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Empirical study to identify the key business activities contributing to manufacturing business performance

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ABSTRACT

Purpose: Within the context of high global competitiveness, knowledge management (KM) has proven to be one of the major factors contributing to enhanced business outcomes. Furthermore, knowledge sharing (KS) is one of the most critical of all KM activities. From a manufacturing industry perspective, supply chain management (SCM) and product development process (PDP) activities, require a high proportion of company resources such as budget and manpower. Therefore, manufacturing companies are striving to strengthen SCM, PDP and KS activities in order to accelerate rates of manufacturing process improvement, ultimately resulting in higher levels of business performance (BP). A theoretical framework along with a number of hypotheses are proposed and empirically tested through correlation, factor and path analyses.

Design/methodology/approach: A questionnaire survey was administered to a sample of electronic manufacturing companies operating in Taiwan to facilitate testing the proposed relationships. More than 170 respondents from 83 organisations responded to the survey. The study identified top management commitment and employee empowerment, supplier evaluation and selection, and design simplification and modular design as the key business activities that are strongly associated with the business performance.

Findings: The empirical study supports that key manufacturing business activities (i.e., SCM, PDP, and KS) are positively associated with BP. The findings also revealed that some specific business activities such as SCMF1, PDPF2, and KSF1 have the strongest influencing power on particular business outcomes (i.e., BPF1 and BPF2) within the context of electronic manufacturing companies operating in Taiwan.

Practical implications: The finding regarding the relationship between SCM and BP identified the essential role of supplier evaluation and selection in improving business competitiveness and long term performance. The process of forming knowledge in companies, such as creation, storage/retrieval, and transfer do not necessarily lead to enhanced business performance; only through effectively applying knowledge to the right person at the right time does.

Originality/value: Based on this finding it is recommended that companies should involve suppliers in partnerships to continuously improve operations and enhance product design efforts, which would ultimately enhance business performance. Business performance depends more on an employee's ability to turn knowledge into effective action.

Keywords: Supply chain management; Product development process; Knowledge sharing; Business performance

1. Introduction

The advances in science and technology and the rapid changes in the market demand manufacturing companies to strengthen managerial and technical capabilities to improve business performance and gain competitive advantage. Some recent studies [1-3] highlighted three key business practices that can facilitate the achievement of these business performance goals. These three practices deal with the two essential components of the manufacturing process, namely the design development process and supply chain integration, and also the management of the strategic asset of knowledge.

It has been reported that the product development process (PDP) is one of the most important business activities that help the manufacturing companies to survive and gain market share [1]. Since a product's life cycle has become much shorter than before, the companies need to design new products based on constant innovation and to co-operate with their suppliers at the early stage of product design [2]. These approaches can ensure the successful launch of new products in time to serve a targeted market. In addition, since the 1980s, supply chain management (SCM) has become one of the most important business practices for manufacturing companies to gain a competitive advantage in the current global environment [4]. The primary focus of SCM is to achieve continuous improvement in manufacturing quality and efficiency through supply chain integration [5]. One of the major approaches is to identify the best practice of SCM to enrich the knowledge base of the business practices in order to further develop an improved supplier assessment system for a company. Moreover, the knowledge sharing (KS) ability of communicating, capturing, organising and disseminating knowledge allows companies to improve decision making, process efficiency, quality, timeliness, customer satisfaction, and cost reduction [6]. Through sharing and harnessing internal knowledge and know-how as well as absorbing external knowledge, a company will improve business practices which will ultimately lead to advanced competitive advantage and performance [7].

Given most manufacturing companies are seeking ways to improve their SCM, PDP and KS activities [1,4,7], it is necessary to identify the activities that are strongly associated with the business performance. This would help the manufacturing companies to focus their resources on implementing those activities that could effectively improve certain aspects of performance they are desired to improve. Therefore this study aims to provide empirical evidence for the impact of SCM, PDP and KS activities on business performance (BP). In order to achieve this research objective, a theoretical framework was designed to examine the relationships between the business activities (i.e., SCM, PDP and KS) and BP within electronic manufacturing companies operating in Taiwan. The following three sections provide a critical review on literature associated with SCM, PDP and KS, as well as their relationship with BP. The review culminated in a theoretical framework consisting of three hypotheses.

