International Journal of Production Economics 199 (2018) 95–103

Contents lists available at ScienceDirect

International Journal of Production Economics

journal homepage: www.elsevier.com/locate/ijpe

The relationships between information management, process management and operational performance: Internal and external contexts

Daniel Prajogo [a,*], Jordan Toy [a], Ananya Bhattacharya [a], Adegoke Oke [b], T.C.E. Cheng [c]

[a] Department of Management, Monash Business School, Monash University, Australia
[b] Department of Supply Chain Management, W.P. Carey School of Business, Arizona State University, USA
[c] Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, PR China

ARTICLE INFO

Keywords:
Information
Process
Performance
Internal
External

ABSTRACT

The role of information in supporting processes in firms' operations has become increasingly important. In today's competitive market, information management has become a "prerequisite" for process management. This study examines the role of information management as the driver of process management and its impact on operational performance. Specifically, we distinguish the contextual factors of the variables used in this study in terms of internal and external aspects that reflect intra-firm and inter-firm boundaries. Using a data set drawn from 202 manufacturing firms in Australia, we find that both internal information management and external information management have positive relationships with both internal process management and external process management. Internal process management has positive effects on both internal and external operational performance, but external process management only has a positive effect on external operational performance. Finally, both internal and external operational performance have positive effects on business performance. We conclude by discussing the implications and contributions of the findings.

1. Introduction

Creating long-term competitive advantage has long been held as one of the most important objectives of management. The importance of process management in improving the efficiency, effectiveness, and flexibility of production, as well as the quality of the final product, has been well recognized in the literature (Chiarini and Vagnoni, 2015; Ebrahimi and Sadeghi, 2013). However, the potential of such improvement is often limited without the coordination and support of external parties along the supply chain, including suppliers, transporters, distributors, and warehouses. Firms that do coordinate with external organizations are able to improve their operational performance (Goffin et al., 1997). Effective supply chain management requires the integration of the inter-firm processes of supply chain firms (Chen and Paulraj, 2004b). In this study we characterize the management of inter-firm processes as external process management (EPM). Combining effective EPM with effective internal process management (IPM) could result in a supply chain that is characterized by timely deliveries and increased flexibility in responding to changes in market demands, thus enhancing operational performance (Jayaram and Xu, 2013).

Achieving effective process management requires information management, which can be defined as the availability and management of timely and relevant information (Devaraj et al., 2007). Modern information technology (IT) allows firms to capture a large amount of internal and external information, which was previously not available, making internal information management (IIM) and external information management (EIM) more important than ever before. In addition, the use of business intelligence systems is increasingly important for firms to analyze internal and external processes. IIM, comprising the provision of real-time, accurate information within a firm, can aid the management of a firm's internal processes, including coordination among a firm's functional departments (Marchand et al., 2000). For example, the use of digital technologies such as computer-aided design, computer-aided manufacturing, 3D printing, and enterprise resource planning (ERP) can make the data flow from one department to another seamless to the extent that information can be quickly used within organizations to reduce production lead time and improve process efficiency. The interconnection of firms through their supply chains suggests that focusing on internal processes alone might not be sufficient to achieve overall process efficiency, especially because competition is no longer among firms but

* Corresponding author.
E-mail addresses: Daniel.Prajogo@monash.edu (D. Prajogo), ananya.bhattacharya@monash.edu (A. Bhattacharya), Adegoke.Oke@thunderbird.asu.edu (A. Oke), Edwin.Cheng@inet.polyu.edu.hk (T.C.E. Cheng).

https://doi.org/10.1016/j.ijpe.2018.02.019
Received 16 August 2017; Received in revised form 29 December 2017; Accepted 27 February 2018
Available online 1 March 2018
0925-5273/© 2018 Elsevier B.V. All rights reserved.

among firms' supply chains (Christopher, 1992). As firms continue to look beyond their own internal processes to improve performance, they need to establish strong communication channels with key supply chain partners through appropriate information technologies (Jitpaiboon et al., 2013; Kembro and Selviaridis, 2015). Managing external information has, therefore, become arguably as crucial to operational performance as IIM.

Despite the important performance implications of information and process management, the interplay between the internal and external aspects of process and information management, and performance has not been explored in the extant literature. In general, previous studies have explored the link between process management and firms' operational performance, as well as the link between information management and process management, while ignoring the different intra-firm and inter-firm contexts of the constructs and the related links. So far, only a few studies have specifically considered the contextual characteristics of information and process management (Barratt and Barratt, 2011; Jayaram and Xu, 2013; Maiga et al., 2015; Savitskie, 2007), none of which specifically or comprehensively covers and distinguishes the internal and external aspects of information and process management of firms' operations and supply chain activities. As such, our overall objective in this research is to investigate how a firm's IIM and EIM relate to its IPM and EPM, and internal operational performance (IOP) and external operational performance (EOP). We argue that how a firm shares information internally and how it manages information with external parties can affect the firm's internal and external processes and performance.

We contribute to the current knowledge base surrounding information management and process management in the field of supply chains in several ways. First, we integrate the intra-firm and inter-firm aspects of information and process management and performance into a single model, and test the relationships simultaneously. We extend the body of work focused on the relationship between information and process management (Kesner and Russell, 2009; Lutters et al., 2000; Seltsikas, 1999; Subramani, 2004; Yu et al., 2006), and the relationship between process management and operational performance (Kannan and Tan, 2005; Prajogo and Olhager, 2012) separately. Second, we examine the cross-effects of information and process management and performance at the intra-firm and inter-firm levels, further building on previous studies in this area. Finally, we identify the mechanisms through which information management relates to performance, thus building on previous studies that focus on the direct effect of information management on firm performance (Devaraj and Kohli, 2000; Honggeng et al., 2008; Maiga et al., 2015; Ravichandran and Lertwongsatien, 2005).

2. Key variables of interest

Process management is a strategic management approach that deals with the policies, methods, and management practices used to coordinate and govern firms' processes (Bruch and Bellgran, 2013). Because processes exist both within organizations and across organizational boundaries, management of such processes exists at the internal intra-firm level, i.e., IPM, and the external inter-firm level, i.e., EPM. In this study, we define IPM as the extent to which a firm possesses the following: standardized and clear process instructions for internal processes, processes under statistical quality control, low set-up times for equipment, and a shop floor layout that facilitates low inventories and fast throughput. IPM relates to a firm's ability to coordinate, streamline, and control its processes required for the delivery of products and services to improve its operational performance of flexibility, speed, and cost economy through the creation of efficient and effective organizational procedures (Miyake et al., 1995).

EPM, on the other hand, deals with the coordination and management of the processes that connect organizations or span inter-organizational boundaries to achieve flexibility, speed, and cost economy (Qi et al., 2017). External processes include the logistics activities involved in the sourcing, production, distribution, transportation, warehousing, and delivery of products. Specifically, we define EPM as the extent to which inter-organizational logistics activities, and inbound and outbound operations are seamless, integrated, and coordinated to ensure effective distribution and delivery of goods.

