THE ROLE OF ORGANIZATIONAL CAPABILITIES IN TECHNOLOGY COMMERCIALIZATION PERFORMANCE

Submitted By

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ABSTRACT

The sustainable economic growth of any country relies heavily on its firms' ability to develop new products or services. In the global marketplace, Canada lags behind other countries in commercializing new products or services. The Conference Board of Canada (CBoC) annual report, published in June 2008, ranked Canada 13th out of 17 developed countries in their ability to produce new and improved goods and services. Other reports from the CBoC and Industry Canada highlight the importance of commercialization and their concern that Canadian companies are unable to succeed in commercialization. The situation is critical because Canada has been performing poorly in this category for more than a decade; this deficiency means that Canada is becoming less competitive and the Canadian productivity level is decreasing.

This thesis investigates the organizational capabilities that allow organizations to efficiently and effectively commercialize technology. Using the resource-based view theory, a theoretical framework is developed that links the firm's marketing capabilities, manufacturing capabilities, R&D capabilities, and integration capabilities with its technology commercialization performance. This framework was tested empirically based on the data from more than 200 small- and medium-sized Canadian manufacturing firms.

The results of this study highlight the association between the organizational capabilities and technology commercialization performance. It also demonstrates the impact of strategic alliance on functional capabilities and the effect of organizational resources on technology commercialization performance. This study contributes to the debate of whether or not small- and medium-sized companies should be treated separately by empirically testing the difference in their technology commercialization performance.

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1 INTRODUCTION

The Conference Board of Canada (CBoC) considers innovation-based commerce to be vital for Canada's future prosperity (Munn-Venn and Guthrie, 2004; Guthrie, 2006). In a report published in April 2006, the CBoC noted that "Canadian corporations struggle when taking new products and services to market" (Guthrie, 2006). The CBoC annual report, published in June 2008, ranked Canada 13th out of 17 developed countries in their ability to produce new and improved goods and services. The CBoC considers the situation critical because Canada has been performing poorly in this category for more than a decade, and this deficiency means that Canada is becoming less competitive and the Canadian productivity level is decreasing.

Industry Canada has expressed similar concerns. In May 2005, Industry Canada formed a panel to help Canadian firms develop new products or services to respond to market needs. The panel was further asked to identify ways in which the Government of Canada could assist Canadian firms to commercialize their new products (Industry Canada Report, 2006).

This situation is dire enough that it requires immediate attention by both the Canadian government and Canadian firms. Canadian firms must be able to use their world-class knowledge to produce marketable goods and services and to successfully bring those goods and services to market. This will help Canadian firms to increase productivity, compete globally, and produce sustainable growth for the Canadian economy (Guthrie, 2006).

The sustainable economic growth of any country relies heavily on its firms' ability to develop new products or services (Brown, 1997; Litan and Song, 2008). In the global marketplace, Canada is behind other countries, not just because of the difficulty in commercializing new products or services but also because it is not at the forefront in developing new technologies. A critical factor in developing and marketing new technologies is investment in R&D, and Canada lags behind other Organisation for Economic Cooperation and Development (OECD) countries in R&D investment. The Industry Canada report claims that instead of R&D activity, the Canadian private sector is focusing on reducing labor costs and operating expenses. In 2001, less than 40 percent of the firms considered developing new products or processes as important aspects of their business objectives. This has hampered Canada's ability to produce new products and processes and to compete in the global marketplace (Industry Canada Report, 2006).

In addition to continuing innovation, commercialization is enhanced by developing products that customers value (Gupta and Wilemon, 1990). To effectively compete globally, Canadian firms must become more innovative in developing products and services and more efficient in the commercialization of these products and services (Hitt *et al*, 1993; Ettlie, 1988; Teece, 1986; Dosi, 1988). The CBoC believes that, although Canada has strong research and technology talents, it fails to utilize these to create new economic values and provide advantages to Canadian firms in global markets. The report noted that technical, managerial, and entrepreneurial skills are essential for successful commercialization. It also highlighted the importance of gathering competitive intelligence, making market assessments, and forming domestic and global collaborations that will help to spur commercialization (Guthrie, 2006).

The Industry Canada report analyzed existing government policies and programs to learn how they affect commercialization. It suggested that the government should pay attention to three areas: talent, R&D, and capital. Additionally, the government should encourage the private sector to invest in R&D. The report underlined the importance of policies and programs to attract and retain highly qualified workers and managers. It further noted that an additional factor affecting the ability to commercialize is the lack of capital to manufacture and launch new products.

These reports from the CBoC and Industry Canada highlight the importance of commercialization and their concern that Canadian companies are unable to succeed in commercialization. Without successfully commercializing their products, Canadian firms cannot become competitive in the marketplace. To become competitive, they need to understand the factors necessary for commercialization. However, existing academic literature on this topic provides only small parts of the total picture.

The literature suggests that technology commercialization requires information about the needs of the customer, new technologies in the market, and the business environment (Ancona and Caldwell, 1990, in Hitt *et al.*, 1993). Researchers have explored the impact of a single functional capability on technology commercialization (Zahra and Nielsen, 2002). However, in our opinion, this does not provide a complete picture because technology commercialization requires the functional capabilities (R&D capability, marketing capability, and manufacturing capability) to gather and evaluate information and use it to provide the desired outcome. The strong collaboration, interaction, and sharing of information among the R&D, marketing, and manufacturing departments provide integration capability, which is essential for successful technology commercialization. Therefore, integration capability is an important organizational capability, and it plays an important role in technology commercialization.

This research makes an effort to fill the gap in the literature by determining the association between various organizational capabilities and technology commercialization performance (TCP). We hope that this study will help our Canadian companies to gain an in-depth understanding of the combined impact of organizational capabilities on technology commercialization. The CBoC report has emphasized the importance of domestic and international alliances, but it does not provide any detail about the type of strategic alliances formed by the Canadian companies (Guthrie, 2006). This empirical study is expected to reveal whether or not Canadian companies form functional strategic alliances and if these strategic alliances help to build capabilities. This study intends to answer the following questions:

- What organizational capabilities are required for technology commercialization?
- To what extent do strategic alliances help in building organizational capabilities?
- What role does firm size play in technology commercialization?
- What kind of organizational resources are required for technology commercialization?

The next section of this thesis provides a review of the existing literature on commercialization, underlying theories related to capability and technology commercialization, and technology commercialization strategy in the context of strategic alliances. This is followed by the discussion of variables in the theoretical framework, the hypotheses empirically tested in this study, the research design of the study, and an analysis of the data. The last two sections deal with a discussion of the results and the conclusions drawn from this study.

2 LITERATURE REVIEW

2.1 Technology Development

Technology is defined as the "know-how" available to a firm that allows it to produce and sell a product or service (Capon and Glazer, 1987). This know-how has three components: product technology, process technology, and technology management.

- Product technology is the know-how embodied in the product.
- Process technology is the use of the know-how to manufacture the product.
- Technology management is the use of know-how in setting up procedures to effectively manage the product marketing.

Kumar *et al.* (1999) have identified two key components of technology: physical components and informational components. The physical components are the equipment, products, techniques, and processes. The informational components are knowledge of management and all other functional areas. In the early 1980s, it was believed that the capability to develop technology depended upon non-transferable organizational routines (Nelson and Winter, 1982). This view has changed completely in the past 25 years. In the late 1990s, researchers started exploring the increase in technology exchange, the formation of R&D joint ventures, and the revenues earned through licensing (Kortum and

Lerner, 1999; Dengan, 1998). Depending upon the availability of the financial resources and R&D capabilities, the firm can decide either to develop the technology internally or to acquire it from external sources. The benefits of developing technology internally are:

- For firms that have the required R&D capabilities, internal development is much cheaper than acquisition from external sources.
- Internal development provides a crucial learning experience for employees and helps the firm create a knowledge base useful in developing new technologies.

The option of acquiring the technology from external sources is beneficial for firms that lack the R&D capabilities required to develop technology in-house. If the technology has already been developed, a firm, instead of reinventing the wheel, can modify it to meet its needs. In today's unstable and dynamic business environment, speed of development is important. Taking already existing technology and modifying it as needed may give a firm a competitive edge in marketing its products. In today's scenario, the technology should be treated as an asset, and the commercialization of technology as more important than simply possessing technology. Firms may also form technological alliances to jointly develop the technology, thereby sharing any risks involved in development.

2.2 Technology Commercialization

The CBoC defines commercialization as "a process through which economic value is extracted from knowledge through the production and sale of new or significantly improved goods or services" (Guthrie, 2006). Mitchell and Singh (1996) view technology commercialization as "the process of acquiring ideas, augmenting them with complementary knowledge, developing and manufacturing saleable goods and selling the goods in the market." Technology can be broadly defined as knowledge, techniques, patented or other proprietary processes, materials, equipment, systems, etc., that are used to generate profit by producing new or improved products. The technology commercialization process requires timely analysis and interpretation of market, technological, financial, and political information to develop saleable products (Ancona and Caldwell, 1990, in Hitt *et al.*, 1993)

Firms may decide not to invest in developing the in-house capabilities needed to commercialize technology. This is most appropriate for small or start-up firms, which prefer to earn monetary benefits by licensing or selling technology instead of using it to manufacture products (Lichtenthaler, 2008). The resources required to manufacture and market the product using the new technology are generally beyond the capacity of small firms (Arora *et al.*, 2001). It has been argued that if firms fail to generate revenue through licensing the technology the other option is to exploit the technology in-house by producing goods or services for sale on the market. This would require building or acquiring complementary assets, such as physical equipment, to manufacture products and marketing channels (Teece, 1986). Complementary assets play a crucial role in commercialization and, if they are not available on the market, the firm will have to develop them internally. The firm with superior complementary assets will obtain greater returns from the technology.

It is important to note that commercialization of technology also depends upon the capacity of the firm to manufacture the new product in large quantity and its ability to successfully market the product. Thus, investment in manufacturing, marketing, and R&D is very important (Chandler, 1990).

2.2.1 Commercialization Grid

Table 1 shows that the firm that has a new technology, either through internal development or acquisition, may decide to commercialize the technology - by developing a new product or service (Cells A and B), developing a new product or service and also by selling the license to other firms (Cell C and Cell D), by selling the technology to another firm (Cells E and F).

Table 1: Technology Commercialization Grid

Commercialization	**Technology Development**	
	Internal Development of Technology	Acquiring Technology from External Sources
Developing product or service using the new technology	A	B
Internally developing product and selling the license to use the technology	C	D
Selling technology	E	F

Source: Adapted from Capon and Glazer, 1987

The reasons for selling the technology to other firms are:

- *Lack of Resources* - The firm does not have the resources and capabilities needed to quickly utilize the new technology. Instead of investing in acquiring the necessary resources, it would be more beneficial for the company to invest elsewhere.
- *Not part of the company's objectives* - Although the company possesses the technology, utilizing the technology is not part of the company objectives.
- *Small market size* - The market for the new technology is so small that it would not be profitable to cater to this market (Capon and Glazer, 1987).

The reasons for developing the new product or service and selling the license to other firms are -

- *Target niche market* -The firm may decide to target only one segment of the domestic market, therefore, it sells the license to firms operating in other segments.
- *Enter international market* -The firm may decide to sell in the domestic market and sell the license to firms operating in the international market.
- *Big market size* -The size of the existing market may be too big for the firm. Selling the right to use the technology would help to establish the new technology as the industry standard and would create an entry barrier for firms without the technology.

2.2.2 Market Entry Strategies

The firm can enter the high growth market following various strategies. In option 1, as shown in Table 2, the firm has strong research capabilities; therefore, it produces the new technology and utilizes it in manufacturing the product and being the first to launch it in the high growth market.

Table 2: Market Entry Strategies

	Commercialization
Research	
Development	1 2
High Growth Market 3	
Low Growth Market	

Source: Capon and Glazer, 1987

Legend
1 – Firm that has the research capability and is able to launch a product using the new technology
2 – Firm that acquires the technology and is able to launch a product using the new technology
3 – Firm that does not have R&D capability but has the capability to launch a product in the high growth market.

The firm gets the first mover advantage and, if its technology is accepted in the market, can reap the benefits of commercializing its technology. These firms target the innovators and early adopters (Figure 1) who are always keen to test the new technology.

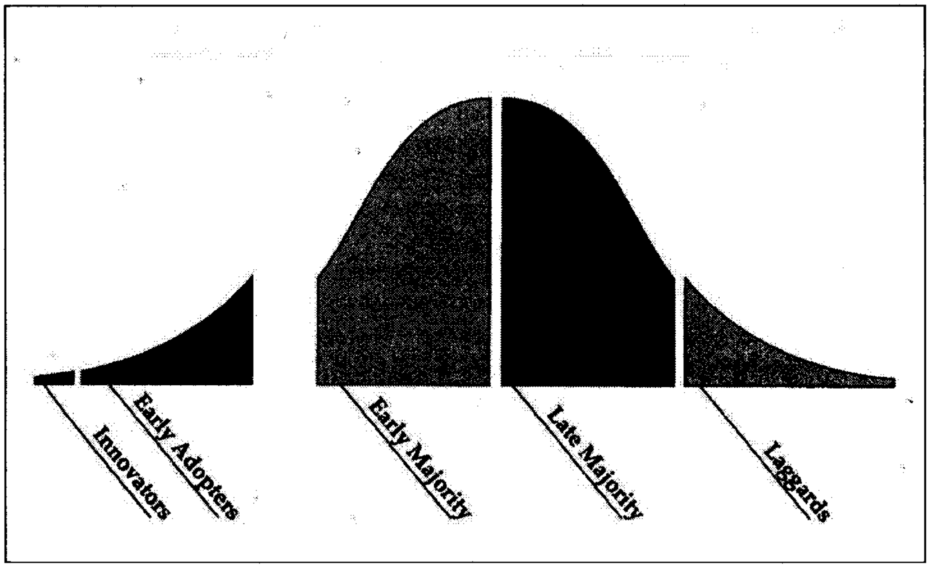

Figure 1: Categories of Technology Adopters

Source: (Moore, 1999)

In option 2, shown in Table 2, the firm does not possess strong research capability and cannot produce the technology in-house, but it has strong development capabilities. It acquires the technology externally, develops it internally, and uses it to launch a product in the high-growth market. These firms test the stability of the technology before investing resources in its development, and their target market is the early majority (Figure 1). In option 3, given in Table 2, the firm completely relies upon its marketing capabilities to enter the high growth market. It has neither research nor development capabilities therefore it acquires the developed technology from external sources. These firms target the early majority and late majority (as shown in Figure 1) to reap the benefits from the new technology.

2.2.3 Technology Commercialization Performance

Performance is defined in the literature as "effectiveness in reaching levels of achievements on specified objective function, given the resources and constraints facing the organization" (Davidson, 1983). It is considered a multi-dimensional construct and has both financial and non-financial dimensions. The financial dimension of performance is often measured in terms of profitability and market position (Hyder and Abraha, 2004), market growth and sales growth (Sundaramurthy *et al.*, 2005; Bonama and Clark, 1988), return on assets, stock returns (O'Sullivan and Abela, 2007; Hansen and Wernerfelt, 1989), market share and cash flow (Bonama and Clark, 1988), and market share (Jaworski and Kohli, 1993). The non-financial dimension of performance in the context of technology commercialization is measured by time to market, frequency of introduction of new product, radicalness of new product, and patents (Nevens *et al.*,1990; Zahra and Nielsen, 2002). Nevens *et al.* (1990), in their study of firms in United States, Japan and Europe, found that firms successful in commercializing technology have the following similarities:

- *Short time to market* – The successful firms launch new products two to three times faster than their competitors. The new technology does not provide competitive advantage for a long time and when it is widely available to other firms, the product life cycle becomes short. The price goes down quickly because the number of competitors increases, entry barriers erode, and the competition intensifies. The firm to enter the market first has the first mover advantage in gaining market share.

- *Breadth of Technologies* – The successful firms embed more new technologies in their products than their competitors. In most markets, the products involve many technologies. The firm develops some of them and acquires others from the leading developers.

- *Number of products* – The successful firm is able to introduce more products than its competitors.

- *Range of markets* – The cost incurred by the firm in developing technology is very high; therefore, to recover the R&D costs the firm needs to use the core technology in many products and compete in many geographic markets.

Zahra and Nielsen (2002) have conducted an empirical study to examine the relationship between the manufacturing capability of the firm and its influence on technology commercialization. The technology commercialization performance of the firms studied was determined by:

- *Frequency* – Introduction of a number of new products.

- *Speed* – After developing the new product the time taken to launch it in the market.
- *Radicalism* – The number of radically new products announced.
- *Patents* – The number of patents acquired.

2.3 Theoretical Background

The literature was reviewed to determine the underlying theories associated with technology commercialization. In this section, the resource-based view (RBV) theory is discussed in detail with emphasis on how it explains the relationship among various organizational capabilities (marketing, manufacturing, and R&D); also discussed are the organizational resources and integration capability of the firm, and technology commercialization. The theories of competitive advantage, environmental uncertainty, and strategic flexibility are discussed in the context of technology commercialization.

2.3.1 Resource-Based View Theory

Grant (1991) has classified resources into tangible, intangible, and personnel based resources. The tangible resources are the firm's financial capital, equipment, manufacturing plant, etc. The intangible resources of the firm are its reputation, brand image, and the perceived quality of its products. The personnel based resources are the skills, knowledge of its employees, and other knowledge assets. Firms assemble different resources to create capabilities that are specific to that firm and extremely difficult to imitate. Resources are productive factors that are owned by the firm; capabilities are the ability of the firm to effectively utilize these resources, along with other organizational processes, to manufacture products or services to meet business objectives (Amit and Shoemaker, 1993).

Capabilities are firm-specific, highly tacit, inimitable, and non-transferable. They are developed over a period of time through the interaction of the firm's resources (Amit and Shoemaker, 1993). Day (1994) has defined capability as a "complex bundles of skills and accumulated knowledge, exercised through organizational processes that enable firms to coordinate activities and make use of their assets." Identification of capabilities is challenging because they are often deeply embedded in the processes of the firm. An important part of capabilities is the tacit knowledge that comes from employee experience, technical knowledge, and the training they receive to upgrade their skills. Capability that is relatively easy to identify is the knowledge stored in the repository of the firm – the formal procedures established within the organization to solve problems. The repository of information contains the detailed instructions about solving routine problems or a specific problem previously faced by the company.

Amit and Schoemaker (1993) consider capabilities as the ability of the firm to use resources in productive activity and to attain certain objectives. The objectives of the firm could be developing innovative technologies, developing new products on a frequent basis, or reducing the manufacturing cost (Dutta *et al.*, 2005). The capabilities of the firm contribute to attaining sustainable competitive advantage and profitability (Day, 1994; Amit and Schoemaker, 1993). This can be enhanced through establishing internal learning processes, frequent in-house employee training, investing in formal R&D, conducting informal experimentation, and changing the products and processes. If the firm does not possess this capability it can be acquired externally by forming strategic alliances. A firm's capabilities are embedded in the firm's managerial and organizational processes in the long run (Teece *et al.*, 1997; Eisenhardt and Martin, 2000) but their effectiveness change with time.

The RBV considers that each firm has unique resources and capabilities (Wernerfelt, 1984) and the growth of the firm is contingent upon the efficient exploitation of the resources and utilization of capabilities. Chandler (1990) has emphasized the importance of investing in manufacturing, marketing, and R&D, which is associated with the RBV of the firm (Penrose, 1959). If the firm invests in functional resources and builds functional capabilities, it can facilitate commercialization of new technology.

The firms registering above average performance have valuable, unique, and imperfectly mobile resources (Barney, 1991). The RBV considers that the resources and the capabilities of the firm are the determinant of competitive advantage and firms that possess superior capabilities compared to their competitors have an enduring competitive advantage (Peteraf, 1993; Russo and Fouts, 1997; Schendel, 1994). Some research suggests that the strategy of the firm should be determined by the firm's capabilities – not by conducting environmental analysis – because there is continuous change in technology, customer needs, and preferences (Chien, 2005). Others do not support this view and suggest that the business environment should be frequently monitored and customers' needs and preferences analyzed to develop dynamic capabilities (López, 2005; Teece, 2007).

The RBV of the firm posits that the performance of a firm also depends on the availability of heterogeneous resources (Barney, 1986; Dierickx and Cool, 1989). Firms that have heterogeneous resources can develop multiple capabilities, which can be marketing capability, manufacturing capability, and R&D capability. These firms more frequently develop new products and manufacture them at lower production cost (Peteraf, 1993; Montgomery and Wernerfelt, 1988).

2.3.1.1 Marketing Capability

In recent years researchers have been focusing upon the impact of marketing activities on firm performance (Krasnilov and Jayachandran, 2008). The marketing activities of a firm indicate the marketing capabilities either developed internally or acquired from alliance partners to respond to the marketing problems arising from the dynamic business environment (Vorhies and Harker, 2000). The unique experience, knowledge, and skills of the marketing personnel – combined with the ability of the firm to gather and analyze information related to market, business environment, needs, and preferences of the customers – generate unique marketing capabilities.

Vorhies and Morgan (2005) conducted field interviews and organized focus groups to identify the marketing capabilities that senior marketing managers consider to be essential in creating value for the company. They interviewed 30 managers and conducted four focus groups. Three of the focus groups had 24 managers from different firms; the fourth focus group had nine participants from the marketing division of a Fortune 500 high technology company. The essential marketing capabilities identified are:

1) Product development – the existence of a process within the firm to develop new products or services to offer to existing or potential customers,

2) Pricing the new product – the ability of the firm to charge an optimal price,

3) Distribution channels – the existence of an efficient distribution network to bring the product to customers in a timely manner,

4) Communication – the ability of the firm to manage customer perceptions,

5) Selling – the ability of the firm to get orders for the new product from existing or prospective customers,

6) Market information management – the ability of the firm to keep updated market knowledge,

7) Marketing planning – the ability of the firm to formulate marketing strategies, balancing resources available in the firm and objectives to be attained, and

8) Using marketing strategies effectively – the ability of the firm to implement the marketing strategies in the marketplace.

The characteristics of marketing capability, as identified by Vorhies and Morgan (2005), dovetail to reflect the importance of market orientation. Market orientation plays a critical role in today's competitive business environment. Firms that can efficiently gather market information are considered highly market oriented (Menon *et al.*, 1992). Market orientation fosters increased sales, efficient customer service, success of new products, and the overall performance of the firm (Oczkowski and Farrell, 1998). Research has shown that market-oriented firms develop distinct marketing capabilities to respond in a timely way to dynamic market conditions, which leads to superior organizational performance (Kohli and Jaworski, 1990; Jaworski and Kohli, 1993; Guenzi and Troilo, 2006). Olavarrieta and Friedmann (2008) conducted an empirical study in Chile and found that market orientation and market sensing has significant influence on the performance of the firm.

Firms having strong marketing capability are able to generate and disseminate market intelligence as well as customer information to the other internal departments (Kohli and Jaworski, 1990). They develop a market sensing ability by systematically collecting and managing information about customers and competitors (Song *et al.*, 2008). They constantly monitor changes in market structure, market segmentation, the entry of new players into the market, and the capabilities of new players. The ability of the firm to efficiently conduct market scanning also influences the technological capability of the firm. It helps to monitor technologies used by the competitors and to develop new technologies to produce innovative products (Kohli and Jaworski, 1990; Narver and Slater, 1990). All firms perform these activities, but firms having strong marketing capability do them systematically through active scanning, self-critical benchmarking, improvement of procedures and practices, and analysis of competitors' successful strategies (Day, 1994). If the market information is shared among the different functions of the firm, this facilitates interfunctional coordination and leads to formation of integrated strategies (Day, 1994; Jaworski and Kohli, 1993).

Firms having strong marketing capability give priority to customer needs and requirements. They involve customers in product and process improvement, and use their resources to manufacture products that create superior customer value (Deshpande *et al.*, 1993; Narver and Slater, 1990; Shapiro, 1988; Slater and Narver, 1994; Day, 1994). They also endeavor to predict the future needs of their customers and utilize some of their resources to develop products that can meet those future needs (Slater and Narver, 1998; Vorhies and Harker, 2000; Krasnilov and Jayachandran, 2008). The interaction of these firms with their customers has increased in recent years because of advancements in communications technology (Yadav and Varadarajan, 2005).