2. Supply chain management

2.1. Background

Within the context of the manufacturing industry, a supply chain (SC) consists of all stages involved, directly or indirectly, in fulfilling a customer request [8]. From this perspective, the SC not only includes the manufacturer and suppliers, but also transporters, warehouses, retailers, and end users themselves [8]. Accordingly, the SC can be seen as an integrated process where various business entities (i.e., suppliers, manufacturers, distributors, and retailers) work together in an effort to acquire raw materials, to convert raw materials to final products and to deliver these final products to retailers or customers [9].

Therefore SCM involves the management of flows of information, materials and human resources between and among stages in a SC to maximise total profitability [8,10]. As defined by Chin et al. [5], SCM is an integrating philosophy to manage the total flow of a distribution channel from suppliers to end users. SCM coordinates and integrates all operational activities into a seamless process, which links the business partners in the chain including various departments within a company and the external partners such as suppliers [11]. A key point in SCM is that the entire process must be viewed as one system. Any inefficiencies incurred across the SC (suppliers, manufacturing plants, warehouses, customers, etc.) must be assessed to determine the true capabilities of the process [4]. In general, SCM seeks to improve the performance through eliminating of waste and better leveraging of internal teamwork and external supplier capabilities and technologies.

2.2. SCM in a manufacturing context

When facing a competitive global market, manufacturing companies endeavour to downsize, focus on their core competencies, and attempt to achieve competitive advantage by effectively managing outsourcing activities and relationships with suppliers and customers [10]. At the same time, manufacturing companies are streamlining all operations and minimising the time-to-customer for their products. It has been reported that the manufacturers have changed their ways of doing business. These changes constitute new challenges which need to be effectively managed. The primary changes are highlighted as [10-12]: greater sharing of information between suppliers and manufacturers; horizontal business processes replacing vertical departmental functions; shift from mass production to customised products and greater emphasis on organisational and process flexibility; increased reliance on purchased materials and outside processing with a simultaneous reduction in the number of suppliers; necessity to coordinate processes across many sites; employee empowerment and the need for rules-based real time decision support systems; and competitive pressure to introduce new products more quickly.

To manage these changes, SC integration has become increasingly critical for most manufacturing companies [10]. Implementing SCM can help manufacturing companies utilise their suppliers' processes, technologies, and capabilities to enhance their own competitive advantage, and effectively coordinate manufacturing, logistics, materials, distribution and transportation functions between manufacturing company and its suppliers. Therefore, one of the most significant paradigm shifts of competitive business strategy is that individual businesses no longer compete effectively in isolation, but rather as integrated SCs [4]. Accordingly, the ultimate success of business depends on management's ability to integrate the complicated network of SC relationships.

Since the 1980s, SCM has come to the forefront of public notice. Many manufacturing companies reaped the benefits of establishing intensive collaborative relationships within and beyond their own company [9]. Two important factors have motivated this strategic shift.

Firstly, manufacturing companies have become increasingly specialised in their products and technology. They realised that better profits and streamlined procedures can be made by searching for suppliers who can provide low cost, quality materials rather than having their own source of supply. It becomes critical for the companies to manage the entire network of supply to optimise overall performance. It has been widely recognised within the industry that whenever a company deals with another company that performs the next phase of the supply chain, both stand to benefit from the other's success [12].

Secondly, due to increasing national and international competition, customers have multiple sources from which to choose to satisfy their needs. Therefore, locating products throughout the distribution channel for maximum customer accessibility at a minimum cost becomes crucial [13]. Previously, companies looked at solving the distribution problem through maintaining inventory at various locations throughout the chain. However, the dynamic nature of the marketplace makes holding inventory a risky and potentially unprofitable business. Customers' buying habits are constantly changing, and competitors are continually producing similar and competitive products. Market demand changes make it almost a sure bet that the company will have the wrong inventory [12]. The cost caused by holding inventory also means most companies can not provide a low cost product when funds are tied up in inventory.