Information management largely comprises the management of IT and information systems. As such, information management is the prime factor that dictates decisions relating to IT and information systems. Similar to process management, information management has been viewed and studied in internal and external contexts. Several studies, particularly in the management of information systems literature, have focused on the management of IT systems within the context of firms (Hammer, 2001), which we refer to in this study as internal information management (IIM). IIM comprises the integration, distribution, and coordination of data and information within an organization through the use of appropriate IT (Wong et al., 2011). Central to IIM effectiveness is the integration of information infrastructure to facilitate the sharing of accurate and timely information in support of cross-functional processes within a firm (Hammer, 2001). As such, in this study, we define IIM as the extent to which relevant databases and IT systems are integrated and accessible across various operational activities and departments within a firm to provide real-time access to information, including inventory status and vendor information.

Though IIM is important, it is not sufficient for firms to ensure the flow and integration of information across functions within the confines of an organization. Due to the interconnected nature of firms in supply chains, ensuring that relevant information is shared and made available across supply chain partners is key to business success (Chengalur--Smith et al., 2012; Huo et al., 2014). As such, firms use EIM to facilitate logistics-related communication and information exchange between supply chain partners and customers through the use of appropriate IT, such as e-mail, electronic feedback forms, electronic data interchange (EDI), and enterprise resource planning (ERP) systems (Savitskie, 2007). In this study we define EIM as the extent to which relevant, timely, and sensitive information is shared and exchanged with supply chain partners through appropriate channels, including face-to-face communication.

We also consider the internal and external aspects of operational performance. The external aspects of operational performance, such as quality, delivery, flexibility, and price, have been well recognized in the literature as sources of competitive advantage in terms of sales, profit, and market share (Hayes and Wheelwright, 1984; Li et al., 2006). The internal aspects of operational performance also offer competitive value (Adisak and John, 2008). Maintaining operating efficiency and high productivity (asset utilization) is also important in producing healthy profit margins through competitive prices and low operating costs (Brigham and Gapenski, 1997).

3. Research model and hypothesis development

Based on the literature review, the importance of information management and process management to operational performance can be established, and previous studies have examined how these important firm practices are related to performance. However, we argue that both IIM and EIM, and IPM and EPM are interconnected practices in firms that can influence firms' operational performance within supply chains. In this regard, previous studies have not examined the interconnected nature of these practices, particularly in terms of how they relate to one another and firm performance. In the sections that follow, we establish the relationships between IIM and EIM, IPM and EPM, and firms' IOP and EOP, as depicted in the research model in Fig. 1.

As mentioned earlier, our model integrates different streams of studies that capture certain parts of the model separately. For example, several studies (Baihaqi and Sohal, 2013; Huo et al., 2016; Liu et al.,

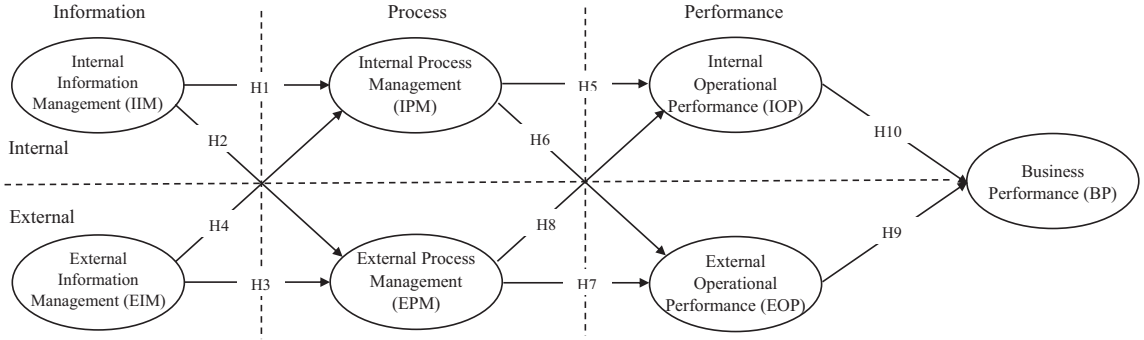

Fig. 1. Research model and hypotheses.

2016; Soo Wook and Narasimhan, 2002) suggest the direct effect of information management (including IT and IS) on firms' performance, while our study considers process management as an explanatory variable through which information management affects performance. Similarly, several studies focus on the effects of process management on firm performance (Kannan and Tan, 2005; Li et al., 2006; Paulraj et al., 2008), while our study considers information management as the driver and enabler of process management in enhancing firms' performance.

3.1. Information management and process management

Effective information management is the main antecedent to process management improvement (Davenport and Beers, 1995). IIM enables employees to visualize and identify opportunities for reductions in process variation and production time, which leads to improvement in organizational performance (Mithas et al., 2011). IIM enables access to integrated database systems for several internal process-related activities, such as logistics, production, distribution, and vendor management, thus enabling improvements in these processes. For example, advanced computerized ERP systems enable on-time and accurate information sharing within a firm, which enhances the management of the processes required to deliver lean production capabilities (Ward and Honggeng, 2006). Similarly, access to detailed, real-time information enables cross-functional communication within firms, thus allowing for effective implementation, monitoring, and control of the processes required to deliver goods and services within firms (Iden and Eikebrokk, 2014). As such, we argue that IPM depends on firms' ability to provide and share real-time and reliable data and information, i.e., IIM, leading to the following hypothesis:

Hypothesis 1. *Internal information management (IIM) is positively related to internal process management (IPM).*

Having information systems in place within a firm also has implications for how processes between firms are managed, i.e., EPM. EPM involves close collaboration and integration of processes between firms and their supply chain partners. Information systems within a firm give the firm the capability to provide and make available reliable information about its inventory levels and inventory status in real time. Having such a capability and information enables the firm to better coordinate with its supply chain partners, thus facilitating integration and management of processes between firms (Martin and Patterson, 2009). IIM provides the springboard for firms to retrieve real-time data quickly within their operations and channel the information to relevant supply chain partners, thus facilitating the integration and management of external processes that may be necessary for effective distribution, transport, and warehousing (Chu and Lee, 2006). In sum, internal information systems enable the constant flow of real-time information from within the firm to supply chain partners, which can make the management and integration of external processes smooth and timely (Wong et al., 2011). Therefore, we hypothesize as follows:

Hypothesis 2. *Internal information management (IIM) is positively related to external process management (EPM).*

EIM involves sharing sensitive but useful information with supply chain partners. Sharing of timely and reliable information frequently and informally builds trust between supply chain partners, which helps facilitate the integration of processes among supply chain partners (Chen and Paulraj, 2004b). In addition, the trust that is built through external information sharing motivates firms to collaborate to streamline and manage the inter-firm processes involved in inbound and outbound logistics, warehousing, and distribution activities (Chen and Paulraj, 2004b). Thus, we offer the following hypothesis:

Hypothesis 3. *External information management (EIM) is positively related to external process management (EPM).*

Using these hypotheses, we argue that sharing information among supply chain partners relates to the management of supply chain processes between such firms. When partners share reliable information, this choice also positively affects process integration within a firm. For example, Toyota's internal processes, upon which practices such as Kanban, inventory reduction, and lean management are based, are improved due to the close collaboration enabled by information sharing among Toyota's supply chain partners and suppliers' networks (Cai et al., 2016). The sharing of information among supply chain partners supports several of firms' internal processes, such as lean management and statistical quality control of the production, and maintenance of low inventory of final products and raw materials.