The marketing capability of a firm is also reflected by the relationship it builds with its distribution channel members. Firms developing a close relationship with their distribution channel members are able to better understand their needs (Day, 1994). This close relationship is nourished by encouraging the distribution channel members to participate in joint programs. It helps to improve product quality and increases awareness of each other's problems. This develops mutual trust and the credibility of the firm, which is essential for survival in today's intense competition (Day, 1994). Ruiz-Ortega and Garcia-Villaverde (2008) found, in their survey of 253 companies in Spain, that efficient distribution channel management is essential for successful commercialization.

Firms with a strong marketing capability are customer centric and endeavor to manufacture products that are highly useful for their customers. Research shows that one of the biggest mistakes that firms make is failing to distinguish between a feature and a benefit (Parker and Mainelli, 2001). They often assume that all new features produce new benefits. Parker and Mainelli (2001) have identified three types of benefits: (1) giving the customers/end users new capability; (2) simplifying the process to make things easier, which saves time; and (3) reducing cost, which saves money. A new product with many features and developed using a completely new technology can be considered revolutionary from the technologists' perspective. If, however, it fails to provide benefit to the end users, it will not be adopted by the masses.

2.3.1.2 R&D Capability

R&D Capability is the competence of the company in developing different technologies to produce a new product or service (Krasnilov and Jayachandran, 2008). R&D

capability is demonstrated by the technological capability of the firm to develop and adapt new technology. Rothaermel and Hill (2005) posit that if the firm does not have strong R&D capability to adapt different technologies then it is less likely to efficiently commercialize technology.

Technological capability has been defined as the "knowledge and skills required to choose, operate, maintain, adapt, improve and develop technologies" (Madanmohan *et al.*, 2003). Jin and Zedwitz (2008) defined technological capability as the capability to use existing technical knowledge and skills in developing new technical knowledge and skills. Rosenberg and Firschtak (1985) have defined technological capability as a "process of accumulating technological knowledge or a process of organizational learning." Technological capability enables a firm to analyze the new technologies and to conduct pre-investment analysis. The existing technological capability of a firm can be assessed in terms of its ability to:

- Identify its own technological needs,
- Select the appropriate technology that can accomplish these needs,
- Operate, maintain, adapt, and improve the selected technology, and

- Promote the technical learning within the organization using internal and external learning mechanisms (Kumar *et al.*, 1999).

Technological capability is a continuing learning process. The extent of learning is contingent upon three crucial capabilities of the firm: investment capability, operational capability, and dynamic learning capability (Kumar *et al.*, 1999; Bell, 1987). The *investment capability* of the firm is its ability to identify and choose the necessary technology and then to invest its resources to acquire it. The *operational capability* of the firm is the availability of the skills and know-how required to operate, manage, repair, and adapt the new technology to increase efficiency (Song *et al.*, 2008). Operational capability can be attained through training, exchange of technical staff, and support from the suppliers of new technology (Bell, 1987). The *dynamic learning capability* enables a firm to reproduce and modify the technology to produce new products, new processes, or new designs (Ranis 1981). This capability can be achieved by learning the new technology in great detail. Kumar *et al.* (1999) have opined that dynamic learning capability can be acquired through "learning-by-doing, learning-by-using, learning-by-interacting and learning-by-in-house research."

2.3.1.3 Manufacturing Capability

Technology commercialization requires strong manufacturing capabilities (Siegel *et. al.*, 1995; Zahra and Nielsen, 2002). The firm's processes, systems and equipment, and the level of skills and knowledge of the manufacturing personnel illustrate the manufacturing capability of the firm. Zahra and Nelsen (2002) have suggested two components of manufacturing capability: the human component and the technological component. The human component comprises the knowledge, skills, and creativity of the manufacturing personnel. The technological component of manufacturing capability is determined by the existing internal technological processes and the system used for manufacturing. These two components of manufacturing capability facilitate technology commercialization by reducing the production cost and shortening the product development cycle. Strong manufacturing capability also gives the firm flexibility to react quickly to the changes in the business environment by making modifications in the internal processes and systems.

Ferdows and De Meyer's (1990) "Sand Cone" model, which is the modification of Nakane's (1986) model, suggests that the firm should develop four dimensions of manufacturing capability in sequence over a period of time. The firm should initially invest its resources to build manufacturing capability to produce a high quality product.

While maintaining its focus on quality, the firm should improve the dependability of the production process in the second stage. In the third stage, the firm, while paying attention to the previous dimensions, also improves its ability to produce varied products. In the fourth stage, the firm focuses upon reducing the manufacturing cost while maintaining the quality and ensuring the dependability of the manufactured products (Leung and Lee, 2004). All these dimensions of manufacturing capability impact technology commercialization. They allow production of high quality products at low cost that can be launched quickly in the market to gain advantage for the firm producing the products.

2.3.1.4 Integration Capability

Souder (1987) has defined integration as "a state of high degree of shared values, mutual goal commitments, and collaborative behaviors." It is the process by which firms manage their functional resources to commercialize technology successfully (Grant, 1991). It has been found that in spite of possessing resources and capabilities, many firms have failed to commercialize newly developed technology due to ineffective integration (Zahra and Nielsen, 2002).

It is essential to integrate the various functional resources with the systems, structures, and processes of the firm at the organizational level (Teece *et. al.*, 1997). The management plays the critical role of ensuring the availability of resources for continuing to develop capabilities. Shared values among the functions of the firm, effective leadership, and focused attention by the management facilitate integration (Orton and Weick, 1990). Song and Perry (1996) have studied the best practices in Japanese firms and found that integration of the R&D, marketing, and manufacturing functions plays a vital role in the success of new products.

Hitt *et al.*, 1993 have hypothesized that the degree of internal integration among various functions affects the ability of the firm to appropriate value from innovation. The interfunctional integration reduces the time to market, and efficiently manages environmental uncertainty which helps the companies to appropriate value from Innovation (Figure 2).

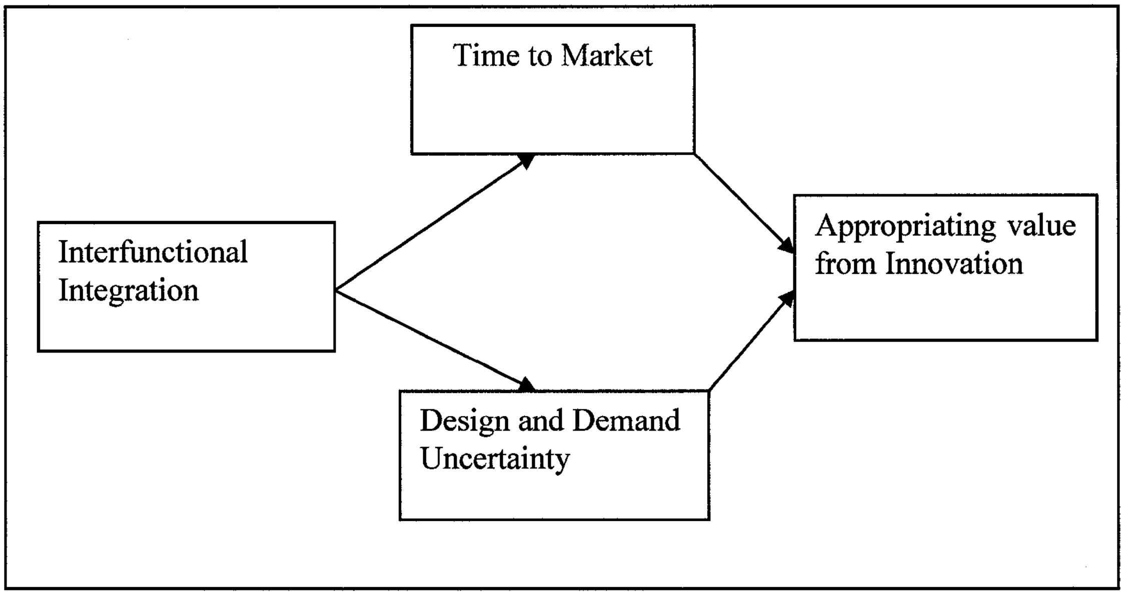

Figure 2: The Effects of Interfunctional Integration

Source: (Adapted from Hitt *et al.*, 1993)

The importance of integration is well known among practitioners and well researched in academic literature, but integration is not widely implemented by the firms (Ettlie, 1988). This has resulted in an inability to achieve maximum advantage from the new technology. Integration increases the competitiveness of the firm because it improves productivity (Whitney, 1988). The capability of the firm to integrate internally and externally is difficult to imitate or transfer, therefore, it also has the potential to provide a competitive advantage (Hitt *et al.*, 1993).

Moenaert *et al.* (1994) have suggested that the interfunctional climate and role flexibility are the two integration mechanisms used by the management to achieve commercial success. Interfunctional climate refers to the amount of interest, awareness, and trust one department has about the activities performed at other departments. Gomes *et al.*, 2003 considered functional integration having two dimensions – collaboration and interaction. The smooth flow of communication among the departments generates trust, which creates a positive interfunctional climate. The use of role flexibility is commonly found in Japanese firms. In Japan R&D engineers are encouraged to meet customers and understand their requirements and expectations (MacDowall, 1984).

2.3.2 Competitive Advantage

Michael Porter (1985) has coined the concept of "competitive advantage." The idea of sustainable competitive advantage existed as long ago as 1965, when Wroe Alderson (1965) pointed out the basic characteristics of sustainable advantage. He strongly advocated the necessity for firms to build unique characteristics to differentiate themselves from their competitors. George S. Day (1984) discussed the various strategies that companies should follow to sustain a competitive advantage. However, the term sustainable competitive advantage was not defined until 1991 when Jay Barney made the first attempt. He defined it this way: "A firm is said to have a sustainable competitive advantage when it is implementing a value creating strategy not simultaneously being implemented by any current or potential competitors and when these other firms are unable to duplicate the benefits of this strategy." He also discussed the attributes of the resources that have the potential to generate sustainable competitive advantage. These attributes are how rare the resources are, how valuable the resources are, how easily imitated the resources are, and how difficult it is to substitute for the resources.

In a slightly different approach, Selznick (1957) had coined the term "distinctive competence" to describe the activities, resources, and skills of an organization that has some special strength. Andrews (1971), applying the concept more to strategy, argued that distinctive competence is not only a single thing that an organization can do well. It can also be viewed as the entire set of things that differentiate an organization from its competitors. Hamel and Prahalad (1990) took Selznick's idea of distinctive competence and suggested the concept of core competencies, which are capabilities created by efficient utilization of resources. If resources are utilized differently and more efficiently than competitors, it could become the source of sustainable competitive advantage.

Diericks and Cool (1989), instead of using the term competitive advantage, wrote that when a firm has the advantage of having a unique combination of resources and capabilities that is difficult to imitate, the firm's competitors also attempt to develop completely new capabilities requiring totally different resources. The economic value of the critical resources may go down. Therefore, to achieve sustainable competitive advantage, a firm has to continue to pursue innovative capabilities to outperform its competitors and monitor frequently the dynamic business environment. The key to sustaining competitive advantage is to continuously commercialize technology by developing and introducing new products or processes. Companies that have a sustainable advantage can reap profits for a longer period of time. However, in today's environment advantages are rapidly eroded and sustaining advantages can be a distraction from developing new ones. Trying to sustain an existing advantage is a harvest strategy, rather than a growth strategy. It is designed to milk the current capabilities of the organization rather than to seek new capabilities to build upon. A strategy of sustaining the advantage created by the existing capabilities creates a danger of complacency and gives competitors time to catch up and become strong.

When a firm has the advantage of having a unique combination of resources that is difficult to imitate, competitors may attempt to develop alternative resources to produce similar benefits (Dierickx and Cool, 1989). If the competitors are successful in their endeavor, the firm that previously had a competitive advantage over others may not only lose its advantage but also find itself in a disadvantageous position. The economic value of the critical resources may go down and it will lose its importance. Therefore, to sustain a competitive advantage, a firm must repeatedly do something different from others and ensure that it enhances current operational effectiveness. Nonaka (1994) suggested that knowledge is the principal productive *resource* of an organization. He also stressed the need for organizations to continually innovate.

This need to continually innovate is evident from the strategy followed by Microsoft and other successful organizations that concentrate on short-term advantages and quickly move on to create new advantages. Microsoft moved from dominance in operating systems to a strong position in applications programs. In 1992, Microsoft held 90 percent of the market for personal computer operating systems, and then it invested $100 million into developing the next generation software applications. From that success, it moved to developing Windows NT, using an operating system that replaced its own MS-DOS. Instead of trying to protect the advantage it had with DOS, Microsoft actively tried to erode this advantage, knowing that failure to change would allow a fast-moving competitor to erode this advantage. Microsoft realized that its success with MS-DOS, Windows, and many applications programs didn't guarantee that it would lead in the next generation of software. Even though its large size can be an advantage, Microsoft doesn't consider itself invincible. The company launched Windows 2000, Windows ME, and Windows XP in very quick succession. Early in 2007 they launched Vista, another version of their windows operating system.

Microsoft has not, however, worked to have total dominance in its field. Critical markets have always remained in the hands of Microsoft's competitors. Novell had 70 percent of the networking market in early 1993. In just one year, Clarisworks won 77 percent of the $50 million integrated software market for Apple Macintosh computers, which Microsoft had held virtually by itself. Success depends not so much on the size of a company, but rather on its ability to move aggressively to the next advantage by innovating new technology and commercializing it before a competitor erodes this advantage.

There are other examples of companies who have chosen not to rely upon creating sustainable advantage but utilized their resources in developing new products. Gillette did not rest after Sensor's success, but introduced a radically redesigned Sensor for women and a new line of personal care products. The company's relentless pursuit of new products left researchers bewildered (D'Aveni, 1995). But Gillette had learned that, rather than relying upon current advantage and wasting time and resources to sustain it, a company must move to develop new products. Otherwise competitors will not only destroy the current advantage but also jeopardize its survival. Attempting to sustain advantage from an existing product can consume the resources that should be used to generate and reconfigure new capabilities. Sustaining advantage is effectively a defensive strategy designed to protect a firm's current resources and the capabilities generated from those resources. This does not ensure a secure future.

The business environment is continuing to become more and more competitive. Competitive intensity is a term that refers to the degree of competition a firm faces from its competitors (Grewal and Tansuhaj, 2001). For example, in the 1970s Digital Equipment Corporation tried to sustain its advantage in minicomputers. It had posted a 31 percent average growth rate from 1977 to 1982 by focusing on the minicomputer. But the company clung persistently to its advantage in minicomputer technology and failed to develop a strong position in the emerging market for personal computers. The company had the technological, marketing, and manufacturing capabilities to develop and launch PCs in the late 1970s, but they were selling so many minicomputers that they did not find it important to focus on the emerging new market. The defensive strategy of pursuing a sustainable competitive advantage had left the company without the series of temporary advantages it needed to thrive in a competitive market. Competitors were able to destroy Digital's advantage by outmaneuvering it. Even for the largest and most successful of competitors, past advantages do not guarantee future success if the firm does not continue to innovate and rely upon their inimitable resources and developed capabilities.

The business strategy in this hyper-competitive business environment should be to disrupt the status quo and seize the initiative by developing new capabilities and creating a series of temporary advantages. As competitive cycles have shortened, the need to rapidly develop new advantages has increased. It has become important for firms to focus on generating new advantages before their current advantages erode. The traditional goal is to build capability that sustains itself for a long period of time. Today, a capability developed over many years may be outmaneuvered by continuing developments and a firm may find that this type of development rarely pays off. It may take so long to create the so-called "sustainable" capabilities that by the time a firm has the capabilities in place, they will be obsolete or the circumstances might have changed and new and better alternative technology emerged.

Therefore, instead of attempting to develop capabilities that provide enduring competitive advantages, effort should be made to have a succession of new advantages in the rapidly changing and hyper-competitive business environments. Companies like Microsoft have used a series of initiatives to keep their advantage intact. Although many of its innovations and capabilities have been copied by competitors, the steady stream of innovations has helped Microsoft succeed. If Microsoft had rested on its laurels with MS-DOS in the way that Digital Equipment clung to manufacturing minicomputers, it would not have kept its competitive position in the marketplace. Instead, it launched new products more frequently than its competitors.

2.3.3 Environmental Uncertainty

Environmental uncertainty is manifested in the form of demand uncertainty and technological uncertainty. Competitive intensity is another aspect of environmental uncertainty. Corporate leaders and management consultants have underscored the profound and rapid changes taking place in the corporate business environment. Many studies have pointed out that various factors, such as globalization and frequent technological innovation, have led to the tremendous amount of uncertainties and turbulence prevailing in the external environment. For instance, globalization has blurred the competitive boundaries of firms and industries that were once considered isolated. The Internet and its associated range of digital and mobile communications technologies have fundamentally altered the way firms and customers interact with each other, thereby intensifying the competitive landscape. Customers are demanding better prices, quality, and customer service at reduced costs. The success of new products in the market largely depends upon meeting customers' expectations and being able to exploit market opportunities, which is often difficult to do in an uncertain technological environment (Dechenaux *et al*, 2008). This means that companies have to keep a close tab on their commercialization costs while at the same time being innovative to survive and remain competitive.

In an uncertain technological environment, senior executives agree that it is important to synchronize technology strategy and marketing strategy (Capon and Glazer, 1987; Booz, Allen, and Hamilton, 1981). Increasingly, researchers and corporate leaders alike (Brown and Eisenhardt, 1998; Hitt *et al.*, 1998; Quinn, 2000) are suggesting that some embedded corporate strategies that were once successful in generating sustainable competitive advantage are not appropriate in the new environment. Solutions seem to revolve around developing capabilities, developing cross-functional coordination, continuing innovation of new products, and implementing flexible strategic architectures.

2.3.4 The Importance of Strategic Flexibility for Competitiveness

The concept of strategic flexibility is a topic of interest among academicians and corporate leaders (Barringer and Bluedorn, 1999; Eisenhardt and Martin, 2000; Farjoun, 2002; Grewal and Tansuhaj, 2001; Hatch and Zweig, 2001; Hitt *et al.*, 1998). It has gained importance because of the need to continue to develop and commercialize new products and processes. Essentially, strategic flexibility means that a firm is able to quickly change its strategies when there is a change in the business environment (Kokil and Sharma, 2006). In turbulent environments, demand tends to be highly variable and unpredictable and firms need strategic flexibility to respond quickly to customer needs. Rapid technology development and deployment, particularly radically new technology, could lead to substantial technological uncertainty. Because new technology presents both opportunities and threats, strategic flexibility allows firms to respond to the new realities of the technology by quickly reconfiguring their capabilities.

Strategic flexibility has been addressed through the lenses of specific strands of management disciplines, such as marketing, strategic management, entrepreneurship, and innovation management (Barringer and Bluedorn, 1999; Davenport *et al.*, 1998; Grewal and Tansuhaj, 2001; Hamel and Prahalad, 1994; Lee *et al.*, 2001; Yli-Renko *et al.*, 2001). Although these studies have yielded excellent insights, this body of research must be extended in another direction by focusing on the ways and extent to which strategic flexibility facilitates the development and utilization of the capabilities that are so crucial for achieving competitive advantage.

Strategic flexibility has been conceptualized in various ways (Johnson *et al.*, 2003), but several common threads tie these definitions together. For example, the majority of studies view strategic flexibility as the ability of the firms to react or adapt quickly to changes in their environment. Companies focus upon short- and long-term strategic flexibility in manufacturing, operational, and administrative processes. When there is greater turbulence in the business environment, strategic flexibility, which is not only about *reacting* or *adapting* to environmental turbulence but to *proactively* managing uncertainty in the environment, is essential (Johnson *et al.* 2003). A proactive approach to strategic flexibility states that firms should develop the capability to counter probable changes, rather than react to changes in the environment. The proactive approach involves greater risk but is likely to generate greater sustainable competitive advantage for the firms.

Strategic flexibility, in the context of *resource-based view* of the firm, is seen as the existence of a flexible resource pool and a diverse portfolio of strategic options that enable firms to respond to rapidly changing markets. Of equal importance is the idea that it is not only the bundle of resources that matter, but the mechanism by which new resources or capabilities are identified, acquired, accumulated, and deployed. Also important are the forces that limit the rate and direction of this process (Teece *et al.*, 1997; Sanchez, 1995). Other dimensions of strategic flexibility include the abilities to exit declining industries, close unprofitable operations, and change administrative processes that limit the capacity to absorb new knowledge. It is also essential to enable new learning to occur (Leonard-Barton, 1992; Burgleman, 1991; Volberda, 1996) and to actively manage relationships among senior, middle, and front-line managers (Burgleman, 1994; Bartlett and Ghoshal, 1991).

Strategic flexibility is not an end in itself but a means to improve a firm's performance, as expressed in terms of various financial or market indicators, and the ability to develop the required capabilities. The technology management literature increasingly advocates the importance of strategy innovations for building technological competence and competitiveness (Dunning, 1992; Bartlett and Ghoshal, 1991; Nohria and Ghoshal, 1997; Ohmae, 1990). Innovative capabilities, as described in the technology management literature, refer to the ability of a firm to develop and leverage innovations from knowledge resources available both within the firm and outside the firm (e.g., through its inter-organizational networks).

The measures previously used to operationalize innovative capabilities in terms of commercial output include the number of new products developed and the number of patents over a particular time period. Also essential are improvements to the production/innovation process, reduced costs, increased efficiency, and innovation outcome (e.g., the increase in the overall success in commercializing technology). Most previous studies use one or several of the measures to assess innovative capabilities (Zahra and Nielsen, 2002). However, greater conceptual clarity of the relationship between strategic flexibility and innovative capabilities can be observed if all the items are used simultaneously.

2.4 Technology Commercialization Strategy

The rapid change in technology has influenced new product development and product life cycle. Because technology is changing so rapidly, it does not provide a competitive advantage to the developer for a long time. Utilizing the new technology to develop a new product or service is more important than possessing it (Capon and Glazer, 1987). Therefore, an integrated technology strategy is needed to constantly monitor the changes in technology, the market, and the needs of the customer.

A technology commercialization strategy examines the level of slack or excess resources, available within the firm that can easily be deployed to deal with uncertainty without disrupting current organizational or production efficiency and effectiveness. Slack resources that are not utilized are a cost to the firm. They may prove to be a burden in turbulent environments when the firm has to respond quickly and effectively to new opportunities or threats. To minimize this cost, firms employ a variety of strategies, including outsourcing non-core activities, establishing “options” to acquire contingent capabilities, and buying necessary resources. Other strategies are, partnering with other firms and ensuring that a firm’s internal resources and capabilities are harnessed and shared effectively across various units of the firm (Grewal and Tansuhaj, 2001; Hatch and Zweig, 2001; Ranft and Lord, 2002). Studies have explored how firms have successfully used strategic alliances and partnerships to acquire needed capabilities, create new capabilities, and accelerate the adaptation of the firm to its environment (Kogut and Zander, 1992). Tapping external resources not only enables firms to combine complementary capabilities with new capabilities to create new innovations, but also significantly increases their strategic flexibility to address the opportunities and threats in the environment (Burgleman, 1994; Kogut and Zander, 1992).

Teece (1986) has suggested that the strategy to exploit the technology depends upon factors, such as the availability of complementary assets and ease of replication. The prime objective for technology commercialization is to generate revenues. The crucial factor for optimal revenue generation is to have a clear picture of one's capabilities. A firm must be able to recognize its core and non-core technologies. As shown in Table 3, non-core technologies can be licensed or sold to other firms because this does not harm the future prospects of the firm. The core technologies are exploited internally, because they are the source of competitive advantage for the innovating firms and have been developed with the objective of getting advantage over competitors. If the firm is lacking superior complementary assets it can generate revenue from its core technology by forming strategic alliance with other firms that possess superior complementary assets and from its non-core technology by selling or licensing it to other firms. Firms with superior complementary assets would exploit the core technology by manufacturing products and the non-core technology by either manufacturing products or by giving license to other firms (Iansiti and West, 1997).

Table 3: Commercialization Strategy

	Core Technology	**Non-Core Technology**
Complementary assets available	Exploit Internally	Exploit Internally **OR** License
Complementary assets not available	Strategic Alliance	Sell OR License

A study conducted by the British Technology Group in 1998 found that large firms in the developed countries possessed technologies that were not used to develop products or licensed to other firms. Most of these firms decided to generate revenue by selling the licenses of the unused, non-core technologies to interested firms (Arora *et al.*, 2001).

