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The value of strategy and flexibility in new product development: The impact on performance

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Abstract

Purpose – The purpose of this paper is to examine the relationship between strategy and flexibility in new product development, and the operational and financial performance in the supply chain context. The motives for conducting this research are to introduce the supply chain strategies and new product development flexibility (NPDF) as constructs that could have the potential to contribute to the success of supply chain performance. Based on the relational view of the firm, the authors propose that supply chain strategy is an antecedent of NPDF and can create value for the buying firm in terms of better financial and non-financial performance.

Design/methodology/approach – The structural equation modeling approach was used to evaluate the proposed model and analyze hypothesized relationships. The analysis, based on data collected from 175 small- and medium-sized (SME) Canadian manufacturing companies.

Findings – The analysis shows that there are direct positive effects from strategy on NPDF. The findings indicate also a direct positive association between NPDF and performance and showed that the total effect (direct and indirect) positively influenced performance.

Originality/value – The literature did not reveal any study which attempted to examine strategy, NPDF, and performance in the supply chain context of SMEs. The current study fills this important gap in the literature.

Keywords Supply chain performance, New product flexibility, Supply chain strategy

Paper type Research paper

1. Introduction

Despite its importance, flexibility in developing new products remains an elusive goal for many firms, as evidenced by the high-failure rates of new product launches. Nearly 50 percent of new products introduced in the market are complete failures and more than 70 percent do not reach their sales goals (Yuan and Zelong, 2009). New product development (NPD) has become a significant factor in today's business environment. In many industries, the ability to develop new products quickly, effectively, and efficiently is now the single most important factor driving a firm's success (Schilling, 2013). Cooper and Kleinschmidt (2000) emphasized the importance of NPD in the success of a company. Supply chain management (SCM) and NPD have become important sources of gaining a sustainable competitive advantage. Unlike traditional NPD, learning takes place when supply chain firms extend company boundaries as the information search becomes used by company decision makers (Jespersen, 2012).

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For a long time firms have recognized the important strategic value of NPD in their business environment. Leonard-Barton (1992) noted that many firms have failed to introduce new products because of their inability to extend resources and capabilities to meet the needs of NPD. Similarly, Tatikonda and Rosenthal (2000) found that firms often fail to introduce new products because they can not redeploy resources. Poolton and Barclay (1998) noted a set of six variables that have consistently been identified in the literature as being associated with successful NPD: top management support, long-term strategy with a focus on innovation, long-term commitment to major projects, flexibility and responsiveness to change, top management acceptance of risk, and support for an entrepreneurial culture. As competition and uncertainty have increased, flexibility in business has emerged as an increasingly important issue for supply chain companies (Saxena and Wadhwa, 2009). Thus, flexibility is definitely of importance in effectively enhancing NPD, and, as a result, more attention is being paid to the impact of flexibility on performance (Márcio *et al.*, 2014; Hemphill, 1996; Bierly and Chakrabarti, 1996; Das, 2001). Flexibility in NPD represents a potential means of improving company competence and is one significant measure of supply chain performance (Fantazy *et al.*, 2009). The goals of new product development flexibility (NPDF) are typically business growth and improved performance. From a performance perspective, flexibility is a powerful system ingredient that enables stable performance under changing conditions. Increasing flexibility in NPD can be regarded as a strategy for a continuous flow of new products to the competitive market (Thomas, 2014).

Several types of supply chain flexibility (SCF) have been acknowledged, flexibility in NPD being among the most significant type of SCF. Flexibility in NPD captures a company's proficiency at getting new products early to the market. However, research on SCF has overlooked the role of flexibility in NPD in general and empirical study in particular (Yi *et al.*, 2009). Many researchers emphasized the fact that there is limited empirical research on SCF in NPD that specifically provides the supply chain managers with empirical evidence to help them develop and implement effective NPD strategies. Moreover, there are even fewer studies about the relationship between strategy and NPDF in the supply chain context, and so this issue offers a research opportunity (Thomas, 2014; Kettunen *et al.*, 2015). This paper aims to fill this gap in the NPD literature and to encourage further research on the concept of flexibility in NPD.

The rational of this research study is to investigate the relationship between the current practices of NPDF and supply chain strategy, and empirically verifying the impact of this relationship on supply chain performance. We take into consideration the multi-dimensional nature of both NPDF and supply chain strategy and examine the relationship between these two factors. The premise is that organizations can be flexible in some ways and less flexible in others (Kettunen *et al.*, 2015; Suarez *et al.*, 1996). Specifically, managers may have to choose the dimension in which they want their plants to be flexible. Supply chain strategy could be the factor that determines this important strategic flexibility choice. In other words, when implementing a certain type of strategy in the market place, management should choose to emphasize and develop particular sets of SCF (Kumar *et al.*, 2006). Therefore, the purpose of this study is to map the relationship between the dimension of NPDF and supply chain strategy. We are interested in how different supply chain strategy dimensions (innovating, customer oriented, and following) link with NPDF. Furthermore, this study tests the effectiveness of such mapping on supply chain performance. Theoretically, the alignment of a particular supply chain strategy dimension with a specific type of SCF should improve overall supply chain performance.

Building on the literature dealing with manufacturing flexibility, SCM, and management of innovation, this research empirically examined the impact of strategy and NPDF on performance in the supply chain context in small- and medium-sized (SME) firms. Using the data collected from 175 manufacturing firms in Canada, the constructs we identified have been used to test a theoretical relationship using the structural equation modeling (SEM) technique. The study is structured as follows. Section 2 reviews the literature relevant to the research model. Section 3 explains the research model and the hypotheses formulated. Section 4 outlines the research methodology of the empirical study. Section 5 provides results and data analysis. Section 6 discusses the research implications. The last section presents conclusions, outlines the limitations of the study, and gives suggestions for further research.

2. Literature review

A substantial amount of literature dealing with manufacturing flexibility has accumulated over the last 30 years. Two schools have emerged in the last three decades that address the impact of flexibility on performance: those proposing a direct link vs those supporting a moderate (or contingency) link (Vokurka and O'Leary-Kelly, 2000). The direct link school suggests that increased flexibility will lead to improved firm performance. On the other hand, the contingency-based school suggests that the performance flexibility link is situational. That is, firms operating in an uncertain demand environment would achieve higher performance by increasing volume flexibility, while, volume flexibility will not necessarily improve performance for firms operating in a more stable environment. Simply increasing flexibility will not necessarily increase firm performance; this will depend on the degree to which flexibility complements the firm's strategy (Vokurka and O'Leary-Kelly, 2000).

