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Total JIT (T-JIT) and its impact on supply chain competency and organizational performance

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ABSTRACT

Total JIT (T-JIT) is defined as an integrated supply chain strategy incorporating previously defined elements of JIT-production, JIT-purchasing, JIT-selling, with the addition of an important new element, JIT-information. It would be interesting and informative to discover the extended concept's effect on supply chain competency and organizational performance. Here we examine the impact of a T-JIT strategy within a supply chain context, and analyze a model incorporating T-JIT as the focal construct with supply chain management strategy (SCMS) as an antecedent and supply chain competency (SCC) and organizational performance as consequences. Data from manufacturing managers were collected and the model assessed using a structural equation modeling methodology. Study results indicate significant, positive relationships between a supply chain management strategy and T-JIT, T-JIT and supply chain competency, and supply chain competency and organizational performance. The hypothesized relationship between T-JIT and organizational performance was not supported; however. This research is among the first to examine the impact of a T-JIT strategy within a supply chain context. The results of this study support T-JIT as a viable supply chain strategy that influences overall supply chain competency, contributing to organizational performance. In addition the definition of total system JIT and a scale for its measure is developed.

1. Introduction

Historically, the focus of operations management has been on continuously improving operations excellence through the development and implementation of strategies designed to improve organizational performance. Current economic conditions make it difficult for organizations to achieve a sustainable competitive advantage without a macro focus on the entire supply chain, as well as the firm's integrated position within its supply chain (Lummus et al., 2008). Firm performance is therefore dependent on the interlacing of competitive strategies throughout the supply chain rather than on strategies which seek to optimize one link in the supply chain. Successful execution of strategies that strengthen supply chain linkages in collaborative and cooperative ways into an integrated, cohesive business model remains the goal (Chen et al., 2009 and Chen and Paulraj, 2004). One advanced strategy (Huang et al., 2012) that has stood the test of time in fostering competitive advantage at the supply chain level is Just-in-Time or JIT (Vokurka and Davis, 1996; Claycomb et al., 1999b; Vokurka and Lummus, 2000; Green and Inman, 2005; Matsui, 2007 and Bayraktar et al., 2007). An empirical investigation of supply chain strategy typologies by Narasimhan et al. (2006) grouped 25 corporate objectives into six underlying factors, one of which was Just-In-Time Capability. Analysis of internal operations issues yielded three factors, one being Just-In-Time Issues. They (Narasimhan et al., 2006) conclude that supply chain integration concepts are manifest in numerous initiatives for JIT manufacturing, hence, the role of JIT should be emphasized. Recent work by Schoenherr and Swink (2012) confirmed that firms can significantly benefit from being strategically interconnected and aligned with their supply chain partners. External integration (we suggest via JIT-information and JIT-selling) can reduce uncertainties and enable better performance capabilities (Schoenherr and Swink, 2012). Internal integration, e.g., purchasing, planning, manufacturing, logistics (we suggest via. JIT-production and JIT-purchasing), can benefit delivery and flexibility performance (Schoenherr and Swink, 2012).

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Claycomb et al. (1999b) define JIT as 'total system JIT' consisting of three elements. Here, the concept is expanded to four elements with the inclusion of JIT-information and renamed Total JIT (T-JIT). The new scale is validated and used to make more explicit the impact of information on the supply chain and investigate the effect of T-JIT on supply chain competency and organizational performance.

The purpose of this study is threefold:

(1) To extend the Total System JIT model presented by Claycomb et al. (1999b) by including JIT-information and renaming the construct Total JIT (T-JIT).
(2) To make more explicit the impact of information on the supply chain, as measured by supply chain competency and organizational performance.
(3) To analyze the effect of T-JIT on organizational performance both directly and through its impact on supply chain competency.

The following sections will discuss the related literature and subsequent hypotheses development. The methodology section describes the data collection process. Next, the results section includes a description of the sample, assessment of the measurement scales for unidimensionality, reliability and validity, and the results of the SEM assessment. Finally, the conclusions section summarizes the T-JIT strategy, discusses contributions of the study to supply chain/operations management theory, discusses the limitations of the study, describes the potential for future research, and presents the implications for practitioners based on the study results.

2. Literature review

The decision to compete at the supply chain level leads to adoption of a supply chain management strategy which in turn leads to adoption of programs and tactics that facilitate the integration and coordination of business processes with suppliers and customers (Wisner, 2003). Wisner (2003) argues that supply chain management seeks improved participant performance through elimination of waste and better use of internal and external supplier capabilities and technologies. We contend that this need to eliminate waste throughout the supply chain can be affected through the adoption of T-JIT. Adoption of a supply chain management strategy can lead to implementation of T-JIT practices. Supply chain management strategy is, therefore, hypothesized as antecedent to T-JIT. It is important to distinguish supply chain management strategy from supply chain management. Supply chain management strategy is an over-arching strategy that focuses the organization on the importance to integrate and coordinate with suppliers and customers (Wisner, 2003), rather than the actual process of integration and coordination. Support for this assertion is seen in the construction of Wisner's (2003) supply chain management strategy scale, used in this study, in which respondents are asked to indicate the importance of supply chain integration and coordination issues within their organizations, rather than the degree to which integration and coordination is taking place.

2.1. Total JIT (T-JIT)

The goal of JIT practices is to reduce and eliminate waste (Wu et al., 2012). While originally focused on the production process inside the plant, JIT practices have been extended throughout the supply chain to include the purchasing and selling linkages (Claycomb et al., 1999b; Gunasekaran, 1999 and Gonzalez-Benito et al., 2000). Frohlich and Westbrook's (2001) paper on 'arcs of integration', empirically corroborated by Schoenherr and Swink (2012), describes this extension to include the 'forward physical flow of deliveries between suppliers, manufacturers and customers,' and the 'backward coordination of information technologies and the flow of data from customers to suppliers'. As a result 'synergies' might emerge (Schoenherr and Swink, 2012). Synergy, from the Greek, means working together or, as stated by Aristotle, 'the whole is greater than the sum of its parts'. Recent works, subsequent to Frohlich and Westbrook (2001), have used the term synergy to refer to the result of integrating the components of supply chains (Narasimhan et al., 2010; Chen and Tan, 2011; Furlan et al., 2011; Schoenherr and Swink, 2012 and Wu et al., 2012). Other papers dealing with supply chains have used the terms 'complementary' (Narasimhan et al., 2010; Chen and Tan, 2011; Furlan et al., 2011; Lado et al., 2011; Feng et al., 2012 and Malhotra and Mackelprang, 2012) and 'combinative' (Kristal et al., 2010; Liu et al., 2011 and Wu et al., 2012) to refer to the effects of integration. Specific to JIT, Claycomb et al. (1999b) use the term 'total system JIT', Chen and Tan (2011) use the term 'aggregate bundle' of JIT elements and White et al. (2010) use the term 'holistic' JIT.