2.3. SCM strategies in electronic manufacturing industry

Strategy 1: Supplier Evaluation and Selection (SES)

The modern electronic manufacturing industry is dynamic and customer-oriented. It is also a major contributor to the strength of the global economy in the present competitive environment [14]. The various companies work in a competitive and fast changing market environment. In view of this, the electronic manufacturing industry has developed special strategies so that they can excel in such highly competitive situations. One of the most important strategies is the selection and evaluation of certified (qualified) suppliers. This strategy helps to ensure the suppliers fulfil the requirements of the manufacturing companies on cost, quality and efficiency [15]. At the same time, the companies also build more effective relationships with their suppliers through the evaluation and selection process [12].

Strategy 2: Early Supplier Involvement (ESI)

Through early supplier involvement (ESI), supplier's performance, capability and latest technology directly contribute to better quality and cost reduction in the manufacturer's own products. More specifically, suppliers' participation in the early stage of the product development process can provide more cost-effective design choices, develop alternative conceptual solutions, select the most suitable and affordable materials, components, and technologies, and help design assessment [11]. Based on this approach, suppliers can help the manufacturing company to reduce the lead-time and to introduce new products earlier in the market. It has been reported that ESI in the design process has a great positive impact on business performance [16].

Strategy 3: Supplier Management Strategy (SMS)

From manufacturing operational perspective, the performance of a key supplier directly influences a manufacturing company's operational performance. On average, manufacturing companies spends over 50% of its revenues on purchasing [17]. Supplier management strategy (SMS) addresses a manufacturing company's efforts in improving its suppliers' performance and capabilities through strategic/culture alliance in order to achieve both short- and long-term supply needs [5]. In other words, SMS has great impact on the quality, costs, technology, and delivery performance of a manufacturing company and its suppliers.

SMS can result in higher product availability, better delivery speed, and enhanced reliability of the manufacturing company (i.e., time-based operational efficiency). In addition, SMS leads to closer cooperation between manufacturing companies and their suppliers in product or component design, resulting in lower engineering changes and operational costs (i.e., cost-related operational efficiency) [18]. Moreover, managing supplier performance is concerned with the sourcing, quality, cost, delivery, response, provision of education and training, monitoring of supplier performance, and supplier certification [19]. It also helps to identify the opportunities for progressive improvements. The ability of suppliers to influence customer satisfaction makes supplier performance essential to longer-term market success.

By early involving suppliers in product development activities and continuous improvement efforts, suppliers learn about manufacturing company's requirements, culture, and decision-making patterns, which help them to be more efficient in meeting the customer's expectation. This strategy helps to enhance communication, share knowledge, improve decision-making, and upgrade supplier and manufacturing company's performance [11].

Lambert and Cooper [4] described that SCM is widely accepted as a necessary strategic approach that improve the competitiveness of manufacturing companies. These above-mentioned SCM strategies can be treated as the most common and major indicators for performance improvement in manufacturing companies and also their suppliers. All of these strategies are constantly finding ways to strive for strengthening manufacturing company's competitiveness in terms of reducing costs, improving quality and reinforcing effectiveness, which benefits both manufacturing companies and suppliers and ultimately lead to their business competency [12]. The above discussion gives rise to the first hypothesis:

Hypothesis 1: SCM is positively associated with BP.

3. Product development process

New product development (NPD) coordinates a series of important aspects of the development process including concept development, design planning, system level design, detail design, testing and refinement [21]. At the same time, product design stage also involves the product development team from various functions to clarify targets and to receive, analyse and disseminate knowledge among team members. The development and introduction of innovative new products is one of the most important challenges for manufacturing companies facing uncertain and competitive business environments [22].

Product development process (PDP) concerns about the implementation of various design activities which contribute to the effectiveness of NPD [21]. Lambert and Cooper [4] explained that if new products can be seen as the lifeblood of a company, then product design and development is the lifeblood of a company's new products. Manufacturing company and its suppliers must be integrated into the product development process in order to reduce time to market and produce better quality products. Since product life cycles shorten, the desired products must be developed and successfully launched in ever shorter timeframes in order to remain competitive and to make better profit.

Market competition requires companies to procure and apply resources to create value by offering better quality products in a timely manner and with continuously improving efficiency. In order to pursue these objectives, companies must emphasize faster and more efficient development processes, shorter and more cost effective design cycles and quicker delivery time [23]. In addition, Ahire and Dreyfus [13] explained that effective product design and development process has been recognised as important market leadership tool by successful companies in competitive industries.

