JUST-IN-TIME MANUFACTURING AND ORGANIZATIONAL PERFORMANCE: 
THE ROLE OF INFORMATION TECHNOLOGY FOR COMMUNICATION

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ABSTRACT

In today's business world where customers place orders in real-time and manufacturers/suppliers are expected to have systems in place to process, fill and ship the orders in real-time, the application of just-in-time manufacturing (JIT) supported by information technology for communication (ITC) is a way forward. This paper reports the results of a study that investigated the role of managers' use of the (ITC) in the relationship between strategic business units' application of the JIT and financial performance. Data for the study were collected from 103 general managers (GMs) in charge of one strategic business unit (SBU) each. The results indicated that the SBUs' financial performance was positively associated with the interaction between managers' use of the ITC and application of the JIT. Specifically, as the application of the JIT and managers' use of the ITC increased; the SBUs' performance improved. Implications of the results are discussed in the paper.

1. INTRODUCTION

In today's increasingly competitive global market where customers demand on-time delivery of quality products at competitive price, organizations must operate efficiently to sustain competitiveness. To survive in such competitive environments, an organization ought to employ strategies consistent with its environmental demands. High productivity, improved product quality, enhanced manufacturing flexibility, and high customer responsiveness are some of the strategies to respond to such competitive environments, where manufacturers have to produce and sell quality products at competitive price and deliver them on time (Fullerton, 2001; Lambert, 1996).

The increasing importance of product quality, manufacturing flexibility and customer responsiveness has challenged the relevance and efficiency of the conventional (push) system of manufacturing. An outcome of such challenge is the application of JIT. Benefits from the application of JIT include high quality production, low inventory, shorter throughput time, low wastage and high customer responsiveness. JIT adopter companies experience less inspection, scrap and rework, close and effective communication among departments and employees, and long-term relationships with suppliers and customers resulting in timely production and delivery of products and low inventory costs (Chapman, 1990). These improvements ultimately accelerate organizational performance.

In most manufacturing and distribution environments, safety stocks constitute an important measure to cope with uncertainties in demand, therefore, in production (Karaeman, 2002). An alternative measure to reduce the demand uncertainty is increased information sharing between the partners of a supply chain, a critical factor for a successful JIT application (Gareth & Derek, 1998; Santacecilia, 1992). When used effectively, the increased information sharing among the chain members serves to reduce the uncertainty in future demands that may thereby enable better planning for inventory, production and performance. Indeed, JIT adopters face a logistics loop; it begins with forecast of customer demand, which in turn, assists decisions on frequency and size of purchase order and production lot size leading to inventory planning and control and finally better customer service (Lawrence, 1999). A supply chain begins with supply of materials into a manufacturing plant and ends with delivery of finished product to traders for sale (Koss, 2000). A supply chain management is the integrated operation of a network of organizations that is involved in management of materials flow and the related information flow from sources of supply to consumption, with the goal being to provide the best relative value for the end customer (Claycomb et al, 1999).
JIT firms need to routinely communicate with all parties in the supply chain for effective management of the chain and add value. ITC improves the efficiency of supply chain management and integration; it is done through (a) improved speed and flow of data exchange between the chain members, and (b) by helping instantaneous availability and exchange of necessary information at the customer’s site, production process and the supplier’s end (Thomas, 1995).

Following the above discussion, we argue that success of the JIT application depends to a large extent on managerial use of the ITC. However, our extensive literature search indicated that the potential role of managerial use of the ITC combined with JIT application influencing organizational performance was not considered by previous studies investigating benefits of the JIT application. In other words, the extant literature does not have an answer to the question, “is managers’ use of the ITC beneficial in firms applying JIT?” Since JIT is being increasingly applied by firms world-wide, and today’s firms heavily invest in ITC, we consider it is important to assess whether the benefits of a JIT application is enhanced by managers’ use of the ITC. This study is an attempt to address the question above.

2. THEORY AND HYPOTHESIS DEVELOPMENT


For the purposes of this study, JIT is viewed as a system under which goods in one stage of the production-sales cycle are completed just prior to being needed at the next stage; it focuses on the minimization of activities or use of resources which do not add value to products (Gordon, 2000).