External information sharing among firms enables a buyer-firm to be aware of the issues and risks of supplies such that the firm is better able to manage its internal processes to cushion operations against such risks. Similarly, information sharing by a buyer-firm with a supplier enables the supplier to be quickly aware of changing market situations or erroneous demand, thus allowing the supplier to better manage its internal processes accordingly for supply deliveries and pickups (Wong et al., 2011). Also, by increasing supply chain visibility, firms can identify weak or slow points in the internal supply chain and locate areas or processes that can be improved to maximize process performance (Brusset, 2016). As suggested by Rahimi et al. (2016), in order to align strategic and operational decisions between information and internal processes, a high level of external communication are necessary. Sahin and Robinson (2005) demonstrated that Dell's supplier-oriented extranet, which facilitates suppliers' involvement early in the product development process, helped Dell improve its internal assemble-to-order process. In sum, we posit that sharing information between supply chain partners facilitates integration and management of internal processes within those firms. Thus, we offer the following hypothesis:

Hypothesis 4. *External information management (EIM) is positively related to internal process management (IPM).*

3.2. Process management and operational performance

The extant literature contends that efficient IPM can impact several factors relating to operational performance (Blome et al., 2013). Process management tools such as statistical quality control systems enable error-free production and better asset utilization. Similarly, preventative maintenance processes minimize manufacturing downtimes (Leyer et al., 2016). Thus, process management could improve internal performance indicators, including lowering inventory carrying costs, increasing inventory turnover, improving overall production costs, and increasing production effectiveness and efficiency (Sahin and Robinson, 2005). Managing internal processes within a firm facilitates cross-functional integration and streamlining of the internal operational activities of a firm. For example, integration between the marketing and production functions enables quick decision-making about production schedules, order sizes, and adherence to customer specifications, which may positively influence production efficiency (Wong et al., 2013). Accordingly, we hypothesize the following:

Hypothesis 5. *Internal Process Management (IPM) is positively related to internal operational performance (IOP).*

In addition, management of internal production procedures and processes has been identified in the literature as one of the strongest predictors of external operational performance, such as the delivery, flexibility, and financial performance of a final product (Blome et al., 2013). As argued above, the integration and management of processes within a firm ensure that information about orders and schedules are quickly transmitted, allowing the firm to meet delivery due dates (an external performance measure). Similarly, quality management systems within a firm ensure that defects and errors in the production processes are minimized such that high-quality and competitively priced final products are delivered to the customer (Yu et al., 2013). The other major impact of IPM on external performance identified in the literature is increased flexibility in both production volume and range of products. A firm's manufacturing setup dictates how much flexibility it has regarding production range and volume. For example, good schedule management ensures that a firm has sufficient capacity to provide volume flexibility if required. Similarly, the shop layout and time required for a firm to set up equipment determine how well it can respond to increases or decreases in market demands and changes in production mix without the need for long periods of downtime in production (Leyer and Moormann, 2015). We offer the following hypothesis:

Hypothesis 6. *Internal Process Management (IPM) is positively related to external operational performance (IOP).*

The literature suggests that integrating and managing inter-firm processes positively influences firms' performance indicators, such as flexibility and delivery performance (Xu, 2011). Integration of processes among supply chain partners helps ensure that market information and changes are quickly noted and identified by relevant partners, thus enabling firms to react accordingly (Sambamurthy et al., 2003). Similarly, such integration and management of inter-firm processes among supply chain partners helps ensure that outbound deliveries are made quickly, cheaply, and accurately (Flynn et al., 2010; Wong et al., 2013). Integration and management of processes among firms ensures that raw materials are received as needed, finished goods are delivered on time, and firms attain the required flexibility to respond to volume and mix changes (Yi-Hui, 2015). For example, the integration of its design and marketing capabilities with suppliers' manufacturing capabilities provides Nike with the design and volume flexibility required to cope with customer requirements (Jayaram and Xu, 2013). In sum, we argue that management of processes among firms in the supply chain positively affects operational performance outcomes, including flexibility, delivery reliability, and product price. Hence, we offer the following hypothesis:

Hypothesis 7. *External Process Management (EPM) is positively related to external operational performance (EOP).*

Integration of processes among supply chain partner firms can also have an impact on the performance indicators within a firm that customers do not necessarily see or directly experience, such as facilitating low inventory levels (Titah et al., 2016). Specifically, external process integration enables timely supply deliveries and pickups, as well as quick deliveries of final products, resulting in high inventory turnover, and consequently low inventory levels and a decrease in production cost. Process integration and management between buyer-firms and their suppliers enables the implementation of lean production, which also leads to low inventory levels and increased efficiency within a firm's operations. In general, external process integration enables smooth flow of materials and information across supply chain firms, resulting in the efficient use of firm resources, which positively impacts production lead time and reduces operational costs (Du et al., 2012). Accordingly, we offer the following hypothesis:

Hypothesis 8. *External Process Management (EPM) is positively related to internal operational performance (IOP).*

3.3. Operational performance and business performance

As we have noted, external operational performance (EOP) relates to the performance indicators that are within the purview of the customer, such as delivery performance, flexibility performance, and price competitiveness. Hayes and Wheelwright (1984) argued that four dimensions of manufacturing performance, namely quality, delivery, flexibility, and cost, positively influence firms' competitive advantage, which is reflected in firms' market and economic performance, such as sales and profit. Several studies in the extant literature have shown the positive impact of operational performance on business performance (BP) (Li et al., 2006; Liu et al., 2012; Maiga et al., 2015). If the price of a product is very competitive, the demand for the product is likely to increase, thus increasing the likelihood of an increase in sales or revenue for the firm (Brigham and Gapenski, 1997). Similarly, a firm that is seen to be highly flexible in terms of coping with sudden changes in demand or changes in product mix requirement is likely to attract more customers, thus increasing its BP (Swink et al., 2005). In addition, a firm that is deemed to be highly reliable in terms of meeting its delivery date promises is likely to attract more patronage, thus improving its BP. As such, we hypothesize as follows:

Hypothesis 9. *External operational performance (EOP) is positively related to business performance (BP).*

The link between internal operational performance (IOP) and business performance (BP) is, however, not as clear-cut because internal performance measures such as production cost and production efficiency are somewhat hidden or removed from the purview of the customer or market. Nevertheless, we posit that to some extent, IOP is directly linked to BP. For example, production efficiency directly translates into cost savings for a firm, which positively affects its bottom line. The gains from high inventory turnover and high asset utilization are directly reflected in a firm's balance sheet in terms of profitability.

Accordingly, we offer the following hypothesis:

Hypothesis 10. *Internal operational performance (IOP) is positively related to business performance (BP).*

4. Method

4.1. Sample and procedures

The unit of analysis of this study is a firm. We sourced the data from 1500 Australian manufacturing firms. We drew a random sample from a

mailing list company in Australia, which provides the complete name and address of each company, as well as the contact person in a position related to, and thus knowledgeable of, the company's operations or supply chain. We received 202 usable responses, yielding a 13.5% response rate. Tables 1 and 2 report the industry sectors and organizational sizes of the firms captured in our sample, respectively.

