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Abstract

Purpose – The purpose of this paper is to study how knowledge management strategy (KMS), technology management strategy (TMS), and information management strategy (IMS) influence an organization's performance.

Design/methodology/approach – The authors use manufacturing data and employ causal modeling, with structural equation modeling, which will enable managers to understand the interrelationships among the use of information, knowledge management, and technology strategy in manufacturing enterprises.

Findings – There are two major findings of the research: first, an organization's financial performance (FINP) is directly dependent on its information management and TMSs, and second, KMSs indirectly influence FINP via mediation.

Practical implications – Managers should be aware of various roles that TMS, IMS, and KMS play on an organization's performance. The model analysis provides a direction to decision makers in understanding various intricate relationships through which information, technology, and KMSs could impact corporate sustainability.

Originality/value – First, the authors present a specific approach to capture and model information-related strategies in a powerful decisions support system framework. Second, the modeling environment provides examination of non-linear relationships among latent variables, as well as examining additive, moderating, and mediating relations so that other modelers could replicate the experiment in other sectors or enterprises. Last, this work addresses one of the major problems in manufacturing research: the lack of empirical research in sustainability development. The paper shows empirically that both TMS and IMS impact organization's performance directly and KMS does so indirectly.

Keywords Organizational performance, Mediating effect, Information management strategy, Knowledge management strategy, PLS analysis, Technology management strategy

Paper type Research paper

1. Introduction

The pace of development in information technology (IT) and its diffusion in the twenty-first century businesses is likely to accelerate. Organizations with ability to capture intelligence, transform it into usable knowledge, and diffuse it rapidly will be positioned well competitively in this changing environment (Zhou and Li, 2012; Hitt *et al.*, 2015). For strategic competitive positioning, it is imperative that managers develop IT-based capabilities in organizations: capturing and use of information, managing knowledge, and building IT infrastructure.

Another critical consideration for managers is that they actively get involved and align IT capabilities with corporate profitability. There is no doubt that information

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and associated technologies are exerting ever increasing influences on corporate growth and profitability (Pearlson and Saunders, 2010; Hao and Song, 2016). Pearlson and Saunders (2010) observe "shouldn't managers rely on experts to analyze all the aspects of IS and to make the best decisions for the organization? The answer to that question is no." Thus managers will have to get involved and participate in the design of IT strategies. Hao and Song (2016) observed that technology-driven strategy is positively related to technology capabilities and IT capabilities in US new ventures. Further, technology-driven strategy is important because it can exert great impact on firm performance through strategic capabilities. IT strategies consist of information, technology, and knowledge strategies (referred to in this paper as information management strategy (IMS), technology management strategy (TMS), and knowledge management strategy (KMS), respectively). As information is an asset to grind prices of things lower and slash the work time, organizations stand to improve both operational profitability and long-term growth with building compatible IT capabilities. Unfortunately, the literature is limited on our understanding on managerial approach to IT capability development and alignment to corporate financial returns.

The motivation for this study is to increase the understanding of managers about the role TMS, IMS and KMS plays on financial performance (FINP) of a firm and how these roles are related. Business managers are often unsure about how the mechanisms of information, knowledge, and IT, as well as the relationships among them, impact long-term organizational profitability. These relationships essentially being non-linear in nature, put extra barrier for managers first to understand the mechanics of interactions and second to predict the intended and unintended consequences of interactions. Kock (2013) observes that "many relationships in nature, including relationships involving behavioral variables, are nonlinear." We argue that non-linear relationship exists in interactions between IMS, TMS, KMS and FINP, and an appropriate modeling approach is needed for better understanding of role of IT in organizations. The main aims of this work are to:

- investigate how strategies based on information management (IM), technology management, and knowledge management (KM) influence organizational performance;
- find empirical evidence of this influence in a manufacturing environment using a structural equation modeling (SEM) framework; and
- examine the possible direct or indirect effects of KMS on organizational performance.

The resource-based view (RBV) theory of firm (Liang and You, 2009; Pearlson and Saunders, 2010; Hitt *et al.*, 2015) has been applied in this research. RBV can help us in understanding how the IT strategies gain and maintain competitive advantages. Resources that are rare, inimitable, have low mobility, low substitutability and add value can help to obtain and sustain competitive advantage (Wade and Hulland, 2004; Liang and You, 2009). Walmart's logistic management system is an example of a good resource. IMS resources on which some IMS strategies are built are unique to the company but used somewhat less effectively and are less substitutable, imitable, and transferable. Resources such as information repository pose moderate difficulties to imitate. TMS strategies include choice of hardware and software both of which are easily replicated but another component "technical knowledge" is hard to copy and transfer. Knowledge in a firm is inherently difficult to imitate, substitute, or transfer.

We conducted a comprehensive literature review and identified several research gaps which are addressed in this paper. First, there are few empirical researches to provide guidance to decision makers in the manufacturing sector. As Wu and Wang (2006) note, "There is a general scarcity of models and frameworks developed from empirical surveys that attempt to evaluate KM system success (or performance)." Things have not changed much in 2016. Second, we discover that there is a lack of understanding of how various intricate relationships among information, technology, and KMSs can impact corporate FINP and, thus, sustainability. The study addresses that issue in the context of US manufacturing. Third, we found that little is known about the exact relationships (including non-linear) between FINP and important strategies (TMS, IMS, and KMS). This study addresses that gap. In particular, the additive, moderating, mediating role of TMS in the relationship between KMS and FINP is made. Fourth, this study adds to the growing literature on business sustainability. Finally, the WarpPLS environment enables us to make a sophisticated analysis of non-linear relationships between latent variables and to conduct and compare additive, moderation, and mediation analyses as stated above.

We propose a relationship model based on SEM framework. The data for the model are taken from a comprehensive national survey of US manufacturing companies, and the analysis focusses on the extent to which these strategies have been important to FINP.

The rest of the paper is organized in the following way. We first discuss the sustainability issues in manufacturing, particularly how information contributes to the long-term viability of an enterprise. Then, we present several research hypotheses and their justifications. After that, we present the research methodology, variables, and descriptive statistics of the survey data. The analysis, both correlation and SEM, and implications are presented next. The paper concludes with a consideration of the limitations of the study followed by recommendations for future research.