Studies by Swamidass and Newell (1987), Parthasarthy and Sethi (1993), Gerwin (1993), Vickery *et al.* (1999), Zhang *et al.* (2003), Garavelli (2003), Sánchez and Pérez (2003), Lummas *et al.* (2005), Swafford *et al.* (2006), Fantazy *et al.* (2009), Liao *et al.* (2010), Rha *et al.* (2013), Oberoi and Ahuja (2013), Gligor and Holcomb (2014), Thomas (2014), and Kettunen *et al.* (2015), have examined the direct effect of flexibility on performance. Fantazy *et al.* (2009) examined the direct impact of five flexibility types (new product, delivery, product, information systems, and sourcing) at the supply chain level on the supply chain performance. The empirical study revealed a direct relationship between all the flexibility types and all measures of financial and non-financial performance included in this study. In contrast, Fiegenbaum and Karnani (1991) found no direct relationship between volume flexibility and financial performance. Rather, they found that this relationship was moderated by organizational attributes. Thomas (2014) shows that strategic flexibility positively and partially mediates the positive relationship between design and performance.

Strategy plays a major role in SCF and it has a significant effect on a firm's competitiveness, (Kumar *et al.*, 2006). The literature has suggested a theoretical relationship between flexibility and strategy (Ettlie and Penner-Hahn, 1994; Gerwin, 1993; Suarez *et al.*, 1996). Other studies (Gerwin, 1993; Gupta and Somers, 1996; Chang Shih *et al.*, 2003; Boyle and Ratghje, 2009; Kumar *et al.*, 2006; Fantazy *et al.*, 2009; Merschmann and Thonemann, 2011; Jin *et al.*, 2014; Thomas, 2014) have taken a further step by investigating the combined relationships between the three giant constructs: strategy, flexibility, and performance. Merschmann and Thonemann (2011) have addressed the link among environmental uncertainty, SCF, and firm performance through a survey of German manufacturing companies. They revealed that in uncertain

environments, companies with highly flexible supply chains perform better than companies with less flexible supply chains, while in certain other environments the opposite holds true. Kumar *et al.* (2006) presented a conceptual framework that considers the importance of linking supply chain strategy, required SCF, and supply chain performance in a systematic manner; it also showed the strategic alignment (i.e. proper fit between supply chain strategy and flexibility). It has been argued that if the alignment (fit) is effective, it should lead to an improvement in performance. Boyle and Ratghje (2009) identified the best practices that manufacturing managers adopt to improve flexibility. In their study, the authors emphasized the importance of aligning manufacturing flexibility and the tools and techniques used with organizational goals and strategy. Table I presents a summary of empirical studies of manufacturing and SC flexibilities.

The basic conceptual model proposed by Gerwin (1993), Suarez *et al.* (1996), and Kumar *et al.* (2006), presents a sequential relationship of manufacturing strategy, manufacturing flexibility, and an organization's performance. The basic model clearly shows the expected links among three variables: strategy, flexibility, and performance. The basic model hypothesizes that the manufacturing strategy will initiate the development and the implementation of manufacturing flexibility dimensions. As a result, the introduction of manufacturing flexibility enhances the organization's performance. As shown in Figure 1 the modified conceptual basic model, we have used supply chain strategy instead of manufacturing strategy. The rationale behind this is based on the fact that flexibility is not only an element of manufacturing strategy but is also related to suppliers, customers, and supply chain strategies (Kumar *et al.*, 2006). In the basic model, shown in Figure 1, we used the term SCF instead of manufacturing flexibility. The supply chain extends beyond the enterprise, which means that SCF must also extend beyond one firm's internal flexibility (Duclos *et al.*, 2003). Finally, in the conceptual basic model shown in Figure 1, we have used the term supply chain performance instead of organizational performance.

In general, the literature we reviewed emphasizes the link between the three variables: strategy, flexibility, and performance. It looked specifically at the causal relation that hypothesizes that the supply chain strategy will trigger the development and implementation of SCF types, including NPDF, and that the introduction of NPDF enhances supply chain performances. Since the objective of this study is to verify the relationship among strategy, flexibility in NPD, and performance, we used NPDF (see Figure 1) instead of flexibility, as suggested in previous studies. Our reasoning is based on the fact that some authors consider flexibility in NPD as a replacement for SCF (Zhang *et al.*, 2002). Furthermore, flexibility in the NPD component plays a strategic role in the success of the supply chain (Kettunen *et al.*, 2015). However, the roles of flexibility in NPD and SCM in strategic issues are still not often the focus of attention in the NPD literature. While the linking of strategy, NPDF, and performance is theoretically justified, we identified no empirical evidence related to such a connection. In the following subsections, we review the literature relevant to each of the constructs used in the research model.

2.1 Supply chain strategy

Several studies provided theoretical and empirical evidence that companies in the supply chain are pursuing a number of different strategies to compete in the marketplace (Fisher, 1997; Christopher and Towill, 2001; Katz *et al.*, 2003; Christopher *et al.*, 2006; Tachizawa and Gimenez, 2010; Fantazy *et al.*, 2011a, b).