To test the nonresponse bias, we follow the method suggested by Armstrong and Overton (1977) by conducting a *t*-test to test the differences between the early and late respondents with regard to the key variables used in this study. Because the results show no statistically significant differences between the two groups of respondents, we have no substantive concern for nonresponse bias in this study.

4.2. Measures

We adapt the scale for internal information management (IIM) from Chang Won et al. (2007) and Savitskie (2007), the scales for external information management (EIM) and external process management (EPM) from Chen and Paulraj (2004a), and the scale for internal process management (IPM) from Cua et al. (2001), and Kannan and Tan (2005). We measure internal operational performance (IOP) using three items, namely production efficiency, inventory turnover, and asset utilization and productivity (Danese and Bortolotti, 2014). The measure for external operational performance (EOP) comprises four key competitive dimensions, namely quality, speed of delivery, flexibility, and price, derived from previous studies on operations and supply chain management topics (Li et al., 2006; Paulraj et al., 2008). Finally, we measure business performance (BP) using three items, namely sales, profit, and market share, based on previous studies on operations strategies and performance (da Silveira, 2005; Li et al., 2006; Ward and Duray, 2000).

5. Results

5.1. Scale validation

We perform a confirmatory factor analysis (CFA) to simultaneously validate the measures for all the variables, i.e., constructs, considered in this study. Table 3 presents the results of the CFA and the Cronbach's alphas as the measure for the reliability of the scales. All the items load strongly on their corresponding latent constructs. The overall indices suggest acceptable fit as the normed chi-square (χ^2/df) = (749.18/384) = 1.95 (<3.00), RMSEA = 0.069 (with a 90% confidence interval between 0.062 and 0.077), NFI = 0.920, NNFI = 0.953, and CFI = 0.959, suggesting acceptable unidimensionality of the constructs (Bollen, 1989). In addition, most of the items are loaded strongly on their respective constructs as all path coefficients exceed 0.5 at $p < 0.01$, supporting convergent validity of the measures (Fornell and Larcker, 1981). We test discriminant validity using the Average Variance Extracted (AVE) as suggested by Fornell and Larcker (1981). All the constructs have AVE values close to 0.5 or above, except for EOP, supporting their discriminant validity. The relatively low AVE value for EOP could be due to the multidimensionality of the operational performance measure, which has also been noted in the study by Samson and Terziovski (1999).

Table 1
Industry sectors.

Industry sector	%
Food, beverage, tobacco	14.5%
Chemical	14.0%
Machinery	19.0%
Paper and printing	7.0%
Textile and apparel	4.5%
Petroleum, mineral, metal, wood	10.5%
Other manufacturing sectors	30.5%

Table 2
Organizational sizes.

Number of employees	%
<49	22.3%
50–99	21.3%
100–499	36.1%
500–999	7.9%
1000 or more	9.9%

5.2. Common method variance

We perform a common method variance test using Harman's single-factor test (Podsakoff et al., 2003), for which we load all the 30 items of the seven constructs into one common factor. The common factor model produces a poor fit ($\chi^2 = 2554$; df = 405; RMSEA = 0.163), and 50% of the items show poor loading paths below 0.5, suggesting that a single-factor model is not acceptable. Therefore, common method bias is not a major concern in our data set.

5.3. MANOVA test

Since the data comprise various manufacturing sectors (see Table 1), we perform a preliminary test using Multivariate Analysis of Variance (MANOVA) to check if there are any differences between the seven key variables (see Table 3) used in this study across the manufacturing sectors. In performing the test, we create composite scores (using the mean scores) of the seven variables that are subjected to MANOVA test. The result shows that there are no significant differences among the variables considered across the sectors (*Pillai's Trace* $F = 0.30$ at $p > 0.05$; *Wilks' Lambda* $F = 0.73$; $p > 0.05$; *Hotelling's Trace* $F = 0.33$ at $p > 0.05$). Since there are no significant mean differences among the key variables across the manufacturing sectors covered, we pool the data in the next stage of the analysis.

5.4. Structural relationships

We test the hypotheses in the research model using structural equation modelling. We include organizational size (based on number of employees) as a control variable for all the performance variables. Overall the model shows a good fit, as indicated by the normed chi-square (χ^2/df) = (806.90/419) = 1.89 (<3.00), RMSEA = 0.068 (with a 90% confidence interval between 0.061 and 0.075), NFI = 0.914, NNFI = 0.950, and CFI = 0.955. In this model, we have two endogenous (dependent) variables, which have common exogenous variables (independent variables), namely IPM and EPM, which are predicted by IIM and EIM, as well as IOP and EOP, which are predicted by IPM and EPM. Therefore, it is necessary to check if there are relationships among those dependent variables beyond the variance explained by their common antecedents (Bagozzi, 1980). We conduct this test by checking the error correlations between IPM and EPM, as well as those between IOP and EOP. The results show that both error correlations are statistically significant ($\psi = 0.17$ at $p < 0.01$ for IPM and EPM, and $\psi = 0.19$ at $p < 0.01$ for IOP and EOP), and the revised model shows a fit improvement with the new chi square at 787.72 (df = 417); therefore, we establish the relationships between the two pairs of dependent variables. The discrepancy between the original and the revised model is 19.18 (with df = 2), suggesting that the revised model is significantly better than the original model at $p < 0.01$.

The next step of analysis is to determine the direction of the relationship between these dependent variables. In doing so, we set up two dummy testing models in Fig. 2 and 3. In Fig. 2, we use IIM and EIM as the dummy instrumental variables for IPM and EPM, respectively, and we allow bidirectional paths between IPM and EPM. The result shows that only one path is significant, i.e., from IPM to EPM

Table 3
Scale validity and reliability.

Scales	Items	Loading Paths	Cronbach's Alpha
Internal Information Management	Our company has an integrated database for production, logistics, distribution, and vendor information	0.85	0.91 (0.67)
	Our company has easy access to key operational data in this integrated database	0.94	
	Our company has a highly integrated information system to link our internal departments	0.89	
	Our company can retrieve inventory status in real time	0.65	
	Our company has a high degree of information system integration for production processes	0.72	
External Information Management	We share sensitive information (financial, production, design, research, and/or competition) with our supply chain partners	0.64	0.89 (0.64)
	We provide our supply chain partners key information that might help them	0.84	
	Exchange of information takes place frequently, informally, and/or timely	0.93	
	We keep each other informed about events or changes that may affect the other party	0.83	
	We have frequent face-to-face communication with our supply chain partners	0.73	
Internal Process Management	We have standardized and clear process instructions for our processes	0.71	0.78 (0.47)
	Most processes in our plants are currently under statistical quality control	0.66	
	The layout of the shop floor facilitates low inventories and fast throughput	0.74	
	We have low set-up times of equipment in out plant	0.64	
External Process Management	Inter-organization logistic activities are closely coordinated	0.84	0.93
	Our logistics activities are well integrated with supply chain partners' logistic activities	0.90	(0.74)
	We have a seamless integration of logistic activities with our key supply chain partners	0.83	
	Our logistic integration is characterized by excellent distribution, transportation and/or warehousing facilities	0.85	
	The inbound and outbound distribution of goods with our supply chain partners is well integrated	0.87	
Internal Operational Performance	Production efficiency	0.70	0.71
	Inventory turnover	0.57	(0.46)
	Productivity/asset utilization	0.76	
External Operational Performance	Performance of our final products	0.56	0.74
	Accuracy of deliveries	0.66	(0.36)
	Flexibility in delivery time	0.74	
	Flexibility to change production volume	0.58	
	Competitiveness of our products price	0.41	
Business Performance	Sales volume	0.76	0.77
	Profitability	0.70	(0.52)
	Market share	0.71	
$\chi^2 = 749.18$	df = 384 RMSEA = 0.069	NFI = 0.920 NNFI = 0.953	CFI = 0.959

Average Variance Extracted (AVE) is in brackets.