Two major dimensions of PDP have been identified as (1) speed of new product development and (2) number of components used in products. The first dimension explains the ability of a manufacturing company to frequently offer new products, new designs and/or new services to marketplace and customers [13]. The second dimension is design simplification, i.e., component standardization and modular product design, which directly affect product cost and performance through their impact on the number of parts used in the product [13]. Therefore, the speed of new product development and components reduction in product designs are two major indicators of product design performance.

The design efforts of designers are usually focused on introducing not only more but better products. Such efforts should take into account manufacturability of the proposed products. Therefore, design simplification and component reduction are important hallmarks of good design performance [22]. Parts reductions allow engineers to produce new products faster by working with previously designed and built components for which costs, standards, bills of materials, and lead times are already known. As can be imaged, process complexity is a function of design complexity, a lower number of parts per product should result in more streamlined production. Fewer and standardised components result in lower inventory costs and easier management of inventory. Simplified production and engineer's prior experience with standardised parts should also result in lower scrap, rework and fewer defective unit which leads to cost saving and production efficiency [10,13].

In addition, design is not only a cost driver, it is also recognised as a major determinant of quality because most companies considered that quality can be designed into the product at least as much as it is built in during manufacturing process. According to Petersen et al. [14], there are a number of influencing factors are important to the creation of successful new products. Two of these factors contain design for quality and design for manufacturability within a manufacturing company. What is more, the importance of its supplier's involvement and collaboration must be also taken into consideration. Good design takes every detail into account which contributes to a company's ability to develop and produce new products more quickly by minimising engineering changes which is the main reason of production delay and cost raise. In other words, good design makes great contributions to the three main operational outcomes which consist of cost, quality and timeliness [24,25]. Therefore, the second hypothesis can be formulated as:

Hypothesis 2: PDP is positively associated with BP.

4. Knowledge management and sharing

4.1. Knowledge management

Haag et al. [26] explained that mountains of information are of little use unless they are extracted and made available to the people or systems that need meaningful information (i.e., knowledge) at the right place and at the right time. Knowledge is rapidly becoming a critical asset for promoting company's future success. Leveraging knowledge in managerial and technical activities can bring long-term benefit to a company [27].

Liu et al. [1] proposed that knowledge has currently become the main manufacturing resource and a prerequisite for success in the production environment. Competitiveness and the resulting rewards can be obtained by taking advantage of knowledge management (KM) and sharing. Manufacturing companies have been creating, coding, storing, retrieving, transmitting and applying knowledge in their production process for years. For example, training and employee development programs have been used to facilitate knowledge acquisition; products reports and manuals have been used to disseminate best practices [28]. Manufacturing companies become increasingly knowledge focused, since in the knowledge economy era, the strategic role of knowledge has been repeatedly addressed [29], and the intensive competition in the market demands the manufacturing companies to manage this strategic asset more effectively in order to achieve desired business objectives [15]. Artail [6] depicted that KM involves collecting and transferring information to the needed individuals or groups. Such activities include systematic processes of obtaining, refining, storing and communicating knowledge so that company can effectively increase the value of the knowledge asset, which lead to better business achievement and company objectives. The recent studies [3,15] reported that an effective KM program can help to promote innovation by encouraging the free flow of ideas; improve customer service by streamlining response time; boost revenues by getting products and services to market faster; enhance employee retention rates by recognising the value of employees' knowledge; and streamline operations and reduce costs by eliminating redundant or unnecessary processes.

4.2. Knowledge sharing

Knowledge sharing is defined as employee behaviours which facilitate the dissemination or transfer of his/her knowledge to others [15]. Within the context of manufacturing industry, KS occurs through a variety of mechanisms, i.e., personnel movement, training, communication, observation, technology transfer, replicating routines, presentations, interactions with suppliers and customers, and other forms of intra- and inter-organizational relationships [30].