Our extensive search of the literature indicates improved productivity and product quality; shortened production lead-time (throughput time), set up time, and customer response time; reduced inventory holdings; and enhanced manufacturing flexibility are examples of benefits that stem from a successful application of JIT (Cowton and Vail, 1994; Currie, 1993; Mia, 2000). Some of JIT purported benefits also result from high quality production, low inventory for having the right amount of raw materials and finished products available precisely when they are needed, shortened throughput time, reduced wastage and improved customer response time (Fullerton, 2001).

Kaplan and Atkinson (1989) argue that organizations successfully applying the JIT enjoy tremendous advantages as a result of direct and indirect financial savings. An example of a direct financial savings is decreased investment required to hold low inventory under JIT (see also Balakrishnan et al, 1996). Application of the JIT also generates indirect financial savings through improved product quality, reduced wastage, better coordination and closer relationships with suppliers and customers (Cobb, 1993). By fostering closer relationships with suppliers, JIT minimizes costs for inventory of raw materials. Similarly, by creating high task interdependencies among work stations and encouraging closer relationships with customers, JIT minimizes slack resources such as inventory of work in process and finished goods, thereby reduce product costs (see also Selito et al., 1995). Previous researchers argue that firms applying JIT are able to make profits even by selling their products at competitive price because they can produce and distribute their products at competitive costs without compromising quality. Therefore, these companies can retain and even increase their market share, and improve profitability (Mia 2000). Other researchers (Sakakibara, 1997; Kaplan and Atkinson, 1989) argue that a successful implementation of JIT reduces wastage and production costs, enhances product quality, and promotes optimal utilization of capacity leading to higher profitability. The hypothesis below summarizes the above discussion.

H1: There is a positive relationship between the application of JIT and a strategic business unit’s performance in terms of its profitability.

2.2 Managers’ use of the information technology for communication (ITC).

Two attributes of the ITC are considered: first, Intranet (i.e., computer network for communication within an organisation), it can contain many documents and large amount of information and data, and can significantly facilitate information access and sharing within an organisation. Second, Internet (i.e., computer network for communication with external parties such as customers, suppliers, creditors and
others), it can help its users to instantly access information from outside their organizations, thereby increasing breath of information across geographic and time barriers.

Following the relevant previous literature, we argue that managerial use of the ITC (Intranet and Internet) is positively associated with a SBU’s performance for the following reasons.

First, managerial use of the ITC increases managers’ volume, speed, efficiency, data handling capacity and interpersonal communication, thereby improves effectiveness of their information processing and decision making (Brynjolfsson and Hitt, 1996, 1988; Powell and Dent-Micallef, 1997; Ragowsky et al, 2000). ITC supports exchanges of information and facilitates innovation among managers across functions, geographical locations, and time zones (Ragowsky et. al, 2000; Andersen, 2001). The relevant literature suggests that managerial use of the ITC may strengthen an organization’s competitive advantage by enhancing the firm’s information processing capabilities (Brynjolfsson and Hitt, 1996; Powell and Dent-Micallef, 1997). For example, Clemons et al. (1993) suggest that integrated computer networks and data interfaces enhance managers’ gathering, processing, analyzing, storing, retrieving and disseminating information which, in turn, help organizations to attain competitive advantage, extend networks, and outsource processes.

Second, managerial use of the ITC supports learning and creativity in organizations because (i) electronic communication is less formal; it reduces organizational barriers, conveys information that would otherwise not be available, and induce new innovative business initiatives, and (ii) use of e-mail speeds up and extends flow of information among employees across organizations.

Third, managerial use of the ITC reduces operating costs. Murphy (1998) argues that managers’ use of the ITC reduces the cost of logistics such as inventory ordering cost, shipping cost, carrying cost, and other overhead costs. By providing accurate and real-time information on inventory levels, it helps reduce inventory holding costs and administrative costs for order and invoice transmissions (Genevieve, 1998). Also, costs are reduced as ITC can speed up transmission of purchasing orders and payments, and reduce production cycle time resulting in faster production and delivery of goods to the customers (Stewart 2000).