(0.44 at $p < 0.01$), while the opposite path from EPM to IPM is not significant (0.01 at $p > 0.05$). Therefore, the relationship between IPM and EPM is unidirectional. Similarly, in Fig. 3, we use IIM and EIM as the dummy instrumental variables for IOP and EOP, respectively, and we allow bidirectional paths between IOP and EOP. The result shows that only one path is significant, i.e., from IOP to EOP (0.64 at $p < 0.01$), while the opposite path from EOP to IOP is not significant (−0.05 at $p > 0.05$). Therefore, the relationship between IOP and EOP is unidirectional.

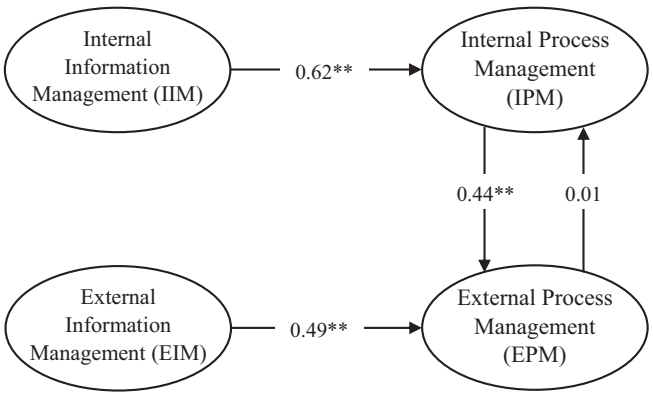

Fig. 2. Testing the direction of the relationship between Internal Process Management and External Process Management.

Having established the relationships between the two pairs of dependent variables, we modify the original research model by adding two paths, i.e., IPM to EPM and IOP to EOP. Fig. 4 shows the final research model, which shows a good fit. The normed χ^2 is 1.89 (787.72/417), which is less than 2, RMSEA is 0.067 (below 0.08), and the fit indices are above 0.9 (NFI = 0.915, NNFI = 0.952, CFI = 0.957), supporting acceptable fit of the model. The additional two paths, i.e., IPM to EPM and IOP to EOP, are also positive and significant (0.28 at $p < 0.01$ and 0.22 at $p < 0.01$, respectively), confirming the results of the two dummy tests performed above.

IIM has positive effects on both IPM (0.48 at $p < 0.01$) and EPM (0.38 at $p < 0.01$), supporting H1 and H2. EIM also shows positive effects on both EPM (0.49 at $p < 0.01$) and IPM (0.24 at $p < 0.01$), supporting H3 and H4. IPM shows positive effects on both IPP (0.26 at $p < 0.05$) and EOP (0.37 at $p < 0.01$), supporting H5 and H6. IPM also shows a positive

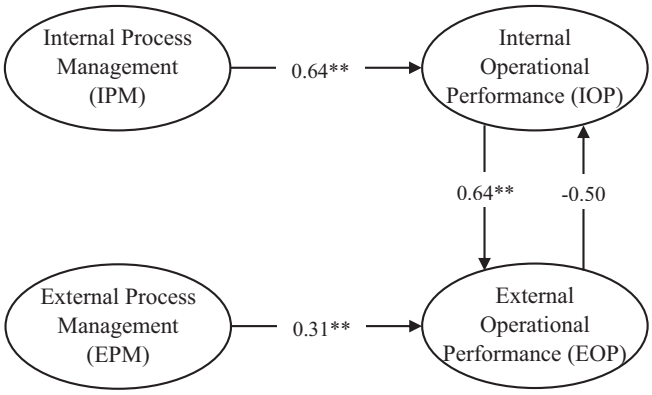

Fig. 3. Testing the direction of the relationship between Internal Operational Performance and External Operational Performance.

effect on EPM (0.28 at $p < 0.01$). EPM shows a positive effect on EOP (0.28 at $p < 0.01$), but not on IOP (0.15 at $p > 0.05$). Therefore, H7 is supported, but H8 is not supported. Finally, both IOP and EOP show positive effects on BP (0.43 at $p < 0.05$ and 0.38 at $p < 0.01$ respectively), supporting H9 and H10.

As a *post hoc* analysis, we test the robustness of our model by adding eight direct paths that are not hypothesized in this study, namely the direct paths from IIM to IOP, EOP, and BP, the direct paths from EIM to IOP, EOP, and BP, as well as the direct path from IPM to BP and the direct path from EPM to BP. This competing model produces a χ^2 value of 787.50, which is hardly different from the χ^2 value of the final model (787.72), with the degree of freedom of 409. This result demonstrates that the additional paths do not bring any improvement to the model's fit, as well as supporting the robustness of our final model. Therefore, we can conclude that process management (IPM and EPM) mediates the relationships between information management (IIM and EIM) and both operational (IOP and EOP) and business performance (BP). Furthermore, operational performance (IOP and EOP) mediates the relationships between process management (IPM and EPM) and business performance (BP).

Having established the mediating effects in the research model, we check the indirect effects of the above variables. The results show that IIM has indirect effects on IOP (0.18 at $p < 0.01$), EOP (0.28 at $p < 0.01$), and BP (0.18 at $p < 0.01$), while EIM has indirect positive effects on IOP (0.13 at $p < 0.01$), EOP (0.23 at $p < 0.01$), and BP (0.14 at $p < 0.01$). These results confirm the mediating effects of IPM and EPM shown in the competing model above. Furthermore, both IPM and EPM have indirect effects on BP (0.29 at $p < 0.01$ and 0.17 at $p < 0.05$, respectively). These results also confirm the mediating effects of IOP and EOP shown in the competing model above. Finally, IPM has an indirect effect on EOP (0.14 at $p < 0.01$), apart from the direct effect shown in the earlier result (H6).

6. Discussion of the findings

Overall, the research model confirms and extends previous studies that link information, process, and performance (e.g., Devaraj et al. (2007), Ghobakhloo et al. (2014), Prajogo and Olhager (2012), Ward and Honggeng (2006)). The results of H1 through H4 show the importance of information management as an enabler of process management. As suggested by Mithas et al. (2011), information management is a significant enabler of process management in a number of ways. For example, it helps firms build portfolios of their processes, including defining the configurations of the processes, designing the process flow, and setting the appropriate metrics and control mechanisms to measure process performance. In addition, having the right information tools and managing them effectively enable firms to reach and connect with other parties, especially those in the supply chain network, thus facilitating inter-firm process integration and management. Such connections through appropriate information systems allow firms to be more responsive in adjusting their processes to changes in the business environment. The findings also show that information management only delivers value, i.e., performance, if it is implemented in the appropriate processes (Peng et al., 2016). At the same time, these findings also show the indirect effect of information management on performance mediated by process management. This result is instructive given the rise of the importance of information for business purposes. While managing information is critical to building competitiveness of firms, it is the process that ultimately delivers values to customers and generates revenues to firms.