Another theory explaining the technology commercialization strategy is the transaction cost approach (Coase, 1937). It suggests that if the cost of acquiring complementary assets is lower than the transaction cost of selling or licensing the technology, the innovating firm should exploit the technology internally. It should either develop or acquire the complementary assets to take maximum advantage of this technology. The firm developing the new technology should conduct environment scanning to have a better understanding of the competition in the market (Arora *et al.*, 2001). If the competition is intense, then the return on investment (ROI) would be low, because there will be too many competitors fighting for the same pie. The firm can get higher returns by selling or licensing the technology to other firms. For example, Qualcomm, developer of CDMA technology, tried to use its internally developed technology in manufacturing handsets. The poor performance compelled them to change their business model and concentrate on generating revenue by licensing the CDMA technology (Arora *et al.*, 2001).

2.4.1 The Role of Strategic Alliance in Technology Commercialization

Traditionally, technology commercialization has been limited to licensing a technology to another party. However, strategic alliances, joint ventures, and spinoffs are now considered valid mechanisms for technology commercialization to develop new products or services. The literature search in this domain attempts to better understand the formation and success of alliances by exploring strategic alliances developed for technology commercialization. Firms often do not have the resources to develop internally all the capabilities to commercialize technology, therefore, this research posits that strategic alliances play an important role in enabling these firms to commercialize technology.

Strategic alliances are considered a potential source of sustainable, competitive advantage, since partners can either leverage existing capabilities or acquire new ones through the alliance. Since the capabilities are seen as the basis on which the firms compete, the acquisition of capabilities through alliances could provide a competitive advantage to this firm (Prahalad and Hamel, 1990). A strategic alliance is defined as a "long-term cooperative arrangement between two or more independent firms that engage in business activities for mutual economic gain" (Hyder and Abraha, 2004). However, the literature provides no single definition of strategic alliance. The term seems to cover a broad spectrum of meanings that depend on how the alliance is structured. It includes equity agreements (joint venture, minority equity positions, and equity swaps) and non-equity agreements (such as joint R&D, joint product development, long-term sourcing agreements, joint manufacturing, or joint marketing). The term does not include mergers and acquisitions; arm's-length sales contracts; or traditional arm's-length distribution, franchising, and licensing agreements (Gebrekidan and Awuah, 2002).

Jiang and Li (2008), in their study of 127 German companies, indicated that strategic alliances help in learning new product development techniques and new manufacturing processes; they also provide marketing expertise that positively influences the financial performance. The most common form of strategic alliance is a technology alliance. A technology alliance is a collaboration between firms, "where the generation or adaptation of technical advances takes a central role" (Fusfeld, 1994). Such collaborations allow firms to respond swiftly to market needs by quickly bringing technology to the marketplace (Lee and Vonortas, 2002). The motives for technology alliances are varied; however, the reduction of costs in accessing technological capability seems to be the main driving force. Facilitating access to a technological capability is the prime characteristic of technology alliances (Nueno and Oosterveld, 1988; Peters and Gersony, 1997). The differentiating factor between technology and non-technology alliances is primarily the consideration of technical factors. The type of innovation (systematic/autonomous or product/process), expected R&D costs (if any), risk/uncertainty, and technological complexity are some of the technology attributes considered for technology alliances (Lee and Vonortas, 2002).

The escalating costs of R&D and the rapid pace of technology change do not allow some technology firms to work alone. For example, the costs of developing and launching a new drug into the market could be around US $200 million. The effective collaborative arrangements of biotechnology and pharmaceutical companies give the drug companies access to cutting edge technology while providing market access and financial resources (Lee and Vonortas, 2002; Bagchi-Sen, 2007), and alliance stability (Jiang *et al.*, 2008). Penetration into other markets is one of the prime objectives of the firms seeking a marketing alliance. A technology intensive firm could lack knowledge about the social, cultural, political, legal, and market conditions to commercialize its technology in local and international markets. Thus, a marketing alliance provides market access to the firms with technological capabilities that lack the capabilities to commercialize their technology. A firm may also form a manufacturing alliance with a firm having the capability to manufacture a high quality product at a low cost.

Reports from the CBoC (Guthrie, 2006) and Industry Canada (Industry Canada Report, 2006), mentioned earlier, note the strong technological capability of Canadian firms but their overall inability to commercialize technology. To understand the factors inhibiting their potential to commercialize technology, it is important to explore the extent to which Canadian firms prefer to form alliances with partners having superior organizational capabilities.

2.4.2 Major Issues Related to Strategic Alliances

The literature contains exhaustive discussions of four issues related to the topic of strategic alliances: (1) motives/benefits (Hyder and Ghauri, 2000), (2) learning (Child and Markoczy, 1993; Lyles, 1994), (3) conflict and control (Killing, 1983; Beamish, 1985; Geringer and Hebert, 1989; Habib, 1987) and (4) determinants of successful strategic alliances (Geringer and Hebert, 1991; Arinö and de la Torre, 1998; Nielsen, 2003; Patel, 2007). Identifying reasons or motives for strategic alliances has been a popular stream of research in the literature. A variety of theoretical perspectives – transaction cost, resource dependency, organizational learning, strategic positioning, and institutional theory – have been used in the literature to explain why firms form strategic alliances (Nielsen, 2003).

2.4.2.1 Benefits of Strategic Alliances

Firms expect to gain a number of benefits by entering into an alliance. By pooling their resources, complementing their skills, and combining their strengths, the partners can achieve individual goals that may be difficult to achieve if they had worked on their own. By leveraging their respective core competencies, the firms create synergy leading to a win-win situation for all the parties involved (Gebrekidan and Awuah, 2002).

An understanding of the partner's motivation for forming alliances is very important in selecting the appropriate strategic partner. The major benefits expected from forming strategic alliance are reducing the cost of developing new technology, reducing the production cost, developing new products frequently, and introducing new products in different markets (Borys and Jemison, 1989; Hamel and Prahalad, 1989; Butler, 2007). Other benefits include legal protection through patents, overcoming barriers to trade, such as tariffs and quotas, and achieving international expansion (Harvey and Lusch, 1995).

A partial listing of benefits from strategic alliances is presented below:

Sr.	**Benefits**
1	Gain presence in new market
2	Gain faster entry to market
3	Facilitate international expansion
4	Compete against common competitor
5	Maintain market position
6	Exchange complimentary technology
7	Develop economies of scale
8	Produce wide range of products
9	Receive faster feedback on investment
10	Concentrate on higher margin business
11	Share R&D costs
12	Spread risk of large project
13	Reduce competition
14	Produce at a lower cost location
15	Exchange patents/territories
16	Confirm to foreign government policy

2.4.2.2 Learning from Strategic Alliances

Firms learn through at least four processes: imitation, grafting, synergism, and experience. Imitation is the endeavor to learn about the strategies, technologies, and functional activities of other firms and replicate them. Imitation can take place openly or secretly. Licensing is an open form of imitation where the licensor willingly provides the technology and accompanying knowledge. Secret learning is related to tacit knowledge learned over time where the owner of the resource has no intention of passing on the knowledge (Hyder and Abraha, 2004). Grafting is the process of explicit learning undertaken to enhance the understanding of the partners. Synergism occurs through joint activities, such as collaborative product development and R&D. Experience is the learning that comes with trial and error and through collaborations with other firms (Hyder and Abraha, 2004).

2.4.2.3 Conflict and Control in Strategic Alliances

Despite having common motives and objectives, which is not always the case, the potential of conflict always exists when firms deal with tactical issues. The focus ought not to be on eliminating conflicts; rather it should be on how conflicts are managed within an alliance. Despite the rapid increase in strategic alliances in the last two decades, a large number of them fail or cease to exist. According to some estimates, 50 to

70 percent of alliances fail (Bleeke and Ernst, 1991; Harrigan, 1988; Killing, 1983; Kogut, 1988; Park and Ungson, 1997; Kok and Wilderman, 1999). The literature identifies a number of factors that contribute to the failure of alliances. The most important among them are conflict, poor perceived performance, inflexibility (Geringer and Hebert, 1991; Parkhe, 1993), poor communications, opportunism, and incompatible objectives (Gugler and Dunning, 1993).

By their very nature, collaborations are bound to face some difficulties. Chief among these difficulties are corporate culture and legal factors, which play an important role in the formation and operation of alliances. The differences in corporate cultures are reflected in the differences in employee reward systems, perception of time, goal setting and decision-making styles, etc. One partner may define success in financial terms while another may be more concerned about the market share. The key elements of corporate cultures, therefore, must be known and carefully considered before an alliance is formed. However, the decision makers are mostly concerned about the strategic, financial, and legal aspects of the alliance. Consequently, a disregard for the alignment of corporate cultures between the partners often leads to conflict in the management of the alliance and lack of trust (Werther, 1998; Butler, 2008).

Before an alliance is formed, a firm must thoroughly evaluate the effects of forming strategic alliances and gain sufficient knowledge about the partner and its objectives. If a partner behaves opportunistically, the cheated partner could lose its technology, marketing plans, customers, markets, and reputation (Gebrekidan and Awuah, 2002). Careful selection of the partner is, therefore, a prerequisite to the success of an alliance. Both the partners must bring complementary skills and resources to the table for the alliance to be successful.

The firm possessing the new technology may consider forming a strategic alliance with firms in other countries. An international strategic alliance is formed when partners come from two or more countries (Hyder and Abraha, 2004). Geringer and Hebert (1989) consider an alliance to be international if one of the partners is headquartered outside the country where the operation is conducted. The literature also describes international strategic alliances as international co-operative or collaborative agreements or ventures (Root, 1988; Hergert and Morris, 1988; Buckley and Casson, 1988; Harrigan, 1988). Other descriptions are as hybrid arrangements (Borys and Jemison, 1989), joint ventures (Harrigan, 1988; Hennart, 1988, Kogut, 1988), and coalitions or partnerships (Porter and Fuller, 1986; Perlmutter and Heenan, 1986).

Even though there is no consensus on the form and structure of a strategic alliance, many authors suggest that strategic alliances with international partners are more likely to be equity-oriented (Gulati, 1995; Hagedoorn and Narula 1996). This compares to domestic alliances, which are more likely to be contractual in nature. The reason given for this difference is the difficulty in monitoring and enforcing contracts over a long distance agreement. An alliance with companies originating from different cultures and nationalities is also strategically more complex. For that reason, an equity exchange can smooth the process of alliance development, resulting in increased trust and commitment (Garcia-Canal, 1996).

The last two decades have seen a dramatic rise in the number of alliances in the global business environment. For instance, Japanese firms signed more than five hundred alliances with American firms between 1980 and 1990 to help them enter the vast North American market. They had developed new technology in-house but did not have the marketing capability to successfully launch their product in the new market. Another report suggests that the number of international alliances worldwide grew more than five-fold between 1989 and 1999 (Chen, 2003). This dramatic increase in the number of inter-firm collaborations across industry and national borders in recent years has raised the importance of the phenomenon of alliances. The increase in international inter-firm alliances is associated with increased globalization and rapid changes in competitive environments (Robson, 2002). The world economy has undergone transformational changes in the last two decades. The business environment has become more complex, uncertain, and competitive. Global competition has been intensified by the emergence of developing countries (such as South Korea, China, India, and Brazil) as serious competitors and the information technology revolution. Additionally, the heightened pace of technological change has led to higher customer expectations and shorter product life cycles.

Companies are realizing that, in spite of developing capabilities in-house, it is not possible for them to remain competitive in various markets simultaneously. Also, amid high customer expectations in the face of the rapidly changing technological environment, firms are finding it difficult to continue to develop the new technologies required for the design, development, manufacture, and marketing of new products (Kauser and Shaw, 2004). Alliances, therefore, provide a mechanism to help firms maintain and regain their competitive positions in markets (Ohmae, 1989). The importance of alliances can be gauged from the attention the topic has received in both media and academic circles (Perlmutter and Heenan, 1986; Hergert and Morris, 1988; Harrigan, 1988; Buckley and Casson, 1988; Borys and Jemison, 1989; Bucklin and Sengupta, 1993; Doz and Hamel, 1998; Osborn and Hagerdoon, 1997; Dussauge *et al.*, 2000).

Control is defined as the process by which one partner influences the behavior, output, and function of the alliance and of another entity through the use of power, authority, and a wide range of bureaucratic, cultural, and informal mechanisms (Baliga and Jaeger, 1984). Control and ownership arrangements are one of the major challenges in any strategic alliance (Kogut, 1988; Beamish, 1985). How this is dealt with is important to the success of the strategic alliance. Maintaining control in an international strategic alliance can be extremely difficult; therefore, strategic alliances with international partners are more likely to be equity-oriented alliances (Gulati, 1995; Hagedoorn and Narula, 1996), as opposed to domestic alliances, which tend to be contractual alliances.

2.4.2.4 Determinants of Successful Strategic Alliances

Partner selection is one of the most important variables in the successful formation and operation of an alliance, as argued by a number of authors (Geringer and Hebert, 1991; Glaister and Buckley, 1996; Arinö and de la Torre, 1998). The performance of an alliance, it is stated, depends a great deal on the characteristics, skills, and resources of the partner. Partner selection becomes even more important across national cultures since it is difficult to maintain a close watch and control over operations in a long distance relationship and a greater degree of responsibility falls on the shoulders of the partners individually, rather than collectively. Hence, it appears crucial to identify and classify partner selection criteria and rate the relative importance of those criteria (Nielsen, 2003).

A variety of selection criteria for selecting partners for strategic alliances has been suggested by various authors in the past. A major criterion has been matching the needs of the partners in an alliance (Geringer and Hebert, 1989; Geringer and Hebert, 1991). Nielsen (2003), in an empirical study of Danish firms involved in joint ventures, further divided partner selection criteria into task-related and partner-related selection criteria. The major variables of task-related partner selection criteria used by Danish firms were access to market knowledge, distribution channels, product-specific knowledge, and local regulatory knowledge. Also important were technology, capital, materials/natural resources, production knowledge, and links with major suppliers/buyers. Major partner-related criteria used for the selection of partners by Danish firms are trust between top management teams, whether the partner business is related, partner reputation, financial status, firm size, firm experience, the ability to negotiate with governments, and access to marketing/distribution systems. Other major criteria are the degree of past favorable experience with the partner, the partner's experience in technology application and potential for new technology development, and the partner's access to technology/knowledge.

The availability of complementary resources for exchange and combination is a prerequisite for the successful operation of the alliance. The effectiveness and performance of the alliance has been linked to the extent that the resources and skill levels of the partners are complementary in nature (Killing, 1983; Harrigan, 1985; Geringer and Hebert, 1991; Parkhe, 1993). Some researchers consider factors concerning cultural (both corporate and national), strategic, organizational, and financial traits of the partners to be critical for a successful strategic alliance (Yan and Luo, 2001). Several authors (Harrigan, 1985; Saxton, 1997) highlight the importance of the form of administrative governance and link it to the overall success and performance of the alliance. Based on the premise that resource commitment in alliances depends on the form of the alliance, it is argued that considerable financial investment, managerial time, and stronger commitment depend on the structural form of the alliance. A contractual agreement without any equity involvement, in the form of a joint venture or equity exchange, may not command the commitment required to resolve problems.

Another important role contributing to stability in an alliance, as argued by Pralahad and Hamel (1990), is the size of the partner firm. Weaker partners, they contend, face potential domination and exploitation, and they remain unsatisfied. Therefore, the performance of the strategic alliance depends on the overall and ongoing satisfaction of the partners in the strategic alliance and the extent to which partners make an effort to understand each other's distinct corporate thought styles (Patel, 2007). Other factors that play a pivotal role in the success of the alliance are:

- Good understanding among the partners.

- Mutual learning about the partners, which facilitates understanding and leads to better performance functioning and success of the alliance.
- The duration of the alliance, in which the longer the duration of the alliance and the greater the learning contribute to a higher chance of success.

Prudent monitoring and control contribute significantly to the success of an alliance. A system of checks and balances ensures the smooth flow of operations. If effective monitoring systems are in place, potential problems can be preempted. However, the issue of control needs to be resolved in the beginning to prevent conflicts from arising at a later stage.

Despite the fact that all necessary steps may be properly taken at the beginning – from partner selection to setting up monitoring mechanisms – the potential for conflict cannot be neglected. Legal recourse, if necessary, should be taken as the last step. However, a certain level of trust and commitment, if developed, could help to diffuse tensions and resolve issues that will arise.

3 THEORETICAL FRAMEWORK

This section discusses the various independent, dependent, and control variables as shown in the theoretical framework (Figure 3). In the literature, researchers have explored the importance of integration of business functions (such as R&D, manufacturing, and marketing) on a firm's performance (Dutta *et al.* 1999) and the influence of a single functional capability on technology commercialization (Zahra and Nielsen, 2002).

This study examines the influence of four types of organizational capabilities (manufacturing capability, R&D capability, marketing capability, and integration capability) on TCP. The association between each organizational capability and TCP, as well as their combined impact on TCP, is also studied. Integration capability is determined by the capability of companies to integrate the internal business functions and with the business functions of the strategic alliance partners. The other three organizational capabilities can either be developed in-house or acquired externally through strategic alliances with other firms.

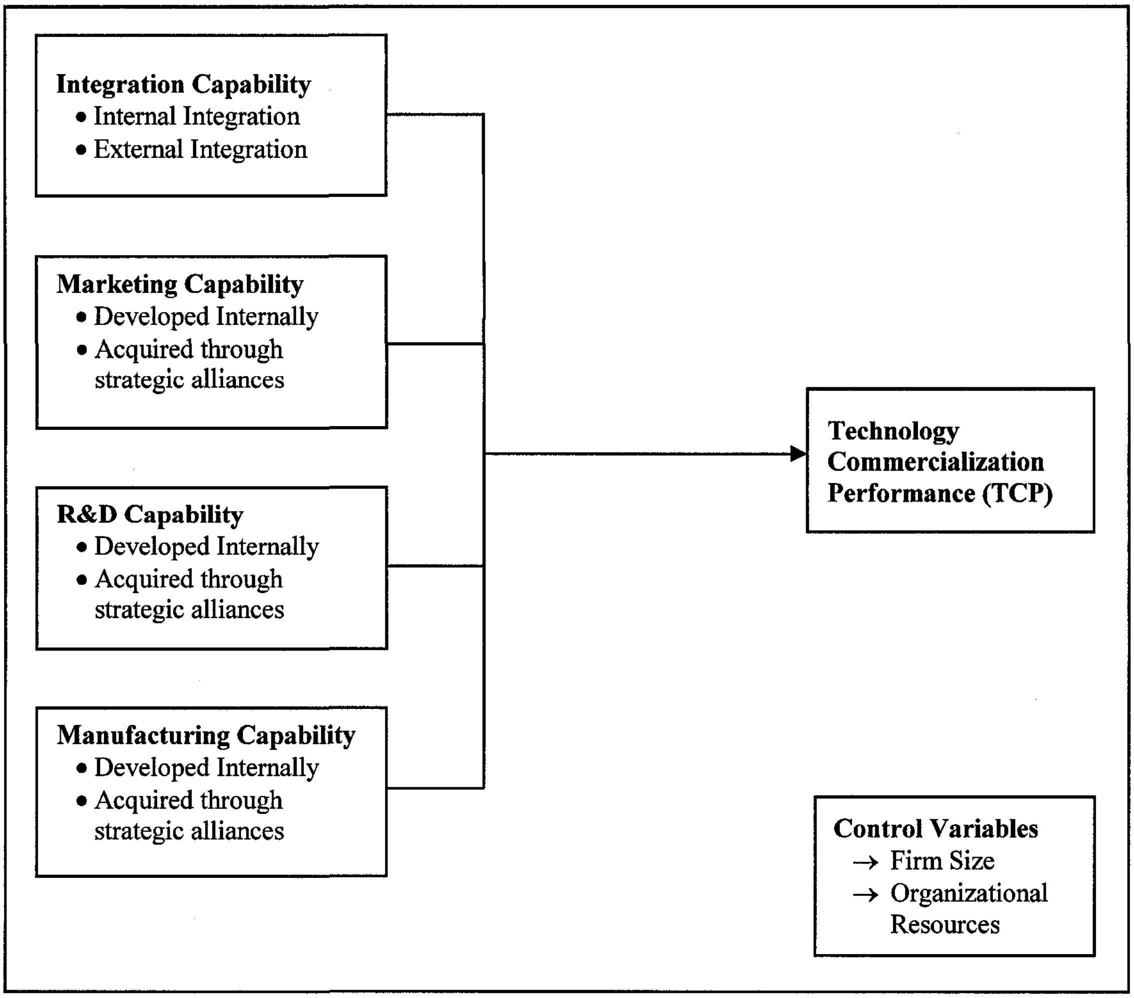

Figure 3: Theoretical framework to study TCP

3.1 Marketing Capability

Marketing capability has been defined as the "integrative processes designed to apply the collective knowledge, skills, and resources of the firm to the market-related needs of the business, enabling the business to add value to its goods and services and meet competitive demands" (Vorhies and Harker, 2000). Firms having a strong communications link with their customers develop strong relationships with them, which helps to determine their various needs. This helps to develop products fulfilling those needs and to simultaneously explore the probable application of new technology in other markets (Dutta *et al.*, 1999). If the firm does not develop an internal marketing capability, it can form a strategic alliance with firms that have strong marketing capabilities. The marketing-related strategic alliance can help to reach new markets across national boundaries; it can also give access to critical information about the needs of the potential customers in the new market and information about the competitors.

The marketing department of a firm frequently monitors competitors' new product development and their marketing strategies. The important activities of the marketing department are conducting test marketing of the new product, managing distribution channels efficiently to ensure timely introduction of new products in the market, developing a marketing communication plan to inform the potential customers about the launch of a new product and make them aware of its benefits, managing market information by monitoring the changes in the business environment, and planning and implementing the marketing program (Vorhies and Morgan, 2005).

Dutta *et al.* (1999) have suggested that the marketing department should be able to understand the factors influencing customer decisions and position the product in the most appropriate segment of the market. Deshpande *et al.* (1993) have considered monitoring markets and managing customer relationship to be essential marketing capabilities of a firm.

In this study, we have adopted the measures of marketing capability of a firm from Vorhies and Morgan (2005) and Dutta *et al.* (1999). These measures are market information management, market planning, distribution channel management, marketing communication program development, and a firm's ability to identify customer needs.

HYPOTHESES

H1: Strong marketing capability positively impacts technology commercialization performance.

H2: Firms having marketing-related strategic alliances have higher marketing capability

3.2 R&D Capability

The R&D department plays an important role in successful technology commercialization. It has to develop the capability to select the appropriate technology and then refine it to develop a new product (Iansiti and West, 1997). The R&D capability of a firm manifests its technological capability. In most industries, it is essential to have many different technologies to manufacture products. It may not be possible for a firm to develop all the required technologies internally. In this case, industries requiring many different technologies to develop products may acquire some technologies from external sources and develop the core technologies internally. The strategic alliances made with other firms, either to acquire the required technologies or to co-develop the required technologies, are expected to enhance the R&D capability of the firm. The variety of technologies from which the firm has to choose the required technology has increased over the years. At the same time, product life cycles have shortened and this has made the task of technology integration extremely critical. A wrong selection of technology can severely affect the commercialization process. Therefore, in the current business environment with reduced product life cycles, successful firms either develop or acquire the capability by choosing the most appropriate technologies. These technologies must work together to manufacture superior quality products, reduce the time to market, and increase productivity (Iansiti and West, 1997). Efficient managerial processes in a firm ensure successful implementation of technology development and acquisition strategy after the appropriate technologies have been chosen. The activities of the R&D department, which demonstrates the technological capability of a firm, are:

- To determine various technological options.
- To refine and modify the selected technology so that it can function properly in combination with other technologies.
- To develop products by working coherently with other functions of the firm (Iansiti and West, 1997)

As mentioned earlier in the literature review, the R&D capability of a firm is manifested by its technological capability. Kumar *et al.* (1999) have suggested measures of a firm's technological capability, which are the ability to: identify technological needs, select technology to fulfill those needs, modify the selected technology to align with other technologies, and operate and maintain the acquired technology. The firm may choose to develop the selected technology internally if it possesses the required resources. Otherwise, it would acquire the technology from external sources through strategic alliances and use its technological capability to adapt it to accomplish the firm's needs. In this research, the measures used for R&D capability are taken from Kumar *et al.* (1999). They are the ability of the firm to select the appropriate technology and to operate, maintain, and improve the selected technology.