Table I. Summary of empirical studies of manufacturing and SC flexibilities

	Research study	Flexibility situation	Types of exogenous variables examined	Flexibility performance relationship	Dimensions performance examined	Flexibility context	Technique used
1	Swamidass and Newell (1987)	DV, IV	Environmental factors	Direct	Financial and growth performance	Manufacturing flexibility	Regression
2	Fiegenbaum and Karnani (1991)	DV, IV	Organizational attributes	Moderated	Financial	Manufacturing flexibility	Regression
3	Parthasarthy and Sethi (1993)	IV	Strategy and organizational attributes	Moderated	Financial and growth performance	Manufacturing flexibility	Regression
4	Gupta and Somers (1996)	DV, IV	Strategy	Direct	Financial and growth performance	Manufacturing flexibility	Regression
5	Suarez *et al.* (1996)	DV	Organizational attributes and technology	none	none	Manufacturing flexibility	Regression
6	Vickery *et al.* (1997)	IV	none	Direct	Financial and growth performance	Manufacturing flexibility	Regression
7	Zhang *et al.* (2003)	DV, IV	Manufacturing capability and competence	Direct	Customer satisfaction	Manufacturing flexibility	SEM
8	Sanchez and Perez (2005)		technological complexity, the average intensity, and the use of firm practices.	Direct	Cost and time	Manufacturing flexibility	Regression analysis
9	Lummas *et al.* (2005)	DV	Operations, logistics, supply network, organizational, and information systems	Direct	Customer satisfaction and supply chain assets	Supply chain flexibility	Delphi method
10	Fantazy *et al.* (2009)	IV, DV	Supply chain strategies	Direct	Financial and non-financial	Supply chain flexibility	Path analysis
11	Liao *et al.* (2010)	IV	Supplier selection, supplier development, strategic supplier alliance	Direct	Cost, supplier performance, reliability, and time-based performance	Supply chain flexibility	SEM
12	Merschmann and Thonemann (2011)	DV	Environmental uncertainty	Direct	Return on sales, sales growth	Supply chain flexibility	SEM
13	Gligor and Holcomb (2014)	IV	Market orientation, supply chain orientation	Direct	Financial performance	Supply chain flexibility	Multiple regression
14	Jin *et al.* (2014)	IV	IT-enabled sharing capability	Direct	Competitive advantage	Supply chain flexibility	SEM
15	Kettunena *et al.*, (2015)	IV	Competitiveness and market type	Direct	Value and use	Supply chain flexibility	Mathematical model

Notes: Situation of flexibility – DV-flexibility as dependent variable; IV-flexibility as an independent variable

Tachizawa and Gimenez (2010) have identified three supply strategies (integrated, domestic, and offshore) and examined the relationship with contingent factors. The results show that there is no single approach to achieve supply flexibility, and that the type of flexibility achieved (supplier responsiveness, delivery policy, and adaptability) depends on the strategy followed.

Fantazy *et al.* (2011a, b) empirically verified the theoretical framework developed by Katz *et al.* (2003). They partially supported the four supply chain strategy types (innovative, modularizing, appending, and follower) proposed by Katz *et al.* (2003). Fantazy *et al.* (2011a, b) revealed three supply chain strategy types, two of which were confirmed by Katz *et al.* (2003): innovative strategy (INS) and follower strategy (FOS). Interestingly, a new strategy called customer-oriented strategy (COS) was identified. However, the study found no evidence of the two underlying dimensions of supply chain strategy that they called modularizing and appending strategies in the Canadian manufacturing industry. The INS tends to be the earliest used to enter the new market or adopt the new technology to achieve a competitive advantage. On the other hand, the INS also has to pay higher risk and innovation costs, which the other two strategies do not require. The COS is used by a firm with exceptional customer service, reasonable quality, and competitive prices; it creates satisfied customers. Thus, the COS focusses on the dynamic interactions among the supply chain partners, internal stakeholders, and customers. As a core concept, it holds that all members of a supply chain must continue to create superior value for customers and do this better than the competitors. The FOS is seen in a firm that enters the market late or adopts new technology late. The FOS usually follows other firm examples and usually focusses on tight cost control to achieve low-cost production. This research employed the typology of the supply chain strategy framework proposed by Fantazy *et al.* (2011a, b).

2.2 New product flexibility development and SCF

The literature available on the specific subject of SCF is limited, a view reinforced by Merschmann and Thonemann (2011) and Buganza *et al.* (2010). However, it is still possible to find some flexibility types and definitions of the various types of SCF. The types of SCF that are frequently discussed in the literature are new products, product development, information systems, suppliers, logistics/distribution, and volume flexibility (Duclos *et al.*, 2003; Lummas *et al.*, 2005; Sanchez and Perez, 2005; Zhang *et al.*, 2002; Kumar *et al.*, 2006; Fantazy *et al.*, 2009). Since this study focusses on flexibility in NPD, this section will highlight important issues related to NPDF.

NPDF is an important capability that enables firms to modify and foresee innovation strategies in response to current or future changes in the environment (Márcio *et al.*, 2014). In product competition, NPDF in decision making becomes especially necessary for firms to increase the speed as well as the range of their

Figure 1.
Research basic model

Sources: Gerwin (1993), Gupta and Somers (1996), Kumar *et al*. (2006), and Fantazy *et al*. (2009)

strategic maneuvers (Kettunen *et al.*, 2015; Márcio *et al.*, 2014). Flexibility in NPD can be improved through decisions related both to choosing and managing suppliers and to the configuration of the supplier's network (Buganza *et al.*, 2010). According to the product innovation management literature, it is possible to increase the flexibility in NPD by managing three main variables, which are the technology, development process, and competences (Buganza *et al.*, 2010). Kumar *et al.* (2006) defined flexibility in NPD as "The ability of supply chain partners to collaborate and coordinate to produce completely new products economically and with no additional time to meet the market demand." Reducing product development cycle time and hence the time to introduce a new product can create relative advantages in market share, profit, and long-term competitive advantage. The new product flexibility can have a significant impact on corporate profits and customer satisfaction, particularly in high-growth markets with short product life cycles.

Other researchers have also stressed the importance of flexibility in NPD as strategic flexibility. Buganza *et al.* (2010) highlight that NPDF plays a growing role in national economies. They note that given their nature, it could be supposed that companies should manage their development processes by leveraging on flexibility in NPD. They suggest that this will lead to a greater competitive advantage for the business. Zhang *et al.* (2002), Barad and Sapir (2003), and Kettunen *et al.* (2015) address the need for NPDF in order to improve efficiency and provide better customer service. For their part, Oberoi and Ahuja (2013) focus on the concept of strategic flexibility that provides organizations with the ability to change levels of production rapidly, to develop new products, and to respond quickly to competitive threats. Organizations need to develop flexibility at the strategic level in order to cope with the external pressure posed by frequent changes in customer expectations, changing market trends and competitor action. Kandemir and Acur (2012) note that strategic flexibility is widely accepted as a prerequisite for a firm's success; its application in strategic decision making to a firm's NPDF is limited to only a few studies. Furthermore, they claim that many organizations still have difficulties incorporating proactive strategic flexibility in their decision-making processes. Kandemir and Acur (2012) study advanced strategic flexibility by adopting the proactive approach of NPD decision-making flexibility and by examining its role in translating organizational resources and capabilities into NPD success.