Our results show the cross-boundary effects of information management on process management. Specifically, we find that not only does IIM affect IPM, it also influences EPM. Similarly, EIM has an impact on both IPM and EPM. This is partly in line with Ding et al. (2014) in the beef industry, which showed that information sharing with supply chain partners, i.e., EIM, not only enhances material flows between firms, i.e., EPM, but also supports lean processes within firms, i.e., IPM, resulting in higher quality, and lower costs and waste. Similarly, Jayaram and Xu (2013) showed that IIM (e.g., chart plotting for defect rates, scheduling, and machine breakdowns) has a positive effect not only on IPM (e.g., "fool-proof" and statistically controlled processes), but also on EPM (e.g., customer and supplier relationships). As an addition to the above studies, we show that the cross-boundary effects between IIM and EPM are strengthened by the significant path from IPM to EPM.

H5 and H6 show that IPM has direct effects on both IOP and EOP. While these findings are expected, they highlight the importance of IPM to operational performance measures within a firm and the measures that

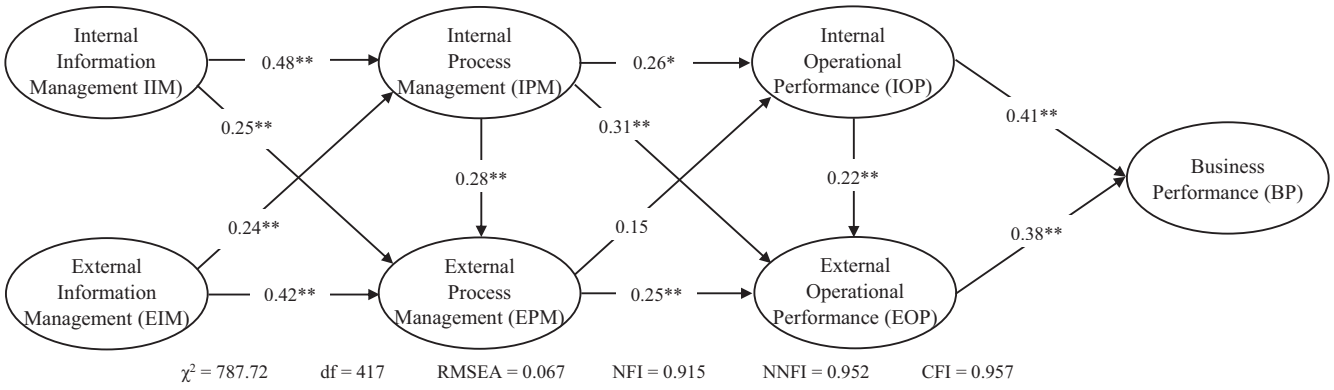

Fig. 4. Results of structural equation modelling.

customers directly experience. Actions within the confines of a firm such as process integration and management could have direct implications for market development and customer retention. This notion is further confirmed by the positive effect of IOP on EOP, suggesting that IPM also has an indirect effect on EOP through IOP. Our results show that the effect of EPM on operational performance is not cross boundary as it has a positive effect on EOP, i.e., H7, but not on IOP, i.e., H8. The lack of support for H8 is rather surprising given the increasing importance of supply chain integration in determining firm performance. Our findings suggest that although EPM may lead to improved volume flexibility and price competitiveness, it may not have similar effects on production efficiency (e.g., lead time) or asset utilization, which is fully under firms' internal control.

Our results support both H9 and H10, which show that both EOP and IOP contribute to BP. These findings are particularly important considering that the focus of many studies in the supply chain literature is on external performance. Although performance measures that are within the purview of the market and customers are very important contributors to a firm's bottom line, we show that achieving production efficiency and high asset utilization could also have a direct impact on a firm's bottom line. The importance of IOP is further confirmed by its significant effect on EOP, which suggests that it has both a direct effect on BP and an indirect effect via EOP. Finally, combining the results of H5 to H10, our findings show that process management has a direct effect on operational performance and an indirect effect on business performance mediated by operational performance. This is also another contribution of our study, which demonstrates the scope of the power of process management as the source of firms' competitive advantage.

6.1. Literature contributions

Our study contributes to the literature by considering the links among practices that have hitherto been looked at separately. We investigate these links and, more importantly, the cross-boundary effects of information management, process management, IOP, EOP, and BP in a single, holistic model. This study also addresses the link between information management and performance management; specifically, it identifies and establishes process management as the missing link in the studies that consider the direct effect of information management on firms' performance. It shows that although process management has been considered an enabler of firm performance in previous studies, process management itself has antecedents, which is information management in this study. The links we find among information management, process management, and performance contribute to the literature by showing that information management is required for building process management capabilities in order to produce high operational performance (Mithas et al., 2011). As an enabler of process management, information management provides horizontal and vertical communication channels of information, which are required for decision-making and management of both internal and external processes (Ward and Honggeng, 2006).

The separation of information management, process management, and supply chain performance into internal and external contexts represents a contribution to the literature. Contextualizing these management capabilities and performance measures is important because their effects may be different; internal capabilities and measures are within the purview and control of individual firms, while external capabilities and measures are not directly within individual firms' control (Carter et al., 2017). As such, it is important to investigate these capabilities as separate constructs; in so doing, our findings of cross-boundary and cross-context effects between internal capabilities, external capabilities, internal performance measures, external performance measures, and BP represent a contribution to the literature. We are not aware of any study that has incorporated all the variables into a single model or tested for all the possible relationships between internal and external components of information, processes, and performance.

6.2. Practical implications

From a practical point of view, we show that good information management practices, including sharing information, using IT tools within a firm, and sharing information with supply chain partners, have positive implications for process management and integration. Such process integration within a firm and across firm boundaries has enormous potential in terms of affecting not only production efficiency and other internal performance measures but also performance outcomes that touch customers directly. This implies that managers must look for ways to facilitate the sharing and management of information across internal functions, as well as across firm boundaries. Similarly, the importance of managing operational processes within a firm cannot be overstated because such management not only affects internal performance outcomes but also key performance outcomes of the firm that directly affect customers. As such, appropriate training in process management and investment in resources to facilitate the integration of processes between supply chain firms should be encouraged.

Through emphasizing the importance of both internal and external aspects of information, process, and performance, we also show that internal components generally perform better than their external counterparts, especially with regard to process management, which suggests that internal capabilities are more impactful of a firm. As the results show, IPM plays a central role in the overall operations described in our research model and has a more significant effect than EPM. Not only does IPM have positive effects on both IOP and EOP, but it also enhances EPM. More specifically, it has both direct and indirect effects on EOP via IOP.

