process in this survey as well as the extent of coverage of the performance measures.

3.4. Survey administration

3.4.1. Sample

A mailing list of companies that were known to be using JIT was purchased from Ed-Burnett Consultants [63]. This list was used to draw a sample of 700 organizations, of which 175 were service-oriented firms. The usable responses consisted of 130 manufacturing organizations (24.8% of the manufacturing firms) and 61 service organizations (34.9% of the service firms). The manufacturing companies produced consumer and industrial products. The service companies were involved in commercial, consumer, health care, industrial, retail, and technology services. These 191 responses represented a usable response rate of 27.29%. The relatively low response rate could be attributed to the extensive and sensitive nature of the information requested. It should be noted, however, that this rate is consistent with that obtained in similar studies reported in the literature (see, for example, [64]). An examination of respondents versus non-respondents including goodness-of-fit Chi-square tests revealed no significant differences in terms of annual sales, and number of employees at the 0.05 significance level. Therefore, our respondents can be deemed to be representative of our surveyed population.

Respondents were asked to specify their job titles. This resulted in five identified classifications: president, vice president, operations manager, owner, and other (this classification included such job titles as manufacturing engineer, controller, and purchasing manager). Table 2 provides the proportion of respondents under each classification. Readers should note that respondents were advised to share the survey with other officers in their organization who had the expertise and experience to address any questions that they were unable to answer. Since over 90% of both the manufacturing and service respondents were top level managers we feel confident that all the responses given would have been vetted by these top level managers and would, therefore, be reflective of the experiences of the firms as seen from a management perspective.

3.4.2. Measures

Given the exploratory nature of this study, exploratory factor analysis will be used in an attempt to reduce the dimensionality of the measures that were covered in our survey. These critical measures included: (a) modifications that were undertaken in preparation for JIT implementation, (b) problems that were encountered during JIT implementation, and (c) benefits that have been derived from the

Table 3
JIT modification factors

Factor variable	Factor loadings	
	Factor 1	Factor 2
1. *Procedures-oriented modifications*		
Training workers	0.881	0.311
Training managers	0.862	0.401
Reducing the number of suppliers	0.689	0.208
Establishing joint quality control procedures with suppliers	0.630	0.423
Sharing production/service plans with suppliers	0.578	0.392
2. *Operations-oriented modifications*		
Simplification of operations	0.310	0.893
Standardization of operations	0.224	0.828
Acquiring machinery for reducing setup or preparation time	0.188	0.806
Modifying facility layout	0.281	0.788
Reducing equipment downtime	0.101	0.740
Use of multi-function equipment	0.215	0.679
Increasing the level of automation	0.126	0.523

Table 4
JIT implementation problem factors

Factor variable	Factor loadings	
	Factor 1	Factor 2
1. *Human-factors related problems*		
Worker resistance	0.904	0.116
Lack of top-management support	0.895	0.121
Lack of communication between management and workers	0.888	0.158
Top-management resistance	0.842	0.281
Lack of formal training for managers	0.820	0.124
Lack of formal training for workers	0.799	0.113
Unionized workers	0.785	0.214
Lack of consultants in the field	0.535	0.112
2. *Supplier-related problems*		
Incorrectly supplied materials	0.144	0.898
Dependability of suppliers	0.180	0.861
Material quality problems	0.240	0.835
Lack of information sharing/ communication with suppliers	0.201	0.787

implementation of JIT. Detailed information on the development of each of these measures is presented below.

3.5. JIT modifications

The 12 variables listed in Table 3 were used to assess the modifications that firms had undertaken in preparation for JIT implementation. Respondents were asked the question: *How much effort, in terms of monetary, human and other resources, did your firm (facility) extend on each of the* 12 *activities listed below as a direct consequence of your impending change to JIT*? Possible responses were presented on a ten-point scale (1 = no effort, to 10 = highest level of effort). Principal component analysis on the responses to these questions indicated that two factors should be extracted. The two-factor Varimax solution explained 0.791 of the common variance. The resulting factors and their factor loadings are presented in Table 3. The Cronbach's alpha reliability was 0.842 for factor 1, and 0.878 for factor 2. These alpha values surpass the acceptable level of 0.70 proposed by Flynn et al. [65]. Factor 1 is labeled as *Procedures-Oriented Modifications*, and factor 2 is labeled as *Operations-Oriented Modifications*. Factor scores were developed using the regression analysis option.