2. IT literature and sustainability in manufacturing

2.1 A review of earlier studies

There are several reasons which add to the ambiguity in management's perception of the role of information in corporate performance. First, information is used in various ways for decision making. The methods of information collection, processing, interpretation, and use vary from organization to organization (O'Brien and Marakas, 2011). Second, the importance of knowledge generation and capture is often undermined. Research points out that the best way to ensure continued success is to learn from the past. So it is essential to document and archive information in order to be able to retrieve it when required. Third, management may ignore a long-term strategic view of IT capability in their organization. Considering the fast-changing development of IT, it is not hard to see how a company can be outmaneuvered by a competitor who is smarter and savvier in the application of technology.

Since the role of KM in organizational performance has aroused interest in recent research literature, we try to cover some previous studies on KM. Wu and Wang (2006) note that "knowledge management literature has mainly focused on general conceptual principles or case studies of KM initiatives in major organizations." Thus KM studies deal with theories (Barney, 1996; Teece, 2000); organizational KM as a source of competitive knowledge (Nonaka and Takeuchi, 1995); possible role of KM in organizations (Anvari *et al.*, 2010). The relation between KM and IT, which is a topic of interest in this paper has also been investigated (Davenport and Prusak, 2000;

Bhatt, 2001). Bhatt (2001), in particular, has argued that interactions between people, technology, and technique allow organizations to effectively manage its knowledge. The present paper builds on Bhatt's (2001) theoretical work by positing that information, technology strategies have a direct influence on corporate profits and that KM strategy impacts corporate profit mediated by technology strategy. In addition, the paper provides empirical evidence of the ideas proposed in manufacturing environment. As Wu and Wang (2006) observe in general there is a scarcity of models and frameworks for empirical study that attempts to evaluate KM system performance. Clearly there is a gap in KM-related strategy and its impact on corporate performance and the present study tries to address that by designing a model from empirical survey evaluates KM impact on corporate performance.

In this research, we take a broader view of the role of information and IM in strategic considerations and organizational performance. There is no doubt that information and associated technologies are exerting ever increasing influences on corporate growth and profitability (Pearlson and Saunders, 2010). IT can capture, store, process, retrieve, and communicate knowledge (Wu and Wang, 2006) and many firms are developing KM systems (Alavi and Leidner, 2001).

We employ a modeling approach, namely SEM, in investigating that role. Many business problems can be represented by a set of equations which can be solved simultaneously to predict the effects of decisions on the system and thus support decision making. The use a SEM technique, such as the partial least squares (PLS) path modeling method, can identify causal relationships among variables. The WarpPLS SEM package, which is used in this paper, allows us to investigate non-linear causal relations, and by doing so, this improves our ability to make logical explanations and provide prediction accuracy. Moreover, a model for corporate growth, which can be used by decision makers in the area of manufacturing, is developed with this package.

Three categories of strategy directly related to information and information resources are considered in this paper: IMS, KMS, and information TMS. From an organizational practices point of view, managers use information to increase operational efficiency which should then translate to improved FINP. At the top level of an organizational hierarchy, CEOs and senior managers set various information strategies for collection, usage, and maintenance of information resources. These strategies are referred to here as IMS. The top-level management also directs the development of an organization's KMSs, referred to here as KMS. As Bhatt (2001) observes, by knowledge leveraging, a long-term competitive advantage can be maintained. KMS is closely related to electronic data management. Also, there are technology-related strategies, such as the development of leading-edge technologies, building technological capabilities, and the application of technology practices, which have a direct impact on manufacturing. These strategies are termed here as TMS. This research analyzes various IMS, TMS, and KMS approaches and their impacts on business FINPs in a manufacturing context.

2.2 Sustainability model of manufacturing

Sustainable manufacturing must ensure that the processes are non-polluting, save energy, use natural resources, and are economically sound and safe for employees, communities, and consumers. Three broad goals of sustainability – eco-efficiency, eco-equity, and eco-effectiveness – are equally applicable to sustainable manufacturing (Watson *et al.*, 2010). Whereas cost reduction is the main goal of eco-efficiency, eco-equity pertains to the equal rights and sharing of environmental resources between peoples and generations. Eco-effectiveness stresses working on the right products, services, and systems. Sustainability goals align very well with the corporate goals, as seeking sustainability does not mean abandoning economic thinking (Watson *et al.*, 2010). Innovation, economic performance (cost saving and profitability), and eco-efficiency for competitive advantage are relevant to sustainable business management.

Sustainability can also be enhanced through information, knowledge, technology, and innovation, all of which can create competitive advantage and add value. The present paper supports this view, based primarily on resource-based findings. From this viewpoint, one can argue that certain IT resources that are rare, difficult to imitate, transfer, or substitute with other resources would help a firm to maintain a competitive advantage in its operating environment. There are various ways IT can add value to a firm. Even simple hardware and software tools can create value by working synergistically with other information systems (IS) and organizational factors (Kohli and Grover, 2008) Value can also be created through unique process improvements, improvements in supply chains, the use of innovations, and the use of IT as an option. This is supported by Melville *et al.* (2004) in their insightful review of IT and its relation to firm performance. Kohli and Grover (2008) state that IT is creating critical changes in the way business is organized and conducted. IT-based value can be achieved through a number of means: co-creation in a multiple firm environment, digitizing various business capabilities, changing the role of information from supportive to active, and exploring intangible aspects of economic value. Firms use IS to build and sustain their advantages by achieving the speed needed for rapid moves and by using IT with agility (Sambamurthy *et al.*, 2003).

3. Research model and hypothesis

IT/IS support organizations in three vital ways: in improving business processes and operations, in rational decision making by managers and employees, and in strengthening strategies for competitive advantage. IT, such as the internet, the world wide web, electronic data interchange (EDI), have already changed, and are changing continuously, the ways organizations do business with the use of IT today (Mandal and Gunasekaran, 2003).