2.3 Supply chain performance

Flexibility has been widely cited as a means for improving firm performance, especially for firms competing in very dynamic markets. Gunasekaran *et al.* (2008), Shepherd and Gunter (2006), Cirtita Segura (2012), and Rha *et al.* (2013) provide a detailed review on supply chain performance metrics, including financial and operational performance measurements. Two approaches group together the supply chain metrics balanced score card approach and process approach, where the metrics are classified into resource, output, and flexibility (Beamon and Balcik, 2008; Cai *et al.*, 2009; Cuthbertson and Piotrowicz, 2011; Rha *et al.*, 2013). This research considers financial and operational performance measurements. The two indicators used to measure financial performance are net profit and sales growth. In the operational performance measurement we focus on customer satisfaction. Customer satisfaction is the degree to which customers perceive that they have received products and services that are worth more than the price they paid (Tracey *et al.*, 1996).

3. Research model and hypotheses

3.1 Research model

Figure 2 represents the research model based upon the literature discussed in earlier sections. In this model, supply chain strategy is linked with NPDF and posited as a primary influence on the supply chain performance. As shown in Figure 2, the three supply chain strategy types – INS, COS, and FOS – may have direct and positive impacts on flexibility in NPD. As a result, flexibility in NPD should lead to higher performance. Supply chain performance includes operational performance (OPRP), measured in terms of customer satisfaction, and financial performance (FINP). Although other dimensions are of great interest, they are not included in this study due to the length of the survey and the concerns regarding the parsimony of this research. The numbers next to the lines correspond to the seven hypotheses specified in the research model.

The following subsections highlight hypotheses development based on the research model. First subsection demonstrates the relationship between supply chain strategy and NPDF. The second subsection demonstrates the relationship between NPDF and supply chain performance. Final subsection demonstrates the total effects of supply chain strategy on supply chain performance relationship.

3.2 Supply chain strategy and NPDF relationship

The first group of hypotheses deals with the relationship between strategy and NPDF. The link between strategy and flexibility is well-established in literature, as there are many empirical and theoretical studies that support the link between strategies and flexibility. Indeed one of the earliest empirical studies to examine the relationship between strategy and manufacturing flexibility was by Ettlie and Penner-Hahn (1994). In a large-scale study, Gupta and Somers (1996) examined the impact of a firm's strategy on nine separate dimensions of manufacturing flexibility. The literature has also suggested the theoretical relationship between flexibility and strategy (Gerwin, 1993; Kumar *et al.*, 2006; Vokurka and O'Leary Kelly, 2000; Fantazy *et al.*, 2009; Kandemir and Acur, 2012; Oberoi and Ahuja, 2013). These studies provide the initial support for the existence of a contingency-based relationship between NPDF and the supply chain strategy adopted by a firm. In general, the researcher studied the hypothesis that supply chain strategy has a direct positive effect on NPDF. According to the NPDF research model presented in Figure 2, this study proposes the following hypotheses:

H1a. FOS has direct effects on the adoption of new product flexibility development.

H1b. COS has direct effects on the adoption of new product flexibility development.

H1c. INS has direct effects on the adoption of new product flexibility development.

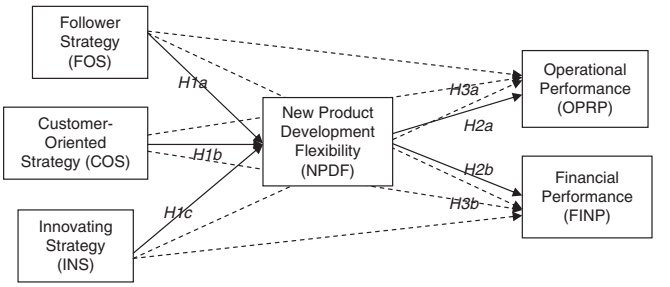


Figure 2.
Research model

3.3 NPDF and supply chain performance relationship

The second group of hypotheses deals with the relationship between NPDF and supply chain performance. Flexibility has been widely cited as a means of improving firm performance, especially for firms competing in very dynamic markets. There are a considerable amount of empirical studies and theoretical studies supporting the link between performance and flexibility. Studies by Gupta and Somers (1996), Ward *et al.* (1995), Vickery *et al.* (1999), Zhang *et al.* (2002), Hallgren and Olhager (2009), Kandemir and Acur (2012), Oberoi and Ahuja (2013), and Wei *et al.* empirically examined the direct effect of flexibility on performance. Wei *et al.* explored how firms should dynamically reconfigure resource portfolios to leverage organizational performance. They find that resource flexibility and coordination flexibility have positive moderating effects on performance. Furthermore, Hallgren and Olhager (2009) addressed flexibility and investigated the relationship between volume and product mix flexibility. The study revealed that flexibility configurations based on high or low levels of volume and mix flexibility combinations show significant differences both in terms of operational performance and in terms of emphasis put into different flexibility source factors. The literature has also suggested the theoretical relationship between flexibility and performance (Gerwin, 1993; Kumar *et al.*, 2006; Vokurka and O'Leary Kelly, 2000; Beach *et al.*, 2000; Zhang *et al.*, 2002). These studies provide initial support for the existence of the relationship between NPDF and supply chain performance. In general, this research hypothesizes that NPDF has a direct effect on supply chain performance. According to the research model presented in Figure 1, the research study proposes the following hypotheses:

H2a. New product flexibility development has a direct effect on the supply chain's operational performance.

H2b. New product flexibility development has a direct effect on the supply chain's financial performance.