3.6. JIT implementation problems

The 12 variables listed in Table 4 were used to assess the areas and extent of problems that firms encountered while implementing JIT. Respondents were asked to respond to the question: *What level of problems did your firm (facility) experience in each of the following areas during the implementation of your JIT systems?* Possible responses on a ten-point scale were, 1 = no problem at all, to 10 = a critical problem. Exploratory factor analysis was also used to determine if these variables could be represented by a smaller number of underlying factors. The principal component analysis revealed that a two-factor solution would be adequate. The two-factor Varimax solution explained 0.73 of the common variance. The resulting factors and their loadings are presented in Table 3. The Cronbach's alpha for Factors 1 and 2, respectively, were 0.832 and 0.851. Factor one is labeled *Human-Factors Related Problems*, while factor 2 is labeled *Supplier-Related Problems*. Factor scores were developed using the regression method.

3.7. JIT performance

The 14 variables listed in Table 5 were used to assess the areas and extent of performance improvements that could be related to the implementation and operation of JIT. Respondents were asked to respond to the following two statements: (1) *On the basis of our company's experience with JIT we would recommend JIT to others*. (2) *A list of* 13 *typical benefits that have been attributed to the operation of JIT is provided below. Indicate your level of agreement with the effectiveness of your JIT effort in bringing each of these benefits to your firm or facility*. For both sets of statements, responses on a ten-point scale, anchored at 1 = strongly disagree, and 10 = strongly agree, were requested. Principal component analysis was also used to assess the

Table 5
JIT performance factor

Factor variable	Factor loadings
Reduction of rejects of final goods/services	0.882
Improvement in relationship with suppliers	0.801
Reduction in the variability of workload levels	0.799
Reduction of inventory	0.761
Improvement in customer service	0.734
Improvement in on-time receipts from suppliers	0.731
Improvement in worker morale	0.659
Improvement in operational efficiency	0.637
Reduction in labor turnover	0.622
Extent to which the company would recommend JIT to others	0.610
Set-up time reduction	0.591
Improvement in customer perceptions of product/service quality	0.570
Lead time reduction	0.562
Monetary savings	0.556

dimensionality of this scale. The eigenvalue-greater-than-one criterion and Scree-plot indicated that one factor would be sufficient to explain the observed correlations. This principal component solution accounted for 81% of the common variance. The factor loading for the one-factor solution is presented in Table 5. The JIT performance success scale is defined as a composite score of the fourteen variables. The Cronbach's alpha value for this scale was 0.85. In addition, the inter-item correlations for the variables were all greater than 0.5 which suggests that the single-factor scale would also have construct validity. The face validity of this scale was also assessed and approved by our panel of field study participants.

In addition to the variables presented above, respondents were asked to provide information on such items as:

(1) Line of business.
(2) Firm production/service strategy.
(3) Firm size.
(4) Type of production/service system used.
(5) Who initiated the JIT effort?
(6) Number of years JIT has been in use.
(7) Who/Which group spearheaded the installation of JIT.

3.8. Hypothesis testing

Hypothesis 1 (H_1) will be tested using one-tailed Pearson's Correlation tests. The variables that will be used in this analysis are the factor scores for Operations-oriented Modifications (O-OM), Procedures-oriented Modifications (P-OM), Human Factors-Related Problems and Supplier-Related Problems. Separate analyses will be prepared for manufacturing and service firms. Our expectation, based on the literature and feedback from our field study participants, is that all the relationships will be statistically significant and negative, since increasing effort on modification prior to implementation of JIT is expected to result in less problems during implementation.