A significant movement that has occurred relatively recently is the push toward worldwide and national integration of information for organizations to achieve competitive advantage. Since it has become critical for businesses to access relevant data and information quickly and easily, large IS such as enterprise resource planning (ERP) systems, supply chain management (SCM), enterprise resource/relationship management (ERM), enterprise application integration, web services, and customer relationship management (CRM) have grown in importance (Mandal *et al.*, 2012).

We postulate that a firm's FINP will be dependent on strategies dealing with better IM, technology management (TM), and KM. The links are shown diagrammatically in Figure 1. The concepts have further been refined through extensive literature review. Some of the major studies which helped us in crystalizing the SEM model and substantiating the hypotheses are shown in Table I.

3.1 The role of IMS

IMS includes using information in decision making, making up-to-date data and information of a firm's performance readily available. Mangers following an IMS meet regularly to review company performance, indulge in competitive benchmarking against the best practice in the industry.

Organizational performance measurement systems need to be efficient, both in terms of appropriate measures and communicating these measures accurately. Marchand *et al.* (2000) relate a firm's performance to its capability to effectively manage and use information. The balanced scorecard system (BSC) is one such measurement system. First, the business value of an investment needs to be identified, looking at value drivers such as customer satisfaction and employee development, besides the main issue of FINP. Next, the measure has to be used and follow-up should take place

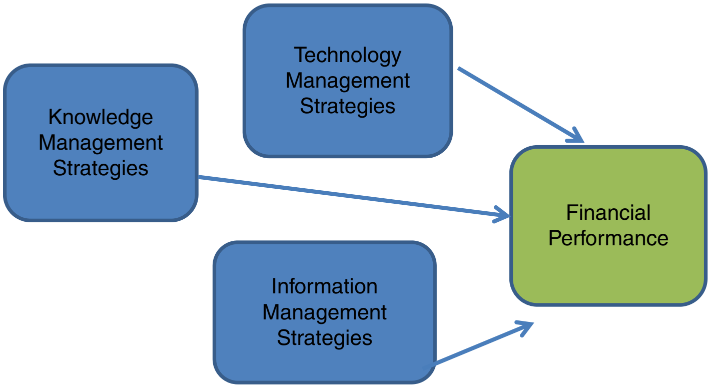


Figure 1. Information, technology, and knowledge leading to financial performance

Table I. Major studies used to form the SEM model

Study	Main focus	Implications	Remarks
Liang and You (2009)	Resource-based view of IS	IT has positive effect on firm performance	Major impact of IT is on firm efficiency
Henderson and Venkatraman (1999)	Strategic alignment	Strategic integration and operational integration	IT can help in organizational transformation
Marchand *et al.* (2000)	Performance, management ability to use information	–	Information use improves financial performance
Kohli and Grover (2008)	IT impact on business	–	IT delivers value to organization
Sedera and Gable (2010)	Knowledge competence and financial performance	Relationship of knowledge to improve financial performance	
Dong and Yang (2015)	Role of IT in organizational learning processes	IT investment moderates its organizational learning processes	
Devaraj *et al.* (2007)	Impact of IT on business	Impact of IT on supply chain operating performance is positive	IT improves performance
Greiner *et al.* (2007)	IT and knowledge management	–	To improve efficiency of operational processes companies use IS
Pavlos (2009) and Yang and Chen (2009)	Firm size and performance	–	Firm size matters in firm's performance

so the value is indeed achieved. The BSC provides a methodology for accomplishing this. Typically, a firm defines its mission and strategy and uses metrics to make these understandable. Using the BSC, managers look at the business from four perspectives: customer, internal business, innovation/learning, and finance. They then design goals and measures for each perspective. The BSC provides summary information collected over a period of time and assists in this process.

Similarly, the strategic alignment model (Henderson and Venkatraman, 1999) uses business strategy, IT strategy, organizational infrastructure and processes, and IT infrastructure and processes as four dimensions. Through strategic integration and operational integration, the management of a company can make changes and adapt to new challenges continuously.

Another best practice method is to use dashboards, which, unlike the BSC, provide snapshots of metrics at any given point in time. A dashboard summarizes the key metrics for management, using frequently updated information, and provides easy and quick understanding of the status of the organization. These decision-support system tools and techniques for enterprise-level data warehousing are used by the managers of most companies for effective decision-making purposes. In this way, IT increases the flow of information and also helps in filtering and analyzing the information.

The IMS is therefore expected to influence the FINP of an organization. Thus, our first hypothesis is the following:

H1. Organizational FINP will be positively dependent on IMS.

3.2 The role of TMS

TMS can be defined as a plan an organization employs to provide technology-based services (Pearlson and Saunders, 2010; Sambamurthy *et al.*, 2003). TMS allows a firm to remain agile by implementing its strategies. Four IT infrastructure components, namely hardware, software, network, and data as well as other latest new technology resources are key elements of TMS. Managers can use these components to understand the critical issues of TM. O'Brien and Marakas (2011) note that internet technologies and e-business and e-commerce applications can be used strategically for competitive advantage. For example, they observe one TMS strategy could be focused on "improving efficiency and lowering costs by using the Internet and the World Wide Web as a fast and low-cost way to communicate and interact with customers, suppliers and business partners."

Next-generation technology, leading-edge technology, and new practice technology are helping firms to achieve financial gains and improve FINP. Many firms have a TMS that addresses long-term technological needs. Kohli and Grover (2008) discuss the value that IT delivers to a firm. Mandal and Gunasekaran (2003) have established that significant improvement in efficiency across an organization can be achieved through implementation of a large ERP system. Since SCM has been of interest for some time, the effect of IT on SCM has been investigated by many.

Coordination of cost, fit, and risk is of essence in IT use in SCM (Dedrick and Kraemer, 2005). IT can reduce both coordination and search cost in a SCM environment. Malhotra *et al.* (2005) discuss the issues of capability platform and the nature of information exchanges and outcomes in an IT-based supply chain partnership. Sambamurthy *et al.* (2003) observed that IT is enabling firms to manage supply chain relationships in many new ways and IT-enabled agility helps in the business performance of a firm. Dong *et al.* (2009), in an empirical study using data from 743 manufacturing firms, reported a significant contribution by IT to the performance improvement of supply chains.