Frohlich and Westbrook (2001) noted that many proponents of supply chain integration fall under the just-in-time (JIT) banner. Chen and Tan (2011) list a number of studies that deal with the complementary relationships between JIT and other manufacturing technologies (such as TQM, TOC, etc.). While there are papers investigating the results of integrating supply chain components and integrating JIT with other elements (Matsui, 2007), there is little research published on the 'synergistic' effect of the elements of JIT. Chen and Tan (2011) found that, though the individual elements of JIT had different impacts, there was a synergistic effect, i.e., improved production operations performance that resulted from implementing an aggregate bundle of all JIT elements no matter the industry or scale of the firm.

Thus, JIT may be viewed as an integrative strategy facilitating timeliness and quality not only in production, but also in supply and distribution (Hall, 1987; Arnold and Bernard, 1989; Lee and Seah, 1988 and Davy et al., 1992). Claycomb et al. (1999b) use the term 'total system JIT' to describe the combination of JIT-production, JIT-purchasing, and JIT-selling strategies. Even though the term 'total system' is used they (Claycomb et al., 1999b) identify the need for a 'fully facetted' extension of the JIT concept. In response to this need, for this research, a fourth component was added, JIT-information, resulting in the adoption of a different term 'Total JIT' (T-JIT), to capture the comprehensive nature of the construct and its effect on supply chain competency and organizational performance.

2.2. JIT-information

Information plays an important role in maximizing the benefits of JIT implementation (Phan and Matsui, 2010). Supply chain coordination relies on prompt and accurate information (Holweg and Pil, 2008) and the swift, even, and accurate flow (Wisner, 2003; Schoenherr and Swink, 2012) of information throughout the network [supply chain] that is visible to all actors in the supply chain (Holweg and Pil, 2008). This suggests an information infrastructure is needed to effectively and efficiently process knowledge gained from both internal and external sources (Schoenherr and Swink, 2012). Such an infrastructure can be provided by a system that provides JIT-information, that is, information that drives waste from the information gathering processes within the supply chain and provides quality information on a JIT basis, i.e., right form, right place and right time (Green, Whitten and Inman, 2007). Green et al. (2007) found that

adoption of a supply chain strategy necessitates development of an information system infrastructure capable of providing JIT-information to all supply chain partners.

2.3. Supply chain strategy

Supply chain strategy is an emerging research area of supply chain management that is used in the literature to cover a broad range of concepts (Rose et al., 2012). Evidence is provided by a look at past issues of this journal. At least nine articles on supply chain strategy were published in the last five years along with older work spanning a breadth of topics including redesign (Berry and Naim, 1996), lean/agile (Naylor et al., 1999), product types (Li and O'Brien, 2001), life cycle (Aitken et al., 2003 and Patel et al., 2010), configuration (Demeter et al., 2006), axiomatic design (Schnetzler et al., 2007), innovation (Lin et al., 2010), information sharing (Yang et al., 2011 and Nativi and Lee, 2012), market growth (Sharifi et al.,2013), recycling (Huang et al., 2013), and quality and marketing effort (Ma et al., 2013), along with several industries such as retail (Brun and Castelli, 2008), manufacturing (Adamides and Pomonis, 2009), and luxury (Caniato et al., 2011).

In his seminal article in *Harvard Business Review*, Fisher (1997) proposes that products be classified as functional or innovative and matched to a supply chain strategy emphasizing efficiency (for functional products) or responsiveness (for innovative products). While Fisher (1997) established a framework for matching supply chain strategies to the appropriate level of demand uncertainty, Lee (2002) expanded this framework by including demand uncertainties characterized as Stable Supply Processes and Evolving Supply Processes.

Other highly cited works expand on this concept of lean (efficient) and (agile responsive) (Naylor, et al., 1999; Martin, 2000; Martin and Towill, 2000) or are dedicated to other supply chain strategy issues such as integration (Frohlich and Westbrook, 2001; Stevens, 1989; Vickery et al., 2003). Martin (2000) draws a distinction between lean and agile and discusses the appropriate application of each. He suggests that the key to survival for firms subject to changing conditions create agile supply chains via the creation of responsive supply chains. Naylor et al. (1999) state that lean and agile strategies have tended to be viewed in a progression and in isolation. They propose that either paradigm has to be combined with a total supply chain strategy considering market knowledge and the decoupling point on the lean–agile continuum. Presenting the case of a PC manufacturer's supply chain, they conclude that agile is best suited to satisfying fluctuating demand, whereas lean requires a level schedule. Continuing Fisher's (1997) concepts and the work of Naylor et al. (1999), Martin and Towill (2000) suggest a lean supply chain strategy be used for the upstream supply part of the supply chain while agile would be the most effective for the downstream supply. They propose that a 'hybrid' supply chain strategy be utilized in order to bring together the best of both strategies. They provide a case example of an actual company to support their proposition.