Hypothesis 2 (H_2) will be tested using hierarchical regression. The dependent variable will be the level of JIT success (JIT-Success) and the independent variables will be O-OM and P-OM—the modification variables. Two additional variables, years of use of JIT and firm size (annual revenues) will be used as control variables. Separate analyses will be prepared for manufacturing and service firms. Our expectation is that both modification variables will be statistically significant and positively related to JIT success.

Hypothesis 3 (H_3) will be tested using a MANOVA procedure in combination with paired-comparison tests. The dependent variable will be JIT Performance and the classification variable will be the department primarily responsible for the initiation of JIT. For this classification, the three major groups self-identified by the field study participants and by respondents in this research are Top Management, the Accounting Department and the Purchasing Department. The literature suggests, as with all major technology changes, that top management involvement at the planning stage is crucial to the eventual success of the project.

Hypothesis 4 (H_4) will also be tested using MANOVA in combination with paired-comparison tests. The dependent variable in this case will be JIT Success and the classification variable will be the major groups participating in JIT installation. The four groups in this classification are: in-house personnel, outside consultants, customers and suppliers.

4. Results

Table 6 presents some general descriptive statistics that underscore the differences between our responding manufacturing and service organizations with regard to production or service strategy and labor force make-up and orientation. These results indicate some significant differences between manufacturing and service organizations with respect to their operations strategy. However, these differences are consistent with the typical characteristics and nature of the operating systems of these two differing types of organizations.

4.1. Hypothesis testing results

Simple correlation analysis was used to assess the relationship between the extent of modification effort and implementation problems. The factor scores for the procedures- and operations-oriented modifications and for supplier-related and human-factors related problems were used in this analysis. Results for both manufacturing and service firms are presented in Table 7. As expected, all correlation coefficients are negative. However, for service firms, the relationship between Operations-Oriented

Table 6
Respondent profiles

Characteristic	Manufacturing		Service	
	Freq.	(%)	Freq.	(%)
Production/service strategy[a]				
Quality	81	65.9	18	31
Reliability	3	2.4	0	0
Efficiency	35	28.5	29	50
Dependability	4	3.3	7	12.1
Missing	7		3	
			3	
Labor orientation				
Labor intensive	22	17.9	38	65.5
Automation intensive	77	62.6	8	13.8
Mixed	24	19.5	13	22.4
Missing	7		3	
			3	
Worker skill levels				
Low-skilled	23	18.7	12	20.7
Semi-skilled	38	30.9	25	43.1
Highly skilled	62	50.4	19	32.8
Missing	7		3	
All respondents	123	100	58	100
Missing	7		3	

Note: Missing responses are not included in the percentages.
[a]Respondents were asked to select one classification that best described their operations.

Table 7
Correlation between modification effort and JIT implementation problems

Operating system type of modification effort	Implementation problems	
	Human-related problems	Supplier-related problems
Manufacturing		
Procedures-oriented modifications	−0.621*	−0.703*
Operations-oriented modifications	−0.501*	−0.593*
Service		
Procedures-oriented modifications	−0.591*	−0.692*
Operations-oriented modifications	−0.706*	−0.107

Note: Pearson correlation coefficient/p-value, where * $p < 0.01$.

Modifications and Supplier-Related Problems was not statistically significant. Hence, Hypothesis H_1 was fully supported for manufacturing firms and partially supported (for 3 of the 4 relationships) for service firms.

Hypothesis H_2 was tested using hierarchical regression. This procedure was required to control for the size of the firm and the number of years JIT has been in use. The results of this regression procedure are shown in Table 8. Based on the results for manufacturing organizations, both procedures- and operations-oriented modification efforts are significant in explaining JIT performance, even after correcting for firm size and the number of years JIT has been in use. In the case of service organizations, while procedures-oriented modifications were found to be positively and significantly related to JIT success, operations oriented modification efforts were not statistically significant in explaining JIT success. Therefore, H_2 was fully supported for manufacturing firms. It was only partially supported for service firms. In addition, the number of years JIT has been in use was a significant positive explanatory variable for both types of firms. However, the size of the firm was only found to be significant in explaining the success of service firms, with larger service firms being more successful than their smaller counterparts.