Recently, Gunasekaran and Ngai (2012) discussed the role of IT in manufacturing and service organizations. They think that IT/IS has significantly changed the operations management strategies, techniques, and technologies in recent times and that this trend is going to continue. They also discuss sustainability issues from environmental and safety perspectives. Ngai *et al.* (2010) studied the relationship between supply chain competence and agility to ascertain its effect upon a firm's performance, and they found that the association between supply chain competence and agility is moderated by the complexity of supply change settings. Devaraj *et al.* (2007) observed that although the impact of IT on e-business technologies is debatable, the impact of IT on supply chain operating performance is productive. IT resources generate a high value for the firm. IT advancements and IT alignments are able to facilitate the development of supply chain capabilities.

Summarizing, one can conclude from past research that although the role of TMS in e-business has not been without criticism, its role in SCM and other areas has been largely a positive one. Thus, our second hypothesis is the following:

> *H2*. Organizational FINP will be positively dependent on TMS that includes advanced technology adoption, innovative, and leading-edge research.

3.3 Role of KMS

While the role of TMS and IMS in a firm's FINP is expected to be direct, the same cannot be said of the role of KMS. Dong and Yang (2015) observed the moderating role of IT investment on organizational learning processes in knowledge networks in a firm, which may improve firm competitiveness. KM is the process necessary to generate, capture, codify, transfer, and synthesize knowledge across organizations to achieve competitive advantage and, thus, sustainability. Knowledge is information that is synthesized and contextualized to provide value and it is information with the most value (Pearlson and Saunders, 2010). According to Greiner *et al.* (2007), knowledge is the "most important resource in creating a sustainable competitive advantage." So KMS is important to a firm. Knowledge is hard to capture electronically, hard to structure and transfer, often tacit in nature, and sometimes so highly personal to the source that it requires synthesis (Davenport, 2006). So, KM may not have any direct immediate effect on a firm's FINP.

Based on Porter's value chain concept, knowledge is needed in raw material handling, operations, manufacturing, product distribution, and in other essential areas. According to McGinnis and Huang (2007), KM must be associated with each phase of an IS project. DSS should integrate decision support and KM for better quality decision making, and as such DSS can be part of the IS portfolio of a firm. Effective KM in enterprise systems (ES) has also been postulated to yield success in ES.

Building intellectual capital (knowledge that has been identified, captured, and leveraged to gain competitive advantage for a firm) is a must for any firm to sustain itself, and IT provides an infrastructure for capturing and transferring such knowledge. In present-day societies the most important sustainable competitive advantage is the capacity to learn. According to McGinnis and Huang (2007), "an organization's sustainable competitive advantage lies in what its employees know and how they apply this knowledge to business problems." Knowledge integration also requires social networking. However, knowledge is not static, and it dynamically evolves over time. So, employees of a firm need to continuously upgrade their knowledge and skill set and share best practices with others in the firm.

It can be assumed that the role of KM can be large, varied, and non-immediate. Sedera and Gable (2010), for example, found that knowledge competence (the effective management of knowledge of value) is associated with IS impact which may affect a firm's FINP. Okumus (2013), in a study in the hospitality field, discussed how hospitality organizations can better facilitate KM through IT. Thus, KM can directly or indirectly influence a firm's performance. The direct influence can be called additive, and the indirect influence through TM can be called moderated or mediated (Sarker *et al.*, 2011). Three different ways can be found that support the fact that KM is related to IT (Pearlson and Saunders, 2010). First, IT contributes to the infrastructure of KM. Second, many IS and applications include KM as data infrastructure. Third, KM is frequently referred to as an application of IS. Greiner *et al.* (2007) observed that electronic discussion forums, e-mail, TV, videoconferences, and CSCW tools support KMS. Also they observed "companies who use knowledge management in order to improve the efficiency of operational processes use databases and information systems." In either way KMS can indirectly influence FINP via TMS. Alavi and Leidner (2001) observed that some managers "associated knowledge management with information technology infrastructure." As noted by them, some managers associated KM with "data warehousing, enterprise-wide systems, executive information systems, expert systems and the intranet" and various IT tools such as search engines and decision-making tools. So the use of IT in KM is implicit in their minds.

Thus, our third hypothesis is:

H3. KMS will indirectly and positively influence organizational FINP via mediation. Thus, TM will mediate the relationship between KMS and organizational FINP.

There could be other factors that may play a role in organizational FINP. We include two such factors as control variables in the study: size of the firm and total quality management adopted (TQM). Firm size matters in a firm's performance (Pavlos, 2009; Yang and Chen, 2009). It has been observed that TQM also matters in a firm's performance when an alignment of an organization's processes and various contextual factors occurs (Hendricks and Singhal, 2001; Kaynak, 2003). The SEM model based on mediating role of TMS on the relationship between KMS and FINP is shown in Figure 2.

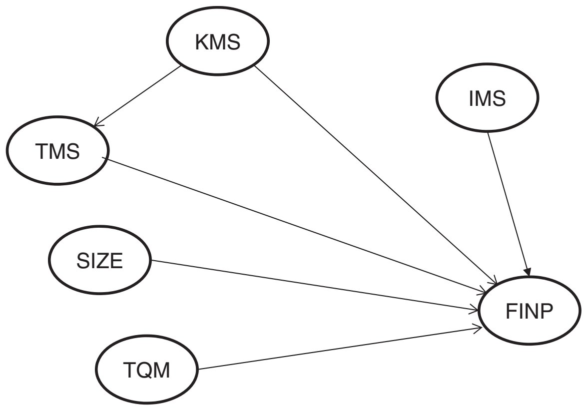


Figure 2.
The proposed SEM model

4. Modeling method and data

The SEM model was analyzed using primary data collected through a comprehensive national survey of US manufacturing companies. WarpPLS 3.0 was employed to create the component-based path analysis model (Kenney *et al.*, 1998). PLS has the advantage of being able to model multiple dependent and independent variables while handling multi-collinearity among the independent variables. It is also robust in handling missing data and the basis of cross-products involving the response variable(s) resulting in stronger predictions. WarpPLS additionally takes into consideration the non-linear nature of relationships between latent variables. PLS analysis was appropriate, as Straub *et al.* (2004) recommend a minimum sample size of 100 data points and our sample of 108 data points met this criterion. Another criterion is that the minimum sample size required by PLS is ten times the larger number of paths going to an endogenous construct when all constructs are reflective and the present model satisfies that: the largest number of paths connects other variables with FINP, and it is only five (Li *et al.*, 2011).