Fourth, managerial use of the ITC facilitates availability of real-time information that enables collaborative decisions among different functional departments such as marketing, production and logistics, so more effective sales and purchase decisions can be made (Bargach, 2001; Clark, 2000; Karaeman, 2002; Kim, 2000; Starr, 2000). By fostering exchange of real-time information among managers and integrating the engineering models with manufacturing and supply chain activities of an organization, ITC can increase the firm’s productivity, maximize return on its assets and improve operating margins through more informed decision making.

Hypothesis H₂ summarizes the discussion.

H₂: There is a positive association between managerial use of the ITC and SBU performance

2.3 ITC, JIT and SBU Performance.

Task interdependency among work stations and functions in JIT environments is high because (i) execution of a succeeding task depends on timely and successful completion of the preceding task, and (b) non-value added activities or use of resources such as inventories are minimized (Gordon, 2000). Due to minimized inventories between production-sales stages, managers in JIT firms do not have a buffer against difficulties caused by defective raw materials, production errors, and irregular supply and demand schedules; therefore, the managers need to act quickly to solve problems and keep production flowing (Mia, 2000). Consequently, managers working in JIT environments have decision making authority and responsibility for smooth running of their operations (Mia, 2000; Selto et al, 1995); they have to take on-the-spot action to solve or prevent a problem at any stage of the operation. Claycomb et al (1999), for instance, argue that JIT firms are more likely to decentralize decision making authority for scheduling production and making strategic as well as marketing decisions. Managers even at lower hierarchical levels in these organizations are more empowered than in traditional manufacturing firms to make decisions such as production scheduling, supplier selection, and pricing. Managers’ use of the ITC provides instantaneous sharing of accurate and real-time information that, combined with decentralized
decision making, enables faster and better decision outcomes (DeSanctis and Poole, 1994; Johansen et al., 1995; Brynjolfsson and Hitt, 1996; Powell and Dent-Mitallel, 1997).

Again, due to high task interdependency, functions within JIT firms are relatively more integrated requiring managers to operate in close cooperation with peers and make decisions in a collaborative manner. ITC-supported communication can make processes of mutual adjustments quick and efficient; thereby support collaborative decision-making (Horvath and Fulk, 1994). Further, ITC assists managers in collaborative decision-making by facilitating their real-time communication with one another irrespective of their locations and time differences, thus helping them accessing instantly both internal and external information required for performance management and benchmarking.

The extant literature reveals that a well-managed supply chain is critical for successful operation of JIT. We argue that managers’ use of the ITC is likely to facilitate management and integration of supply-chain. A JIT, supported by well-managed supply chain, is likely to be successful in minimization of total production and delivery costs (Persson, 1995; Pragman, 1996), thereby improve profitability. To make JIT work, all partners in the supply chain need to communicate closely; and the ITC can help an effective and on-time communication between manufacturers and suppliers allowing the latter to learn what the manufacturer needs and just how much to deliver, and when to deliver it. Speed and accuracy of information are critical for coordination of the complex supply-chain management in JIT operations. The ITC, providing access to real-time communication, can play a vital role in this process. For JIT to work, better communication among all links in the supply chain is essential (Fitzgerald, 1999). Atkinson (2001) argues that Internet, where transactions and interactions can take place at lightning speed, significantly increases the speed of information flow from manufacturers to suppliers. In a highly competitive market, companies always are under pressure to get product out quickly and at competitive price. Application of JIT is an effective strategy to do it and ITC plays a vital role in this respect. Consider, for example, the statement by Ron Pariseau, Vice President of Foxboro, “We see the Internet and other technological advances increasing the impact of JIT for us, not decreasing it. Information technology in terms of Internet makes JIT stronger” (Atkinson, 2001).

Following the above discussion, we argue that managerial use of the ITC is critical for accessing real-time information required for a successful application of the JIT. ITC-supported communication can make processes of mutual adjustments quick and efficient, thereby support decentralized decision making (Horvath and Fulk, 1994). Such decision making is critical in a JIT firm. Moreover, managers’ use of the ITC provides instantaneous sharing of accurate and real-time information that, combined with decentralized and collaborative decision making, enables faster and better decision outcomes required in JIT firms (DeSanctis and Poole, 1994; Johansen et al., 1995; Brynjolfsson and Hitt, 1996; Powell and Dent-Mitallel, 1997). Based on the above analysis, we argue that, managers’ use of the ITC and JIT together enhance performance of JIT firms. In other words, a high application of JIT is positively associated with high organizational performance where manager’s use of the ITC is high.