Stevens (1989) found that companies that manage the supply chain from a strategic perspective as a single entity (i.e., integrated) and use tools and techniques that meet market needs will survive. Frohlich and Westbrook (2001) question how to best characterize supply chain strategies. Citing evidence from the literature, they suggest that the higher the level of integration, the greater the potential benefits. Analyzing results of a survey of a global sample of 322 manufacturers, they find consistent evidence that the firms with the widest degree of integration with customers and suppliers had the strongest association with improvement in performance. Recently, Frohlich and Westbrook's (2001) findings have been validated and extended by Schoenherr and Swink (2012). Vickery et al. (2003) prescribe two major components of an integrated supply chain strategy as integrative information technologies and supply chain integration with information as the antecedent. By analyzing data from the top 150 independent suppliers to the automotive Big 3, they found a direct relationship between integrated information technologies and supply chain integration and customer service

Chopra and Meindl (2004) broadly define the role of supply chain strategy as:

> *A supply chain strategy determines the nature of procurement of raw materials, transportation of materials to and from the company, manufacture of the product or operation to provide the service, and distribution of the product to the customer, along with any follow-up service and a specification of whether these processes will be performed in-house or outsourced. Supply chain strategy specifies what the operations, distribution, and service functions, whether performed in-house or outsourced, should do particularly well.*

Wisner (2003) defines the ideal supply chain management strategy as 'a linkage of internally-focused, mature, and successful supplier/customer-oriented capabilities throughout the supply chain's members'. The objectives of such a strategy are to provide the supply chain's final customers with the quantity and quality of goods and services at the precise time desired by the customers. A supply chain management strategy requires an end-to-end supply chain focus that supports integration of business processes such as purchasing, manufacturing, selling and logistics throughout the chain for the purpose of providing optimum value to the ultimate customer/consumer (Cohen and Roussel, 2005; Schnetzler et al., 2007; Green et al., 2008 and Droge et al., 2012).

2.4. Supply chain competency

Recent studies (Ding et al., 2010; Lado et al., 2011; Vokurka, 2011; Barnes and Liao, 2012; Ellinger et al., 2012) and not so recent studies (Spekman et al., 2002) have examined the concept of supply chain competency. Ellinger et al. (2012) found that 'firms with superior supply chain management (SCM) competency exhibit higher levels of customer satisfaction and shareholder value than their respective industry averages'. Thus, supply chain competency is included as a reflection of supply chain performance, as opposed to the performance of the individual partnering firms. Supply chain competency is defined as the ability of supply chains to respond to customer demands with low cost, high quality products and services (Bowersox et al., 2000).

2.5. Organizational performance

Organizational performance, or success, is defined and determined by a firm's ability to compete and is measured as return on investment, return on sales, and profitability as compared to its competition (Claycomb et al., 1999a; Green et al., 2004 and Green and Inman, 2005).

3. Hypotheses

Hunt (1991) describes theory as a systematically related set of statements with law-like generalizations that are empirically testable. The theory tested in this study is described as follows:

> *The T-JIT strategy is defined as the incorporation of the practices of JIT-production, JIT-purchasing, JIT-selling and JIT-information, which combine to eliminate waste and more fully utilize resources throughout the entire supply chain. T-JIT serves to operationalize a manufacturing organization's overall supply chain management*

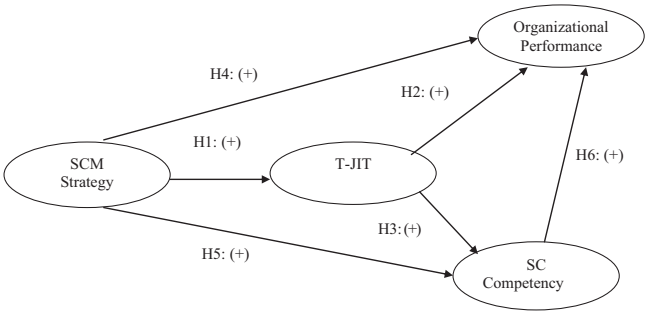

Fig. 1. Theorized T-JIT model.

strategy and both directly and indirectly, through supply chain competency, enhances a manufacturing organization's performance. Additionally, both supply chain competency and organizational performance are directly impacted by the firm's supply chain management strategy.

The theory is conceptually shown in Fig. 1 with six testable hypotheses identified. Please note that all of the direct associations are hypothesized as positive. The theorized structural model incorporates T-JIT as the focal construct with SCM strategy as an antecedent and SC competency and organizational performance as consequences. The model illustrates both direct and indirect associations among the study constructs. The model is designed to assess the impact of T-JIT within a supply chain context. Generally, we theorize that the combination of a SCM strategy and T-JIT will enhance supply chain competency, ultimately improving organizational performance. The remainder of this section describes the rationale supporting each of the hypotheses.

Utilizing JIT to affect supply chain management includes the expansion to JIT-purchasing (Germain and Dröge, 1998) and JIT-selling (Germain et al., 1994 and Green and Inman, 2005) practices, which focus on developing and strengthening the integrating mechanisms. Mentzer et al. (2001) describe a 'direct supply chain' as including a focal organization with first-level supplier and customer linkages. Green et al. (2007) hypothesized supply chain management strategy as antecedent to JIT-information and found the relationship between the constructs to be positive and statistically significant. JIT at the supply chain level provides both strategic and tactical alternatives for practical implementation of the overall supply chain strategy. Hypothesis one follows from the theoretical justification and empirical evidence:

H1. *A supply chain management strategy is positively associated with a T-JIT strategy.*

The next area of interest is the impact on organizational performance of implementing a JIT supply chain strategy. Germain and Dröge (1997) found that JIT-purchasing predicted both marketing and financial performance. Claycomb et al. (1999b) found that a total system JIT strategy, comprised of JIT-production, JIT-purchasing, and JIT-selling, results in improved financial performance. In addition, Claycomb et al. (1999a) found that a JIT-with-customers strategy improved overall financial performance, and Germain and Dröge (1998) found that JIT-buying firms perform better than non-JIT-buying firms. Similar results were obtained by Inman and Mehra (1993) who found that JIT implementation success is related to firm financial success. Others also found that JIT-users significantly outperformed non-users (Brox and Fader, 2002 and Kinney and Wempe, 2002). This considerable evidence supports the hypothesis that implementation of T-JIT, a strategy designed to eliminate waste and optimally utilize resources, will lead to improved organizational performance. While the existing evidence supports a positive association between T-JIT and organizational performance, an alternate argument that the effect of T-JIT on organizational performance may be indirect through supply chain competency can be made (Chopra and Meindl, 2004). Based upon the extensive existing empirical evidence, however, we hypothesize as follows:

H2. *A T-JIT strategy is positively associated with organizational performance.*

As previously defined T-JIT focuses on the elimination of waste and optimal utilization of resources throughout the supply chain. T-JIT integrates the supply, manufacturing, and logistics processes throughout the supply chain. These integrated processes should result in minimum levels of out-bound inventory and enhancements in one or more of the following areas: logistics speed, dependability, responsiveness, and flexibility. Integration, as proposed by Olhager (2002), is dependent on developing the 'linking mechanisms' between successive companies in the supply chain. In comparing the elements of JIT with those of supply chain management, Vokurka and Lummus (2000) conclude that firms that have successfully implemented JIT strategies at the firm level will be able to more easily transition to management at the supply chain level. The empirical work by Claycomb et al. (1999b) alludes to a link between implementation of total system JIT with supply chain competency. They found that firms implementing JIT purchasing practices, JIT-production practices, and JIT-selling practices as an integrated strategy reduced out-bound (logistics-related) inventory levels. Halley and Beaulieu (2009) found that firms with the most highly integrated supply practices had mastered an operational competency in logistic services, providing evidence of a positive logistics (i.e. T-JIT)/supply chain competency relationship. Similarly, Bowersox et al. (2000) assert that there are a number of essential supply chain competencies. These competencies, including their parallel T-JIT element(s) in parentheses, include: customer integration (JIT-selling, JIT-information), internal integration (JIT-production, JIT-information), relationship integration (JIT-selling, JIT-purchasing), technology and planning integration (JIT-production, JIT-information), measurement integration (JIT-information) and supplier integration (JIT-purchasing, JIT-information). Hypothesis 3 is therefore stated as follows:

H3. *A T-JIT strategy is positively associated with supply chain competency.*

Wisner (2003) hypothesized supply chain management strategy as a positive predictor of firm performance. Justification for the hypothesis was based on the argument that performance evaluation of the purchasing and supply management functions will become closely linked to measures of organizational performance, such as growth, profitability, and market share (Carter and Narasimhan, 1996). Wisner (2003) structurally assessed a model that incorporated supplier management and customer relationship strategies as antecedents to supply chain management strategy and firm performance as a consequence. The link from supply chain management strategy to firm performance was found to be positive and significant as hypothesized.

Chen and Tan (2011) analyzed survey data involving ten elements of JIT production in order to identify the relationship among the ten elements (both individually and integrated). Using regression, they found that the individual elements of JIT production had different impacts and that as an aggregate bundle JIT had significant positive impact on production operation performance. White et al. (2010) studied the impact of implementing JIT holistically as four JIT practice bundles grouped as quality practices, delivery practices, volume flexibility practices and cost related practices. They found that JIT implementation in this fashion improved non-value added performance.

Additional empirical evidence is provided by Armistead and Mapes (1993) who measured supply chain integration and perceptions of manufacturing performance and found them to be highly and positively correlated. After surveying senior supply and materials management professionals in the United States, Tan (2002) concluded that supply chain management practices positively impact firm performance. Whitten et al. (2012), via survey data, found that supply chain strategy is positively related to overall performance of the supply chain. There is also evidence that supply chain practices can create competitive advantage from the resource-based view of the firm, (Rungtusanathan et al., 2007; Cousins et al., 2008; Squire et al., 2009) lending support to Hypotheses 4–6. Resource-based competitive advantage can come from supply chain linkages that exclude competitors from forming the same connections with critical suppliers or customers or guarantee availability of materials (Rungtusanathan et al., 2007). Based on the theoretical justification and supporting empirical evidence, the fourth hypothesis, somewhat replicating Wisner (2003) and Chen and Tan (2011), and to a lesser degree, Tan (2002), Armistead and Mapes (1993) and Whitten et al. (2012), is presented as:

H4. *A supply chain management strategy is positively associated with organizational performance.*

According to Wisner (2003), implementation of the strategy should enhance customer value and satisfaction which in turn enhances the competitive advantage of the supply chain. Vokurka and Lummus (2000) support the goal of supply chain management as adding value for customers. The added value should be reflected in the cost, quality, flexibility, and delivery components of supply chain performance (Ho et al., 2002). Additional empirical evidence related to the impact of a supply chain management strategy on supply chain performance is provided by Oliver and Delbridge (2002) and Bowersox et al. (2000). Oliver and Delbridge (2002) compared 'high performing' supply chains with 'low performing' chains on the basis of four supply chain performance measures. High performing chains exhibited fewer incoming defects, fewer outgoing defects, a lower percentage of late deliveries to second tier suppliers and a lower percentage of late deliveries from first tier suppliers. An important contribution to this research is provided by Bowersox et al. (2000) who divided companies into 'high achievers' and 'average achievers' in terms of supply chain competencies, and then compared them on the basis of performance metrics related to customer service, quality, productivity and asset management. The high achievers exhibited significantly higher scores for each performance metric measured. Because Bowersox et al. (2000) found that firms with strong supply chain management strategies exhibit superior performance, this research utilizes supply chain competency as an indicator of supply chain performance. While this measure is limited to the individual organization and does not truly measure at the supply chain level, Bowersox et al. (2000) state that the competencies measured are 'characteristic of companies achieving high levels of supply chain logistics integration'. Additionally, Halley and Beaulieu (2009) found support for the idea that a more thorough integration of the supply chain may be associated with greater mastery of operational competencies. Based on this theoretical justification and the supporting empirical evidence, hypothesis five is stated as follows:

H5. *A supply chain management strategy is positively associated with supply chain competency.*

Managers have traditionally focused on improving the performance of the organizational entity for which they are directly responsible. However, attempts to optimize organizational performance may negatively impact overall supply chain performance, thus damaging the competitive advantage of the chain (Meredith and Shafer, 2002 and Chopra and Meindl, 2004). Therefore, supply chain management should benefit from an external focus in which managers must consider the impact of organizational strategies on supply chain partners. According to Chopra and Meindl (2004), supply chain performance is optimized only when an 'inter-organizational, inter-functional' strategic approach is adopted by all chain partners. Such an approach maximizes the supply chain surplus available for sharing by all supply chain members. Organizational strategies that support supply chain strategies should strengthen the competitive position of the supply chain which, in turn, enhances performance of each of the individual supply chain partners. Although no empirically tested measure of supply chain performance was found, supply chain management competency focuses outside the manufacturing function on the manufacturer/customer relationship, and, as Bowersox et al. (2000) describe it, is a reflection of supply chain superiority. Based upon the theoretical justification, hypothesis six is stated as follows:

H6. *Supply chain competency is positively associated with organizational performance.*

4. Methodology

Our purpose is to investigate the impact of a T-JIT strategy within a supply chain context. A structural model with T-JIT embedded as the focal construct was described and supported in the previous section. Using measurement scales either taken directly from or modified based on scales identified in the existing literature (Claycomb et al., 1999a, 1999b; Wisner, 2003; Bowersox et al., 2000), data were collected from a sample of experts (plant and operations managers) following a traditional two-wave mailing procedure. The data were then analyzed to assess the structural model using a two-step, covariance-based structural equation modeling process in which the measurement model is first assessed followed by an assessment of the fit of the theorized structural model (Wisner, 2003). Covariance-based structural equation modeling is recommended when the purpose of the study is theory confirmation (Hair et al., 2011), as is the case in this study. Such an approach supports testing how well the complete model fits the data in addition to supporting assessment of the individual hypotheses embedded within the structural model.

4.1. Data collection

Plant and operations managers working for large U.S. manufacturers were targeted because of their particular knowledge pertaining to manufacturing, purchasing, selling, and information related processes within their organizations. Each of 1600 plant and operations managers was mailed an initial request to participate that included a cover letter, a 'non-participating' form, the survey instrument, and a postage-paid return envelope. The cover letter requested participation and assured that all responses would be anonymous. In an effort to improve the participation rate, an offer was made to supply an executive summary to each of the respondents. The 'non-participating' form allowed managers who did not wish to participate in the study to remove their names and addresses from the database and, consequently, not receive further contact from the researchers. A follow-up mailing including a revised cover letter, another survey instrument, and return envelope was sent two weeks after the initial mailing. This second mailing did not include managers who filled out the 'non-participating' form.

4.2. Measurement of constructs

The T-JIT scale includes items related to JIT-manufacturing, JIT-purchasing, JIT-selling, and JIT-information. This four-item scale is generally patterned after one previously used by Claycomb et al. (1999b). The Claycomb et al. (1999b) scale incorporated items related to JIT-manufacturing, JIT-purchasing, and JIT-selling, but not JIT-information.

A 12-item scale developed by Wisner (2003) was used to measure supply chain management strategy. Respondents were asked to indicate the importance of the listed issues and concerns regarding their organization's supply chain efforts.

A 4-item organizational performance scale, developed by Claycomb et al. (1999a) and subsequently used by Green and Inman (2005) and Green et al. (2004), was adopted to assess both the financial and marketing performance of the organization.

Supply chain competency was measured using a 13-item scale developed by Bowersox et al. (2000). The items incorporate customer service, cost management, quality, productivity, and asset management performance metrics. Respondents were asked to rate their organization's performance compared to that of their competitors on the metrics.

It should be noted that all measurement scales have an organization-level focus. For T-JIT scale, respondents are asked how successfully their organizations have implemented specific JIT-based programs. For the supply chain management strategy scale, respondents are asked to indicate the importance of specific issues/concerns to their organization's supply chain management efforts. For the organizational performance scale, respondents are asked to rate their organization's performance in specific areas as compared to the industry average. And, for the supply chain competency scale, respondents are asked to rate their company's performance in specific areas as compared to the performance of their organization's competitors.

4.3. Statistical analysis

The effectiveness of the sample is assessed in terms of response rate, item completion rate, and non-response bias. All measurement scales are assessed for unidimensionality, validity, and reliability within a measurement model context and common method bias is assessed to ensure that the scales consistently measure what they are supposed to measure and that the method of data collection has not significantly biased the dataset. Summary variables are computed and descriptive statistics are computed to ensure that the study variables are sufficiently normally distributed. Correlations are computed to establish bivariate relationships among the study variables. The theorized model is then assessed following a structural equation modeling methodology using the Lisrel software. This software is used because it generates goodness of fit indices that are used to determine how well the theorized model fits the data. In addition, the software generates standardized coefficients that are used to assess support for the study hypotheses.

5. Results

5.1. The sample

One hundred and forty-two manufacturers responded with completed instruments for a response rate of 9.7%. Although higher response rates are desirable, Harmon et al. (2002) note that low response rates are typical in industrial research. Examples of low response rates in this type of research are 6.7% (Ward and Zhou, 2006), 7.5% (Nahm et al., 2003a, 2003b), 6.7% (Tan et al., 2002), 10% (Roth and Van der velde, 1991). Therefore, the response rate for this research compares favorably to prior research.

In addition to the survey response rate, item completion rate can be used as another measure of survey effectiveness (Klassen and Jacobs, 2001). Klassen and Jacobs (2001) define item completion rate as 'the proportion of survey items answered relative to all applicable items'. Their respondents held various positions in manufacturing organizations with the majority in plant and operations manager positions. This group was targeted because they are familiar with concepts related to supply chain management, JIT programs, and organizational performance. Both JIT and supply chain management are relatively mature strategic approaches that we believe are well understood within the manufacturing sector whether they have been adopted within specific organizations or not. While we cannot be certain that all respondents understood each item the same way, we computed the item completion rate at a relatively high 97% indicating that respondents were comfortable enough with the meanings underlying the items to respond. One reason that respondents leave items blank is that they do not understand the meaning of the items.

All of the respondents indicated that they worked for manufacturing organizations. Sixty-two percent of the respondents identified themselves specifically as plant or operations managers. An additional 15% held purchasing and inventory management positions. Respondents averaged 5.7 years in their current positions. Mean sales revenues for the firms included in the sample were $6.2 billion, and the mean number of employees per firm was

Table 1
Sample demographics summary.