In this paper, we use primary data collected for a comprehensive study of American manufacturing companies that was reported elsewhere (Mandal *et al.*, 2008). Empirical data were collected through a questionnaire survey of US manufacturing companies. The survey instrument was very similar to ones used for the UK, Australia, Singapore, and Hong Kong surveys (Prajogo and Sohal, 2003), but it was modified to incorporate US-specific information. The six-part, six page questionnaire included questions on organizational profile, organizational practices, organizational performance, business environment, organizational strategy, and organizational culture. The organizational practices part was designed to capture detailed input in areas of leadership, strategy and planning process, customer focus, information and analysis, personnel management, process management, supplier relationships, TM, R&D management, KM, and creativity and idea generation. The organizational performance part asked for detailed input in the areas of product quality, product innovation, process innovation, and FINP.

Two rounds of mail surveys were conducted. In the first mailing, roughly 1,500 letters were posted requesting CEOs or presidents to respond to the survey. In the second mailing, 2,200 companies, including many of those approached in the first mailing, were approached. Altogether, 108 responses were received. The data were entered into a SPSS file and analyzed. A table of study variables can be found in Table AI.

As shown in Table II, out of 108 companies in the sample, the majority (about 57 percent) of the companies employed between 101 and 500 workers. About 32 percent of the companies employed between 501 and 1,000 workers, and about 7.4 percent of

Table II.
Company profile in survey

Number of employees	Frequency	Percent	Average annual revenue	ISO 9000 certification	TQM program
< 100	4	3.7	\$314.90 million	Certified = 89 companies	Has TQM program = 86
101-500	62	57.4			
501-1,000	34	31.5		Not certified = 16 companies	No TQM program = 19
> 1,000	8	7.4			
Total	108	100.0			

the companies employed 1,000 or more workers. The average annual revenue was $315 million. About 83.2 percent of the respondents stated that their companies held quality system certification (ISO 9000 series), while 15 percent stated that their companies did not have it.

The survey revealed that 80 percent of the companies had a formal total management or similar quality improvement program, while 18 percent did not. About 80 percent of the companies were both ISO 9000 certified and had established TQM programs.

5. PLS-based model hypothesis analysis

We employed modeling via WarpPLS (Kock, 2013) to analyze *H1*, *H2*, and *H3* simultaneously.

5.1 Measurement model fit

Empirically, the soundness of the model was first ensured by construct validity which consisted of checking for convergent and discriminant validity as well as by reliability for internal consistency. First, to test measurement model reliability, a confirmatory factor analysis (CFA) was conducted using the dataset consisting of 108 data points (see Table III). Convergent validity was assessed by reviewing the *t*-tests for the factor loadings. For the model, most survey question items loaded at acceptable levels (loading > 0.70). One of the original three items from FINP loaded poorly, and so it had to be dropped from consideration. Since this is an exploratory study a Cronbach's α value greater than 0.6 is considered acceptable. The Cronbach's α values ranged from 0.61 to 0.94 (Table III). Composite reliability (CR) is another measure of reliability. As shown in Table IV, CR values are all above 0.8.

The CFA loadings clearly indicate three major independent variables: KMS, IMS, TMS. The main dependent variable was FINP, and two control variables were also included: size of the firm (SIZE) and adoption of TQM practice.

Generally, it is assumed that a construct displays convergent validity (the degree to which the measurement items are sufficiently correlated for the same latent variable) if the *p*-values associated with the loadings are equal to or lower than 0.05 and if the loadings are equal to or greater than 0.5 with cross-loadings $< 0.0.5$. As seen in

Construct	Item	KMS	IMS	TMS	SIZE	TQM	SE	*p* value
KMS	KM_a	*0.877*	–0.051	–0.016	0.042	–0.06	0.06	< 0.001
KMS	KM_b	*0.879*	–0.057	0.054	0.071	0.138	0.067	< 0.001
KMS	KM_c	*0.824*	0.003	0.123	–0.064	–0.115	0.09	< 0.001
KMS	KM_d	*0.788*	0.117	–0.171	–0.059	0.033	0.084	< 0.001
IMS	IM_a	–0.332	*0.829*	–0.093	–0.025	–0.062	0.113	< 0.001
IMS	IM_b	–0.171	*0.9*	–0.032	–0.052	–0.041	0.104	< 0.001
IMS	IM_c	–0.133	*0.821*	0.302	0.035	0.144	0.083	< 0.001
IMS	IM_d	0.726	*0.74*	–0.192	0.052	–0.041	0.08	< 0.001
TMS	TM_a	–0.045	0.128	*0.914*	0.053	–0.042	0.071	< 0.001
TMS	TM_b	–0.051	–0.081	*0.938*	0.027	–0.139	0.059	< 0.001
TMS	TM_c	0.068	–0.15	*0.936*	–0.032	–0.02	0.054	< 0.001
TMS	TM_d	0.032	0.127	*0.783*	–0.056	0.24	0.086	< 0.001
SIZE	Size	0	0	0	*1*	0	0.293	< 0.001
TQM	TQM	0	0	0	0	*1*	0.212	< 0.001

Table III. Results of confirmatory analysis

Table IV. Additional convergent validity measures

FINP	KMS	IMS	TMS	SIZE	TQM
R^2 coefficients					
0.296			0.59		
Composite reliability coefficients					
0.837	0.907	0.894	0.941	1	1
Cronbach's α coefficients					
0.61	0.863	0.841	0.916	1	1
Average variances extracted					
0.719	0.71	0.68	0.801	1	1

Table III, the last column denotes p-values which are all < 0.001. The loadings are also all greater than 0.07. For example, the loadings of all IMS components (denoted by IMS_a to IMS_d) lie between 0.74 and 0.9. The cross-loadings are all less than 0.5. In addition, average variance extracted (AVE) is at least 0.50, or the square root of AVE is at least 0.71 (i.e. when the variance explained by the construct is greater than measurement error). It can be observed from Table IV that the AVE values of all multiple-item constructs varied from 0.68 to 0.80, in the case of the present model, which confirms the convergent validity of the survey instrument.