H₃: The interaction between managers’ use of the ITC and application of JIT is positively associated with a SBU’s performance in terms of its profitability.

3. METHOD
3.1. The sample.

Using Dunn and Bradstreet ‘Salescan’ database, initially, 250 firms were selected at random for the study from among the manufacturing firms operating in Australia and having annual sales revenue of $300m to $600m. A senior executive officer (SEO) of each of the selected firms was approached in writing followed by telephone calls to nominate one SBU general manager who has been in charge of the SBU at least for one year prior to the study. In total, 175 SBU general managers were nominated and subsequently approached to participate in the study. We wrote a personal letter to each of the nominated SBU general managers explaining the purpose and the potential benefits of the study and seeking their participation. A self-addressed postage paid envelope was attached to the letter for return of the completed questionnaire direct to the researchers. In total, 106 SBU general managers completed and returned the questionnaire within nine weeks of mailing the questionnaire yielding a response rate of over 60% of the total number of nominated general managers. Three of the questionnaires had to be discarded, as they were incomplete,
leaving 103 cases in the final sample representing manufacturers including automobiles, garments, building products, home appliances, and pharmaceutical. Only manufacturing firms were selected for two reasons - first, the previous empirical research in JIT concentrates on manufacturing firms, and second, the current study attempts to address the limitations and extend the results of those studies that are based on manufacturing firms.

3.2 Measurement of variables.

The questionnaire measuring the JIT application, managers’ use of the ITC and SBU financial performance was pilot tested to improve reliability and validity of the instruments.

SBU’s financial performance was measured in terms of return on investment (ROI) in the previous year. A SBU was a business unit operating as a profit centre and carrying out the usual business activities including manufacturing and selling of products (Mia, 2000). The return on investment (ROI) for each SBU was calculated using the profits and assets as presented in the SBU’s profit and loss statement and balance sheet. ROI was defined as earnings before interest and tax over total assets (Martin, 1994). The relevant data were extracted from the SBU’s financial statements for the previous year. Although ROI as a measure of performance is subject to criticism, it remains a fundamental approach to measuring organizational profitability (see Horngren and Foster, 1991; and Swierenga and Weick, 1987). The variable had a mean of 5.83 with a standard deviation of 0.94 and the actual range of the scores varied from 1 to 7. It was measured using a 7-point Likert scale anchored at both ends where 1 indicated well below the industry average and 7 indicated well above the industry average.

3.2.1. The JIT application.

The literature suggests that JIT application may comprise of six key aspects of manufacturing activities including (i) set-up time, (ii) manufacturing process flexibility, (iii) preventive equipment maintenance, (iv) equipment layout flexibility, (v) supplier relationship, and (vi) use of kanban (Sakakibara et al., 1997; Yasin et al., 1997; Cobb, 1993).

For purposes of the current study, we followed Sakakibara, et al (1997) to develop the six-item instrument measuring both the breadth and extent of the JIT application. Each of the six items, covering the above six key aspects of JIT application, was anchored at both ends of a 7-point Likert scale indicating 1 (very low) to 7 (very high). The managers were provided with the definition of each of the six “key” aspects (items) of the JIT application and they were asked to indicate the extent to which their SBU applied the JIT under each of the six “key” aspects. Each manager’s score for the application of JIT was the average of the manager’s score for each of the six items in the instrument. The variable had a mean of 5.18 with a standard deviation of 1.01 and the actual range of 2 to 7. A reliability check of the instrument for the study produced a Cronbach (1951) alpha of 0.78, which was considered satisfactory.

3.2.2. Information technology for communication (ITC).

The 5-item instrument measuring managers’ perceived use of the information technology for communication (ITC) was adapted from Andersen (2001). The instrument was employed using a 7-point Likert-scale anchored at both ends. On the scale, 1 represented ‘very low’ and 7 represented ‘very high’. A manager’s overall score for use of the ITC was the average of the manager’s score on each of the five items in the instrument. The variable had a mean of 5.45 with a standard deviation of 1.43 and the actual range of 1 to 7. A reliability check of the instrument for the study produced a Cronbach (1951) alpha of 0.80, which was considered satisfactory.