HYPOTHESES

H3: Strong R&D capability positively impacts technology commercialization performance.

H4: Firms having R&D-related strategic alliances have higher R&D capability.

3.3 Manufacturing Capability

The manufacturing capability of a firm is found in its technological core and systems. The use of modern manufacturing technology and processes by Japanese and Korean companies has played a vital role in successful technology commercialization (Zahra and Nielsen, 2002). A firm possessing strong manufacturing capability can have sustainable competitive advantage because it enables the firm to develop new products sooner than its competitors. The manufacturing capabilities can be developed internally or may be acquired from external sources. The internal development of manufacturing capabilities has its own advantages and disadvantages. It requires a heavy investment, which is generally not reversible. Therefore, in the uncertain and dynamic business environment, firms select certain core manufacturing capabilities to develop internally and rely on external sources for the non-core manufacturing capabilities. The manufacturing capabilities acquired from external sources through strategic alliances may provide the required capabilities quickly. But they also need to be modified to be aligned with existing internal capabilities (Leonard-Barton, 1995). The manufacturing-related strategic alliance is expected to enhance the manufacturing capability of the firm, which influences the commercialization of technology.

Manufacturing capability is considered a multi-dimensional construct having four dimensions that illustrate the manufacturing prowess of the firm. These dimensions are low manufacturing cost, a high quality product, dependable production process, and the flexibility to produce a range of products (Wheelwright, 1984; Corbett and Claridge, 2002; Leung and Lee, 2004). These dimensions, which are used in other empirical studies (Krajewski and Ritzman, 2001; Hill, 1994), are considered to be the measures of manufacturing capability in this study.

HYPOTHESES

H5: Strong manufacturing capability positively impacts technology commercialization performance.

H6: Firms having manufacturing-related strategic alliances have higher manufacturing capability.

3.4 Integration Capability

Research conducted in the field of organizational renewal, corporate restructuring, and innovation management suggests that innovation and strategy-making require effective integration. This integration capability can be developed through coordination and interaction among managerial levels, business units, and external partners (Burgleman, 1994; Bartlett and Ghoshal, 1991; Hamel and Prahalad, 1990; Agryis and Schon, 1978). Commercialization of technology is an organization-wide activity to which the managerial level, business unit, and external partner contribute uniquely. Integration is needed to harness these disparate contributions. Integration is the process by which the firm coordinates and deploys its different capabilities to successfully commercialize technology (Grant, 1991). Commercialization of technology requires the integration of internal functions of the firm and integration with the internal systems and processes of the external sources (Leonard-Barton, 1995). This requires strong interaction among internal business functions and external partners to provide the capabilities and collaboration needed. Interaction and collaboration are the two dimensions of integration. The level of interaction is determined by the activities jointly performed between departments, which can be in the form of routine meetings, conference calls, official memos (Kahn, 1996). Collaboration is represented by the nature of the relationship that exists between the departments. The extent to which the departments work together, have common goals, and are willing to share resources determines the intensity of collaboration (Kahn, 1996). When a firm forms strategic alliances with other firms, it is essential to integrate them with the internal functions. This can be achieved by increasing the level of interaction with the partner firms and aiming for strong collaboration.

In this study, we have measured the integration capability of the firm by studying the level of interaction and collaboration among the departments within the firm and with the strategic alliance partners by the items proposed by Kahn (1996). The items measuring the interaction among the departments and with the external partners are formally coordinated activities, routine meetings, routine telephone calls, and documentation flow. The level of mutual understanding, common vision, and collective goals measure the collaborations among the departments and with the strategic alliance partners.

HYPOTHESIS

H7: Strong integration capability of the firm positively affects technology commercialization performance.

3.5 Organizational Resources

Cooper (1989) has given interesting statistics of the success rate of the commercialization of new technology. Only 10 out of 100 research ideas have the potential to become feasible projects. Two out of these 10 feasible projects pass through the phases of commercialization and only one of them turns out to be profitable. It is assumed that 50 percent of the money that companies spend on projects to commercialize a technology ends up as sunk cost. The low success rate of technology commercialization is mostly due to organizational shortcomings, such as unavailability of organizational resources, rather than the functioning of the new technology (Parker and Mainelli, 2001). The lack of organizational resources – such as financial capital, physical facilities, and personnel with functional expertise – impedes the successful commercialization of technology (Reamer *et al.*, 2003).

HYPOTHESIS

H8: The availability of organizational resources positively affects technology commercialization performance.

3.6 Size of the firm

Small firms or start-ups are efficient in developing new technology, but the lack of complementary resources impedes commercialization of this new technology. Arora *et al.* (2001) are of the opinion that in recent years small start-ups have been able to attract investors that have helped in acquiring resources and capabilities to commercialize technology. The 2006 report from Industry Canada does not support such a view and posits that small firms generally fail to successfully commercialize technology by developing new or significantly improved products. There are examples in the literature illustrating how the small-sized firms have failed in the past to commercialize technology. For example, Cambridge Display Technologies (CDT), a small-sized firm, was founded by a group of Cambridge University researchers who had developed a new polymer technology and decided to manufacture the product internally. They did not have enough employees with functional skills to manage all the activities properly and failed in their endeavor. The firm did not have organizational resources to manufacture new product, therefore, it changed its business model by abandoning the manufacturing activity and positioned the company as a technology developer. Later, the company started forming alliances with other firms that had the capability to manufacture and market the product.

In the literature, empirical studies (Zahra and Nielson, 2002) have considered organizational contingency variables – such as size of the firm, age of the firm, past performance, and industry type – as control variables. The results of the study indicated that the age of the firm and the past performance did have any significant impact upon technology commercialization. The size of the firm, however, was found to be a significant explanatory variable.

In the literature, the size of the firm is determined using market value of equity (Berk, 1995; Demsetz and Lehn, 1985; Baker and Hall, 2004), sales (Schaefer, 1998; Cohen *et al.*, 1987; Horst, 1972), assets (Schaefer, 1998; Horst, 1972), and number of employees (Audretsch and Acs, 1991; Scherer, 1965). The Industry Canada report (2006) and the CBoC report (2006) have used number of employees as a criterion to determine the size of the firm. In this study, we consider the number of employees as determinant of size of the firm and follow the classification provided by Statistics Canada, which considers businesses having less than 100 employees as small-sized firms, 100 to 499 employees as medium-sized firms, and more than 500 employees as large-sized firms. According to the 2004 Statistics Canada Report (Debus, 2005), 99.9 percent of the Canadian firms are small- and medium-sized firms and only 0.1 percent are large firms. Since 99.9 percent of the Canadian firms fall in the small- and mid-sized category, in this study we are only focusing upon the small- and medium-sized firms.

HYPOTHESIS

H9: Larger the size of the firm, stronger will be the organizational capabilities and technology commercialization performance.

3.7 Technology Commercialization Performance

The process of commercialization starts when the firm is able to identify market needs and use technological advances to cater to them. Successful commercialization needs the involvement of various departments – such as R&D, manufacturing, and marketing – to develop and market the new product. This is generally considered a linear process. However, in firms with strong commercialization capability it is found to be a series of overlapping phases involving simultaneous contributions by various functions of the firm (Nevens *et al.*, 1990).

The TCP of a firm has qualitative and quantitative elements focusing upon different aspects. In this study we have adopted the measures of technology commercialization performance from Nevens *et al.* (1990) and Zahra and Nielsen (2002). The measures suggested by Nevens *et al.* (1990) after conducting a number of case studies are used by Zahra and Nielsen (2002) in their empirical study.

The qualitative element of technology commercialization measured in this study is the radicalness of the new products introduced in the market; the quantitative elements are time to market, the number of products/services developed, frequency of introduction of new products/services in the market, and cost. The cost is determined by using the proxy measure – the ratio between sales achieved and the expenditure incurred (Brown, 1997; Lowe and Ziednois, 2006).

4 RESEARCH DESIGN AND METHODOLOGY

Research design is considered a road map for an empirical study that illustrates the objectives of the study and the path chosen to achieve those objectives. Research design comprises a series of decisions made by the researcher pertaining to the study, such as, the type of design, unit of analysis, data collection in terms of defining sampling frame and survey instrument development, and the techniques to be used in analyzing the data to answer the research questions of the study.

Researcher control over the independent variable determines the type of design, which is either *ex-post facto* or experimental. In this study, we will measure the existing organizational capabilities of the firms, which are our independent variables. Since we do not have any control over the independent variables, this study is an *ex-post facto* type of design. The unit of analysis in this cross-sectional study is the firm.

4.1 Research Sample

This study focuses upon the firms in the manufacturing sector (NAICS Code 33) in Canada. The two sub sectors chosen in the manufacturing sector are

1) Computer and electronic product sub sector (NAICS code 334)
2) Electrical equipment, appliance and component sub sector (NAICS Code 335).

The industries in these two sub sectors frequently introduce new products and continuously develop new technologies. The production processes in the chosen sub sectors are technology intensive and require new technologies to produce new products as mentioned in the report of the standing committee presented in the House of Commons in February '2007 (Rajotte, 2007). Therefore, these two sub-sectors are primarily chosen for this study. The collection of data from more than one industry may have confounding effects on the results of the study, but the benefits outweigh the disadvantages. It provides higher generalizabilty to the outcome of the study (Vokurka and O'Leary-Kelly, 2000) and can help to draw broad conclusions which can be relevant for many industries in the manufacturing sector.

The firms manufacturing computers, computer peripheral equipments, and various electronic products are part of the computer and electronic product manufacturing sub-sector. The complete list of industries in this sub-sector is given below in Table 4 with their NAICS code. In 2005, there were 3,681 firms in this sector in Canada, and most of them were located in Ontario (47.7 percent) and Quebec (22.5 percent). The report submitted by the standing committee to the House of Commons mentioned that firms operating in this industry face very high competition from products manufactured in other countries, difficulties in attracting skilled labor, and delays in sending the products to other markets (Rajotte, 2007).

Table 4: List of Industries in Computer and Electronic Product Manufacturing Sub Sector (NAICS Code 334)

NAICS Code	Industries
334110	Computer and peripheral equipment manufacturing
334210	Telephone apparatus manufacturing
334220	Radio and television broadcasting and wireless communications equipment manufacturing
334290	Other communication equipment manufacturing
334310	Audio and video equipment manufacturing
334410	Semiconductor and other electronic component manufacturing
334511	Navigational and guidance instruments manufacturing
334512	Measuring, medical and controlling devices manufacturing
334610	Manufacturing and reproducing magnetic and optical media

The electrical equipment, appliance, and component manufacturing sub sector is made up of industries manufacturing household appliances, electrical equipment, electrical components, etc. The complete list of industries with their NAICS code is given in Table 5. In 2005 there were 1964 firms in this sub sector in Canada; 47.3 percent of them are located in Ontario and 25.6 percent are located in Quebec (Rajotte, 2007).

Table 5: List of Industries in Electrical Equipment, Appliance, and Component Manufacturing Sub Sector (NAICS Code 335)

NAICS Code	Industries
335110	Electric lamp bulb and parts manufacturing
335120	Lighting fixture manufacturing
335210	Small electrical appliance manufacturing
335223	Major kitchen appliance manufacturing
335229	Other major appliance manufacturing
335311	Power, distribution, and specialty transformers manufacturing
335312	Motor and generator manufacturing

335315	Switchgear and switchboard, and relay and industrial control apparatus manufacturing
335910	Battery manufacturing
335920	Communication and energy wire and cable manufacturing
335930	Wiring device manufacturing
335990	All other electrical equipment and component manufacturing

The Scottsinfo database was used to obtain the basic information – such as the names of the CEO/President, firm mailing addresses and telephone number, and the number of employees. This database is updated annually and is considered a very comprehensive database listing Canadian manufacturers, wholesalers and distributors. The sampling frame for this study was the top management officials of the companies (e.g., CEOs, presidents, and vice presidents). The reason for targeting the top management officials is their knowledge about the various organizational capabilities of the company. A junior or middle management official in the R&D department will certainly be aware of the R&D capability of the company but, most probably, will not be able to provide information about the marketing or R&D capabilities of the company. The top management officials are supposed to have thorough knowledge about all the organizational capabilities and can provide a clear picture of the technology commercialization performance of the company. The concern associated with targeting the top management is the low response rate. These officials are extremely busy and generally do not have the time to complete the surveys.

4.2 Survey Instrument

A questionnaire was designed to measure the constructs in the model. To maintain the instrument validity wherever possible, measures that have been previously operationalized and tested in empirical research were used. These measures have been slightly modified to fit the context of the present study. To ensure the content validity, the questionnaire was pretested by the top management officials of three firms. This helped to identify any potential problem with the design and content of the questionnaire. The literature showed that other empirical studies have resorted to a subjective assessment of performance, because most companies do not wish to reveal sensitive information about their performance (O'Neill *et al.*, 1987; Conant *et al.*, 1990). Therefore, in the questionnaire, the respondents are asked to compare their company's technology commercialization performance with the industry standards using a 5-point scale.

The questionnaire has been divided into seven sections (Appendix 1). The first section collects information about the position of the respondent in the company, types of products produced by the company, number of employees in the company, and whether the company is Canadian or owned by any US or foreign company. It also collects information about the various business functions in the company. We are particularly interested in knowing whether they have R&D, manufacturing, and marketing functions. The first section also asks questions about the strategic alliances of the company. Three questions are asked to learn whether the company has marketing-related strategic alliances, R&D-related strategic alliances, and manufacturing-related strategic alliances with other companies. In total, there are eight questions in the first section of the questionnaire.

The second section collects information about the integration capability of the company. A 12-item scale has been designed to measure the internal and external integration capability. The items are on a scale of 1 (never) to 5 (always) and the average of the 12 items will be calculated to determine the integration capability score of the company.

The third section deals with the TCP of the company. An eight-item scale has been designed on a five-point scale – 1 (lower) to 5 (higher) to collect information about the six measures of TCP: frequency, radicalism, patents, time to market, number of products, and cost. The respondents are asked to compare their technology commercialization performance with their respective industry standards and rate each item accordingly. The TCP score of the company is the average of all the items in this section.

Information about the marketing capability of the company is gathered in the fourth section of the questionnaire. A 15-item scale is designed using a five-point scale with 1 (not important) to 5 (extremely important) to capture the five measures of marketing capability: market information management, marketing planning, distribution channel management, ability to identify customer needs, and marketing communication. The respondents are asked to rate the importance of each item in their company, and the average is calculated to determine the marketing capability score.

The fifth section gathers information about the R&D capability of the company. There are 10 items in this section that cumulatively measure the ability of the company to select the appropriate technology, operate the technology, maintain the technology, and make minor modifications to the technology. All the items are on a five-point scale with 1 (not important) to 5 (extremely important).

The sixth section deals with manufacturing capability, and this variable is measured using a 10-item scale measured on a scale of 1 (not important) to 5 (extremely important). The measures of manufacturing capability used in this study are quality, cost, flexibility, and dependability. As in previous sections, the average of all the items in this section is calculated to determine the manufacturing capability score of the company.

The seventh section has three items which intend to explore the scarcity of organizational resources faced by the companies. A five-point scale of 1 (never) to 5 (always) is used to find the availability of financial capital, skilled personnel, and physical facilities. The detailed descriptions of the measures with their corresponding items are given in Table 6.

Table 6: Operational Measures of the Variables

Variables	Measures	Hypotheses	Question Numbers
			SECTION A
Integration Capability	1. Internal Integration	H7	Q.1, Q.2, Q.3, Q.4, Q.5, Q.6, Q.7
	2. External Integration		Q.8, Q.9, Q.10 Q.11, Q.12
			SECTION B
Technology Commercialization Performance	1 Frequency		Q.1, Q.6
	2. Radicalism		Q.2
	3. Patents		Q.4
	4. Time to market		Q.7
	5. Number of services/processes		Q.3, Q.5
	6. Cost		Q.8
			SECTION C
Marketing Capability	1. Market information management	H1	Q.7, Q.10, Q11
	2. Marketing planning		Q.8, Q.12, Q.13
	3. Distribution channel management		Q.1, Q.2, Q.3
	4. Ability to identify customer needs		Q.9, Q.14, Q.15
	5. Marketing communication		Q.4, Q.5, Q.6
			SECTION D
R&D Capability	1. Selecting appropriate technology	H3	Q.5, Q.6
	2. Operating the		Q.1, Q.9, Q.10

	technology 3. Maintaining the technology 4. Making minor modifications to the technology		Q.2, Q.3, Q.4 Q.7, Q.8
Manufacturing Capability	1. Quality 2. Cost 3. Flexibility 4. Dependability	H5	**SECTION E** Q.1, Q.2, Q.11, Q.5, Q.6, Q.7 Q.8, Q.10 Q.3, Q.4
Organizational Resources	1. Financial capital 2. Physical facilities 3. Personnel with functional expertise.	H8	**SECTION F** Q.1 Q.2 Q.3

4.3 Data Collection

The questionnaire was sent to the selected 2,500 companies along with a cover letter and prepaid return envelope. The questionnaire and the cover letter were pre-approved by the Carleton University ethics committee. To maintain anonymity, the questionnaire asked no personal information, other than the position of the respondent in the company. The cover letter briefly explained the objective of the study and the researcher gave assurance that the responses will be kept strictly confidential (Appendix 2). The respondents were requested to provide contact details if they are interested in getting a summary of the survey results. The contact details of the researcher and supervisors were given in the cover letter for use by the respondents if they had any query about the survey or any concern about the confidentiality of their responses.

After the questionnaires were mailed out, the researcher started calling the respondents to encourage them to participate in the survey. It was extremely difficult to talk to these busy top management officials and, in most cases, a message was left in their answering machine. After two weeks, the researcher contacted the target sample by sending personalized email reminders. More than 2,000 companies were contacted by email and most of them did not respond. In an attempt to increase the response rate, the questionnaire was also uploaded on a server and the link was sent by email to all the companies. Out of 238 responses received, only 40 of them were received electronically. It appeared that most senior management officials preferred to fill the hard copy of the questionnaire rather than filling it online. A few, who did not receive the hard copy requested to be able to send the electronic version of the questionnaire by email. They printed the questionnaire and sent it back either by regular mail or as an email attachment. They did have the alternative of filling out the questionnaire online, but they preferred to fill out the hard copy and send it by regular mail. After talking to some CEOs, it became clear that their preference for the hard copy was because:

1. They found that it takes more time to fill out the questionnaire online compared to marking questions (in a Likert scale) in a hard copy.

2. Most senior management officials do not check their official emails themselves but leave this up to their secretary.

5 DATA ANALYSIS

This section presents the statistical analysis of the data to test the hypotheses mentioned earlier in the text. The information obtained from the questionnaire about the companies and the designation of the respondents is presented. The descriptive statistics are extremely helpful in providing important information about the quality and richness of the data and the extent to which the researcher was successful in getting responses from the targeted sample.

5.1 Descriptive Statistics

The survey was sent to the senior management (CEO/President/Chairman/Sr. Vice President) of the manufacturing companies (two sub sectors) that are located in Canada. The questionnaire collected information about the ownership of companies to know how many of them are foreign-owned companies operating in Canada. A study by Ceh (1996) found that the domestic Canadian companies and foreign-owned companies in Canada have very distinct R&D activity; foreign-owned companies in the small-sized category are mostly non-inventive. Unfortunately, our study could not confirm such results. It was found that 88.65 percent of the respondents of our study are Canadian-owned companies (Table 7). Only 4.2 percent of the companies are owned by US-based companies and 3.36 percent are owned by companies from Europe and Asia. Since the number of foreign-owned companies in the dataset is so low, it is not feasible to compare them and reach any conclusion.

Table 7: Ownership of the Companies

Ownership	**Frequency**	**Percent**
Canada	211	88.65
US	10	4.20
Europe	4	1.68
Other Countries	4	1.68
Missing Information	9	3.79
TOTAL	**238**	**100**

In this study, the objective was to collect information from senior management about the technology commercialization performance and the organizational capabilities of the companies. The challenge was to get responses from them because they have extremely busy schedules and are not likely to answer surveys. Therefore, every effort was made to contact them by phone and email to request that they complete the questionnaire. The resulting response rate was 9.52 percent, which is a good response rate in our discipline, especially considering that only the senior management was targeted. More than half (51 percent) of the questionnaires were completed by the president of the participating companies (Fig. 4).

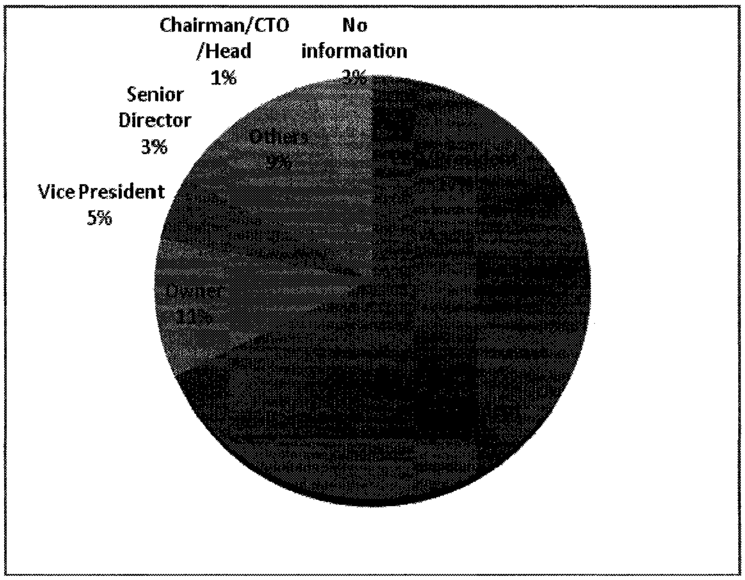

Figure 4: Designation of Respondents

The table that follows shows the breakup of the total number of surveys received. In total, 122 responses were received from the president of the companies, 39 responses were from CEO/president, 25 responses from the owners of the companies, 12 responses from vice presidents, 7 responses from senior directors, 3 responses from the chairman/head, and 22 responses from participants holding other positions (Table 8). Only 8 questionnaires had no information about the designation of the individual completing the questionnaire.

Table 8: Job Title of the Respondents

Position	**No. of Respondents**
CEO/President	39
President	122
Owner	25
Vice President	12
Senior Director	7
Others	22
Chairman/Head	3
No information	8
TOTAL	238

In this study, the size of a company is measured by the number of employees. We had sent our questionnaire to small-, medium-, and large-sized companies and, as expected, most responses came from small-sized companies. Overall, we received 238 responses out of which 198 responses (83.2 percent) were from small companies and 31 responses (13 percent) from medium-sized companies (Figure 5).

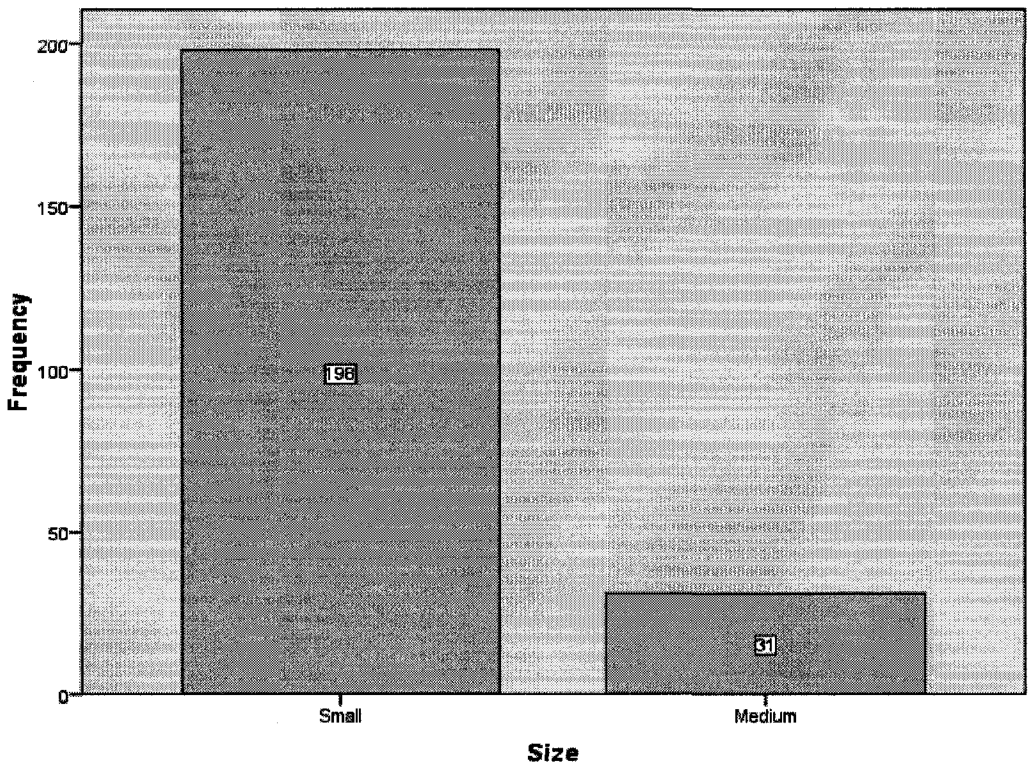

Figure 5: Classification of Companies Participating in the Study

Only 2 responses were from large-sized companies and 7 responses did not have information about the number of employees. The companies who have not provided information about their number of employees and the responses received from large-sized companies were not considered for statistical analysis.