To test for discriminant validity (the degree to which the measurement items are dissimilar), we first considered the correlations between the variables (see Table V). Table V shows the correlations among latent variables with the diagonals showing the square roots of AVE. Findings of discriminant validity are also supported by the relatively small inter-item correlations and by the large differences observed between the AVE and the absolute value correlation for each pair of variables. For good discriminant validity, the square root of the AVE for a given construct should be greater than the absolute value of the standardized correlation of the given construct with any other construct in the analysis, and this was true for the model considered (Kock, 2013). For example, the square root of AVE of TMS is 0.895, and that is greater than 0.767, which is the correlation between TMS and KMS.

5.2 Structural model fit

For the structural model, a resampling technique was used, based on bootstrapping (100 resamples) (Kock, 2013). The examination of the t-values was based on a two-tail test with statistically significant levels of $p < 0.05$ (*) and $p < 0.001$ (***). The quality criteria used in judging structure model fit are the following: path coefficients, CR, and R^2.

Table V. Results for discriminant validity

	FINP	KMS	IMS	TMS	SIZE	TQM
FINP	*0.848*	0.201	0.313	0.373	0.051	0.082
KMS	0.201	*0.843*	0.781	0.767	0.094	–0.049
IMS	0.313	0.781	*0.825*	0.705	0.071	–0.084
TMS	0.373	0.767	0.705	*0.895*	0.101	–0.011
SIZE	0.051	0.094	0.071	0.101	*1*	0.001
TQM	0.082	–0.049	–0.084	–0.011	0.001	*1*

Note: Square roots of average variances extracted (AVE's) shown on diagonal

To keep things simple, we discuss the results in terms of the mediating model only. Our other results (although not included in this paper) show that mediation relation as discussed in this paper works better than additive or moderation relations.

The CR of each construct was also satisfactory, ranging from 0.84 to 0.94 (see Table IV). For a confirmatory model, a CR value of 0.7 or better is required. R^2 values of 0.67, 0.33, and 0.19 are considered as substantial, moderate, and weak, respectively. The R^2 value of FINP was 0.296. Finally, effect size values of all path coefficients are shown in Table VI. With these effect sizes, the effects indicated by path coefficients can be determined as small, medium, or large. The values usually recommended are 0.02, 0.15, and 0.35, respectively (Kock, 2013). Values below 0.02 suggest that the effects are too weak to be considered relevant from a practical point of view, although the corresponding p-values are statistically significant. Effect size values of all paths of the present model (except for paths, KMS → FINP and TQM → FINP) are > 0.02 (Table VI).

Additionally, WarpPLS provides three fit measures: average path coefficient (APC), average R-squared (ARS), and average variance inflation factor (AVIF) (Kock, 2013). Usually, the addition of a new latent variable increases ARS and AVIF and reduces APC. The recommended maximum p-values of APC and ARS should be 0.05 for a good fit with the data. In the present case, APC = 0.260, $p < 0.001$, ARS = 0.443, $p < 0.001$. The AVIF should be lower than the recommended maximum limit of 5 and the present model has a satisfactory AVIF value of 1.475 (<5).

5.3 *Analysis of model*

The results from the final PLS-SEM model are shown in Figure 3. In the figure, for example, KMS (R) 4i denotes that KMS is a reflexive latent variable with four items. The β coefficients with p-values are also shown for each latent variable. The control

	FINP	KMS	IMS	TMS	SIZE	TQM
FINP		0.009	0.116	0.098	0.06	0.014
TMS		0.59				

Table VI. Effect sizes of path coefficients

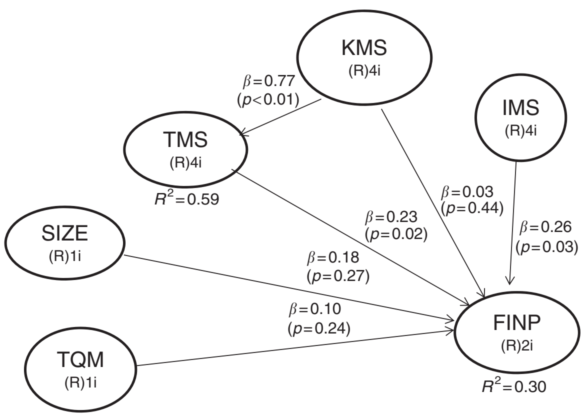


Figure 3. The final model with mediation

paths TQM → FINP and SIZE → FINP were insignificant. The paths IMS → FINP and TMS → FINP are significant (at $p < 0.05$), thus supporting *H1* and *H2*.

The mediating model results for *H3* are shown in Table VII. The paths, IMS → FINP and TMS → FINP were significant ($p < 0.05$). The control paths of TQM → FINP and Size → FINP were insignificant. The R^2 value of FINP was 0.30. Here TMS mediates the relations between KMS → TMS and TMS → FINP. Table VIII shows the mediation results. Sobel's test shows that the mediating effect of TMS is significant at $p < 0.05$ ($p = 0.0388$).

6. Discussions

The analysis done with the WarpPLS SEM showed several options that any decision maker can take. We illustrate two of the decision-making environments that are provided in the present modeling framework. First, the choice of testing our model in PLS as well as in WarpPLS environments must be noted. The model when run with pure PLS yielded an R^2 of FINP as 0.18 with coefficients weaker in values. The model was tested in the WarpPLS environment to see what improvements it could make, if any. It was found that in a WarpPLS environment with an R^2 of FINP as 0.30 with most coefficients stronger in value, all the paths were warped, as shown in Figure 4(a)-(f). As stated earlier, Kock (2013) observes that many relationships involving behavioral variables, are non-linear and resembles a *U*-curve (or inverted *U*-curve). WarpPLS may provide a better fit with such data.