4. RESULTS

In order to verify if industry characteristic and company size affected ROI of the sample organizations, a test of the difference in the mean ROI for different industries and company sizes in the sample was carried out using ANOVA. The test did not produce a significant result, thereby indicating the lack of a systematic industry or size effect on the ROI of the companies in the sample.
The bivariate correlations for the variables are presented in Table 1. It can be observed from the table that the correlation between the ITC and JIT is not significant, thereby indicating that these variables are independent of each other. One interpretation of this result is that the adoption of a new manufacturing strategy like JIT is not necessarily accompanied by a modernization or improvement of existing information technology.

**TABLE 1: CORRELATION MATRIX FOR THE VARIABLES IN THE STUDY**

<table>
<thead>
<tr>
<th>Variables</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SBU performance (ROI)</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. JIT</td>
<td>0.15</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>3. ITC</td>
<td>0.40**</td>
<td>0.25</td>
<td>1.00</td>
</tr>
</tbody>
</table>

Significance ** p<.01; * p<.05; n=103

Test of the hypothesis:

**Hypotheses H1 and H2** predict that there is a positive association between application of JIT, managers' use of the ITC and SBU performance (ROI). Theses hypotheses were tested using the regression equation below:

\[
Y = \beta_1 + \beta_2 l + \beta_3 J + \epsilon
\]

Where: \( Y \) = the return on investment (ROI); \( l \) = information technology for communication, \( J \) = just in time manufacturing, and \( \epsilon \) = the error term.

The results presented in Table 2 show that \( \beta_2 \) is significant at the \( p < 0.001 \) level. This supports hypothesis H2, which predicts that there is a positive association between managerial use of the ITC and SBU performance. The model explains almost 15% (adjusted \( R^2 = 0.1485, p < 0.0001 \)) of the variance in ROI. The results indicate that there is a significant and positive relationship between the managers' use of the ITC and their SBU performance.

**Hypothesis H3** predicts that the interaction between application of JIT and managers' use of the ITC is positively associated with SBU performance (ROI). This hypothesis was tested using the regression equation below:

\[
Y = \beta_1 + \beta_2 l + \beta_3 J + \beta_4 IJ + \epsilon
\]

Where: \( Y \) = the return on investment (ROI); \( l \) = information technology for communication, \( J \) = just in time manufacturing, \( IJ \) = the interaction, and \( \epsilon \) = the error term.

**TABLE 2: RESULTS OF REGRESSING SBU PERFORMANCE (ROI) AGAINST JIT AND MANAGERS' USE OF ITC (ASSESSMENT OF HYPOTHESES H1 AND H2)**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Reg. Coeff. ( \beta )</th>
<th>Std. Error of ( \beta )</th>
<th>T Value</th>
<th>Signif. Level</th>
<th>P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>JIT</td>
<td>( \beta_3=0.049 )</td>
<td>0.088</td>
<td>0.555</td>
<td>0.580</td>
<td></td>
</tr>
<tr>
<td>ITC</td>
<td>( \beta_2=0.256 )</td>
<td>0.062</td>
<td>4.14</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>( \beta_1=4.183 )</td>
<td>0.503</td>
<td>8.320</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

Adjusted \( R^2 = 14.85\% \), \( F(2, 100) = 9.891 \), \( P < 0.001 \)