To test hypothesis H_3 a MANOVA procedure utilizing pair-wise mean comparisons was used. The MANOVA procedure detected significant differences with regard to impact of the locus of JIT initiation on JIT performance. Based on the results presented in Table 9, H_3 is supported for both manufacturing and service organizations. The pair-wise comparisons for both manufacturing and service firms

Table 8
Stepwise regression results for dependent variable JIT performance

Type of business	Department variable	Stepwise regression stage	Independence variables					R^2	Change in R^2
			Intercept	Size	Years	P-OM	O-OM		
Manufacturing	JIT performance	Stage 1	45.69	1.06	4.11 **			0.24	
$n = 128$		Stage 2	20.8	0.93	3.93 **	3.81 **		0.36	0.12
		Stage 3	9.96	0.43	3.42 **	3.16 **	1.98 *	0.47	0.11
Service	JIT performance	Stage 1	38.69	6.22 **	5.66 **			0.31	
$n = 58$		Stage 2	26.82	5.32 **	4.32 **	4.16 **		0.48	0.17
		Stage 3	18.69	4.03 **	3.98 **	3.48 **	1.26	0.51	0.03

Table 9
Impact of JIT implementation activities and industry status on JIT success

Activity	Type of business		JIT initiated by			F-value	p-value	Significant group differences at alpha = 0.05
			(1) Top management	(2) Accounting department	(3) Purchasing department			
Initiation of JIT	Manufacturing	(Mean)	113.60	70.68	75.93	19.83	0.001	(1–2), (1–3)
		(S.D.)	13.20	16.36	14.81			
	Service		108.90	90.86	66.77	18.65	0.001	(1–2), (1–3), (2–3)
			14.31	12.42	11.92			

Activity	Type of business		Major participation by				F-value	p-value	Significant group at differences alpha = 0.05
			(1) In-house personnel	(2) Outside consultant	(3) Customers	(4) Suppliers			
Participation of JIT implementation	Manufacturing	(Mean)	69.32	106.69	128.61	131	28.32	0.001	(4–1), (4–2) (3–1), (3–2) (2–1)
		(S.D.)	18.21	11.13	14.20	16			
	Service		55.01	110.36	131.86	121	30.06	0.001	(3–1), (3–2), (3–4), (4–1) (4–2), (2–1)
			14.92	9.76	12.33	14			

revealed that top management involvement in the initiation of the JIT effort tended to enhance JIT performance. Projects initiated by either the accounting or purchasing departments were significantly less successful than those initiated by top management.

The test for Hypothesis H_4 also utilized a MANOVA procedure. The results for this test are also presented in Table 9. In terms of participation in JIT installation in manufacturing firms, projects that had major participation by suppliers were associated with higher levels of JIT performance than those projects in which third-party consultants or in-house personnel were the major participants. However, there were no significant differences in JIT performance between projects that were spearheaded by suppliers or customers. Although

H_4 was supported for manufacturing firms, there was also significant support for the involvement of customers during JIT installation.

Service firms with major supplier or customer participation reaped significantly higher benefits than those projects where in-house personnel or outside consultant were the major participants. However, unlike the case of the manufacturing firms, the level of performance due to the involvement of customers was significantly higher than for those firms where suppliers were involved. Hence, H_4 was partially supported for service firms. Our sample provided strong evidence supporting the need for the involvement of customers during JIT service installations.

5. Discussion and managerial implications

5.1. Modifications prior to the implementation of JIT

For manufacturing firms, greater effort invested in either procedures-oriented or operations-oriented modifications prior to implementation was found to result in significant reductions in human-factors related and supplier-related implementation problems. Increasing effort on both types of modifications was also positively related to achieving JIT success in manufacturing firms. For the manufacturing firms in our sample, the number of years of use of JIT was also found to be a significant variable in explaining JIT success, firm size was not a significant explanatory variable.