PLS analysis supports all hypotheses. In this paper, we tried to address these issues: how IMS impacts FINP (*H1*), how TMS influences FINP (*H2*), and whether the influence of KMS is direct or indirect on FINP (*H3*). The mediating model (*H3*) yielded good fit and significance (see Table VI). It should be noted that decision makers can make many such experiments before deciding on the final model. The ability of experimentation is essential for rational decision making. This provides an opportunity for knowledge synthesis and in the process allows firms to compete based on analytics (Davenport, 2006).

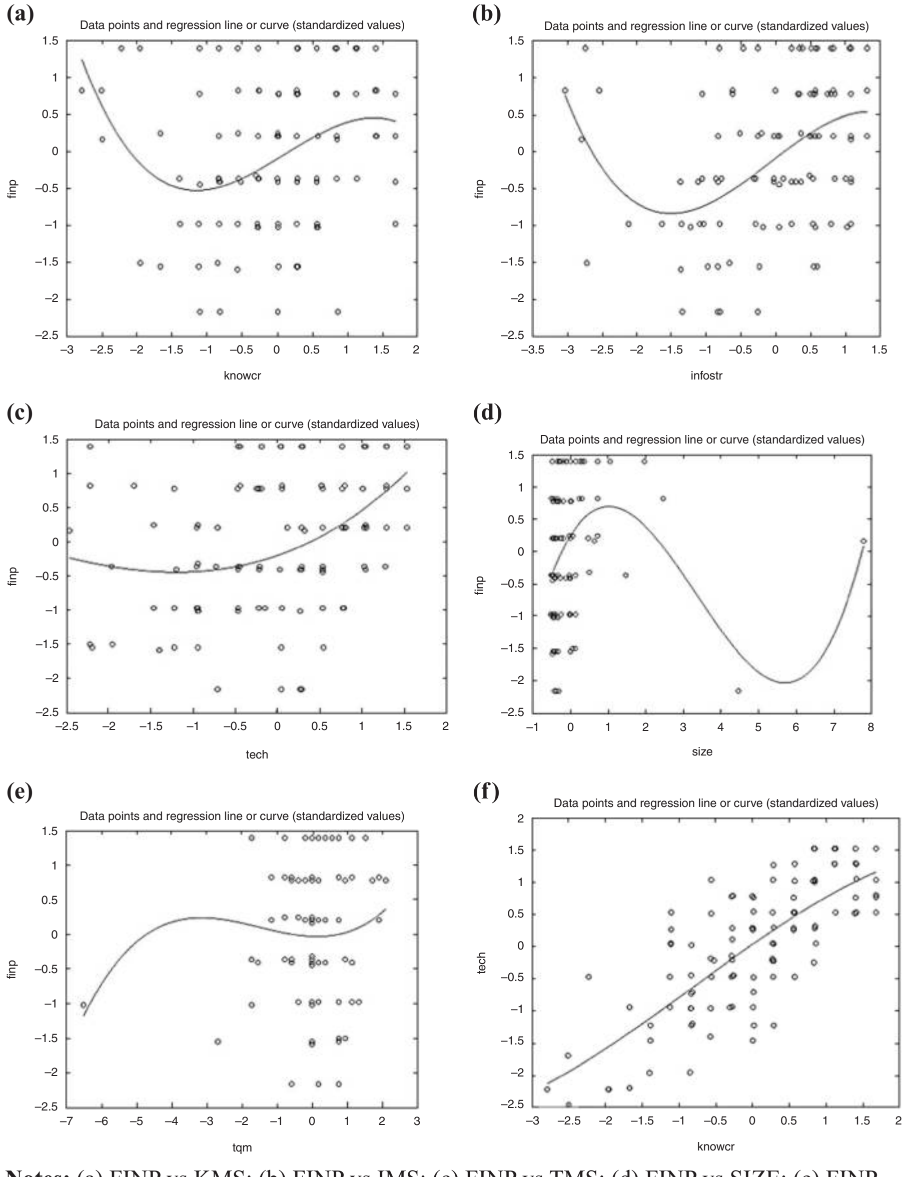
Table VII.
Path coefficients and their significances (mediation model)

	FINP	KMS	IMS	TMS	SIZE	TQM
FINP		–0.026	0.256*	0.226*	0.178	0.103
TMS		0.768***				

Notes: *$p < 0.05$; ***$p < 0.001$

Table VIII.
The mediation test results

n	108	Sample size
a(KMS → TMS)	0.7680	Path coefficient calculated by WarpPLS
b(TMS → FINP)	0.2300	Path coefficient calculated by WarpPLS
Sa	0.0430	Standard error calculated by WarpPLS
Sb	0.1090	Standard error calculated by WarpPLS
Sab	0.0844	Sobel's standard error for mediating effect
Ab	0.1766	Product path coefficient for mediating effect
Tab	2.0923	*t*-value for mediating effect
Pab	0.0388	*p*-value for mediating effect, two-tailed



Notes: (a) FINP vs KMS; (b) FINP vs IMS; (c) FINP vs TMS; (d) FINP vs SIZE; (e) FINP vs TQM; (f) TMS vs KMS
Source: Table VI

Figure 4.
The Warp fits of paths of the final model

With respect to the hypothesis on IMS (*H1*), we found that IMS influences FINP positively, as postulated in previous research, and its impact is the largest on FINP (coefficient = 0.256). This finding is not surprising as there is a general view that the use of information helps managers in monitoring organizational financial targets.

Tambe *et al.* (2012) found IT use (in 253 firms sample) especially when combined with decentralized decision making show significantly higher productivity. Marchand *et al.* (2000) suggested a relationship of effective use of information to a firm's performance. The strong positive relation between IMSs and FINP in our study is of particular interest, meaning managers may significantly improve firm's FINP by effectively using information resources.