Support for the hypothesis required that \( \beta_4 \) in equation (2) be both significant and greater than zero. The results presented in Table 3 show that \( \beta_4 \) is significant at the \( p < 0.037 \) level; this supports the hypothesis. The model explains 17.67% (adjusted \( R^2 = 0.1767, p < 0.037 \)) of the variance in ROI. The results indicate that there is a positive and significant relationship between the SBUs' profitability (ROI) and the interaction of application of JIT and managers' use of information technology for communication (ITC).
TABLE 3: RESULTS OF REGRESSING SBU PERFORMANCE (ROI) AGAINST JIT, MANAGERS’ USE OF ITC AND THE INTERACTION (IJ)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Reg. Coeff. β</th>
<th>Std. Error of β</th>
<th>T Value</th>
<th>Signif. Level P &lt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interaction term (JITC)</td>
<td>β₄ = 0.094</td>
<td>0.045</td>
<td>2.11</td>
<td>0.037</td>
</tr>
<tr>
<td>JIT</td>
<td>β₃ = -0.419</td>
<td>0.238</td>
<td>-1.758</td>
<td>0.082</td>
</tr>
<tr>
<td>ITC</td>
<td>β₂ = -0.186</td>
<td>0.219</td>
<td>0.851</td>
<td>0.400</td>
</tr>
<tr>
<td>Constant</td>
<td>β₁ = 6.332</td>
<td>1.334</td>
<td>5.585</td>
<td>0.001</td>
</tr>
<tr>
<td>Adjusted R² = 17.67%, F (3, 99) = 8.299, P&lt; 0.0001</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. DISCUSSION AND CONCLUSIONS

The significant and positive relation between the SBUs' financial performance and managers’ use of the ITC supports our argument that information technology for communication assists organizations perform better. An explanation for the results is that the use of ITC helps managers get access to necessary information and communicate with peers, subordinates and others on real-time basis, thereby enhances quality decisions leading to better organizational performance. As we have argued earlier in the paper, ITC may also reduce operating costs, thereby improve profit. Murphy (1998) reports that use of the ITC reduces costs of logistic such as inventory ordering cost, shipping cost, carrying cost, and overhead costs; these are realized through reduction/minimization of paperwork, elimination of duplication of reports/receipts, faster processing of orders, and faster and cheaper flow of accurate data/information. ITC supported procurement is an example of a function that can significantly reduce costs through realization of the above advantages.

The significant and positive relation between the SBUs' financial performance and the interaction of JIT and managerial use of ITC is consistent with our argument that ITC plays an important role, particularly in organizations applying JIT. This is because, managerial use of ITC facilitates decentralization of decision making to where local knowledge exists (Kalagannam and Lindsay, 1998), coordination of interdependent functions and activities, and management of supply chain; these are critical ingredients for a successful JIT application.

Just like other previous studies conducted in field settings, the following limitations to the current study are worth mentioning here. First, the study is based on the manufacturing industry only; therefore, the results may be manufacturing industry specific. Given that JIT is applicable in service organizations and that cost structures in a service organization is different from that in a manufacturing organization, future research investigating the impact of JIT application and managerial use of ITC in service organizations will be beneficial.

Second, while considerable care was taken in selecting the sample, participation of the SBU general managers in the study was voluntary. Thus, there is potential for self-selection (response) bias in the sample. Third, only the financial indicator of SBU performance was investigated in the study. There are other performance indicators relevant to a strategic business unit or a company, therefore future research incorporating other performance indicators might be interesting. Fourth, although considerable care was taken in devising measures for the variables in the model, there is still room for improvements.

Notwithstanding the above limitations, the results of the study have implications for theory and practice. For theory the results provide empirical support for the prescriptive studies advocating the benefits of just-in-time manufacturing applications for making organizations more profitable (Anderson, et al., 1989; Kaplan and Atkinson, 1989; Johansson, 1990; Cowton and Vail, 1994; Ansari, 1997). So far empirical research on JIT has been mostly prescriptive (Skakibara, et al., 1993). Although prescriptive research is an important step towards developing theory, empirical research is a step forward to testing the theory in reality. Moreover, the study also provides empirical support for the view that managers' use of the
information technology for communication can play an important role in achieving JIT organizations’ goals, such as enhancing profitability.

One implication for practice is that an organization, which plans to implement a strategy like the application of JIT may perform better if it also plans concurrently to encourage managers to make use of its ITC. This implies that the organization upgrades/designs its ITC to meet the managers’ need for accessing necessary information on real-time basis for decision making; otherwise, realization of the full benefits of implementing JIT may be at least slow. Another practical implication for the results is that organizations that apply JIT would be better off to invest in upgrading ITC to meet managers’ information needs as they emerge.

REFERENCES


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