These results suggest that manufacturing firms should make the required investment in both procedures-oriented and operations-oriented modifications when implementing JIT systems. Modifications such as training to improve job skills and to enhance decision making were found to be desirable. Actively seeking ways to improve relationships with a reduced number of suppliers will also be required. Manufacturing firms will need to make operational changes as well. Our findings suggest that such pre-implementation changes as simplification and standardization of operations, modification of facility layout and deployment of automated, multi-functional equipment help to dampen implementation problems. However, manufacturing firms should be cognizant of the fact that, while firms of all sizes may benefit from implementing JIT, it may not be possible to achieve the wide array of JIT benefits covered in this study in the short-term.

For service firms, greater effort invested in procedures-oriented modifications prior to implementation led to less supplier-related problems. In addition, greater effort exerted on the both procedures-oriented and operations-oriented modifications had a significant impact on reducing human-factors related problems. While increasing effort on procedures-oriented modifications was significant in explaining JIT success, effort on operations-oriented modifications, though positively related to JIT performance, was not a significant explanatory variable. For the service firms in our sample, both firm size and the number of years of use of JIT were found to be significant variables in explaining JIT success. Indeed, each of these variables explained more of the variation in JIT performance than procedures-oriented modifications (the only other significant variable). Larger firms and firms with longer years of experience with JIT tended to be more successful.

These result imply that service firms that are desirous of overcoming supplier-related problems, should focus their efforts on modifications such as management and operator training and on reducing their supplier base while working at improving relationships with the chosen suppliers. Service firms should be encouraged to pursue both procedures-oriented and operations-oriented modification efforts in order to reduce human-factors related implementation problems. Operations-oriented modifications such as simplifying operations, deploying new equipment and modifying service layouts prior to JIT installation appear to help in circumventing some of the human-factors related problems that may be encountered in the implementation process.

Our field study participants from the service sector indicated that although they had addressed operations-oriented activities such as simplification of operations and modifying facility layouts in their implementation activities, they have been less proactive in their technology efforts. These results should encourage service firms to place greater emphasis on improving technology since it appears that such changes help to minimize human-factors related problems. It should be noted, however, that the procedures-oriented modifications appear to pay more dividends, because they will contribute both to reducing both human-factors and supplier-related problems and to the achievement of JIT success. If resource availability is a constraining factor, smaller service firms that are desirous of implementing JIT should be encouraged to make the less-costly procedures-oriented modifications rather than the operations-oriented modifications as a first step in their implementation process.

In seeking to understand why larger firms and firms with longer experience with JIT are more successful we consulted with a panel of our field study participants. The general consensus of our panel was that many service firms are not yet exploiting all the capabilities available from those components of JIT that they implemented. The readers should note that, in addition to inventory measures, our JIT success score included such items as improvements in operational efficiency, customer service and worker morale, and reductions in labor turner and the variability of workforce levels. Our panel felt, however, that many service firms are still viewing JIT purely as a means of reducing inventory or supplies and their associated costs. They also indicated that larger service firms such as Wal-Mart and K-Mart, with their larger inventories were the first to implement the systems. These firms, after initial successes in reducing inventory costs, quickly recognized that the discipline required to operate JIT systems could also be utilized to provide other

substantial company-wide benefits. These firms are further along the path towards reaping some of these JIT holistic benefits. It was felt that smaller firms, that implemented JIT later, might still be focusing on the benefits associated with inventory reduction. If this sentiment is true, JIT vendors and researchers will need to do a better job at communicating the full capabilities of JIT systems for smaller firms.