The SEM model confirms positive relationship between TMS and FINP (*H2*). This means TMSs focussing on leading-edge technologies, new practices, technological capability development, and new generation technologies could positively influence FINPs of organizations. In fact, this finding supports several other studies. Kohli and Grover (2008) pointed out that IT delivers value and in most cases financial profitability to a firm. A similar study by Devaraj and Kohli (2002) established the positive relationship of IT and finance of a firm. New technological capability development such as using intranets and extranets as per O'Brien and Marakas (2011) could lead to performance improvement in business effectiveness (and thus financial profitability).

Finally, the role of KMS was shown to be indirect. It has been argued that in stable environments, higher IT capability in the form of varied types of competitive intelligence and knowledge may not be required for profitability and long-term sustainability. Flynn and Flynn (1999) also found IT's moderating role to be insignificant in the relationship between manufacturing environment uncertainty and manufacturing performance. *H3*, which postulated that TMS mediates the relationship between KMS and FINP, was supported by our findings. Pearlson and Saunders (2010) observed that KM depends on IT. Thus any KM strategy should depend on TMS and TMS leads to FINP. So KMS indirectly influences FINP via TMS. Greiner *et al.* (2007) argue that KM strategy should match with business strategy. Their study found a "relationship between success of KM in terms of improving business performance of the organization and the alignment of KM strategy and business strategy." As noted earlier this can be made successful by mediation of TMS between KMS and FINP.

The study contributes in several ways. First, the WarpPLS environment enabled us to make a sophisticated analysis of non-linear relationships between latent variables and provided an environment to conduct and compare additive, moderation, and mediation analyses. Second, empirical research to provide guidance to decision makers in the manufacturing sector was made. Third, the literature review lead us to discover that there is a lack of understanding of how various intricate relationships among information, technology, and KMSs can impact corporate FINP and, thus, sustainability. Through SEM model we showed the causal relationships in the context of US manufacturing. Fourth, we found that little is known about the exact relationships between FINP and important strategies (TMS, IMS, and KMS). The hypothesis testing addressed that gap. IMS, TMS, and KMS showed positive influence to FINP. In particular, the mediating role of TMS in the relationship between KMS and FINP is revealing. Finally, this study adds to the growing literature on business sustainability.

In conclusion, it is essential to note that this work primarily addressed IMS, TMS, and KMS issues and company performance at the strategic level in US manufacturing companies. The study has implications for managers. The survey analysis leads to several important findings which could be useful to top-level management in framing long-term improvement strategies, thus paving the way for sustainable business development. Two major findings of the research are: an organization's FINP is directly dependent on its IM and TMSs, and KMSs indirectly influence FINP via mediation. This may suggest various combinations of strategies that may increase FINP of a firm in manufacturing sector. For example, proper attention to IMS and TMS as also augmenting KMS may help a firm to better its FINP in the long run. In addition, the study has implications for research. Previous research has indicated that in a manufacturing environment the roles of IMS, KMS, and TMS in corporate performance are less understood. For researchers in the manufacturing area, the roles of IMS, TMS, and KMS are essential as a knowledge gap exists which requires investigation at both theoretical and empirical levels for organizational sustainability. The paper also showed how a PLS-SEM-based model can be used to explore various decision-making criteria. We sincerely hope that this paper will generate further interest in future research in this area.

7. Limitation and future research

This study's limitations indicate the need for future research in several areas. First, the limited sample size was a hindrance, although it is acknowledged in manufacturing research that getting a large sample of data from managers is often not an easy task. A larger sample size in future empirical research would more rigorously test the model's viability. Second, any generalization of results from manufacturing to other sectors would be unwarranted and should be done only through future empirical research. Third, our measure of FINP was limited. Future work needs to explore whether a more extended measure of FINP will be needed. Finally, a similar study for other nations can be taken up to validate the model.

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Appendix

Variable name	Question/description	Measurement scale
SIZE	How many people does your organization employ?	Less than 100; 101-500; 501-1,000; 1,001 or more
TQM	Has your organization ever engaged in a formal total quality management or a similar quality improvement program?	Yes/no
Information management strategy (IMS)		
IM_a	Our company has an effective performance measurement system that incorporates a number of measures and indicators to track overall organizational performance	Strongly disagree to strongly agree (5 scale)
IM_b	Up-to-date data and information of company performance is always readily available for those who need it	Strongly disagree to strongly agree (5)
IM_c	Senior management regularly meets to review company performance and use information as a basis for decision making	Strongly disagree to strongly agree (5)
IM_d	We are engaged in active competitive benchmarking to measure our performance against "best practice" in the industry	Strongly disagree to strongly agree (5)
Technology management strategy (TMS)		
TM_a	Our company always attempts to stay on the leading edge of new technology in our industry	Strongly disagree to strongly agree (5)
TM_b	We make an effort to anticipate the full potential of new practices and technologies	Strongly disagree to strongly agree (5)
TM_c	We pursue long-range programs in order to acquire technological capabilities in advance of our needs	Strongly disagree to strongly agree (5)
TM_d	We are constantly thinking of the next generation of technology	Strongly disagree to strongly agree (5)
Knowledge management strategy (KMS)		
KM_a	The build-up of intellectual capital is of strategic importance to management to gain competitive advantage	Strongly disagree to strongly agree (5)
KM_b	We always upgrade employees' knowledge and skills profiles	Strongly disagree to strongly agree (5)
KM_c	Our company builds and maintains virtual and physical channels for sharing and disseminating information	Strongly disagree to strongly agree (5)
KM_d	Our company manages its own intellectual assets, e.g. special techniques, patents, copyrights, licenses	Strongly disagree to strongly agree (5)
Financial performance (FINP)		
FINP_a	Relative to the major competitors in our industry, our sales growth is …	Worst in industry to best in industry (5 scale)
FINP_b	Relative to the major competitors in our industry, our market share is …	Worst in industry to best in industry (5 scale)

Table AI. The survey questions: a subset of the original six page questionnaire

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