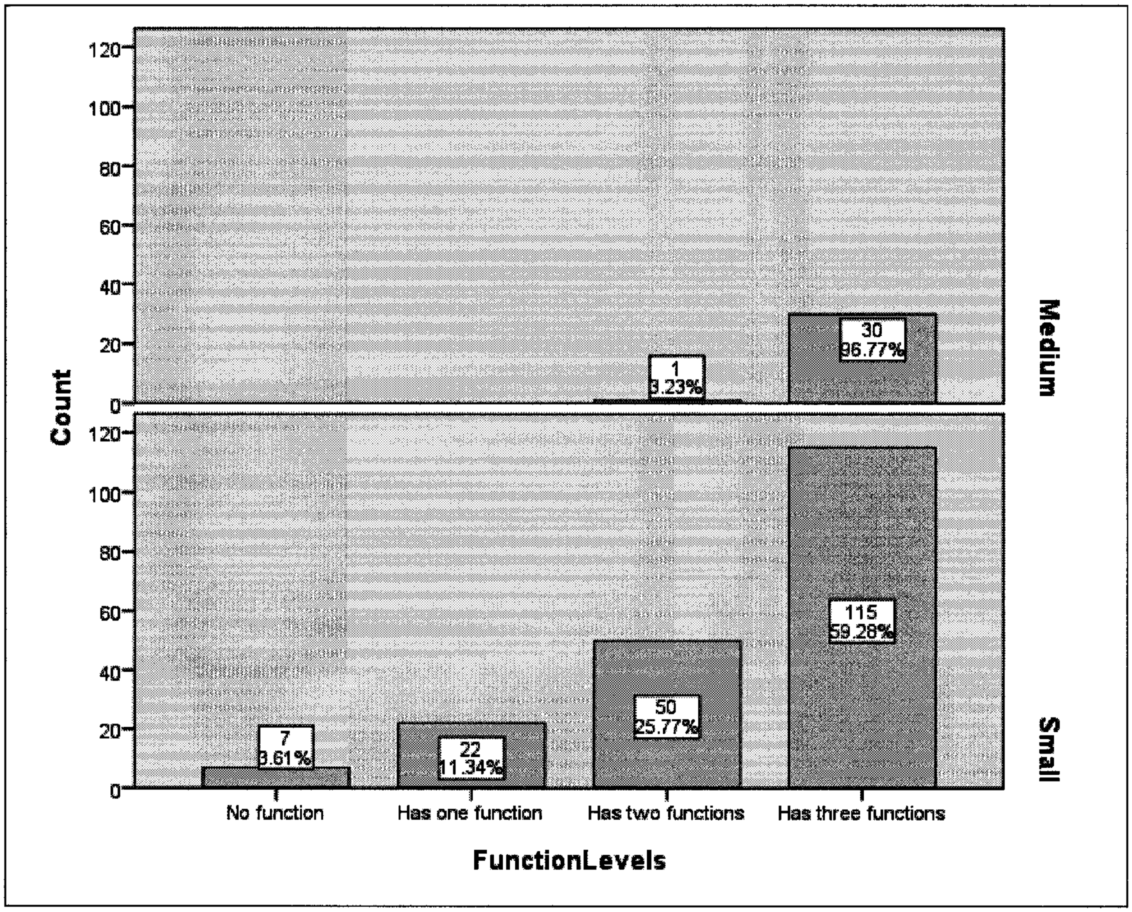

Figure 6: Business Functions in the Company

In the questionnaire we collected information about the various business functions of the company. We were interested in companies having marketing, manufacturing, and R&D functions or at least one of these functions. Among the small sized companies all three functions were reported by 115 (59.28 percent) companies, 50 (25.77 percent) companies reported having two functions, 22 (11.34 percent) companies reported having only one function and 7 (3.61%) companies did not report any function (Figure. 6). As per our expectation, 30 out of 31 medium-sized companies have all three functions. It was interesting to find that 22 small companies who have reported having only one business function answered questions related with at least two of the functional capabilities. The companies who have reported having one function are very small companies therefore they probably do not have all three formal business functions. Since they provided vital information about at least two of three functional capabilities of their company, they were not excluded from the dataset used for statistical analysis.

Further analysis of the data revealed that 181 companies (76.1 percent) reported having an R&D function in their company, 190 companies (79.8 percent) reported having a marketing function, and 196 companies (82.4 percent) reported having a manufacturing function in their company (Table 9).

Table 9: Functions in the Companies

Function		**Frequency**
R&D Function	Companies not having R&D Function	42
	Companies having R&D Function	181
Marketing Function	Companies not having Marketing Function	33
	Companies having Marketing Function	190
Manufacturing Function	Companies not having Manufacturing Function	28
	Companies having Manufacturing Function	196

Strategic alliances are a source of competitive advantage and provide economic gains (Prahalad and Hamel, 1990; Hyder and Abraha, 2004). The most common form of strategic alliance is an R&D alliance, which influences the production and introduction of a new product into the market (Lee and Vonortas, 2002). In this study, we gathered information about three types of functional strategic alliances (R&D, marketing, and manufacturing) that Canadian companies form with other companies, either domestic or international. In the small-sized company category, 80 (40.82 percent) do not have any alliance, 52 (26.53 percent) have one functional alliance, 42 (21.43 percent) have two functional alliances, and only 22 (11.22 percent) companies reported having all three functional alliances. The trend remains the same in the medium-sized category, where 11 (35.48 percent) do not have any alliance. The numbers of companies having one and two functional alliances are almost the same – 7 (22.58 percent) and 8 (25.81 percent) respectively – and 5 (16.13 percent) medium-sized companies reported having all three functional alliances (Figure 7).

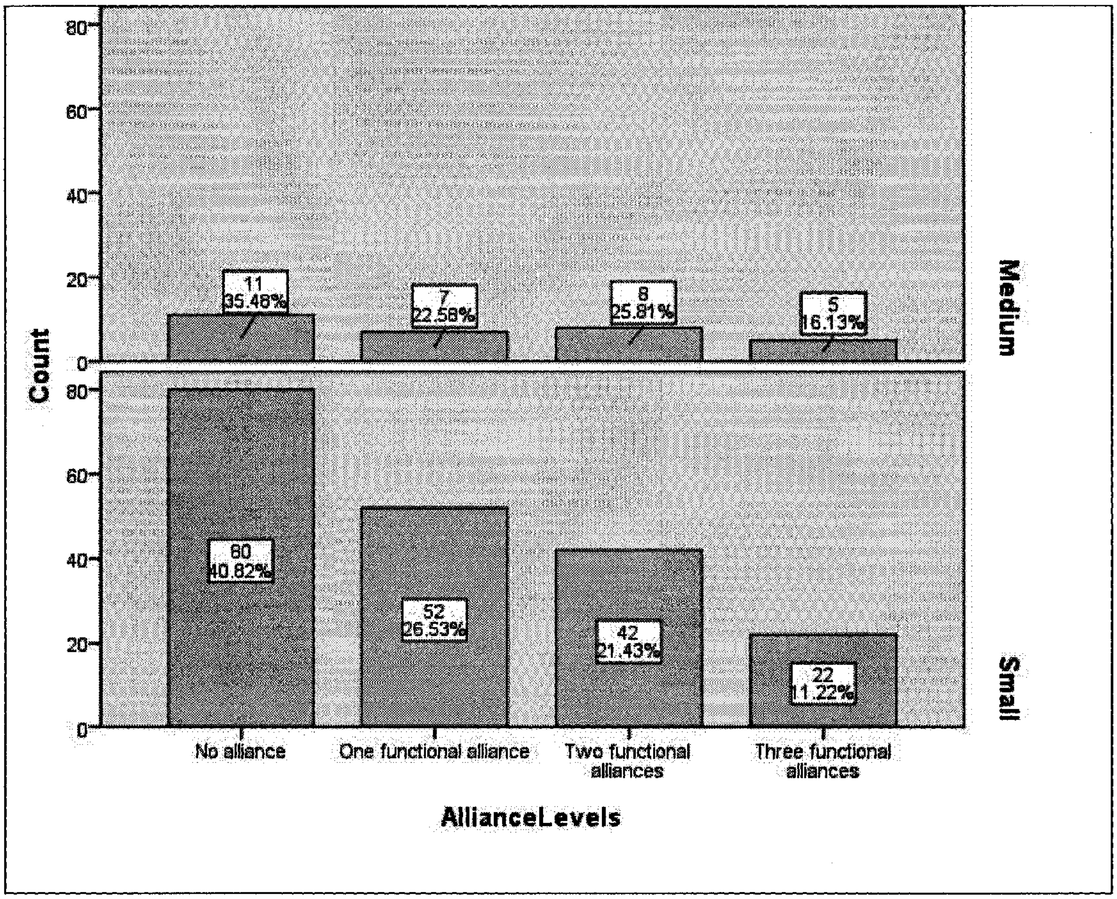

Figure 7: Functional Strategic Alliances in participating Companies

The dataset was divided into groups to examine the propensity for alliances among the companies. It was found that 130 (59.09 percent) companies do not have a manufacturing alliance, 139 (61.77 percent) companies do not have a marketing alliance, and 156 (71.55 percent) companies do not have an R&D alliance (Table 10). Most companies who have alliances prefer to form manufacturing-related alliances (40.90 percent), followed by marketing alliances (38.22 percent), and R&D alliances (28.44 percent). Table 10 shows that the most popular form of alliance formed by the Canadian companies is the manufacturing alliance. The impact of a manufacturing alliance on the manufacturing capability of the company is analyzed in Section 5.3.6. The literature review suggested that the most popular form of strategic alliance is an R&D alliance, whereas our data shows that an R&D alliance is the least favored by the Canadian companies, as compared to marketing or a manufacturing alliance.

Table 10: Alliances formed by the Companies

Alliance		**Frequency**
Manufacturing Alliance	Companies not having Manufacturing Alliance	130
	Companies having Manufacturing Alliance	90
Marketing Alliance	Companies not having Marketing Alliance	139
	Companies having Marketing Alliance	86
R&D Alliance	Companies not having R&D Alliance	156
	Companies having R&D Alliance	62

5.2 Non-Response Bias

When the response rate is low, it is important to check the non-response bias to find whether there is any difference between those who responded and those who did not respond. Non-response bias is often considered to be a continuum ranging from those who are very prompt in sending back the questionnaire to non-respondents who are at the extreme end of the continuum. Armstrong and Overton (1977), have suggested two methods to test the non-response bias –

1. Extrapolation method
2. Comparing the known parameters of those who responded and those who did not respond.

In the extrapolation method, the researcher considers those who have responded very late to be non-respondents because they fall in the continuum close to non-respondents. During data entry, the date response received was recorded. In this study, while checking the non-response bias using extrapolation method, 40 responses received online were not used. The remaining dataset was divided into two groups – the first 50 responses and the last 50 responses (Table 11). The t-test performed to check the difference in their TCP score, marketing capability score, manufacturing capability score, and R&D capability score did not produce significantly different scores at 5 percent confidence level.

Table 11: Extrapolation method to check Non-Response Bias

	Mean TCP Score	**Mean Marketing Capability Score**	**Mean R&D Capability Score**	**Mean Manufacturing Capability Score**
First 50 cases	2.94	3.74	3.92	4.07
Last 50 cases	2.85	3.64	3.97	4.02

The t-test performed does not completely rule out the existence of a non-response bias therefore we also conducted chi-square test by comparing the size of the companies of those responded and those who did not respond. The results confirmed that there is no difference in terms of size of those companies who have responded and those who have not responded (Table 12).

Table 12: Chi-square results to check Non-Response Bias

	Value	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.110	.740		
Continuity Correction	.038	.846		
Likelihood Ratio	.108	.743		
Fisher's Exact Test			.683	.411
Linear-by-Linear Association	.110	.740		
N of Valid Cases	2386			

5.3 Test of Hypotheses

In this section, the hypotheses mentioned earlier related to the marketing capability, manufacturing capability, R&D capability, integration capability, organizational resources, and size of the firm will be tested using various statistical methods. The TCP score is obtained by averaging the individual measures of TCP. Next, the score for each of the organizational capabilities (marketing capability, manufacturing capability, R&D capability, and integration capability) is calculated. The mean marketing capability score is the average of the scores of the measures of marketing capability used in this study. The R&D capability score and manufacturing capability scores are calculated in a similar manner.

5.3.1 Association between Marketing Capability and TCP

***H1:* Strong Marketing Capability positively impacts technology commercialization performance.**

The correlation is the traditional way of checking the association between two variables. The first step is to find the correlation between TCP and marketing capability. Using SPSS, the correlation is calculated between the TCP score and the marketing capability score (Table 13). The correlation coefficient is 0.247, which is statistically significant giving an indication of positive association between TCP and marketing capability.

Table 13: Correlation between TCP and Marketing capability

	Mean	Pearson Correlation	Sig.(2-tailed)
TCP Score	2.9425	.247**	.000
Marketing Capability Score	3.7371		

** Correlation is significant at 0.01 level (2-tailed)

5.3.1.1 Reliability Analysis of Marketing Capability and TCP

Before further analysis of the association between TCP and marketing capability, it is important to determine the reliability of the measures used to determine TCP and marketing capability. Cronbach's alpha is generally used to determine the reliability of the measures. This statistic also informs about the internal consistency of the items in measuring the same construct. The value of Cronbach's alpha lies between 0 and 1. A higher value of Cronbach's alpha indicates higher reliability, although there is no agreement in the literature over its acceptable value. Some statisticians have suggested a value of 0.7 or higher to be acceptable (Nunnally, 1978). In this study, TCP is measured using 8 items and the Cronbach's alpha is 0.743. Marketing capability is measured using 15 items and the Cronbach's alpha is 0.871 (Table 14). Since, the Cronbach's alpha values are more than 0.7, the reliability of the measures are ensured.

Table 14: Reliability Statistics for the measures of TCP and Marketing capability

		N	%	Cronbach's Alpha	No. of Items
TCP	Valid	211	92.1	0.743	8
	Excluded[a]	18	7.9		
	Total	229	100.0		
Marketing Capability	Valid	189	82.5	0.871	15
	Excluded[a]	40	17.5		
	Total	229	100.0		
a. Listwise deletion based on all variables in the procedure.					

5.3.1.2 Confirmatory Factor Analysis (CFA) of Marketing Capability

Factor analysis determines whether the number of factors and the measures conform to the literature. If the measures are tested in other studies, the literature recommends performing confirmatory factor analysis instead of exploratory factor analysis (Stewart *et al.*, 2001). In this study, CFA is performed using LISREL software to check how the observed variables, 15 items (C1-C15), load upon the marketing capability.

5.3.1.2.1 Model Identification

In the marketing capability model (Appendix 3), there are 15 factor loadings and 15 error covariances for the observed variables, which give a total of 30 parameters. The correlation matrix formed to determine the associations among the observed variables have $\{p*(p+1)\}/2$ unique values (p is the number of observed variables). The number of unique observations is {15*(15+1)}/2 = 120. A model having more observations than the number of parameters is considered an over-identified model and can be analyzed using CFA.

5.3.1.2.2 Goodness of Fit Statistics

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). The acceptable values of these indices are given in Table 15. Another goodness of fit statistic is chi-square, which was used in many studies but has severe limitations because it is affected by the size of the data; when the data goes beyond 200 cases, it mostly gives a significant result.

Table 15: Recommended Goodness of Fit Values

Goodness of Fit Statistics	Recommended Value	Source
RMSEA	<0.08	Byrne, 2001; Kline, 2004
CFI	>0.9	Bentler, 1990; Byrne, 2001
NFI	>0.9	Hu and Bentler, 1995

The goodness of fit statistics showed that the model is a poor fit to the dataset because the indices do not provide an acceptable value. The RMSEA value is 0.226, which is much higher than the acceptable value; the CFI value is 0.65, which is lower than the acceptable value; and the NFI value is 0.64, which is lower than the acceptable value (Appendix 3). The output of the LISREL software suggested adding 34 error covariances. The following error covariances are set free: between C2 and C1, C3 and C1, C3 and C2, C6 and C5, C8 and C4, C10 and C1, C10 and C2, C10 and C3, C10 and C8, C11 and C10, C13 and C12, C14 and C9, C14 and C12, C15 and C4, and C15 and C14. The RMSEA value improved from 0.226 to 0.09, but it still remained a poor fit model (Appendix 4). After careful analysis of the loading values of the observed variables on latent variable and adding error covariances, many possible models were generated. Out of these, the best fit model was chosen (Figure 8).

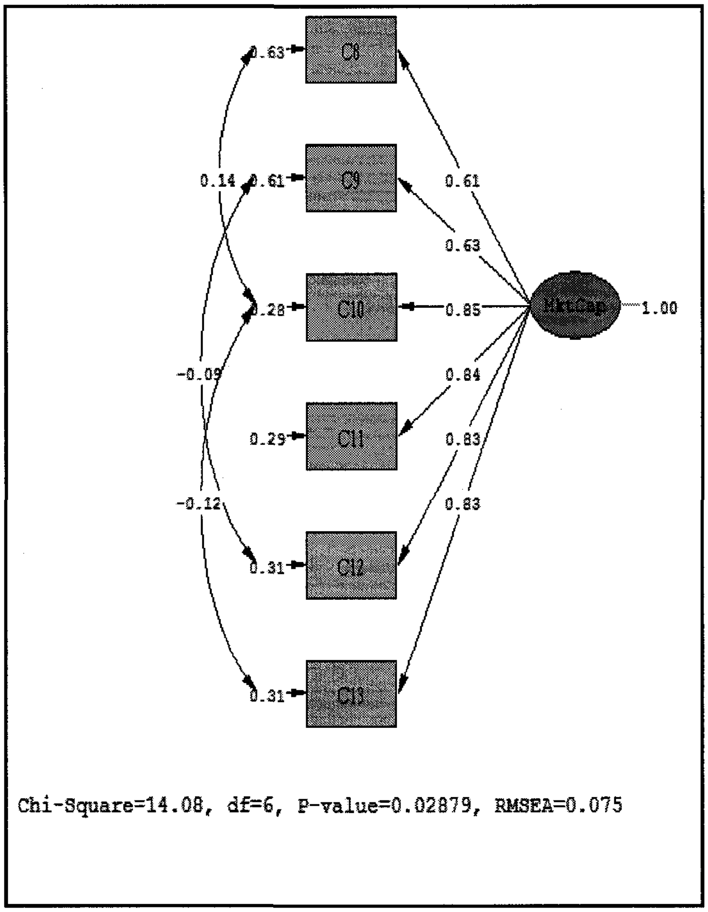

Figure 8: Modified Marketing Capability Measurement Model

In this model, the observed variables (C1, C2, C3, C4, C5, C6, C7, C14, and C15), having loadings of lower than 0.5, were dropped from the measurement model. The improved goodness of fit values are: RMSEA is 0.075, CFI is 0.99, and NFI is 0.99. Other goodness of fit statistics are given in Appendix 5. The modified model (Figure 8) indicates that marketing capability is measured in this study by six items (C8, C9, C10, C11, C12, and C13).

5.3.1.3 Confirmatory Factor Analysis (CFA) of TCP

5.3.1.3.1 Model Identification

In the TCP model (Appendix 6), there are eight factor loadings and eight error covariances, which gives a total of 16 parameters. The number of unique observations is $\{p*(p+1)\}/2 = \{8*(8+1)\}/2 = 36$. Since the model has more observations than the number of parameters, it is, therefore, over identified.

5.3.1.3.2 Goodness of fit Statistics

The RMSEA value is 0.162, which is much higher than the acceptable value; the CFI value is 0.81, which is lower than the acceptable value; and the NFI value is 0.79, which is lower than the acceptable value. The output of the LISREL software suggested adding 5 error covariances (Appendix 7). After careful analysis of the loading values of the observed variables on latent variables and adding error covariances, other possible models were generated. Out of these, the best fit model was chosen (Figure 9).

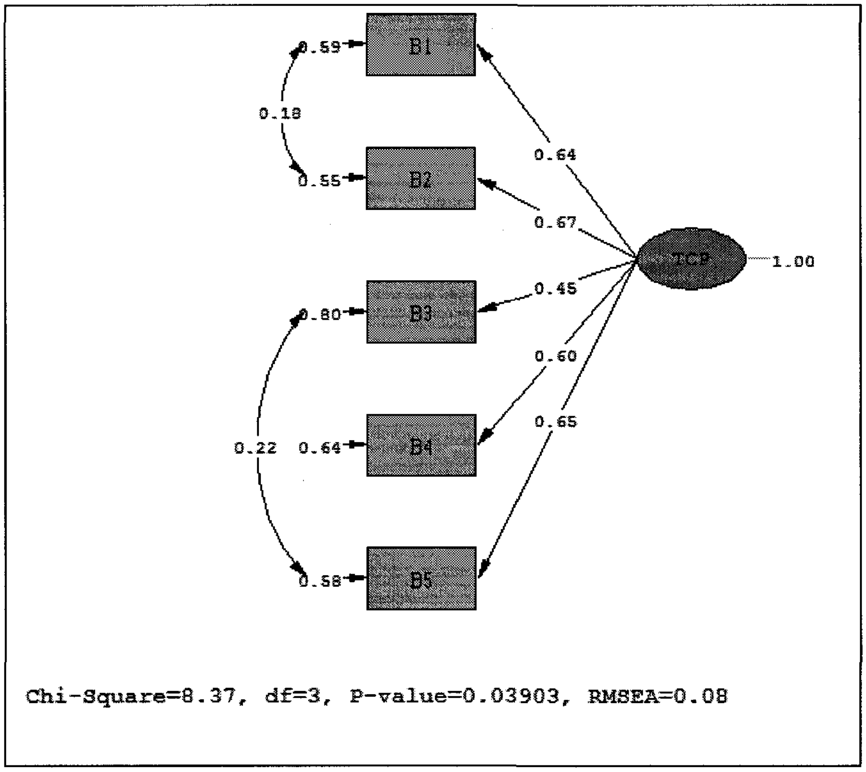

Figure 9: Modified TCP measurement model

In this model, the variables having low loadings (B6, B7, and B8) are dropped. The observed variable, B3, has a slightly low loading but when it is dropped, the model does not remain a good fit model; therefore, it has been retained in the CFA model. The RMSEA score is 0.08, CFI is 0.99, and NFI is 0.98. The other goodness of fit statistics are given in Appendix 8. The modified model (Figure 9) indicates that TCP is measured in this study by five items (B1, B2, B3, B4, and B5).

5.3.1.4 Analysis of TCP-Marketing Capability Model

5.3.1.4.1 Model Identification

In the TCP-Marketing Capability model, there are 11 factor loadings, 11 error covariances, and one factor correlation, which gives a total of 25 parameters. The number of unique observations in the TCP-marketing capability correlation matrix is $\{p*(p+1)\}/2 = \{11*(11+1)\}/2 = 66$. Since the model has more observations than the number of parameters, it is, therefore, over identified.