5.2. JIT implementation management

Our results indicated that, for both manufacturing and service firms, JIT projects initiated by top management were significantly more successful than projects initiated by either the accounting or purchasing departments. For service firms, JIT projects that were initiated by the accounting department reaped significantly higher levels of success than those initiated by the purchasing department at the 5% level. However, much of the literature still suggests that JIT projects are likely to be initiated by the purchasing or accounting departments. One avenue that firms can use to overcome this dichotomy is to ensure that wherever the idea is generated it is allowed to flow up to top management perhaps by way of a departmental manager report or a presentation at an executive meeting. After deliberation and consensus is reached at the top management level and top management support for the project is assured, responsibility for the project can then delegated with the appropriate level of resources and authority to implement the project. In this way, any cross-functional conflict that may result in the derailment of the project may be averted.

Our results also point to the importance of involving supply chain partners in the JIT implementation. For both manufacturing and service concerns, involving customers and suppliers in the implementation was found to be significantly more critical to JIT success than involving third-party consultants or in-house personnel. For service firms, customer involvement was even more critical than supplier involvement. In addition, firms that used third-party consultants had reaped significantly higher levels of success than firms that relied on in-house personnel. Along with emphasizing the importance of customers and suppliers, these findings suggest that some manufacturing firms and service firms may need to seek third-party assistance to ensure effective implementation of JIT. As our earlier results indicated, successful implementation of JIT requires substantial procedural and operational modifications related to training and development of operators and managers, changes in relationships with suppliers, changes in facility layout, and modernization of plant and equipment. It also requires the firm to undertake drastically new approaches to dealing with customers and suppliers. Given this reality, it may be almost impossible for an organization to attempt to tackle such great changes without recourse to knowledgeable outside help. Therefore, firms should not be reluctant to engage the services of knowledgeable third-party consultants that have some experience in the implementation of JIT in reasonably similar environments.

6. Conclusion

This study is prone to all of the problems normally associated with the usage of mail-questionnaire based survey research JIT studies. Foremost among these is typically low response rate. However, we sought to ameliorate this problem by analyzing for possible non-response bias. The notable lack of empirical research dealing with different facets of JIT in the context of service operational settings limited our ability to provide a comparative context to our results. Therefore, we underscore the need for more research in relation to JIT effective implementation in service organizations. In this context, research addressing the relationships between effective JIT implementation and the size, type and nature of the service is called for. Such research should incorporate the lessons learned from the manufacturing JIT experience.

This article compared the requirements for implementation success in manufacturing and service organizations. We focused on pre-implementation modifications and their impact on reducing implementation problems and on the eventual success of the JIT project. We also investigated the importance of top management involvement in the initiation of JIT projects and the use of internal and external groups in the installation process.

It was determined that increased efforts in both operations-oriented and procedures-oriented modification promote JIT success in manufacturing organizations. In the case of service organizations, procedures-oriented modification efforts appear to be more directly linked to promoting JIT success than operations-oriented modification efforts. Our results also indicate that top managers should champion the initiation phase of JIT in contrast to having the accounting or purchasing department initiate this effort. This research also reinforces the contention that suppliers and customers ought to be integral partners in the JIT implementation process. Moreover, in the case of service organizations, the involvement of customers proved to be relatively more important to JIT success than the involvement of suppliers. This underscores the need for service operations to maintain an active customer-orientation even during periods of new technology implementations such as JIT.

The findings presented above help us to better understand the pre-implementation criteria that can promote successful JIT implementation in both service and manufacturing firms. However, there are some interesting questions that remain to be addressed. The history of JIT implementation in manufacturing predates implementations in the service arena by almost two decades. It would be very interesting to survey to what extent service firms have utilized the lessons learned

by manufacturers to assist them in their implementation efforts. Moreover, one of the principal concerns about service JIT is that it will never have the pervasive holistic impact that JIT has in the manufacturing sector. However, we tend to forget that the early adopters of JIT in manufacturing were not expecting and did not achieve many of the manufacturing benefits that we now routinely expect from JIT. Further studies that compare, for example, the expectations and benefits of the first 5 or 10 years of implementation of JIT in both manufacturing and service environments should shed some light on any true differences in the capabilities of JIT in manufacturing and services.

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