According to Davenport and Prusak [31], most KM programmes have one of three aims: (1) to make knowledge visible and show the role of knowledge in an organisation, mainly through education, training, open communication and information technology (IT) tools; (2) to develop a knowledge-intensive culture by encouraging and aggregating behaviours such as knowledge sharing (as opposed to hoarding) and proactively seeking and offering knowledge; and (3) to build a knowledge infrastructure not only a technical system, but a system of connections among people given space, time, tools and encouragement to interact and collaborate. Hence, within an organisational context, KS is the most critical component in any KM programmes which aim at improving business performance [3].

According to Hsu [15], an organisation that applies effective KS will constantly develop its employee's competency. As employee's capability enhanced, their job performance can be improved, and ultimately contribute to business performance. Lubit [3] explained that the previous working experience transfer should improve performance of those within a work team. Experience accumulated in different work teams strengthens the overall competitiveness of the company, which would outperform the competitors without effective KS implementation. Thus intra and inter work team KS activities are fundamental for both the functioning of their members and the competitive dynamics of the company. In short, a creative approach of KS should result in improved efficiency, higher productivity, and increased revenues in practically any business function [28].

4.3. KS in manufacturing companies

Within the context of the manufacturing companies, KS can be seen as the cornerstone of organisational learning as KS activities facilitate communications between the stakeholders of the manufacturing process [32]. In the manufacturing environment business activities such as SCM and PDP require a high proportion of the company resources such as budget and manpower. Therefore, SCM and PDP can be seen as two major business activities, which contribute to the companies' competitive advantage and performance [2,3]. Sufficient KS is required to understand the context and the background of the problem in order to improve these activities.

For example, a new product development project needs to deal with information from multiple sources, e.g. customers' requirement, market trend, technological development and suppliers' suggestions. Effective KS could decrease the uncertainty in the course of PDP [28]. In other words, PDP is dependent on cross-functional integration and KS to achieve its success [28]. In case of SCM, evidence indicates that due to Japanese automaker's KS and joint problem solving routines, their suppliers seek to create more additional value for the manufacturing companies, hence these automakers could achieve lower costs, higher quality and greater innovativeness [32]. The cases of Toyota Corporation and Honda Corporation suggest that KS activities can also lead to supplier performance improvement [33]. Therefore KS is essential for manufacturing companies to achieve desired performance [34]. Hence:

Hypothesis 3: KS is positively associated with BP.

5. Theoretical framework

Based on the above discussion, this study proposes a theoretical framework in order to investigate the relationships between business activities (SCM, PDP, KS) and BP. As illustrated in Figure 1, the theoretical framework has four constructs which are linked by the hypothetical relationships proposed by H1, H2 and H3.

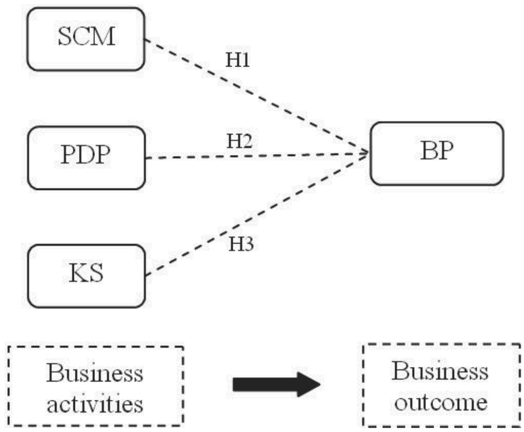


Fig. 1. Proposed theoretical framework

The above mentioned literature review of empirical studies addressing SCM, PDP, KS and BP in the manufacturing context provided the basic measurable variables for operationally defining the four constructs of the theoretical framework. The following section describes the method for measurement development and relationship identification.

6. Research methodology

Following a deductive approach, this study started by forming rational relationships between constructs and then moved toward solid empirical evidence [35]. The primary purpose of this study was hypothesis testing, which offers a cross-sectional design to provide understanding of the effect of SCM, PDP and KS activities in achieving desired BP within electronic manufacturing companies operating in Taiwan. Data were gathered over a period of five (5) months via a mail questionnaire survey to elicit respondents' opinions on the extent of SCM, PDP, KS activities and the perceived BP level in targeted companies. In the questionnaire, five-point Likert scales were used to measure the operationally-defined variables of the constructs within the proposed theoretical framework. Demographic information about the respondents and their companies were also collected. The questionnaire was pre-tested with forty (40) managerial and professional staff members to evaluate the questionnaire for clarity, bias, ambiguous questions, and relevance to the designated industries and operations of Taiwanese manufacturing companies. Thirty (30) respondents offered valid feedback and useful suggestions [36]. The data collection process began after the questionnaire had been finalised, based on the pre-test feedback.