3.4 Total effects of supply chain strategy on supply chain performance relationship

Besides the direct effect, supply chain strategy also indirectly affects performance through the flexibility in NPD. The third group of hypotheses deals with the total effect of strategy and flexibility in NPD on performance. The total effect is simply the sum of the direct effects and all the indirect effects that occur through an intervening variable, which in this model is NPDF. This group of hypotheses proposes that the positive effect of supply chain strategy on performance can be enhanced by linking it with NPDF. The indirect effects of strategy, through flexibility, on performance have been expanded upon by several researchers. For example, Gerwin (1993), Gupta and Somers (1996), Vokurka and O'Leary Kelly (2000), and Fantazy *et al.* (2009) all examined the total effects of business strategy and flexibility on performance. However, there is a lack of empirical studies in the context of the supply chain that address the total effect of supply chain strategy and the NPDF dimension on performance. Managers in the industry would benefit greatly from knowledge of these interrelationships as they use and build their flexibility capability to improve their competitive advantage. The research study proposes the following hypotheses for the total effect of supply chain strategy on performance through its effect on the NPDF dimension:

H3a. In addition to a direct effect, supply chain strategy also indirectly affects the supply chain's operational performance through its effect on the new product flexibility development dimension.

H3b. In addition to a direct effect, supply chain strategy also indirectly affects the supply chain's financial performance through its effect on the new product flexibility development dimension.

4. Research methodology

4.1 Scale development and questionnaire design

For scale development, procedures and guidelines recommended by were followed. Each construct was measured by multiple items to increase reliability, decrease measurement error, ensure greater variability among the survey participants, and improve validity (Churchill, 1979). To develop a valid and reliable survey instrument, an extensive literature review was first conducted to identify scales used in relevant literature that were shown to have strong validity and reliability. Data for this research were collected using a questionnaire instrument. The population for the research included SME supply chain firms in the Canadian manufacturing industry. In this section we will describe items used in measuring the variables in this study. In designing the questionnaire, a schema based on a combination of seven-point Likert scale-type questions was used for the preliminary test version. A final version was then designed based on the feedback received from a selected number in a trial sample. Overall, the questionnaire was divided into four main sections: basic data, supply chain strategy, NPDF, and supply chain performance.

Basic data. This section collected information on the profiles of the firms, such as firm name, address, respondent's position within the company, type of manufacturing industry, number of employees in the organization, type of products produced, approximate turnover, and the number of years the firm has implemented a supply chain program.

Supply chain strategy. An 18-item scale was designed with reference to the supply chain strategy model by Fantazy *et al.* (2011a, b), Chang Shih *et al.* (2003), and Katz *et al.* (2003) to measure three supply chain strategies: INS, COS, and FOS. Respondents were asked to indicate the importance of supply chain strategy variables, using a seven-point scale with the end points of "least important" (1) and "extremely important" (7). Also in this section were two questions considering the time as compared with the company's major competitors. Respondents were asked to indicate how early they adopt new manufacturing technology, with each item using a seven-point scale with the end points of "late" (1) and "early" (7).

NPDF. Seven items affecting NPDF were identified from the operations management literature and the limited literature on SCF (Hallgren and Olhager, 2009; Kumar *et al.*, 2006; Zhang *et al.*, 2002). This section collects data pertaining to a firm's relative competitive edge on the NPDF. The criteria question employed a seven-point scale with end points of "poor" (1) and "excellent" (7).

Supply chain performance. This study used financial and non-financial dimensions to measure a firm's supply chain performance. For the FINP, respondents were asked to rate overall performance using the following measures: net profit performance (FINP1) and sale growth performance (FINP2). OPRP was measured in terms of customer satisfaction by multiple items using the following measures: delivery speed performance (OPRP1), product innovation performance (OPRP2), level of customer perceived quality of product performance (OPRP3), and level of service systems to meet particular customer needs performance (OPRP4); these were adopted from Hallgren and Olhager (2009), Gunasekaran (2004), and Chang Shih *et al.* (2003).

The criteria were compared with the relative major competitors for the last three years and the response options were anchored on a seven-point scale with "1" being "very weak" and "7" being "very strong."

4.2 Questionnaire response rate

To develop a valid and reliable survey instrument, an extensive literature review was first conducted to identify scales used in relevant literature that were shown to have strong validity and reliability. The research instrument is comprised of structured questions. Responses to the structured questions were used to test the research hypotheses. The research instrument was pre-tested with a selected small sample of managers and CEOs in Canada. Examples of our survey questions assessing NPDF are displayed in Table II. NPDF items were developed based on two popular aspects of flexibility, range and mobility/adaptability (e.g. Fantazy *et al.*, 2009; Swafford *et al.*, 2006). Range represents the number of states an organization can adopt; mobility is the ease of changing from one state to another in terms of cost and time. From these two aspects, each flexibility item was developed from various flexibility literatures. The items measuring NPDF came from existing literature, which discussed the ability for new product introduction and design change accommodation (e.g. Narasimhan *et al.*, 2004; Vickery *et al.*, 1999).

The respondents for the final survey were randomly selected from Scott Directory of manufacturing firms in Canada. Senior-level executives were deemed to be at a sufficiently high level in the organizational hierarchy to have supply chain-level visibility and knowledge. High-ranked respondents, with sufficient level of responsibility tend to be more reliable sources of information than their subordinates, in accordance with Phillips (1981) and various other past studies. In accordance with Dillman's (1978) guidelines for mail surveys, a mailing package was sent, which included a cover letter from the researchers, the questionnaire, and a pre-paid return envelope. A reminder phone call was made after 48-72 hours of mailing the package.

A sample of 175 firms, representing a response rate of about 11.66 percent was randomly selected from a population of 1,500 Canadian manufacturing firms. This is in line with the response rate for studies of this kind and other studies targeting senior executives. For instance, the response rate was 7.25 percent in the study of Kristal *et al.* (2010), 6.4 percent in Tan and Vonderembse (2006), etc. Although the response rate was

Table II.
Items used to measure new product development flexibility (NPDF)

Item no.	Items	Flexibility element	Label in SEM
1	Developing a number of new products per year	Range	NPDF1
2	Performing design activities concurrently	Range	NPDF2
3	Involving and supporting design of suppliers in new product development	Range	NPDF3
4	Using computer-aided design and computer-aided manufacturing to create new products	Range	NPDF4
5	Handling a number of new product development projects in design at a given time and at reasonable cost	Mobility	NPDF5
6	Managing the time and cost to perform design activities concurrently	Mobility	NPDF6
7	Managing the time and cost to develop new products	Mobility	NPDF7

moderate, it was sufficient to perform SEM as previously done in other studies such as (Kuruppuarachchi and Perera, 2010; Fantazy *et al.*, 2011a, b).