	Number
Title:	
Plant manager	51
Operations manager	37
Inventory manager	12
Purchasing manager	9
Production planning & scheduling manager	5
Engineering manager	3
Supply chain manager	3
Logistics manager	2
Other manufacturing manager	20
Total	142
Industry category:	
Food & kindred products	7
Textile and mill products	6
Apparel & other except furniture	2
Lumber & wood products	3
Furniture & fixtures products	3
Paper & allied products	2
Printing publishing & allied industries	3
Chemicals & allied products	5
Petroleum refining & related industries	4
Rubber & miscellaneous plastics	4
Stone, clay, glass & concrete products	3
Primary metals industries	1
Fabricated metal products	18
Industrial & commercial machinery	6
Electronic & other electrical equip	19
Transportation equipment	10
Measuring & analyzing instruments	2
Miscellaneous manufacturing	4
Other manufacturing	28
No response	12
Total	142
Mean years in current position	5.7
Mean annual sales revenues	$6.2 billion
Mean number of firm employees	18,570
Number of U.S. states with home offices	30

18,570. Nineteen specific manufacturing SIC codes were identified. Table 1 provides a more detailed description of the sample.

5.2. Scale assessment process

Measurement scales must exhibit content validity, unidimensionality, reliability, discriminant validity, convergent validity, and predictive validity. Since the study scales were either taken directly from prior research (supply chain management strategy, supply chain management competency, and organizational performance scales) or are a modified version of a previously used scale (total system JIT), content validity is assumed. The detailed statistical results from the assessments for unidimensionality, discriminant validity, convergent validity, and predictive validity are presented in Table 2.

Confirmatory factor analysis was used to test for unidimensionality (Gerbing and Anderson, 1988). The T-JIT scale exhibited unidimensionality as structured, but the supply chain management strategy and supply chain competency scales did not. Therefore, it was necessary to re-specify the supply chain management strategy and supply chain competency scales to achieve unidimensionality. The supply chain strategy scale originally developed by Wisner (2003) was reduced from 12 to seven items, and the supply chain competency scale from 13 to six items. The organizational performance scale incorporates four items and was previously used by Claycomb et al. (1999a) and Green and Inman (2005).

Each scale returned goodness-of-fit index (GFI) values greater than .90 (Ahire et al., 1996), non-normed-fit index (NNFI) and comparative-fit index (CFI) values greater than .90 (Garver and Mentzer, 1999), and root mean square error of approximation (RMSEA) values less than .08 (Garver and Mentzer, 1999) indicating sufficient unidimensionality. The measurement scales as incorporated in the survey instrument are presented in Table 3 with items necessarily removed during re-specification denoted with an asterisk.

Garver and Mentzer (1999) recommend computing Cronbach's coefficient alpha and the SEM construct-reliability and variance-extracted measures to assess scale reliability. They indicate that alpha and construct-reliability values greater than or equal to .70 and a variance-extracted measure of .50 or greater indicate sufficient reliability. All scales exceeded the recommended values. Thus, all study scales are sufficiently reliable.

Ahire et al. (1996) recommend assessing convergent validity using the normed fit index (NFI). Also, Garver and Mentzer (1999) recommend reviewing the magnitude of the parameter estimates for the individual measurement items to assess convergent validity. Statistically significant parameters with values greater than .7 indicate a strong condition of convergent validity. All scales have NFI values exceeding the .90 level. All parameter estimates for all scales are statistically significant and exceed .65. Only four of the total 24 estimates did not exceed the .70 level. Therefore, all scales exhibit sufficient convergent validity.

Discriminant validity was assessed using a chi-square difference test for each pair of scales under consideration. Analysis of all possible pairs of the study scales resulted in a statistically significant difference, indicating discriminant validity for all scales (Gerbing and Anderson, 1988; Ahire et al., 1996 and Garver and Mentzer, 1999).

Both Ahire et al. (1996) and Garver and Mentzer (1999) recommend assessing predictive validity by determining whether the scales of interest correlate as expected with other measures. A review of the correlation matrix (Table 4) for the study variables supports claims of predictive validity for each study variable. As theorized, organizational performance and supply chain competency are significantly correlated (.247, significant at .01 level), supply chain competency and supply chain management strategy are significantly correlated (.266, significant at .01 level), and supply chain management strategy and T-JIT are significantly correlated (.331, significant at .01 level). Hence, all scales exhibit sufficient predictive validity.

A structural assessment of the full measurement model indicates that the measurement model fits the data relatively well with a relative chi-square (chi-square/degrees of freedom) of 1.70, a RMSEA of .07, a GFI of .83, and a CFI of .95. The individual measurement scales are, therefore, considered sufficiently unidimensional, reliable and valid and the fit of the measurement model is considered sufficient to support further assessment of the structural model.

Lambert and Harrington (1990) describe a common approach to assessment as comparing the first and second waves and

Table 2
Measurement scale assessment results.

Total JIT (T-JIT) scale	
Unidimensionality:	GFI=1.00; CFI=1.00; NNFI=1.00; RMSEA=.00
Reliability:	Alpha=.86; construct-reliability=.86; variance-extracted=.62
Convergent Validity:	NFI=1.00; Parameter estimates all significant and 3 of 4 greater than .70
Discriminant Validity:	Chi-square differences 267.35, 327.78, and 333.75 with 1 degree of freedom (significant at the .01 level)
Criterion Validity:	Positive correlations with SCMS (.33), SCC (.40), and OP (.23) significant at .01 level
Supply chain management strategy (SCMS) scale	
Unidimensionality:	GFI=.96; CFI=1.00; NNFI=.99; RMSEA=.05
Reliability:	Alpha=.89; construct-reliability=.87; variance-extracted=.68
Convergent Validity:	NFI=.98; Parameter estimates all significant; 6 of 7 greater than .70
Discriminant Validity:	Chi-square differences of 327.78, 655.70, and 720.61 with 1 degree of freedom (significant at the .01 level)
Criterion Validity:	Positive correlations with TS-JIT (.33), SCC (.27), and OP (.24) significant at .01 level
Supply chain competency (SCC) scale	
Unidimensionality:	GFI=.97; CFI=.99; NNFI=1.00; RMSEA=.06
Reliability:	Alpha=.88; construct-reliability=.90; variance-extracted=.61
Convergent validity:	NFI=.98; Parameter estimates all significant; 4 of 6 greater than .70
Discriminant validity:	Chi-square differences of 267.35, 720.61, and 747.37 with 1 degree of freedom (significant at the .01 level)
Criterion validity:	Positive correlations with TS-JIT (.40), SCMS (.25), and OP (.23) significant at .01 level
Organizational performance (OP) scale	
Unidimensionality:	GFI=.97; CFI=1.00; NNFI=.99; RMSEA=.05
Reliability:	Alpha=.94; construct-reliability=.97; variance-extracted=.83
Convergent validity:	NFI=.99; Parameter estimates all significant and greater than .70
Discriminant validity:	Chi-square differences of 333.75, 655.70, and 747.37 with 1 degree of freedom (significant at the .01 level)
Criterion validity:	Correlation with TS-JIT (.23), SCMS (.24), and SCC (.25) significant at .01 level

Table 3
Measurement scales.