The sample population consisted of 241 manufacturing companies randomly drawn from the list in the Taiwan Stock Exchange (TSE) market. A mixture of large- and medium-sized electronic manufacturing companies represented the theoretical population because they provide a relatively better organisational structure of implementing business activities compared to small companies. Self-administered questionnaires were mailed or delivered in person to the managerial and professional staff member(s) within targeted companies. A total of 168 usable responses were received from 83 companies representing 34.4% of the research population. No more than five (5) usable (containing no missing data) feedback questionnaires were chosen from each company to avoid bias in the data. The responses were considered a good representation of the opinions of the population, since the majority of the respondents were middle-aged, well-educated, experienced, and knowledgeable about manufacturing operations and management within their companies.

7. Data analysis

Exploratory factor analysis (EFA) was applied to determine how and to what extent the measurement variables were linked to their underlying factors under each construct. Based on these scales, correlation was performed to establish the general relationships between these factors. Then path models were assessed to simultaneously examine interrelationships to determine the most active factors. Data examination, EFA and correlation analyses were performed by the Statistical Package for Social Sciences Software (SPSS version 15.0). Version 5 of AMOS (Analysis of Moment Structure), the structural equation modelling (SEM) software, was then used to perform the path analysis. Data screening techniques were applied to all variables to assess their distribution and ensure that normality and linearity are reasonably upheld [37].

7.1. Measurement development

EFA was adopted for identifying the structure among the set of measurement variables for each construct and also data reduction. The VARIMAX method for orthogonal rotation under the component factor model was chosen to give a clear separation of the factors. The 168 cases met the acceptable sample size of 100 for undertaking the factor analysis; and was much larger than the minimum requirement of 80, that was five (5) times as many subjects as the variables to be analysed in the constructs with the largest number of variables (16) [38]. Checks were undertaken to ensure factorability is upheld for all factor analysis scenarios. With the sample of 168, a factor loading of 0.50 and above was considered significant at the 0.05 level to obtain a power level of 80% [38]; thus, variables having a factor loading of less than 0.50 were eliminated. Moreover, the reliability coefficient of all measures was above 0.70, indicating good consistency of the scales for the constructs and their factors [38]. Since the constructs were conceptually defined based on a combination of the literature review, previous empirical studies, and the pilot study, the factors' scales were considered to have face validity [38]. The factor analysis results are summarised in Table 1.

Table 1.
Factor analysis results

Constructs and Factors	Cronbach's Alpha	Total Variance Explained (%)
SCM: Supply Chain Management		
SCMF1: supplier evaluation and selection	0.81	71
SCMF2: supplier involvement		
PDP: Product Development Process		
PDPF1: employee involvement	0.74	69
PDPF2: design simplification and modular design		
KS: Knowledge Sharing		
KSF1: top management commitment and employee empowerment	0.80	65
KSF2: continuous knowledge sharing and learning		
BP: Business Performance		
BPF1: business competitiveness		
BPF2: long term business performance	0.78	74
BPF3: process efficiency		

As presented in Table 1, the analysis found two (2) factors for the SCM construct. SCMF1 represents a company's effort on sourcing, evaluating and selecting potential strategic suppliers. SCMF2 indicates early involvement of efforts and resources from suppliers. These two factors suggest that both the manufacturing company and its suppliers need to make efforts in order to improve SCM activities. The analysis found two (2) factors for the PDP construct. PDPF1 reflects employees' effort and contribution in the development process. PDPF2 represents improvement in the practices of the design process such as simplification and modular design. These two factors characterises the primary foci of the PDP improvement in manufacturing companies. The analysis identified three (3) factors for the KS construct. KSF1 denotes the contribution to KS from both top management and employees. KSF2 reflects the knowledge sharing and learning activities. KSF3 stands for the cross-functional communication and teamwork. These three factors represent KS activities that are commonly implemented to improve business performance in a manufacturing company. The analysis identified three (3) factors for the BP construct. BPF1 indicates a company's competitive ability. BPF2 represents long-term general business performance from both a financial and customer satisfaction perspective. BPF3 reflects production and service efficiency. These three factors measure BP based on competitiveness, financial performance, customer satisfaction and process efficiency in the Taiwanese electronic manufacturing industry.