The industries selected for this study are listed in North American Industry Classification System (NAICS) codes operating in five manufacturing industries. The industries selected for this study are presented by the NAICS codes 314 (textile product mills), 333 (machinery manufacturing), 334 (computer and electronic product manufacturing), 335 (electrical equipment, appliance, and component manufacturing), 336 (transportation equipment manufacturing), and 337 (furniture and related product manufacturing). The proportions of the five manufacturing industries in the sampling frame are: textile product mills (12.99 percent); machinery manufacturing (11.69 percent); computer and electronic product manufacturing (13.33 percent); electrical equipment, appliance, and component manufacturing (11.14 percent); and transportation equipment manufacturing (10.6 percent). The sampling process chosen was simple random sampling without replacement.

Although the questionnaires were mailed to a specific managerial position such as director, CEO, or supply chain manager with the person's name on the cover letter, the respondents have the following managerial positions: owner (22.85 percent), president or vice president (34.40 percent), CEO (8.57 percent), supply chain manager (14.28 percent), general manager (14.85 percent), and staff (5.7 percent).

4.3 Non-response bias

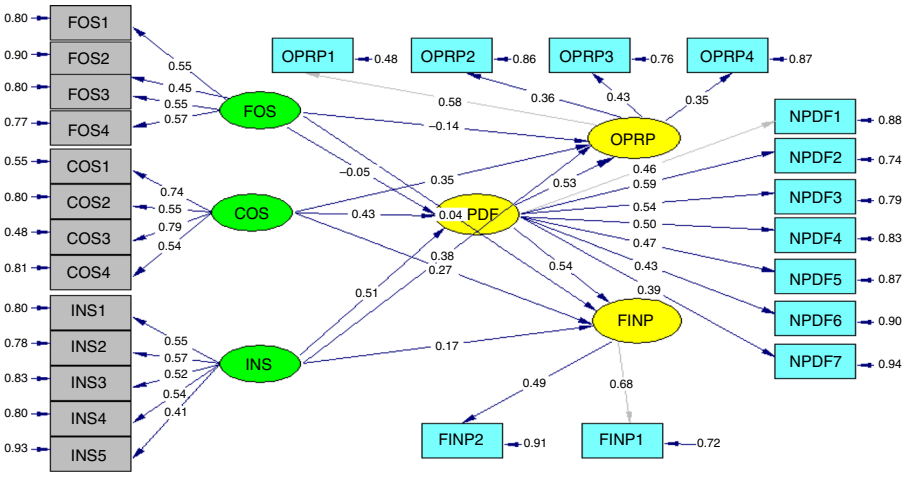
In order to detect if non-response bias was an issue in the research sample, one commonly used method is based on the assumption that the opinions of late responders are representative of non-respondents (Armstrong and Overton, 1977). For this research study, approximately 25 percent of the surveys were randomly selected from each of the first and second waves of surveys received ($n_1 = 15$ and $n_2 = 15$ for the two groups, respectively), and 18 items were used for the analysis. Then *t*-tests were performed on the responses of the two groups. The tests revealed no statistically significant differences across the two groups for any of the dependent variables or independent variables contained in the study.

5. NPDF structural model

The best SEM obtained from LISREL software accepted for the study is illustrated in Figure 3, with the structural model determining the significance of the relationships between the independent and dependent variables. The SEM is a multivariate analysis methodology for empirically examining the sets of relationships represented in the form of linear causal models (Joreskog and Sorbom, 2001).

5.1 Model identification

Before analyzing the NPDF structural model, it is important to check the model identification to obtain the correct estimate of the parameter values. The SEM is over-identified with 26 observed variables – there are $(26 \times 27)/2 = 351$ observations. The number of parameters to be estimated is 60, including the variances of 26 variables (13 exogenous and 13 indigenous variables that are the disturbance), 23 direct loading on each latent variable, and a total of 11 direct effects. Furthermore, six error co-variances were set to free. Thus, the model degrees of freedom are $351-60-6 = 285$ (see Figure 3; df = 285). Since the number of observations is greater than the number of parameters to be estimated, we conclude that the NPDF model is over-identified and can be tested statistically.



Notes: $\chi^2 = 441.88$; df = 285; p-value = 0.00000; RMSEA = 0.056

Figure 3.
SEM of new product development flexibility

5.2 Model goodness fit

The literature mentions many goodness of fit statistics to check the fitness of the model with the data. The three most commonly used indices are root mean square error of approximation (RMSEA), comparative fit index (CFI), and normed fit index (NFI). Another goodness of fit statistic is χ^2, which was used in many studies but has severe limitations because it is affected by the size of the data; when the data go beyond 200 cases, it usually produces a significant result. The best SEM obtained from LISREL software accepted for the research model is illustrated in Figure 3, with the structural model determining the significance of the relationships between the independent and dependent variables. The research model presented in Figure 3 shows a good fit of strategy, NPDF, and performance to the empirical data. The observed $\chi^2 = 411.88$, df = 285, p-value = 0.0000, and RMSEA = 0.056. Generally, a rule of thumb is that RMSEA $\leqslant$ 0.05 indicates close approximate fit and values between 0.05 and 0.08 suggests a reasonable error of approximation (GFI = 0.84, AGFI = 0.80, NFI = 0.81, NNFI = 0.79, and CFI = 0.91); these all represent a good fit (Bentler and Bonett, 1980).

5.3 Results and data analysis

Based on the results of the regression analyses presented in Figure 3, not all of the hypothesized relationships were supported. The hypotheses for the relationships were tested using their associated t-statistics. t-values greater than 1.65, 1.98, or 2.576 were considered to be significant at the 0.10, 0.05, and 0.01 levels, respectively (Hair *et al.*, 1995).

To test *H1a*, *H1b*, and *H1c* the regression results and the standardized path coefficients are shown in Table III. For *H1a*, the path coefficient was −0.05, which indicates a very weak and negative relationship; this is statistically insignificant. The insignificant path coefficient implies that FOS do not influence the performance in the proposed model. One possible explanation is that part of the relationship between FOS firms and performance is indirect through other flexibility dimensions that are not included in this research study. For example, Chang Shih *et al.* (2003) indicated that FOS firms should at least choose to develop service flexibility for long-term customer loyalty and sales growth. For *H1b*, the path coefficient was 0.43; it was significant at

the 5 percent level and positively correlated. Customer satisfaction can be achieved through NPDF, which enables fast product introduction, dependable delivery of finished products, and high-quality product to customers (Jin *et al.*, 2014). For *H1c*, the path coefficient was 0.51 and significant at the 1 percent level. In short, the research data supported *H1b* and *H1c* while it did not support *H1a*.