Total-JIT
Please indicate the extent to which you agree or disagree with each statement. (1=strongly disagree, 7=strongly agree)
This organization has successfully implemented a JIT-manufacturing strategy.
This organization has successfully implemented a JIT-purchasing strategy.
This organization has successfully implemented a JIT-selling strategy.
This organization has successfully implemented a JIT-information strategy.

Supply-chain-management-strategy
Please indicate the importance of each of the following issues/concerns to your organization's supply chain management efforts. (1=low importance, 7=high importance)
Reducing response times across the supply chain.
[a]Improving the integration of activities across the supply chain.
Searching for new ways to integrate SCM activities.
Creating a greater level of trust throughout the supply chain.
Identifying and participating in additional supply chains.
Establishing more frequent contact with supply chain members.
[a]Creating a compatible supply chain communication.
Involving all supply chain members in your firm's product/service marketing plans.
[a]Communicating customers' future strategic needs throughout the supply chain.
[a]Extending supply chains beyond your firm's customers/suppliers.
Communicating your firm's future strategic needs to suppliers.
[a]Creating SCM teams including members from different firms.

Organizational-performance
Please rate your organization's performance in each of the following areas as compared to the industry average. (1=well below industry average, 7=well above industry average).
Average return on investment over the past three years.
Average profit over the past three years.
Profit growth over the past three years.
Average return on sales over the past three years.

Supply-chain-competency
Please rate your company's performance in each of the following areas as compared to the performance of your competitors. (1=much worse than competition, 7=much better than competition)
Customer satisfaction
[a]Product customization
Delivery speed
[a]Logistics cost
Delivery dependability
Responsiveness
[a]Order flexibility
Delivery flexibility
[a]Information systems support
Order fill capacity
[a]Advance ship notification
[a]Inventory turn
[a]Return on assets

[a] Denotes items removed during scale assessment process.

assuming that 'non-response bias is nonexistent if no differences exist on the survey variables'. Following this common approach, respondents were categorized as responding to either the initial or follow-up requests sent approximately two weeks later. Those responding to the initial requests were classified as early-responders; those responding to the follow-up requests were classified as late-responders. Fifty-four percent (77) of the respondents were categorized as early respondents and 46% (65) were categorized as late respondents. A comparison of the means of the descriptive variables and the scale items for the two groups was conducted. With one exception, the comparisons resulted in statistically non-significant differences. The exception was for an item in the supply chain competency scale that was eliminated during the assessment for unidimensionality. Because non-respondents have been found to descriptively resemble late-respondents (Armstrong and Overton, 1977), this finding of general equality between early- and late-respondents indicates that non-response bias has not negatively impacted the assembled data set.

When data for the independent and dependent variables are collected from single informants, common method bias may lead to inflated estimates of the relationships between the variables (Podsakoff and Organ, 1986). To reduce the potential for common method bias, care was taken to (1) develop scale items that are simple and unambiguous, (2) format the survey such that scales representing dependent constructs appeared before those representing independent constructs (T-JIT) before supply chain management strategy and organizational performance before supply chain competency, (3) separating the scale for the focal construct T-JIT from the other study scales by four additional scales not related to this study, (4) using various instruction sets and anchor combinations for the study scales, and (5) taking steps to ensure respondent anonymity, as recommended by Podsakof et al. (2003). Mossholder et al. (1998) recommend assessing common method bias through single factor confirmatory factor analysis. This analysis with all items loading on one factor does not fit the data well with a relative chi-square value of 10.33, a GFI of .43, a RMSEA of .26, an NNFI of .59, and a CFI of .64. This lack of fit indicates that common method bias is not a significant concern with the data set.

5.3. Structural equation modeling results

Fig. 1 depicts the theorized T-JIT model. Fig. 2 illustrates the model with the structural equation modeling results specified in the LISREL 8.7 output. The relative chi-square value of 1.70 is less than the 3.00 maximum recommended by Kline (1998). The RMSEA (.07) is lower than the recommended maximum of .08

Table 4
Descriptive statistics and correlations.

	Mean	Standard deviation	Skewness	Kurtosis
A. Descriptive statistics ($n=142$)				
Total JIT (T-JIT)	3.8857	1.3593	−.115	−.398
Supply chain management strategy (SCMS)	5.0148	1.0817	−.514	.762
Supply chain competency (SCC)	5.4188	.8760	−.915	1.250
Organizational performance (OP)	4.6327	1.2175	−.198	−.091

	T-JIT	SCMS	SCC	OP
B. Correlation matrix ($n=142$)				
T-JIT	1.000			
SCMS	.331*	1.000		
SCC	.401*	.266*	1.000	
OP	.227*	.242*	.247*	1.000

* Correlation is significant at the .01 level (2-tailed).

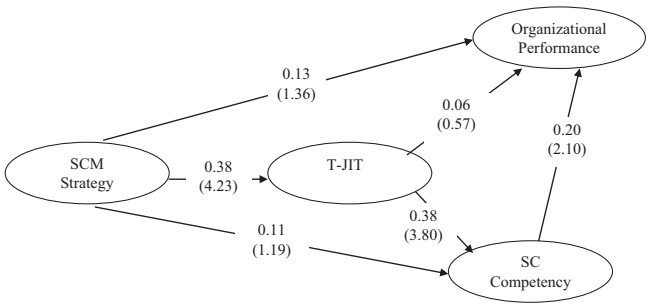

Fig. 2. T-JIT model with standardized estimates and (*t*-values). Relative chi-square = 1.70 CFI = .95; GFI = .83; RMSEA = .07.

(Schumacker and Lomax, 1996). While NNFI (.95) is above the recommended .90 level (Byrne, 1998), the GFI (.83) is not. These indices, however, are more heavily impacted by a relatively small sample size, and, as Byrne (1998) points out, the comparative-fit index (CFI) and incremental-fit index (IFI) are more appropriate when the sample size is small. The CFI (.95) and IFI (.95) both exceed the recommended .90 level (Byrne 1998).