In summary, the EFA developed measurement scales for the four (4) constructs shown in Table 1, each having satisfactory reliability, validity, dimensionality, and conceptual definitions. These scales were used in the further multivariate analyses for identifying the relationships between these constructs.

7.2. Relationship identification

Correlation analysis

Correlation analysis was employed to investigate the associations between the factors within the business activity constructs (SCM, PDP, KS) and those of the BP construct. The objectives of the correlation analysis were: (1) to identify the factor within each business activity construct that has the strongest association with the BP factors; and (2) to reveal the BP factors that are strongly associated with the business activity factors. Table 2 maps the Pearson correlation values between the business activity factors and the BP factors. Indicated by Pearson correlation *r* (coefficient of correlation) values significant at the 0.01 level (2-tailed), SCMF1, PDPF2 and KSF1 showed the strongest association with two BP factors (BPF1 and BPF2), suggesting their potential stronger influence on the variance of these two BP factors. Whilst, BPF1 and BPF2 were strongly associated with most of business activity factors, indicating that they might be more sensitive to the variance in the business activity factors, in particular SCMF1, PDPF2 and KSF1. Based on this exploratory analysis, path analysis was then employed to confirm the impact of these three active business activities factors (SCMF1, PDPF2 and KSF1) on the two sensitive BP factors.

Path analysis

Based on the findings of the correlation analysis, a path model was formed to simultaneously estimate a series of separate, but interdependent, regression equations between the most active factors of SCM, PDP and KS with the most sensitive factors of the BP construct. In the model fitting process the insignificant links represented by regression weights of *p* value larger than 0.05 were removed. In the final path model, the estimates of both regression weights and variances are statistically different from zero at a 0.05 level of significance. Table 3 reports the unstandardised regression weights for both initial and the final path models. Figure 2 illustrates the final path model with standardised estimates, and the fit indexes are indicative of satisfactory fit to data.

Path analysis provided strong empirical evidence for the existence of causal relationships between KSF1, SCMF1, PDPF2, BPF1 and BPF2. This finding suggests that a higher level of top management commitment and employee empowerment for KS activities and supplier evaluation have a positive impact on both competitiveness and long-term business performance. In particular, as indicated by the comparatively larger standardised estimates, the findings also reveal that the policies for encouraging employees to share knowledge and experience could improve competitiveness of the company. Moreover, well-performed supplier assessment and evaluation systems would benefit the long-term business performance. In addition, design simplification and modular design positively contributes to business performance in the long run.

Table 2.
Correlation analysis results

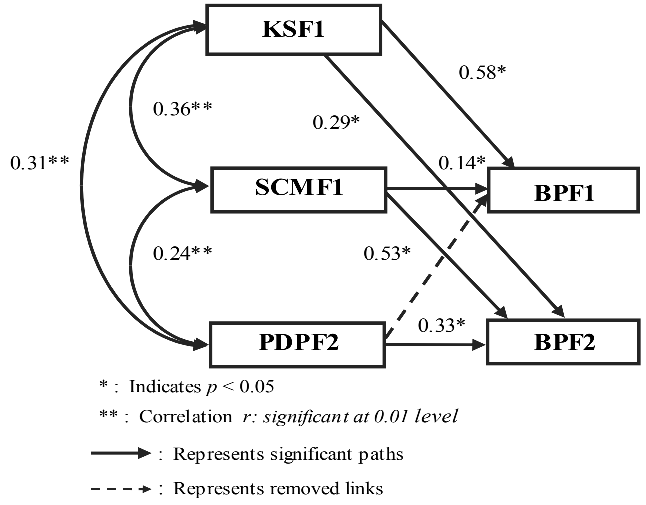
	Pearson Correlation Coefficient		
	BPF1	BPF2	BPF3
SCMF1	0.50**	0.66**	0.01
SCMF2	0.47**	0.05	0.36**
PDPF1	0.05	0.50**	0.21**
PDPF2	0.32**	0.50**	0.20*
KSF1	0.68**	0.44**	0.11
KSF2	0.36**	0.55**	0.19*
KSF3	0.08	0.20*	0.35**