5.3.1.4.2 Goodness of fit Statistics

The TCP-marketing capability model is not a good fit model with goodness of fit vales; RMSEA is 0.107 (much higher than the acceptable value of 0.08), CFI is 0.93, and NFI is 0.91. The output generated by LISREL is shown in Appendix 9. The modification indices suggested adding 8 error covariances. After adding error covariances, the modified model gave acceptable goodness of fit values: RMSEA is 0.057, CFI is 0.98, and NFI is 0.96. Other goodness of fit statistics are given in the LISREL output (Appendix 10). In the modified TCP-Marketing Capability Model (Figure 10), six indicators measure marketing capability and five indicators measure TCP. The t-value of 3.11 between TCP and marketing capability is highly significant and shows a strong association between them.

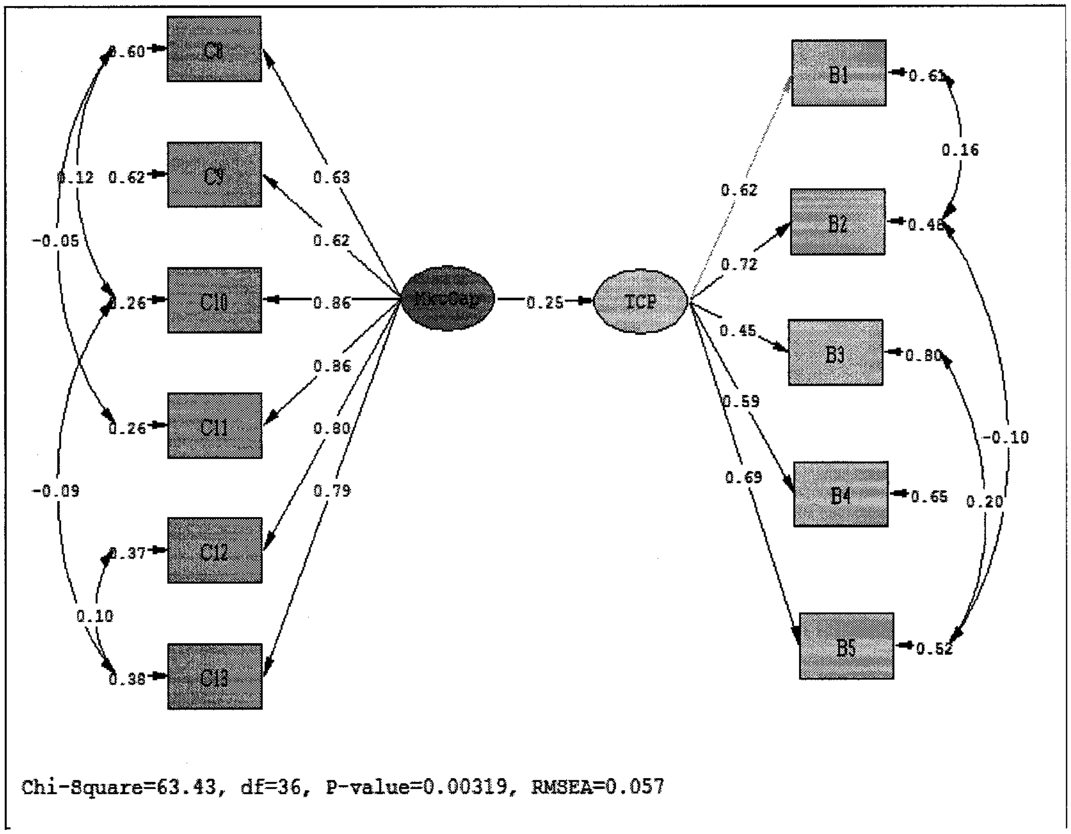

Figure 10: Modified TCP-Marketing Capability Model

5.3.2 Effect of Marketing related Strategic Alliance on Marketing Capability

H2: **Firms having marketing-related strategic alliances have higher marketing capability.**

The dataset is divided into two groups – those who have a marketing alliance and those who do not have a marketing alliance. In total, 139 companies do not have a marketing alliance and 86 companies reported having marketing alliances with other companies (Table 16).

Table 16: Effect of Marketing Alliance on Marketing Capability

Marketing Alliance	Frequency	Marketing Capability Score
Do not have alliance	139	3.74
Do have alliance	86	3.71

The mean marketing capability scores of the two groups, those who do not have an alliance and those who do have an alliance, are 3.74 and 3.71 respectively. The t-test will help to determine whether the means of the two groups are statistically different from each other. One of the important assumptions of a t-test is that the data should be normally distributed. When the dataset is large and the variables are measured in a five-point or seven-point Likert scale, then the distribution is often skewed toward one end and it is highly improbable to get a normal distribution having a skewness value of zero (Stewart *et al.*, 2001). Table 17 shows that the items measuring marketing capability are skewed and have kurtosis.

Table 17: Descriptive Statistics of the Items measuring Marketing Capability

ITEMS	N	Minimum	Maximum	Mean	Skewness	Kurtosis
C8	228	1	5	3.23	-0.11	-0.39
C9	235	1	5	4.11	-0.87	0.11
C10	229	1	5	3.31	-0.21	-0.34
C11	231	1	5	3.33	-0.39	0.10
C12	229	1	5	3.28	-0.33	-0.09
C13	231	1	5	3.33	-0.26	-0.29

Curran *et al* (1996) have suggested that if the value of skewness lies within the range of -2 to +2, the distribution is not excessively skewed. Similarly, if the value of kurtosis lies within the range of -7 to +7, then the data does not have excessive kurtosis. In Table 17, all the skewness and kurtosis values fall within the acceptable range; therefore, the scores should be considered having normal distribution. If the data is not wildly non-normal, then the researchers should not be worried about the violations of normality (Bollen, 1995)

The normal Q-Q plot also shows that the dataset is not highly non-normal and the observations follow the normal distribution (Figure 11).

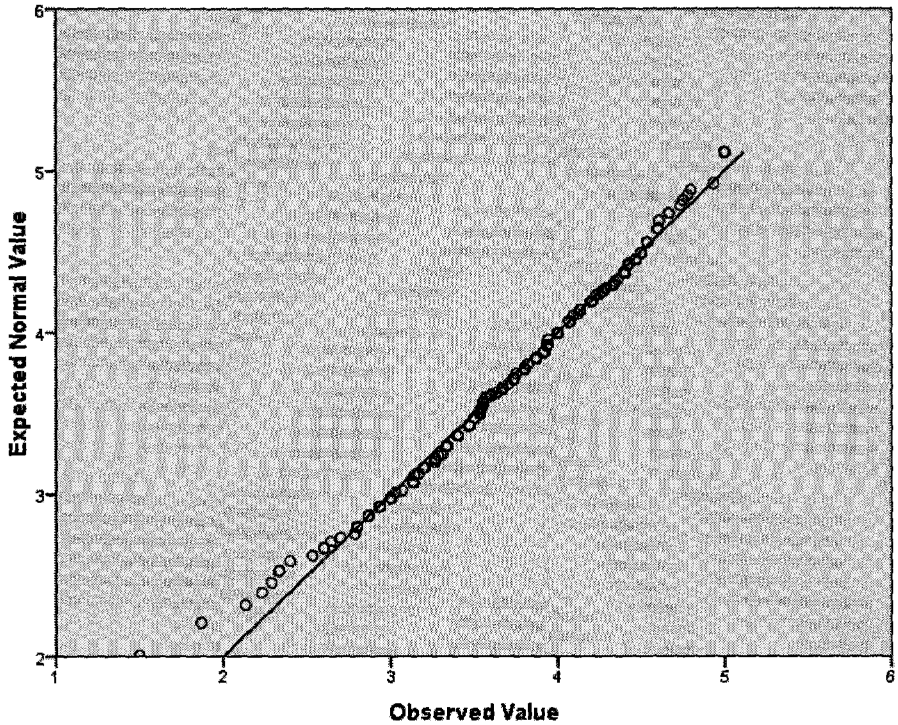

Figure 11: Normal Q-Q Plot of Marketing Capability Score

It is often suggested that when the dataset is large, instead of relying completely upon the results of the parametric tests, other non-parametric tests should also be performed. The results of the two non-parametric tests namely Wilcoxon test and Kolmogorov-Smirnov test indicated that the two groups are not significantly different from each other in terms of their marketing capability score which is also confirmed by the results of the t-test as shown in Table 18. Therefore, the hypothesis that a marketing alliance will lead to higher marketing capability is not accepted.

Table 18: Difference in the Marketing Capability Score of two Marketing Alliance Groups

Marketing Alliance	Frequency	Marketing Capability Score	Sig.
Do not have alliance	139	3.74	0.703
Do have alliance	86	3.71	

5.3.3 Association between R&D Capability and TCP

***H3:* Strong R&D capability positively impacts technology commercialization performance.**

The R&D capability of a company is measured by 10 items and is hypothesized to have a strong association with TCP. The Pearson correlation coefficient is 0.235, which indicates a statistically significant association between TCP and R&D capability (Table 19).

Table 19: Correlation between TCP and R&D Capability

	Mean	**Pearson Correlation**	**Sig.(2-tailed)**
TCP Score	2.9425	.235	.000
R&D Capability Score	3.9816		

5.3.3.1 Reliability Analysis of R&D Capability

The R&D capability of a company is measured by 10 items falling under four dimensions: selection of technology, operation of technology, maintenance of technology, and modification of technology. The Cronbach's alpha value is 0.902, which is considered to be high and indicates that the 10 tens used in the questionnaire are reliable measures of R&D capability (Table 20).

Table 20: Reliability Statistics for the measures of R&D Capability

		N	%	Cronbach's Alpha	Number of Items
R&D Capability	Valid	188	82.1	0.902	10
	Excluded[a]	41	17.9		
	Total	229	100.0		
a. Listwise deletion based on all variables in the procedure.					

5.3.3.2 Confirmatory Factor Analysis of R&D Capability

5.3.3.2.1 Model Identification

The R&D capability is measured by 10 observed variables. In the R&D capability measurement model, there are 10 factor loadings for the observed variables and 10 error covariances. Therefore, the number of parameters in the model is 20. The correlation matrix gives $\{p^*(p+1)\}/2 = \{10^*(10+1)\}/2 = 55$ unique observations, where p is the number of observed variables. The R&D capability measurement model has more observations than the number of parameters; therefore, it is over identified.

5.3.3.2.2 Goodness of Fit Statistics

The R&D capability measurement model is a poor fit. The RMSEA value is 0.172; the CFI value is 0.90 (equal to the acceptable value of 0.9); and the NFI value is 0.89, slightly less than 0.9. The output with other goodness of fit statistics is given in Appendix

11. The output generated by LISREL suggested adding 13 error covariances; out of these, seven error covariances, which made the model fit better, are added, as shown in Figure 12. When the error covariances are added, the modified model generated acceptable goodness of fit statistics (RMSEA = 0.06, CFI = 0.99, NFI = 0.98, shown in Figure 12). Other goodness of fit values generated by the software, are given in Appendix 12.

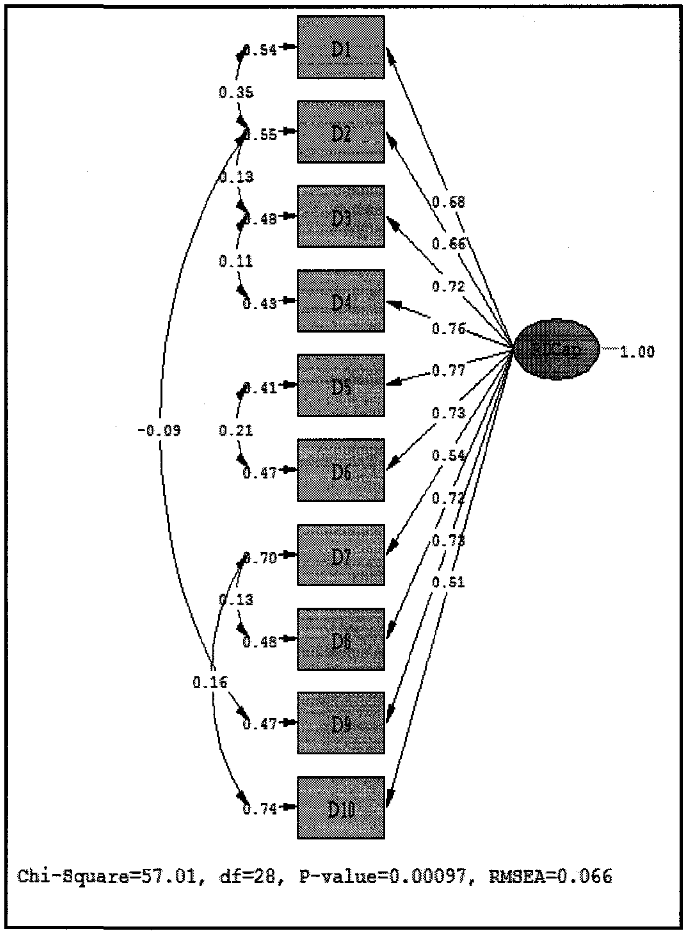

Figure 12: R&D Capability Measurement Model

5.3.3.3 Analysis of R&D Capability-TCP Model

5.3.3.3.1 Model Identification

In the TCP-R&D capability model, there are 15 factor loadings for the observed variables, 15 error covariances, and one factor correlation between the latent variables. Therefore, the number of parameters in the model is 31. The correlation matrix formed to find the association of each observed variable with other observed variables will have {p*(p+1)}/2 unique values, where p is the number of observed variables. Since the number of observed variables in the TCP-R&D capability is 15 (10 observed variables of R&D capability and 5 observed variables of TCP), the number of unique values in the correlation matrix is {15*(15+1)}/2, which is 120. The TCP-R&D capability model has more observations than the number of parameters, therefore, it is over identified.

5.3.3.3.2 Goodness of Fit Statistics

The primary TCP-R&D capability model is a poor fit. The RMSEA value is 0.121 (above the acceptable value of 0.08); the CFI value is 0.90 (equal to the acceptable value of 0.9); and the NFI value is 0.88, which is less than 0.9. The output with other goodness of fit statistics is given in Appendix 13. The output generated by LISREL suggested adding 17 error covariances, out of which 13 error covariances that made the model fit better are added, as shown in Figure 13. The modified model generated acceptable goodness of fit statistics (RMSEA = 0.037, CFI = 0.99, NFI = 0.97). All the observed variables have statistically significant loadings on their respective latent variables and the t-value of 4.15 shows a strong statistically significant association between TCP and R&D capability (Figure 13). The other goodness of fit statistics are given in Appendix 14.

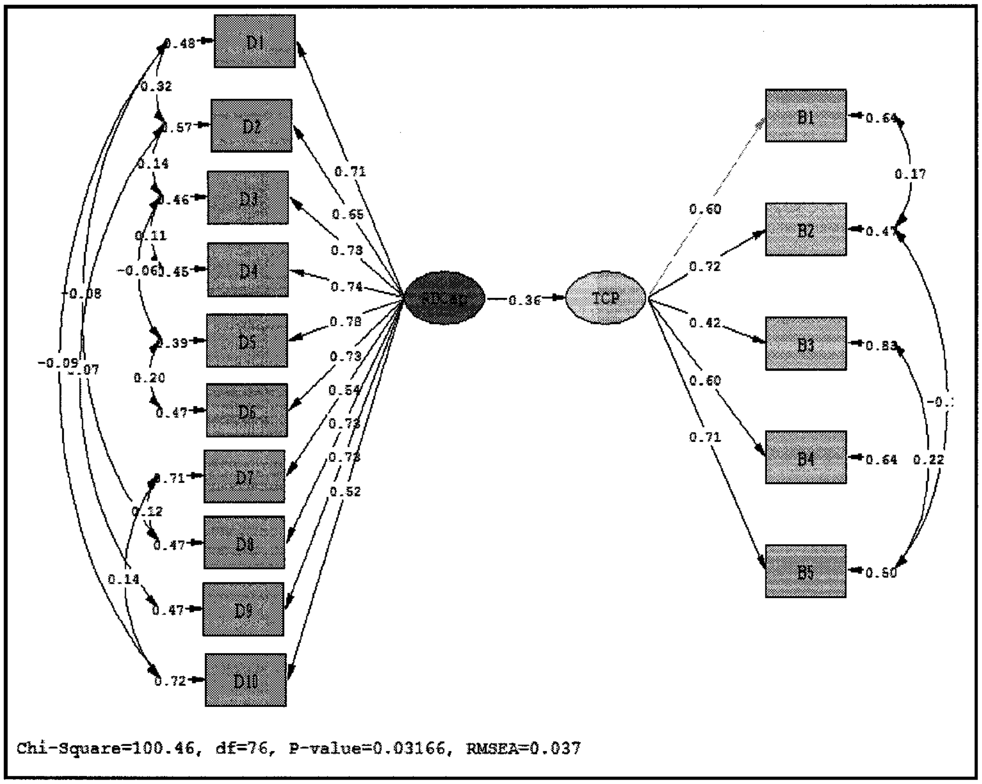

Figure 13: Modified TCP-R&D capability Model

5.3.4 Effect of R&D related Strategic Alliance on R&D Capability

H4: **Firms having R&D-related strategic alliances have higher R&D capability.**

To determine the impact of an R&D alliance on R&D capability, the dataset is divided into two groups. The first group is comprised of companies that do not have R&D-related strategic alliances and the second group is comprised of companies that have R&D-related strategic alliances. In the dataset, only 62 companies reported having an R&D-related alliance with other companies, whereas 156 companies do not have an R&D alliance (Table 21).

Table 21: Effect of R&D Alliance on R&D Capability

R&D Alliance	Frequency	R&D Capability Score
Do not have alliance	156	3.89
Do have alliance	62	4.21

The mean R&D capability score of the companies having an R&D alliance is higher than the mean R&D capability score of the companies that do not have an R&D alliance. The skewness and kurtosis values indicate that the scores are negatively skewed and have kurtosis (Table 22). However, they fall within the acceptable range; therefore, the data does not seem to be excessively skewed or have excessive kurtosis.

Table 22: Statistics of the Items measuring R&D Capability

ITEMS	N	Minimum	Maximum	Mean	Skewness	Kurtosis
D1	228	1	5	4.26	-1.09	0.94
D2	228	1	5	4.06	-0.85	0.65
D3	227	1	5	4.07	-0.71	-0.01
D4	224	1	5	4.28	-1.11	1.44
D5	227	1	5	4.04	-0.77	0.53
D6	226	1	6	4.02	-0.60	0.31
D7	212	1	5	3.50	-0.30	-0.31
D8	223	1	5	3.97	-0.81	0.46
D9	228	1	5	4.08	-0.97	1.04
D10	213	1	5	3.46	-0.40	-0.39

The normal Q-Q plot, drawn to visually check the distribution of the data points also shows that the data points do follow the normal distribution and, therefore, meet the assumptions of conducting a t-test (Figure 14).

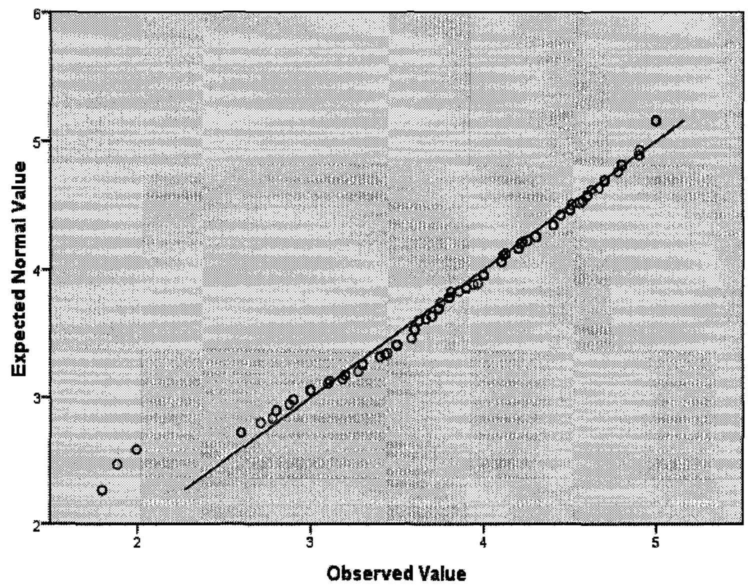

Figure 14: Normal Q-Q Plot of R&D Capability Score

The output of the t-test shows that the difference in the R&D capability score of the two groups is statistically significant at 0.01 level (Table 23). The results of the Wilcoxon test and Kolmogorov-Smirnov test also confirmed the results of the t-test. Thus, the hypothesis that companies having R&D alliance have higher R&D capability is accepted.

Table 23: Difference in the R&D capability score of two R&D alliance groups

R&D Alliance	**Frequency**	**R&D Capability Score**	**Sig.**
Do not have R&D alliance	156	3.89	
Do have R&D alliance	62	4.21	0.003

5.3.5 Association between Manufacturing Capability and TCP

H5: **Strong manufacturing capability positively impacts technology commercialization performance.**

The Pearson correlation coefficient is calculated between the mean TCP score and the mean manufacturing capability score. Its value of 0.058 is not significant and indicates no association between the two variables (Table 24). In other words, it means that the manufacturing capability of a company does not have any influence upon the technology commercialization performance of a company.

Table 24: Correlation between TCP and Manufacturing Capability

	Mean	**Pearson Correlation**	**Sig.(2-tailed)**
TCP Score	2.9425	0.058	0.381
Manufacturing Capability Score	4.0132		

5.3.5.1 Reliability Analysis of Manufacturing Capability

It is essential to perform other diagnostic tests to confirm the result of correlation analysis. It has been found that the items used to measure TCP have an acceptable Cronbach's alpha of 0.747. The Cronbach's alpha of the manufacturing capability items used in the questionnaire is 0.810, which is fairly high (Table 25). This shows that the items used to measure the manufacturing capability are reliable measures.

Table 25: Reliability Statistics for the Measures of Manufacturing Capability

		N	%	Number of Items	Cronbach's Alpha
Manufacturing Capability	Valid	205	89.5	10	0.810
	Excluded[a]	24	10.5		
	Total	229	100.0		

a. Listwise deletion based on all variables in the procedure.

5.3.5.2 Confirmatory Factor Analysis (CFA) of Manufacturing Capability

CFA can throw more light onto the association of the items used in the questionnaire with their respective latent variables. As mentioned earlier, the questionnaire measures TCP by eight items and manufacturing capability by 10 items.

5.3.5.2.1 Model Identification

The manufacturing capability model has 10 factor loadings and 10 error covariances for the observed variables. The number of parameters in the model is 20. The correlation matrix has $\{p*(p+1)\}/2$ unique values, which is $[\{10*(10+1)\}/2] = 55$. The manufacturing capability measurement model has more observations than the number of parameters; therefore, it is over identified.

5.3.5.2.2 Goodness of Fit Statistics

The primary manufacturing capability measurement model is not a good fit, although some of the fit indices are close to the acceptable value. The RMSEA value is 0.19; the CFI value is 0.90 (equal to the acceptable value of 0.9); and the NFI value is 0.89, slightly less than 0.9. The output, with other goodness of fit statistics, is given in Appendix 15. The output generated by LISREL suggested adding 14 error covariances. After adding 5 error covariances and dropping two observed variables – E8 and E10, which have low loadings (lower than 0.5) – the modified model generated acceptable goodness of fit statistics: the RMSEA is 0.058, the CFI is 0.99, and the NFI is 0.99. The other goodness of fit indexes are given in Appendix 16. The modified model (Figure 15) indicates that manufacturing capability is measured in this study by eight items (E1, E2, E3, E4, E5, E6, E7, and E11).