While the overall theorized model fits the data well, the standardized estimates and associated *t*-values support only three of the six hypothesized relationships. The proposed relationship between supply chain management strategy and T-JIT (Hypothesis 1) is significant with an estimate of .38 and *t*-value of 4.23. The estimate of .06 for the relationship between T-JIT and organizational performance (Hypothesis 2) is not significant with a *t*-value of .57. The proposed relationship between T-JIT and supply chain competency (Hypothesis 3) is supported.

While the overall theorized model fits the data well, the standardized estimates and associated *t*-values support only three of the six hypothesized relationships. The proposed relationship between supply chain management strategy and T-JIT (Hypothesis 1) is significant with an estimate of .38 and *t*-value of 4.23. The estimate of .06 for the relationship between T-JIT and organizational performance (Hypothesis 2) is not significant with a *t*-value of .57. The proposed relationship between T-JIT and supply chain competency (Hypothesis 3) is supported with an estimate of .38 and *t*-value of 3.80. The relationship between supply chain management strategy and organizational performance (Hypothesis 4) is not significant with a standardized estimate of .13 and an associated *t*-value of 1.36. Hypothesis 5, the relationship between supply chain management strategy and supply chain competency, is not significant with an estimate of .11 and a *t*-value of 1.19. Finally, Hypothesis 6, the relationship between supply chain competency and organizational performance is significant with an estimate of .20 and a *t*-value of 2.10.

6. Discussion

In summary, a relatively broad sample of U.S. manufacturers provided data for assessing the T-JIT model. All study scales were determined to be unidimensional, reliable, and valid and the measurement model fits the data well. Results of the structural equation modeling analysis supported three of the six individually specified hypotheses. Supply chain management strategy is positively associated with T-JIT, T-JIT is positively associated with supply chain competency, and supply chain competency is positively associated with organizational performance. Surprisingly, however, supply chain management strategy is not directly associated with either supply chain competency or organizational performance, and T-JIT is not significantly associated with organizational performance. The impact of supply chain management strategy on performance is indirect through T-JIT, and the impact of T-JIT on organizational performance is indirect through supply chain competency. The T-JIT strategy, which incorporates JIT-manufacturing, JIT-purchasing, JIT-selling, and JIT-information principles and practices, is a viable, effective strategy for directly improving supply chain competency, which, in turn, improves organizational performance. The JIT philosophy and associated practices have been successfully integrated at the supply chain level as well as the organizational level.

In summary, The T-JIT performance model was subjected to structural equation modeling analysis with support for three of the six study hypotheses found. The direct links from supply chain management strategy to supply chain competency and organizational performance and the direct link from T-JIT to organizational performance are not significant. Because the T-JIT strategy is in fact a supply chain strategy, it makes sense that a T-JIT strategy would directly impact the supply chain competency (manufacturer/customer linkage) performance measure, rather than organizational performance. A T-JIT strategy serves to integrate and coordinate business processes throughout the entire supply chain. This end-to-end integration and coordination allows the supply chain to better serve its ultimate customers.

7. Conclusions

Again, our main objective was threefold: (1) to extend the Total System JIT model (2) to make more explicit the impact of information on the supply chain and (3) to analyze the effect of T-JIT on organizational performance.

We found that success at the supply chain level requires supply chain management strategy and competency as well as organizational management. Our results support T-JIT as a viable supply chain management strategy. Practitioners wishing to compete at the supply chain level are advised to become JIT-producers, JIT-purchasers, JIT-sellers, and JIT-information providers. In short, manufacturing managers should benefit from adopting a T-JIT strategy. This comprehensive strategy will serve to move the supply chain toward the ultimate goal of delivering zero-defect, quality products to the supply chain's ultimate customers in the exact quantities and at the precise times desired by those customers.

7.1. Contributions of the study and implications for future research

Other than Chen and Tan (2011) the authors found no work on the synergistic effect of the integration of the individual elements of JIT. Hence, our paper makes only the second (know to the authors) contribution in this area. A fourth element, JIT-information, was added to Claycomb's et al. (1999b) three element concept, thereby expanding the body of research. Wisner (2003) structurally assessed a model that incorporated supplier management and customer relationship strategies as antecedents to supply chain management strategy and firm performance as a consequence. He found the link from supply chain management strategy to firm performance to be positive and significant. Our work adds to the literature by narrowing the focus to JIT and incorporating production practices as a variable. Chen and Tan (2011) analyzed survey data involving ten elements of JIT production and found that, as an aggregate bundle, JIT had a significant positive impact on production operation performance. Our work expands on this to include JIT-purchasing, JIT-selling and JIT-information with JIT-production in the analysis. White et al. (2010) found holistic JIT, seen as implementation of four bundles of practices related to quality, delivery, volume flexibility and cost, to result in improved non-value added performance. Our work adds to the body of knowledge by proceeding from a different

perspective, thereby providing a more complete picture of the arcs of integration.

Optimization at the supply chain level through improved supply chain competency leads to improved organizational performance for each participating supply chain partner. In short, global optimization at the supply chain level leads to improved local performance. It also makes sense that a supply chain management strategy impacts performance indirectly through T-JIT. It can be concluded that T-JIT is a supply chain level strategy. Once managers determine that they should adopt a supply chain strategy, they must determine how it can be strategically and tactically implemented, for example, by adopting a T-JIT strategy.

JIT has been expanded from the three-component total system JIT to the four-component T-JIT. This study assesses the impact of supply chain management strategy and T-JIT on supply chain competency and organizational performance. Future research should include additional measures of performance such as the operational performance of the firm and the overall performance of the supply chain, although a supply chain performance measure would have to be developed. Further research could also investigate the individual impact of each component on measures of performance. Additionally, the individual elements could be assessed separately to determine unique outcomes of each or results from various combinations of the individual components could be assessed in order to determine the existence of some sort of 'synergy'. Future research could also assess the T-JIT model in the service and governmental sectors. Finally, work could be directed toward the facilitation of T-JIT implementation and the overcoming of inherent barriers in the process.

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