Notes:
The active business activity factors and the sensitive BP factors are bold.
** Correlation is significant at the 0.01 level (2-tailed)
*Correlation is significant at the 0.05 level (2-tailed)

Table 3.
Regression weights of the Initial and Final Path Model

Path link		URW	SE	CR	*p*
Initial path model					
BPF1	· KSF1	0.52	0.05	9.71	***
BPF2	· PDPF2	0.37	0.06	6.09	***
BPF2	· SCMF1	0.32	0.03	9.62	***
BPF1	· SCMF1	0.16	0.03	4.82	***
BPF2	· KSF1	0.14	0.05	2.53	0.01
BPF1	*PDPF2*	*0.09*	*0.06*	*1.42*	*0.16*
Final path model					
BPF1	· KSF1	0.53	0.05	10.31	***
BPF2	· PDPF2	0.37	0.06	6.09	***
BPF2	· SCMF1	0.32	0.03	9.62	***
BPF1	· SCMF1	0.17	0.03	5.06	***
BPF2	· KSF1	0.14	0.05	2.55	0.01
BPF1	*PDPF2*	*n*	*n*	*n*	*n*

*Note: URW: unstandardised regression weights; SE: standard errors; CR: critical ratio; *n*: deleted links; ***: < 0.0005.



Notes:
KSF1: Top management commitment and employee empowerment
SCMF1: Supplier evaluation and selection
PDPF2: Design simplification and modular design
BPF1: Business competitiveness
BPF2: Long term business performance
Fit indexes:
Absolute fit indexes: χ^2= 3.413 (df: 2); p= 0.181; GFI= 0.992; AGFI= 0.940.
Incremental fit indexes: χ^2/df= 1.707; NFI= 0.989; CFI= 0.995.
Parsimonious fit indexes: RMSEA= 0.065
Sample adequacy: Hoelter's critical N= 451 at 0.01 level (> 200) indicative adequate sample size.

Fig. 2. Final path model with standardised estimates

8. Conclusions and recommendations

The empirical study supports that key manufacturing business activities (i.e., SCM, PDP, and KS) are positively associated with BP. The findings also revealed that some specific business activities such as SCMF1, PDPF2, and KSF1 have the strongest influencing power on particular business outcomes (i.e., BPF1 and BPF2) within the context of electronic manufacturing companies operating in Taiwan.

The finding regarding the relationship between SCM and BP identified the essential role of supplier evaluation and selection in improving business competitiveness and long term performance. It reveals the importance of making the right decision, up front, about which supplier to work with. This finding suggests that companies need to rethink and reorganise their supply base as an extension of their manufacturing operation. This means both suppliers' capabilities and their cultural compatibility with the manufacturing companies should be taken into consideration during the supplier evaluation process. Based on this finding it is recommended that companies should involve suppliers in partnerships to continuously improve operations and enhance product design efforts, which would ultimately enhance business performance.

The analysis also provides strong empirical evidence to the positive influence of PDP upon BP. Many practitioners are now implementing the 'simple design rule' in their company. Production complexity normally comes from design complexity. Thus, when companies develop a series of products, design simplification and modular design are two major product design efforts applied in the manufacturing industry which leads to better design performance, better quality and faster design practice. The reason is that they not only reduce the product design life cycle, but also decrease the subsequent production and quality problem. Hence, companies should continuously focus on design simplification and modular design in the PDP.

The study revealed the essential role of KS activities in achieving sustainable competitiveness of a manufacturing company. The process of forming knowledge in companies, such as creation, storage/retrieval, and transfer do not necessarily lead to enhanced business performance; only through effectively applying knowledge to the right person at the right time does. Business performance depends more on an employee's ability to turn knowledge into effective action. This finding suggests that top management's support and employee empowerment are critical for the implementation of KS. Since the utilisation of knowledge can enhance an employee's ability in performing their tasks, solving problems and making decisions, which eventually contributes to business performance, it is recommended the companies need to allocate resources to guide and encourage KS activities.

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