7. Limitations

This study has a number of limitations. First, we acknowledge the limitations of our constructs in measuring information management and process management. We recommend that future research expand on this study by considering the technological side of both information and process management. Second, as suggested earlier, it is important for firms to examine more deeply how integration can be built into the intra-organizational inter-organizational levels, which may involve social aspects such as communication and collaboration (Shi and Liao, 2015). Such studies would complement our study by considering both the hard and soft aspects of management. Finally, our sample is restricted to Australian firms; therefore, although our research model is built on generic concepts, the results could be affected by Australian contextual factors (e.g., culture and geographical distance), which may not be applicable to other contexts.

References

Adisak, T., John, C.S.T., 2008. A conceptual model of performance measurement for supply chains: alternate considerations. J. Manuf. Technol. Manag. 19, 125–148.
Armstrong, J.S., Overton, T.S., 1977. Estimating nonresponse bias in mail surveys. J. Mark. Res. 14, 396–402.
Bagozzi, R.P., 1980. Performance and satisfaction in an industrial sales force: an examination of their antecedents and simultaneity. J. Mark. 44, 65–77.
Baihaqi, I., Sohal, A.S., 2013. The impact of information sharing in supply chains on organisational performance: an empirical study. Prod. Plan. Control 24, 743–758.
Barratt, M., Barratt, R., 2011. Exploring internal and external supply chain linkages: evidence from the field. J. Oper. Manag. 29, 514–528.
Blome, C., Schoenherr, T., Rexhausen, D., 2013. Antecedents and enablers of supply chain agility and its effect on performance: a dynamic capabilities perspective. Int. J. Prod. Res. 51, 1295–1318.
Bollen, K., 1989. Structural Equations with Latent Variables. Wiley, New York.
Brigham, E.F., Gapenski, L.C., 1997. Financial Management: Theory and Practice. Dryden Press, Fort Worth, TX.
Bruch, J., Bellgran, M., 2013. Characteristics affecting management of design information in the production system design process. Int. J. Prod. Res. 51, 3241–3251.
Brusset, X., 2016. Does supply chain visibility enhance agility? Int. J. Prod. Econ. 171, 46–59.
Cai, Z., Huang, Q., Liu, H., Liang, L., 2016. The moderating role of information technology capability in the relationship between supply chain collaboration and organizational responsiveness. Int. J. Oper. Prod. Manag. 36, 1247–1271.
Carter, C.R., Kosmol, T., Kaufmann, L., 2017. Toward a supply chain practice view. J. Supply Chain Manag. 53, 114–122.