H2a and *H2b*, which dealt with the direct relationships between flexibility and the performance dimensions, were tested according to the results from the SEM model, Table IV. The test showed that NPDF had a direct positive impact on the performance. For *H2a*, the standardized path coefficient was 0.53 and is positively correlated with OPRP and significant at the 1 percent level. This is consistent with the majority of the empirical studies conducted in the literature about flexibility. For instance, Jin *et al.* (2014) reported the positive effect of new product flexibility on quality, delivery, and early introduction product in the market. For *H2b*, the standardized path coefficient for was 0.54; it is positively correlated with financial performance and significant at the 1 percent level. The results show strong positive correlation between NPDF and FINP, which are also supported by previous empirical findings. For instance, Cheng (2011) reported that SCF leads to superior industry-level profitability and efficiency in the manufacturing sector.

To test *H3a* and *H3b*, the regression results and the standardized path coefficients representing the direct, indirect, and total effects are shown in Table V. *H3a* examines the relationship of the total effects of each strategy and NPDF on OPRP. The INS total effects path coefficient was 0.65 and the COS total effects path coefficient was 0.58; both indicated a strong positive relationship and are statistically significant at the 1 percent and 5 percent levels, respectively. On the other hand, the FOS total effects path coefficient was −0.17, which showed a moderate negative relationship with OPRP that is statistically insignificant.

H3b examined the total effects of each strategy and NPDF on FINP. The total effects path coefficient for INS was 0.45; this has a relatively high-positive relationship with FINP and is statistically significant at the 1 percent level. On the other hand, the COS total effects path coefficient was 0.50; this has a strong positive relationship with FINP

Table III.
Direct effects of supply chain strategy on NPDF

Flexibility	Supply chain strategies FOS (*H1a*)	COS (*H1b*)	INS (*H1c*)	
New product development flexibility (NPDF)	−0.05	0.43**	0.51***	Path coefficient
	(0.039)	(0.18)	(0.12)	Standard error
	−1.28	2.38	4.25	*t*-statistics

Notes: $n = 175$. *,**,***Significant at 10, 5, and 1 percent level, respectively

Table IV.
Direct effects of NPDF on supply chain performance

Flexibility	Supply chain performance OPRP (*H2a*)	FINP (*H2b*)	
New product development flexibility (NPDF)	0.53***	0.54***	Path coefficient
	(0.20)	(0.12)	Standard error
	2.65	4.50	*t*-statistics

Notes: $n = 175$. *,**,***Significant at 10, 5, and 1 percent level, respectively

	Direct	Indirect	Total	
H3a		INS		
OPRP	0.38	0.270	0.65***	Path coefficient
	0.18	0.14	0.22	Standard error
	2.11	1.92	2.95	*t*-statistics
		COS		
OPRP	0.35	0.23	0.58**	Path coefficient
	0.18	0.12	0.23	Standard error
	1.94	1.9	2.52	*t*-statistics
		FOS		
OPRP	−0.14	−0.026	−0.17	Path coefficient
	0.11	0.018	0.11	Standard error
	−1.27	−1.44	−1.54	*t*-statistics
H3b		INS		
FINP	0.17	0.28	0.45***	Path coefficient
	0.07	0.13	0.15	Standard error
	1.88	2.11	3.06	*t*-statistics
		COS		
FINP	0.27	0.23	0.50**	Path coefficient
	0.14	0.17	0.21	Standard error
	1.93	1.36	2.38	*t*-statistics
		FOS		
FINP	−0.05	−0.027	−0.08	Path coefficient
	0.011	0.018	0.052	Standard error
	−1.36	−1.5	−1.48	*t*-statistics

Notes: $n = 175$. *,**,***Significant at 10, 5, and 1 percent level, respectively

Table V.
Total effects of supply chain strategy on supply chain performance

and is statistically significant at the 5 percent level. However, the total effects path coefficient for FOS was −0.08, which indicates a low-negative relationship and is statistically insignificant. The total effects of strategy and NPDF seem to have a greater impact on operational performance than on financial performance.

The results presented in Table V demonstrate full support for the notion stating that flexibility in NPD would play a mediating role between strategy and performance. Comparing the results of the two columns in Table V for the direct effect of strategy on performance and for the total effects, it was observed that the role of NPDF as a moderating variable was confirmed by the finding that INS achieved 0.65 with OPRP through NPDF. This means that NPDF as a moderating variable enhanced OPRP by 0.27. Furthermore, INS achieved 0.45 with FINP. This means that NPDF as a moderating variable enhanced FINP by 0.28. Similarly, COS achieved 0.58 with OPRP through NPDF. This means that NPDF as a moderating variable enhanced OPRP by 0.23. Furthermore, COS achieved 0.50 with FINP. This means that NPDF as a moderating variable enhanced FINP by 0.23. Innovative and customer strategies achieved a higher rate of operation and financial performance through NPDF. In short, the research data supported *H3a* and *H3b*.

6. Discussion and managerial implications

The main objective of this paper was to empirically investigate the relationship among strategy, flexibility in NPD, and performance of Canadian SMEs. The first group of hypotheses provided evidence of the direct positive relationship between strategy and

NPDF. The second group of hypotheses provided evidence of the direct positive relationship between NPDF and performance. The third group of hypotheses provided evidence of the total (direct and indirect) significant relationship with operational and financial performance.

6.1 Theoretical implications

Supply chain firms can achieve financial and operational performance by developing flexibility in NPD, which enables supply chain businesses to create new products and processes and to foresee changing market conditions (Kandemir and Acur, 2012). Thus, flexibility in NPD is an important capability that enables firms to modify and foresee innovation strategies in response to current or future changes in the environment (Lee *et al.*, 2003). We can see from Tables IV-V that NPDF has high correlations with financial and operational performance. Based on the structural modeling results and these correlations, we can conclude that the indirect, rather than the direct, influences of NPDF through its interactions with other functions can be more clearly observed in the specific sample. From the theoretical standpoint, coordinating and managing flexibility in NPD together with other major functions will have positive implications for the overall business performance. Potentially, flexibility in NPD increases market share, speed to market, and the range of their strategic maneuvers (Kettunen *et al.*, 2015).