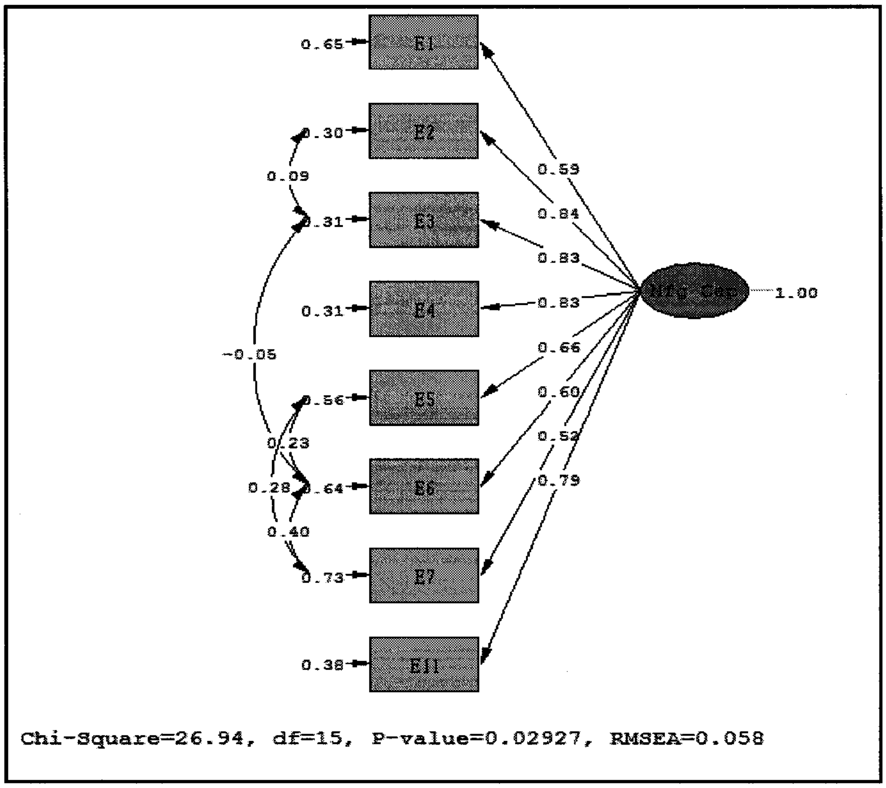

Figure 15: Modified Measurement Model of Manufacturing Capability

5.3.5.3 Analysis of TCP-Manufacturing Capability Model

5.3.5.3.1 Model Identification

The TCP-manufacturing capability model has 13 factor loadings, 13 error covariances, and 1 factor correlation between the latent variables. The number of parameters in the model is 26 (13+13+1). The correlation matrix, formed to find the association of each observed variable with other observed variables, will have {p*(p+1)}/2 unique values, where p is the number of observed variables. The number of observed variables in the TCP-manufacturing capability is 13 (5 observed variables for TCP and 8 observed variables of manufacturing capability); therefore, the number of unique values in the correlation matrix [{13*(13+1)}/2] is 91. The TCP-manufacturing capability model has more observations than the number of parameters, therefore, it is over identified.

5.3.5.3.2 Goodness of Fit Statistics

The initial TCP-manufacturing capability model, given in Appendix 17, shows that the dataset is a poor fit giving unacceptable goodness of fit values (RMSEA = 0.128 and NFI = 0.88, CFI = 0.90)). The software suggested 13 modification indices and when the error covariances were added the goodness of fit indices improved. The goodness of fit values of the modified model are: RMSEA = 0.01, CFI = 1.00, and NFI = 0.98. The t-value of 2.33 now shows an association between TCP and manufacturing capability, which is significant at 0.05 level (Figure 16). The output of the analysis with other goodness of fit values is given in Appendix 18.

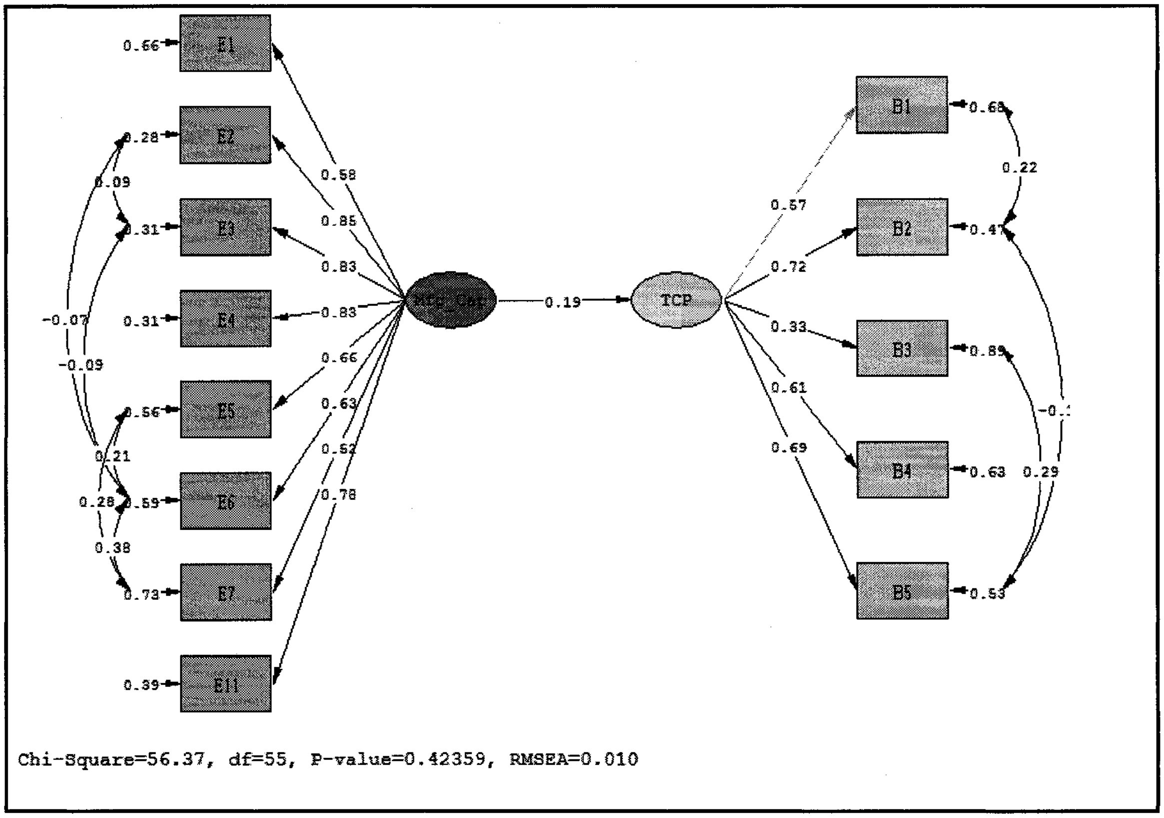

Figure 16: TCP-Manufacturing Capability Model

In the modified TCP-manufacturing capability model, certain observed variables, which have lower than 0.5 loading, are dropped. When the mean TCP score and mean manufacturing capability score are recalculated after dropping the low loading observed variables, the Pearson correlation coefficient increased to 0.133, which is significant at the 0.05 level and shows a weak, but statistically significant, association between the two variables (Table 26).

Table 26: Correlation between TCP and Manufacturing Capability

	Mean	Pearson Correlation	Sig.(2-tailed)
TCP Score	2.9425	0.133	0.042*
Manufacturing Capability Score	4.2167		

*Correlation is significant at the 0.05 level (2-tailed).

5.3.6 Effect of Manufacturing-Related Strategic Alliance on Manufacturing Capability

H6: **Firms having manufacturing-related strategic alliances have higher manufacturing capability.**

The dataset is divided into two groups – companies that do not have a manufacturing-related strategic alliance and companies that have a manufacturing-related strategic alliance. In total, 90 companies reported having a manufacturing alliance, whereas 130 companies do not have a manufacturing alliance (Table 27). The mean manufacturing capability score of the two groups is almost the same.

Table 27: Effect of Manufacturing Alliance on Manufacturing Capability

Manufacturing Alliance	Frequency	Manufacturing Capability Score
Do not have alliance	130	4.02
Do have alliance	90	3.98

In order to check the assumptions of normality, the skewness and kurtosis were calculated and the normal Q-Q plot was drawn to see the graphical distribution of the data. In Table 28, the skewness and kurtosis values of each item measuring manufacturing capability are calculated. The skewness values indicate that the scores are skewed, but, as mentioned earlier, the skewness values fall within the range of -2 to +2; therefore, there is no case of excessive skewness. The kurtosis values also fall within the range of -7 to +7 and, therefore, do not display excessive kurtosis. The values shown in Table 26 indicate that the data meets the conditions of normality.

Table 28: Descriptive Statistics of the Items measuring Manufacturing Capability

ITEMS	N	Minimum	Maximum	Mean	Skewness	Kurtosis
E1	228	1	5	3.99	-0.84	0.09
E2	232	3	5	4.55	-1.18	0.28
E3	231	3	5	4.65	-1.40	1.12
E4	233	1	5	4.41	-1.23	1.64
E5	230	1	5	4.13	-0.85	0.06
E6	228	1	5	3.86	-0.70	-0.13
E7	227	1	5	3.64	-0.38	-0.59
E11	233	2	5	4.47	-1.10	0.90

The normal Q-Q plot drawn to check the visual distribution of the data also indicates that the scores are skewed and have kurtosis; but, overall, they follow the path of normal distribution (Figure 17).

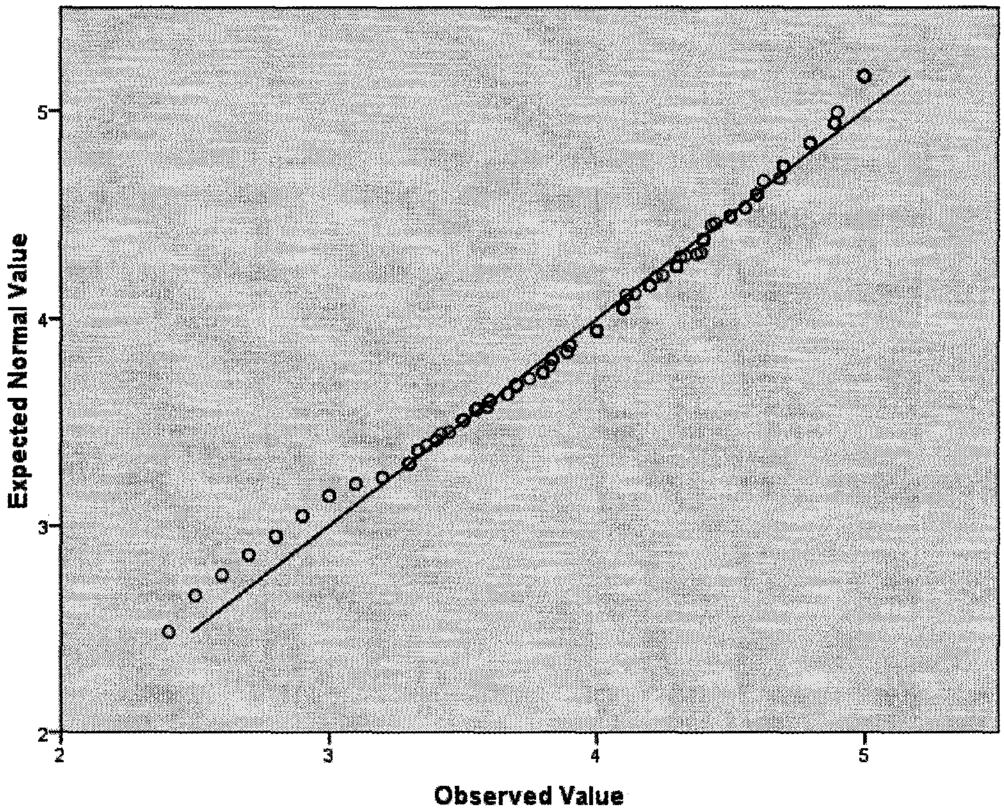

Figure 17: Normal Q-Q Plot of Manufacturing Capability Score

The result of t-test indicates that there is no statistically significant difference in the mean manufacturing capability score of the two groups (Table 29) which is also confirmed by the results of the Wilcoxon test and Kolmogorov-Smirnov test. Therefore, the hypothesis that companies having a manufacturing alliance will have a higher marketing capability score than those companies that do not have a manufacturing alliance is not accepted.

Table 29: Difference in the Manufacturing Capability score of two Manufacturing Alliance Groups

Manufacturing Alliance	Frequency	Manufacturing Capability Score	Sig.
Do not have manufacturing alliance	130	4.02	0.466
Do have manufacturing alliance	90	3.98	

5.3.7 Association between Integration Capability and TCP

H7: **Strong integration capability of the firm positively affects technology commercialization performance.**

Integration capability has two dimensions – internal integration and external integration. The integration capability of a firm is the average of all the items measuring internal and external integration. The Pearson correlation coefficient of 0.293 shows a positive association between TCP and integration capability, which is significant at a 0.01 level of significance (Table 30).

Table 30: Correlation between TCP and Integration Capability

	Mean	Pearson Correlation	Sig. (2-tailed)
TCP Score	2.9425	0.293	0.000
Integration Capability Score	3.5148		

5.3.7.1 Reliability Analysis of Integration Capability

The reliability analysis performed using SPSS gives a Cronbach's alpha of 0.818. The high value of Cronbach's alpha indicates that the 12 items measuring integration capability are its reliable measures (Table 31).

Table 31: Reliability Statistics for the Measures of Integration capability

		N	%	Number of Items	Cronbach's Alpha
Integration Capability	Valid	155	67.7	12	0.818
	Excluded[a]	74	32.3		
	Total	229	100.0		

a. Listwise deletion based on all variables in the procedure.

5.3.7.2 Confirmatory Factor Analysis (CFA) of Integration Capability

5.3.7.2.1 Model Identification

The measurement model of integration capability has 12 factor loadings and 12 error covariances. Therefore, the number of parameters in the model is 24. The number of unique values in the correlation matrix between all the items measuring TCP and integration capability was calculated using the formula $\{[p^*(p+1)]/2\}$, where p is the total number of observed variables.

P = 12

$\{[p^*(p+1)]/2\} = \{[12^*(12+1)]/2\} = 78$

The number of parameters in the CFA model is less than the number of unique values, therefore, the model is over identified.

5.3.7.2.2 Goodness of Fit Statistics

The measurement model of integration capability, as shown in Appendix 19, is a poor fit with goodness of fit values: the RMSEA = 0.22, the NFI = 0.69, and the CFI = 0.71. The LISREL software suggested adding 23 error covariances. Even after adding the error covariances we did not get a good fit model, therefore, the observed variables having less than 0.5 loading on integration capability were dropped one by one. In the modified model (Figure 18), the observed variables A8, A9, A10, A11, and A12 are dropped. The goodness of fit values of the modified model are RMSEA = 0.014, NFI = 0.99, and CFI = 1.00. The syntax and other values of goodness of fit are given in Appendix 20. The integration capability is measured in this study by seven items (A1, A2, A3, A4, A5, A6, and A7) as shown in Figure 18.

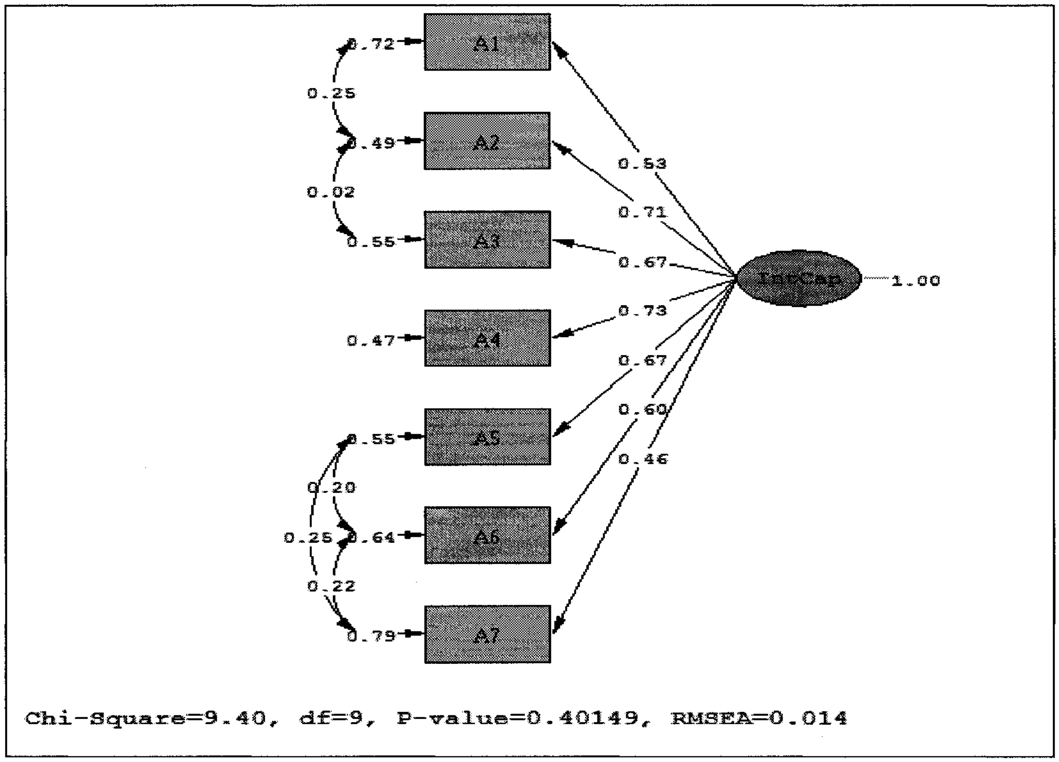

Figure 18: Modified Measurement Model of Integration Capability

5.3.7.3 Analysis of TCP-Integration Capability Model

5.3.7.3.1 Model Identification

The SEM Model has two latent variables, namely TCP and integration capability, that have in total 12 factor loadings, 12 error covariances, and 1 factor correlation between the latent variables. Therefore, the number of parameters in the model is 25. The number of unique values in the correlation matrix between all the items measuring TCP and integration capability was calculated using the formula {[p*(p+1)]/2} = {[12*(12+1)]/2} = 78, where p is the total number of observed variables. The number of parameters in the CFA model is less than the number of unique values, therefore, the model is over identified.

5.3.7.3.2 Goodness of Fit Statistics

The initial TCP-integration capability model shown in Appendix 21 is not a good fit model; the goodness of fit values are RMSEA = 0.108, NFI = 0.88, and CFI = 0.91. The software suggested adding 11 error covariances to improve the goodness of fit statistics (Appendix 21). In the modified TCP-integration capability model (Figure 19), the goodness of fit statistics are RMSEA = 0.035, NFI = 0.96, and CFI = 0.99. The t-value of 3.94 indicates a strong association between TCP and integration capability. Other values of goodness of fit are given in the output shown in Appendix 22.

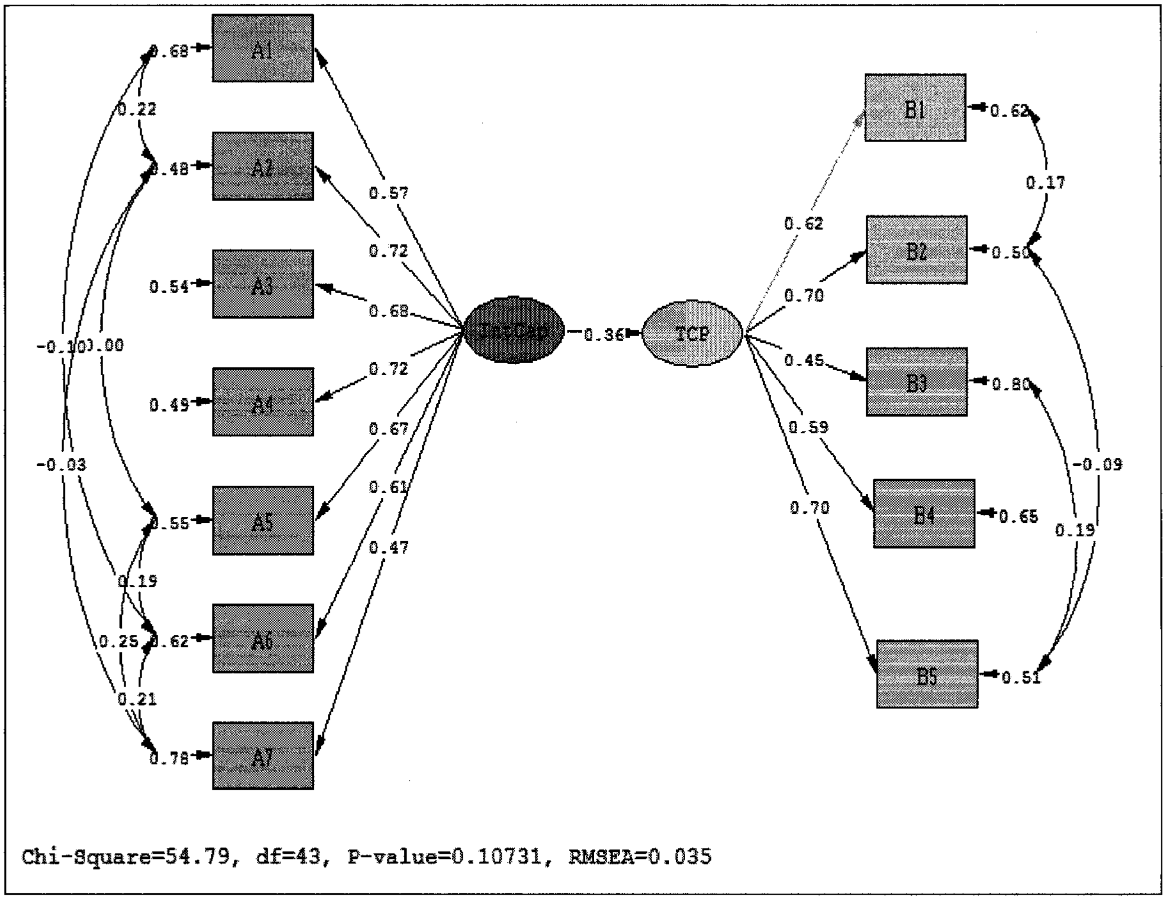

Figure 19: Modified TCP-Integration Capability CFA Model

5.3.8 Effect of Organizational Resources on TCP

H8: **The availability of organizational resources positively affects technology commercialization performance.**

In this study, information is gathered from the respondents about the availability of three types of organizational resources: financial resources, human resources, and physical facilities.

5.3.8.1 Financial Resources

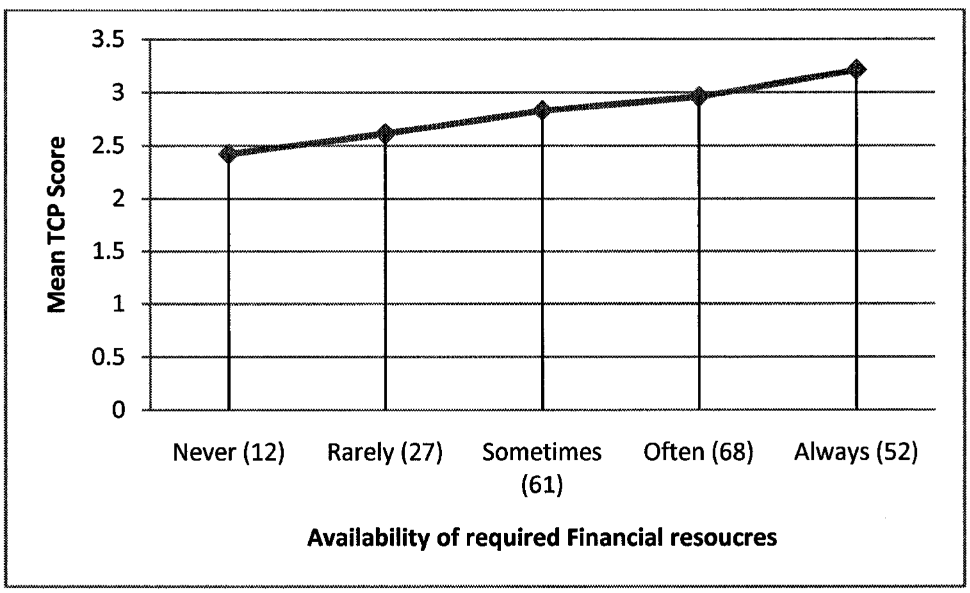

Figure 20: Effect of Financial Resources on TCP

On a scale of 1 to 5, the respondents were asked how often they are able to arrange the required financial capital while commercializing a new product, process, or service. In total, 220 companies responded to this question. Of that total, 52 (23.6 percent) companies were always able to arrange the financial resources, 68 (30.9 percent) companies were often able to arrange the required financial resources, 61 (27.7 percent) companies were sometimes able to arrange the required financial resources, 27 (12.2 percent) companies were rarely able to arrange the required financial resources, and only 12 (5.45 percent) companies reported that they were never able to arrange financial resources (Figure 20). The line graph shows that the technology commercialization performance of the companies improved linearly with an increase in the availability of financial resources. The t-test results also indicate that there is a significant difference in the TCP score of the companies who were never able to arrange financial resources and those who were always able to arrange financial resources (Table 32).