Chang Won, L., Ik-Whan, G.K., Dennis, S., 2007. Relationship between supply chain performance and degree of linkage among supplier, internal integration, and customer. Supply Chain Manag. 12, 444–452.
Chen, I.J., Paulraj, A., 2004a. Towards a theory of supply chain management: the constructs and measurements. J. Oper. Manag. 22, 119–150.
Chen, I.J., Paulraj, A., 2004b. Understanding supply chain management: critical research and a theoretical framework. Int. J. Prod. Res. 42, 131–163.
Chengalur-Smith, I., Duchessi, P., Gil-Garcia, J.R., 2012. Information sharing and business systems leveraging in supply chains: an empirical investigation of one web-based application. Inf. Manag. 49, 58–67.
Chiarini, A., Vagnoni, E., 2015. World-class manufacturing by fiat. Comparison with Toyota production system from a strategic management, management accounting, operations management and performance measurement dimension. Int. J. Prod. Res. 53, 590–606.
Christopher, M.G., 1992. Logistics and Supply Chain Management. Pitman Publishing, London, UK.
Chu, W.H.J., Lee, C.C., 2006. Strategic information sharing in a supply chain. Eur. J. Oper. Res. 174, 1567–1579.
Cua, K.O., McKone, K.E., Schroeder, R.G., 2001. Relationships between implementation of TQM, JIT, and TPM and manufacturing performance. J. Oper. Manag. 16, 675–694.
da Silveira, G.J.C., 2005. Market priorities, manufacturing configuration, and business performance: an empirical analysis of the order-winners framework. J. Oper. Manag. 23, 662–675.
Danese, P., Bortolotti, T., 2014. Supply chain integration patterns and operational performance: a plant-level survey-based analysis. Int. J. Prod. Res. 52, 7062–7083.
Davenport, T.H., Beers, M.C., 1995. Managing information about processes. J. Manag. Inf. Syst. 12, 57–80.
Devaraj, S., Kohli, R., 2000. Information technology payoff in the health-care industry: a longitudinal study. J. Manag. Inf. Syst. 16, 41–67.
Devaraj, S., Krajewski, L., Wei, J.C., 2007. Impact of eBusiness technologies on operational performance: the role of production information integration in the supply chain. J. Oper. Manag. 25, 1199–1216.
Ding, M.J., Jie, F., Parton, K.A., Matanda, M.J., 2014. Relationships between quality of information sharing and supply chain food quality in the Australian beef processing industry. Int. J. Logist. Manag. 25, 85–108.
Du, T.C., Lai, V.S., Cheung, W., Cui, X., 2012. Willingness to share information in a supply chain: a partnership-data-process perspective. Inf. Manag. 49, 89–98.
Ebrahimi, M., Sadeghi, M., 2013. Quality management and performance: an annotated review. Int. J. Prod. Res. 51, 5625–5643.
Flynn, B.B., Huo, B., Zhao, X., 2010. The impact of supply chain integration on performance: a contingency and configuration approach. J. Oper. Manag. 28, 58–71.
Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. J. Mark. Res. (JMR) 18, 39–50.
Ghobakhloo, M., Tang, S.H., Sabouri, M.S., Zulkifli, N., 2014. The impact of information system-enabled supply chain process integration on business performance: a resource-based analysis. Int. J. Inf. Technol. Decis. Mak. 13, 1075–1113.
Goffin, K., Szwejczewski, M., New, C., 1997. Managing suppliers: when fewer can mean more. Int. J. Phys. Distrib. Logist. Manag. 27, 422.
Hammer, M., 2001. THE superefficient company. Harv. Bus. Rev. 79, 82–91.
Hayes, R.H., Wheelwright, S.C., 1984. Restoring Our Competitive Edge : Competing through Manufacturing. Wiley, New York.
Honggeng, Z., Collier, D.A., Wilson, D.D., 2008. The relationship of strategic business alignment and enterprise information management in achieving better business performance. Enterp. Inf. Syst. 2, 201–220.
Huo, B., Han, Z., Prajogo, D., 2016. Antecedents and consequences of supply chain information integration: a resource-based view. Supply Chain Manag. 21, 661–677.
Huo, B., Zhao, X., Zhou, H., 2014. The effects of competitive environment on supply chain information sharing and performance: an empirical study in China. Prod. Oper. Manag. 23, 552–569.
Iden, J., Eikebrokk, T.R., 2014. Exploring the relationship between information technology infrastructure library and process management: theory development and empirical testing. Knowl. Process Manag. 21, 292–306.
Jayaram, J., Xu, K., 2013. The relative influence of external versus internal integration on plant performance in China. Int. J. Prod. Econ. 146, 59–69.
Jitpaiboon, T., Dobrzykowski, D.D., Ragu-Nathan, T.S., Vonderembse, M.A., 2013. Unpacking IT use and integration for mass customisation: a service-dominant logic view. Int. J. Prod. Res. 51, 2527–2547.
Kannan, V.R., Tan, K.C., 2005. Just in time, total quality management, and supply chain management: understanding their linkages and impact on business performance. Omega 33, 153–162.
Kembro, J., Selviaridis, K., 2015. Exploring information sharing in the extended supply chain: an interdependence perspective. Supply Chain Manag. 20, 455–470.
Kesner, R.M., Russell, B., 2009. Enabling business processes through information management and IT systems: the FastFit and winter gear distributors case studies. J. Inf. Syst. Educ. 20, 401–405.
Leyer, M., Kronsbein, D., Willis, R., Chakraborty, A., Moormann, J., 2016. Implementation of service systems on the shop-floor level in financial service companies. empirical evidence from Australia and Germany. Int. J. Prod. Res. 54, 3229–3242.
Leyer, M., Moormann, J., 2015. Comparing concepts for shop floor control of information-processing services in a job shop setting: a case from the financial services sector. Int. J. Prod. Res. 53, 1168–1179.
Li, S., Ragu-Nathan, B., Ragu-Nathan, T.S., Subba Rao, S., 2006. The impact of supply chain management practices on competitive advantage and organizational performance. Omega 34, 107–124.
Liu, X., Yang, J., Qu, S., Wang, L., Shishime, T., Bao, C., 2012. Sustainable production: practices and determinant factors of Green supply chain management of Chinese companies. Bus. Strategy & Environ. 21, 1–16.
Liu, Z., Prajogo, D., Oke, A., 2016. Supply chain technologies: linking adoption, utilization, and performance. J. Supply Chain Manag. 52, 22–41.
Lutters, E., Brinke, E.T., Streppel, T., Kals, H., 2000. Information management and design & engineering processes. Int. J. Prod. Res. 38, 4429.
Maiga, A.S., Nilsson, A., Ax, C., 2015. Relationships between internal and external information systems integration, cost and quality performance, and firm profitability. Int. J. Prod. Econ. 169, 422–434.
Marchand, D.A., Kettinger, W.J., Rollins, J.D., 2000. Information orientation: people, technology and the bottom line. Sloan Manag. Rev. 41, 69–80.
Martin, P.R., Patterson, J.W., 2009. On measuring company performance within a supply chain. Int. J. Prod. Res. 47, 2449–2460.
Mithas, S., Ramasubbu, N., Sambamurthy, V., 2011. How information management capability influences firm performance. MIS Q. 35, 237–256.
Miyake, D.I., Enkawa, T., Fleury, A.C.C., 1995. Improving manufacturing systems performance by complementary application of just-in-time, total quality control and total productive maintenance paradigms. Total Qual. Manag. 6, 345–363.
Paulraj, A., Lado, A.A., Chen, I.J., 2008. Inter-organizational communication as a relational competency: antecedents and performance outcomes in collaborative buyer–supplier relationships. J. Oper. Manag. 26, 45–64.
Peng, J., Quan, J., Zhang, G., Dubinsky, A.J., 2016. Mediation effect of business process and supply chain management capabilities on the impact of IT on firm performance: evidence from Chinese firms. Int. J. Inf. Manag. 36, 89–96.
Podsakoff, P.M., MacKenzie, S.B., Jeong-Yeon, L., Podsakoff, N.P., 2003. Common method biases in behavioral research: a critical review of the literature and recommended remedies. J. Appl. Psychol. 88, 879–903.
Prajogo, D., Olhager, J., 2012. Supply chain integration and performance: the effects of long-term relationships, information technology and sharing, and logistics integration. Int. J. Prod. Econ. 135, 514–522.
Qi, Y., Huo, B., Wang, Z., Yeung, H.Y.J., 2017. The impact of operations and supply chain strategies on integration and performance. Int. J. Prod. Econ. 185, 162–174.
Rahimi, F., Møller, C., Hvam, L., 2016. Business process management and IT management: the missing integration. Int. J. Inf. Manag. 36, 142–154.
Ravichandran, T., Lertwongsatien, C., 2005. Effect of information systems resources and capabilities on firm performance: a resource-based perspective. J. Manag. Inf. Syst. 21, 237–276.
Sahin, F., Robinson, E.P., 2005. Information sharing and coordination in make-to-order supply chains. J. Oper. Manag. 23, 579–598.
Sambamurthy, V., Bharadwaj, A., Grover, V., 2003. Shaping agility through digital options: reconceptulaizing the role of information technology in contemporary firms. MIS Q. 27, 237–263.
Samson, D., Terziovski, M., 1999. The relationship between total quality management practices and operational performance. J. Oper. Manag. 17, 393–409.
Savitskie, K., 2007. Internal and external logistics information technologies: the performance impact in an international setting. Int. J. Phys. Distrib. Logist. Manag. 37, 454–468.
Seltsikas, P., 1999. Information management in process-based organizations: a case study at Xerox Ltd. Inf. Syst. J. 9, 181–195.
Shi, X., Liao, Z., 2015. Inter-firm dependence, inter-firm trust, and operational performance: the mediating effect of e-business integration. Inf. Manag. 52, 943–950.
Soo Wook, K., Narasimhan, R., 2002. Information system utilization in supply chain integration efforts. Int. J. Prod. Res. 40, 4585.
Subramani, M., 2004. How do suppliers benefit from information tecnology use in supply chain relationships? MIS Q. 28, 45–73.
Swink, M., Narasimhan, R., Kim, S.W., 2005. Manufacturing practices and strategy integration: effects on cost efficiency, flexibility, and market-based performance. Decis. Sci. 36, 427–457.
Titah, R., Shuraida, S., Rekik, Y., 2016. Integration breach: investigating the effect of internal and external information sharing and coordination on firm profit. Int. J. Prod. Econ. 181, 34–47.
Ward, P., Honggeng, Z., 2006. Impact of information technology integration and lean/just-in-time practices on lead-time performance. Decis. Sci. 37, 177–203.
Ward, P.T., Duray, R., 2000. Manufacturing strategy in context: environment, competitive strategy and manufacturing strategy. J. Oper. Manag. 18, 123–138.
Wong, C.W.Y., Lai, K.-h., Cheng, T.C.E., 2011. Value of information integration to supply chain management: roles of internal and external contingencies. J. Manag. Inf. Syst. 28, 161–200.
Wong, C.W.Y., Wong, C.Y., Boon-itt, S., 2013. The combined effects of internal and external supply chain integration on product innovation. Int. J. Prod. Econ. 146, 566–574.
Xu, L.D., 2011. Information architecture for supply chain quality management. Int. J. Prod. Res. 49, 183–198.
Yi-Hui, L., 2015. Performance measurement of interorganizational information systems in the supply chain. Int. J. Prod. Res. 53, 5485–5499.
Yu, J.-H., Lee, H.-S., Kim, W., 2006. Evaluation model for information systems benefits in construction management processes. J. Constr. Eng. Manag. 132, 1114–1121.
Yu, W., Jacobs, M.A., Salisbury, W.D., Enns, H., 2013. The effects of supply chain integration on customer satisfaction and financial performance: an organizational learning perspective. Int. J. Prod. Econ. 146, 346–358.