In short the theoretical implication suggests that Canadian manufacturers can achieve operational and financial performance through NPDF, which enables them to develop new products that meet customer needs/demands and offer benefits such as quality, timeliness, and cost (Workman, 2004). To enhance operational and financial performance, flexibility in NPD should be organized, planned, and managed carefully in order for its potential benefits to be fully realized. Manufacturers adopting INS or COS must seriously consider making an investment to develop flexibility in NPD through effective innovation programs and adequate information systems support. Advanced information technology tools provide real-time information, which enables flexibility in NPD and precise order information (Ghourly, 1996). In general, achieving high-customer satisfaction, net profit, and improved sales growth can also be accomplished by offering customers new product design, better quality, and competitive prices.

6.2 Managerial implications

The findings of this study have two very important management implications. First, our findings indicated that the relationship of INS and COS with NPDF and performance is significant and positive. However, the results showed FOS strategy relationships with NPDF and performance to be insignificant and negative. For a COS situation, flexibility in NPD creates value for customers and future access to opportunity. Customers value the tangible side of NPDF, which is the ability of a firm to provide the right product in the right time, place, and quantity. The COS total effects path coefficient was 0.58, which almost doubled operational performance after introducing NPDF as a mediating variable. NPDF allows Canadian manufacturers to increase overall customer satisfaction performance by improving their ability to quickly alter their product development decisions to react to their environments' changing markets and technological opportunities and/or to seize the initiative and steer these changes to their advantage (Gerwin, 1993). According to the findings

reported in Tables IV-V, NPDF not only enhanced operational performance but also helped to elevate the financial performance total effects path coefficient from 0.27 to 0.58. The positive relationship noted in this research among NPDF, financial, and operational performance is consistent with other findings on the topic of new product in supply chain (Kandemir and Acur, 2012; Kun Cho *et al.*, 2008).

For INS situations, flexibility in NPD also contributed to enhancing financial performance. The INS total effects path coefficient was 0.27, which almost doubled financial performance after NPDF as a mediating variable was introduced. This finding is consistent with other research, such as (Vickery *et al.*, 1999; Kun Cho *et al.*, 2008). Furthermore, flexibility in NPD increased financial performance as a mediating variable. It appears that Canadian manufacturers who are adopting NPDF are seeing an impact on their overall profitability and an increase in their sales growth.

For the FOS situation, NPDF did not help to achieve either financial or operational performance. However, the reason for a negative relationship of FOS and flexibility in NPD could be that FOS firms do not have many resources and usually focus on tight cost control in order to achieve low-cost production. Given their small scale and limited investment capability, most of their investments have been focussed on short-term gains – direct and immediate impact on the top and bottom lines of the business being the key decision criterion. As a result, investments that pay off in the longer term, such as those in NPD and innovation, have historically been minimal (KPMG, 2007). Another reason for this might be that the part of the relationship between FOS and supply chain performance is indirect through other flexibility dimensions that are not included in this research study.

Second, implication for management reveals that NPD is becoming critical to many manufacturing organizations who want to be world-class manufacturers, and that the product development function should be aligned with the supply chain strategy. Today, the product development function is different in that it has been recognized in strategic-level decision making. Supply chain managers should have a better understanding of the potential impact of flexibility in NPD on financial and operational performance, and understand how it relates to different supply chain strategies. NPDF enables firms to break into new markets, products, and technological arenas and allows these firms to be better able to meet customers' needs/demands, deliver new products on time, and offer better cost and quality benefits. Thus it is critical that managers review the flexibility in the NPD requirement during the process of developing their supply chain strategy. However, flexibility in NPD cannot help to improve performance if it is not appropriately matched with the firm's strategy.

7. Conclusions, limitations, and further research

Prior research on SCF focussed on several dimensions but overlooked NPDF. In this research, the focus was specifically on flexibility in NPD, in order to highlight the strategic importance of NPD in the supply chain. The results of this study demonstrate the positive direct effects of strategy on NPDF and the positive direct effect of NPDF on performance. The findings suggest that INS and COS firms are required to invest heavily in time and resources in developing NPDF. It should be also noted that no significant association between the FOS firms and NPDF was observed in this study.

This study has made several contributions to both the theory and practice of NPD and strategic management. First, this study examined a theoretical framework that links strategy, NPDF, and performance in the supply chain environment. Second, this study has employed rigorous statistical techniques (i.e. SEM) for hypotheses testing,

which reinforce the reliability of explanations and implications of findings. Third, this study's sample was drawn from the manufacturing industry in Canada; this provided an opportunity to review NPDF in a different cultural context since previous empirical studies have usually focussed on the USA and Europe. Fourth, these findings validate other empirical research related to NPDF and performance obtained in the supply chain environment (Zhang *et al.*, 2002; Kun Cho *et al.*, 2008).

The research instruments of the study relied on a manager's perceptions for measuring strategy, flexibility, and performance as accurate reflections of measurements that are widely accepted in academic literature. These measures of strategy, NPDF, and performance are a possible limitation. Another possible limitation of this study is the use of cross-sectional data; a future time series data study would provide a robust test of causal relationships hypothesized in the research model. Data collection from more different firm's size and regions would provide healthier results for the purpose of generalizability. Though the sample in the study represents several industries, the research study focussed only on SME firms. Also, it will be very interesting to see if there are regional variations when compared to the findings of this research study. Research in the area of SCF should try to establish operationally useful measurement criteria across different industries to facilitate empirical study. However, since there has yet to be a consensus on the appropriate measures of NPDF and the dimensions of supply chain strategy, the measures employed in this research should be regarded as contributing to the ongoing discussion. This study focusses on short-term new product flexibility development however long-term supply chain relationships differ from short-term relationships. Future research should look at the degree to which these findings are valid in long-term NPDF perspective. The research study was limited to the manufacturing industry in the Canadian geographical region. We recommend that managers use caution in generalizing the findings of this study to larger firms, which could be included in future research endeavors.

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