Table 32: Difference in the TCP score of two Financial Resources Groups

Response	N	TCP Score	Sig (2-tailed)
Never	12	2.418750	
rarely	27	2.606481	
Sometimes	61	2.831674	0.001
Often	68	2.956373	
Always	52	3.206158	

We further regrouped the companies into three categories:

1. Companies who were rarely able to arrange the required financial resources and those who were never able to arrange financial resources were put in one group.

2. Companies who were sometimes able to arrange the required financial resources.

3. Companies who were always able to arrange the financial resources and those who were often able to arrange the required financial resources were put in one group.

The t-test performed to analyze the difference between the means of group 1 and group 3 indicated a statistically significant difference in their TCP scores (Table 33).

Table 33: Difference in the TCP score of two Financial Resources Regroups

Response	N	Mean TCP Score	Sig (2-tailed)
Group 1 (Never + rarely)	39	2.53	0.002
Group 2 (Sometimes)	61	2.69	
Group 3 (Often + Always)	120	3.04	

5.3.8.2 Human Resources

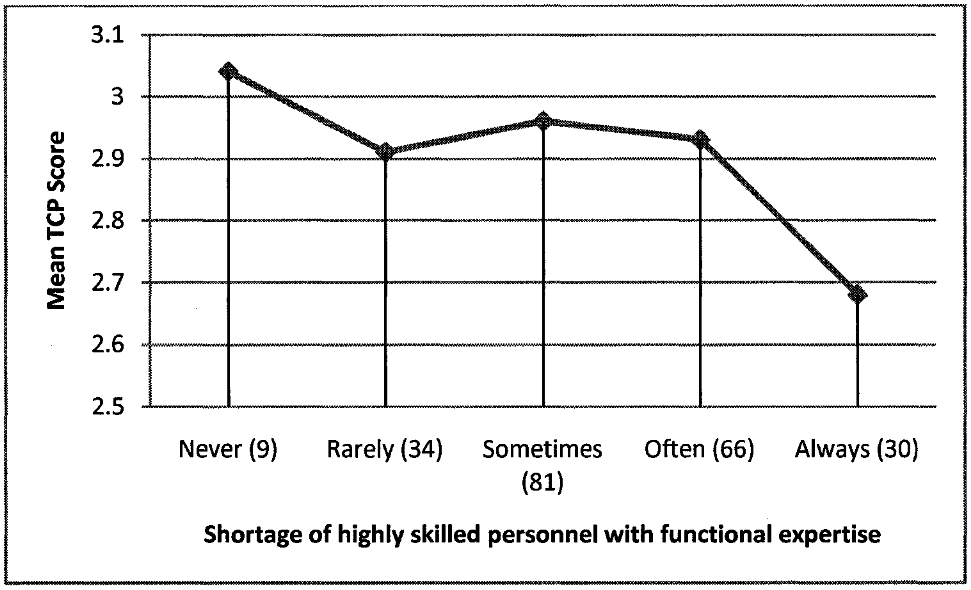

Figure 21: Effect of Human Resources on TCP

In the questionnaire, the respondents were asked to provide information about whether they faced a shortage of highly skilled personnel with functional expertise in their company. Out of 220 responses, 30 (13.6 percent) companies reported always having a shortage, 66 (30.0 percent) companies often faced a shortage, 81 (36.8 percent) companies sometimes faced a shortage, 34 (15.4 percent) companies rarely faced a shortage, and 9 (4.0 percent) companies never faced a shortage (Figure 21). Although, there is a difference in the TCP scores of the companies who have never faced a shortage of skilled personnel and those who always faced this shortage, the t-test indicated that the difference is not statistically significant (Table 34).

Table 34: Difference in the TCP score of two Human Resources Groups

F2			
Response	N	TCP Score	Sig.(2-tailed)
Never	9	3.04	0.326
Rarely	34	2.91	
Sometimes	81	2.96	
Often	66	2.93	
Always	30	2.68	

5.3.8.3 Physical Facilities

In the questionnaire, the respondents were asked whether they considered a lack of physical facilities as impeding their commercialization performance. Out of 219 responses, 40 (18.2 percent) companies never faced any shortage, 68 (31.0 percent) rarely faced a shortage, 64 (29.2 percent) sometimes faced a shortage, 35 (15.9 percent) often faced a shortage and, 12 (5.4 percent) companies always faced a shortage. Almost half of the respondents have rarely or never faced a shortage of physical facilities. The mean TCP scores of the companies are shown below in Figure 22.

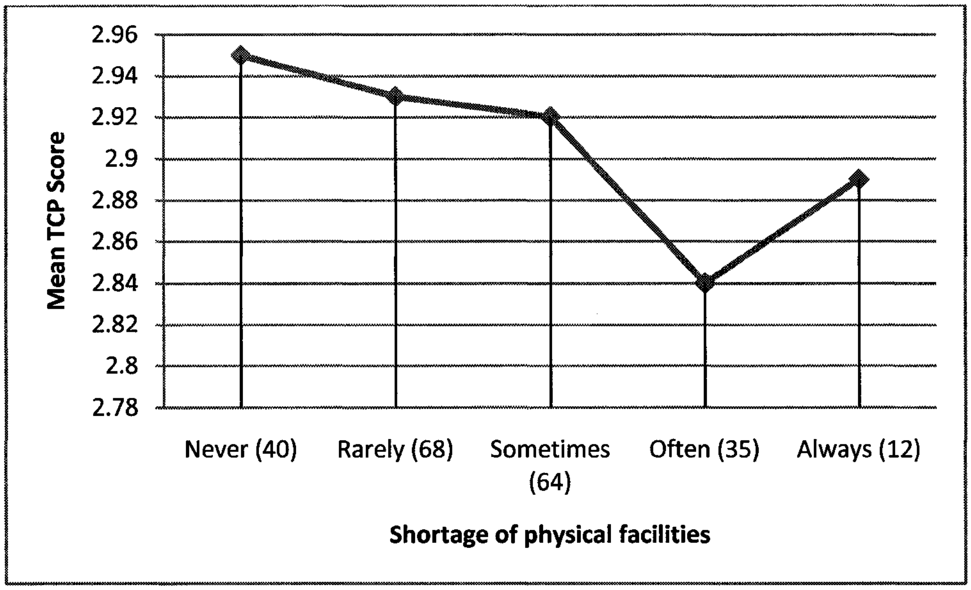

Figure 22: Effect of Physical Facilities on TCP

The line graph drawn between TCP and shortage of physical facilities, as shown in Figure 22, does not show a clear distinction in the TCP scores of those that faced a shortage and those that have not faced a shortage. A t-test was performed to test the level of significance in the difference of TCP scores of those who never faced a shortage and those who always faced a shortage. The t-test result indicated that there was no significant difference in the TCP score of the companies who never faced a shortage and those who always faced a shortage of physical facilities (Table 35).

Table 35: Difference in the TCP score of two Physical Facilities Groups

F3			
N		Mean TCP Score	Sig. (2-tailed)
40	Never	2.95	0.636
68	Rarely	2.93	
64	Sometimes	2.92	
35	Often	2.84	
12	Always	2.89	

5.3.9 Effect of firm size on Organizational Capabilities and TCP

H9: **Larger the size of the firm, stronger will be the organizational capabilities and technology commercialization performance**

In the dataset, there are only two responses from large companies (having more than 500 employees); therefore, in the analysis we have only focused on small- and medium-sized companies. The data set is divided into two groups – the first group composed of the small-sized companies (0-99 employees) and the second group of medium-sized companies (100-499 employees). In total, there were 198 (86.4 percent) responses from small-sized companies and 31 (13.5 percent) responses from medium-sized companies. The mean organizational capability scores and the TCP scores of the small-sized companies and medium-sized companies are shown in Table 36.

Table 36: Difference in TCP score and Organizational Capability Scores of Small- and Medium-sized Companies

	Size	N	Mean	Sig. (2-tailed)
TCP Score	Small-sized companies	198	2.90	0.05
	Medium-sized companies	31	3.17	
Marketing Capability Score	Small-sized companies	198	3.74	0.82
	Medium-sized companies	31	3.71	
R&D Capability Score	Small-sized companies	198	3.96	0.18
	Medium-sized companies	31	4.13	
Manufacturing Capability Score	Small-sized companies	198	4.01	0.67
	Medium-sized companies	31	3.97	
Integration Capability Score	Small-sized companies	198	3.52	0.55
	Medium-sized companies	31	3.61	

The t-test indicates that there is a significant difference between the TCP scores of small- and medium-sized companies. The organizational capability scores of the medium-sized companies are not statistically different from the organizational capability score of the small-sized companies (Table 36).

In Table 37, only the small-sized companies are considered for analysis. The small-sized companies are further divided into five groups to study the impact of size on TCP and organizational capabilities. In the dataset, 119 (60.1 percent) small-sized companies out of 198 were in group 1 having 0-19 employees, 46 (23.2 percent) small-sized companies were in group 2 having 20-39 employees, 17 (8.5 percent) small-sized companies were in group 3 having 40-59 employees, 11 (5.5 percent) small-sized companies were in group 4 having 60-79 employees, 5 (2.5 percent) small-sized companies were in group 5 having 80-99 employees. The comparison of the groups indicated no significant difference in the TCP score or organizational capability scores.

Table 37: Difference in TCP score and Organizational Capability Scores of different Categories of Small-Sized Companies

Group	Size of the company	N	TCP Score	Marketing Capability Score	R&D Capability Score	Manufacturing Capability Score	Integration Capability Score
1	0-19 employees	119	2.88	3.73	4.01	4.01	3.46
2	20-39 employees	46	3.03	3.84	4.02	4.09	3.68
3	40-59 employees	17	3.00	3.75	3.75	3.91	3.63
4	60-79 employees	11	2.95	3.57	4.18	4.07	3.64
5	80-99 employees	5	3.24	3.91	3.96	4.10	3.43

We further regrouped the companies into three categories reflecting the actual size of the companies (in terms of number of employees) in Canada. Group 1 comprises companies having 0-19 employees, Group 2 comprises companies having 20-79 employees, and Group 3 comprises companies having 80 to 499 employees (Table 38).

Table 38: Difference in TCP score and Organizational Capability Scores of Reclassified Categories of Small Sized Companies

Group	Size of the company	N	TCP Score	Marketing Capability Score	R&D Capability Score	Manufacturing Capability Score	Integration Capability Score
1	0-19	119	2.8372	3.7178	3.9722	4.0073	3.4324
2	20-79	73	2.9899	3.7573	3.9385	4.0192	3.6647
3	80-499	38	3.2164	3.7371	4.0983	3.9848	3.5703

The Tukey-HSD test and Scheffe's test were performed to find the difference in the means of TCP score and all organizational capability scores across the three groups. The results do not show a significant difference in the organizational capability scores across the three groups.

Table 39: Tukey-HSD and Scheffe's Multiple Comparison Statistics for TCP Score

	Group	N	Subset for alpha = 0.05	
			1	**2**
Tukey HSD	1	119	2.8372	
	2	73	2.9899	2.9899
	3	38		3.2164
	Sig.		**.451**	**.176**
Scheffe	1	119	2.8372	
	2	73	2.9899	2.9899
	3	38		3.2164
	Sig.		**.485**	**.205**

Table 39 shows the output of the Tukey-HSD and Scheffe's test comparing the mean TCP score across the three groups. It indicates a significant difference in the TCP score of Group1 and Group 3.

5.4 Organizational Capabilities and Technology Commercialization Performance

In the previous sections, the association between the TCP and each organizational capability was tested separately. In this section, the combined impact of all the organizational capabilities on TCP is examined.

5.4.1 CFA of Organizational Capabilities Measurement Model

5.4.1.1 Model Identification

The organizational capabilities measurement model has 31 factor loadings, 31 error covariances, and 6 factor correlations between the latent variables. Therefore, the total number of parameters in the full model is 68. The correlation matrix used to input the data to the software has [{p*(p+1)}/2] = 496 observations, where p is equal to 31 (number of observed variables). Since the number of observations is more than the number of parameters to be estimated, the full model is over identified. Goodness of Fit Statistics

The primary measurement model is a poor fit because the goodness of fit statistics – RMSEA = 0.09, CFI = 0.92, and NFI = 0.88 – are not giving acceptable values (Appendix 23). The software output suggested adding 36 error covariances, and the modified measurement model achieved after some iteration is shown in Figure 23. The goodness of fit statistics improved and the new values attained were RMSEA = 0.059, CFI = 0.96, and NFI = 0.92. The output of the LISREL program with other goodness of fit statistics is shown in Appendix 24.

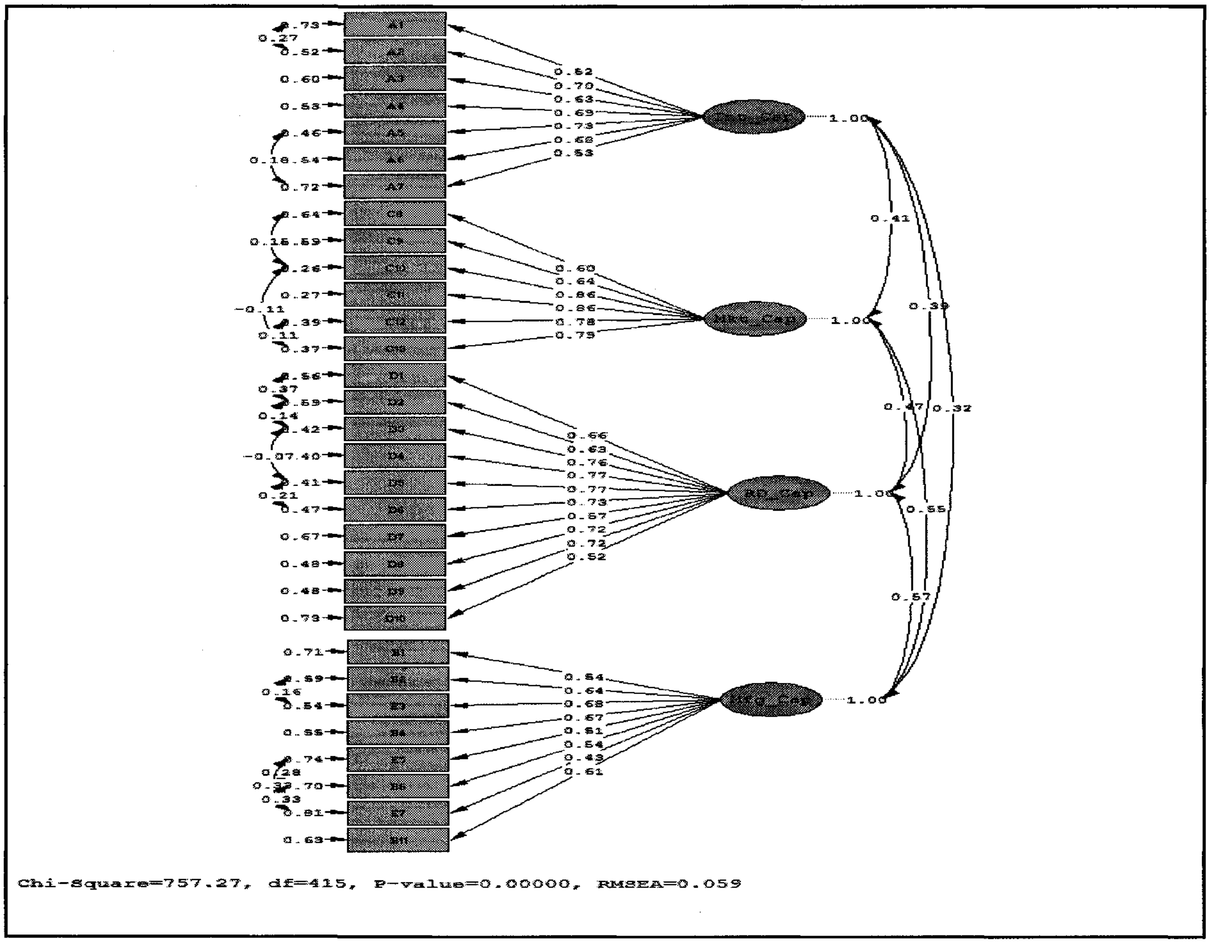

Figure 23: Organizational Capabilities Measurement Model

5.4.2 Analysis of TCP-Organizational Capabilities Model

5.4.2.1 Model Identification

The SEM model has 36 factor loadings, 36 error covariances, and 10 factor correlations between the latent variables. Therefore, the total number of parameters in the SEM model is 82. The correlation matrix used to input the data to the software has $[\{p*(p+1)\}/2]$ = $[\{36*(36+1)\}/2]$ = 666 observations, where p is equal to 36 (number of observed variables). Since the number of observations is more than the number of parameters to be estimated, the full model is over identified.

5.4.2.2 Goodness of Fit Statistics

The SEM model is moderately fit, having the goodness of fit statistics RMSEA = 0.08, CFI = 0.91, and NFI = 0.87 (Appendix 25). The modified SEM model attained after adding error covariances is shown in Figure 24. The goodness of fit statistics improved and the new values attained are RMSEA = 0.052, CFI = 0.96, and NFI = 0.91. The output of the LISREL program, with other goodness of fit statistics, is shown in Appendix 26. The association of TCP with integration capability and R&D capability has a t-value of 2.66 and 2.25 respectively, which is significant at the 0.05 level. The marketing capability and manufacturing capability do not indicate any significant association with TCP.

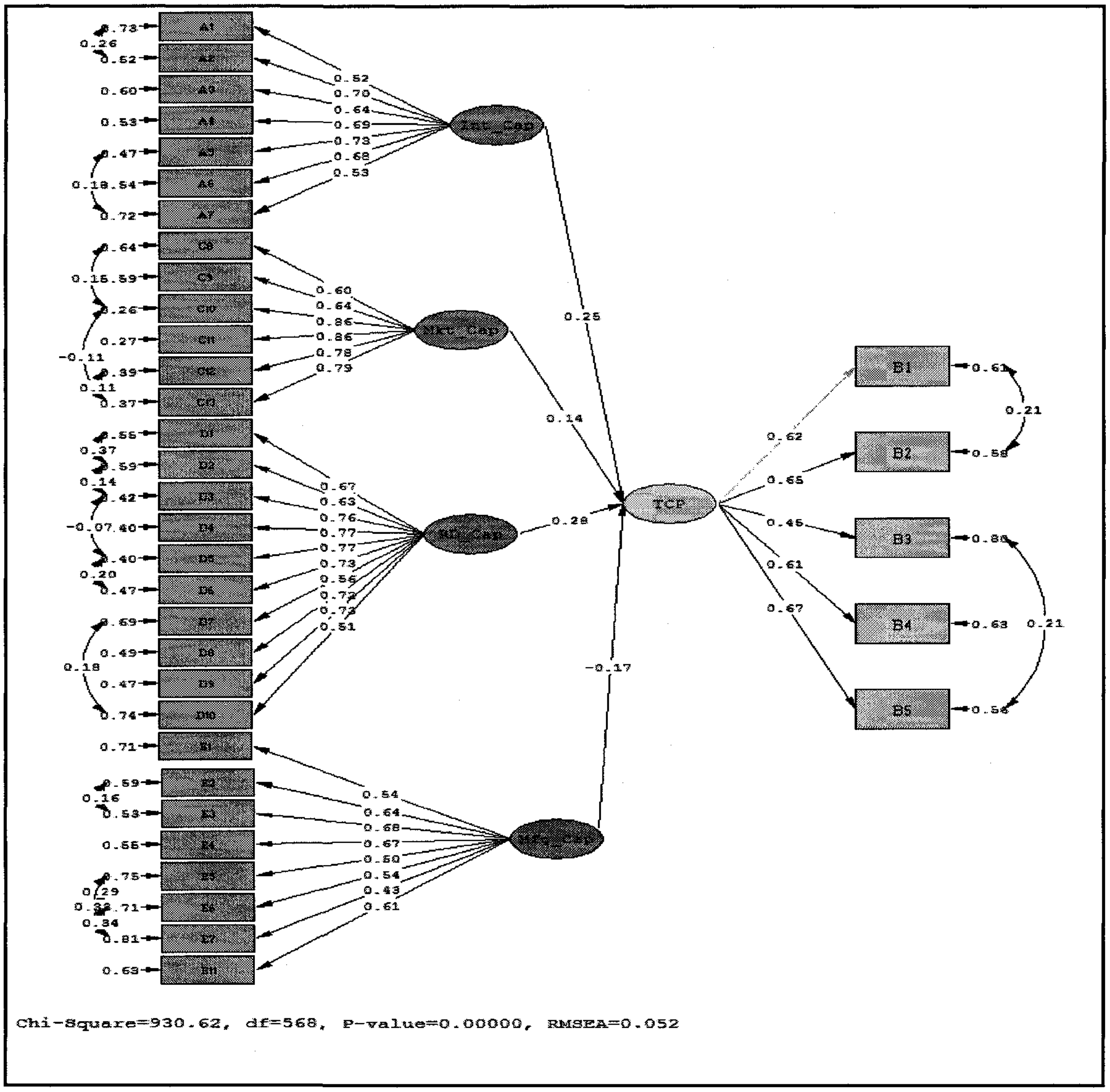

Figure 24: TCP-Organizational Capabilities Model

6 DISCUSSION

The objectives of this study are to examine the association between the organizational capabilities and TCP, the association between strategic alliances and organizational capabilities, and the effect of the size of the firm and organizational resources on TCP. We examined nine hypotheses, as shown in Table 40. The data analysis results supported five of them, partially supported two hypotheses, and failed to accept two hypotheses.

Table 40: List of Hypotheses

H1:	Strong marketing capability positively impacts technology commercialization performance.	Supported
H2:	Firms having marketing-related strategic alliances have higher marketing capability.	Not Supported
H3:	Strong R&D capability positively impacts technology commercialization performance.	Supported
H4:	Firms having R&D-related strategic alliances have higher R&D capability.	Supported
H5:	Strong manufacturing capability positively impacts technology commercialization performance.	Supported
H6:	Firms having manufacturing-related strategic alliances have higher manufacturing capability.	Not Supported
H7:	Strong integration capability of the firm positively affects technology commercialization performance.	Supported
H8:	The availability of organizational resources positively affects technology commercialization performance..	Partially Supported
H9:	Larger the size of the firm, more positive the relationship between organizational capabilities and technology commercialization performance	Partially supported

6.1 Relationship between Organizational Capabilities and TCP

In this study, we examined the organizational capabilities of the companies: marketing capability, manufacturing capability, R&D capability, and integration capability. The impact of these capabilities on TCP are examined in two stages – first, the association of each individual organizational capability with TCP was examined and, second, the association of TCP with all four organizational capabilities was studied.

6.1.1 Marketing Capability

The correlation analysis showed that there is a significant correlation between marketing capability and TCP. In this study, marketing capability is measured by five dimensions – distribution channel management, marketing communication, market information management, market planning, and identifying customer needs. Each dimension has been measured by three questions. In the marketing capability measurement model the items that were dropped because they had a low loading on marketing capability are given in Table 41.

Table 41: Marketing Capability Items dropped from CFA Model

Questions	Dimension
C1, C2, C3	Distribution Channel Management
C4, C5, C6	Marketing Communication
C7	Market Information Management
C14, C15	Identify customer needs

The Canadian manufacturing companies do not consider distribution channel management to be an important dimension of marketing capability. This dimension was measured by three items – C1, C2, and C3 – and all three have extremely low loading on marketing capability.

C1: Developing strong relationships with distributors

C2: Attracting and retaining the best distributors

C3: Providing high levels of service support to distributors

Vorhies and Morgan (2005) have conducted in-depth interviews, focus groups, and surveys to benchmark marketing capabilities. Distribution channel management was found to be an important dimension of marketing capability, and it also influences the performance of the company. It is important to note here that the sample used in their empirical study was drawn from large companies. In the literature, other studies on efficient distribution channel management have also focused upon large companies like IBM, Kodak, Frito-Lay, Estee Lauder, Goodyear, etc., which have a structured distribution channel management system (Hardy and Magrath, 1988). Michael Porter (1980) has also emphasized the importance of efficient distribution channel management and considered it to be the major source of entry barrier for the companies not having a strong distribution channel network.

In our dataset, most respondents are small-sized companies. The small-sized Canadian companies probably do not have a structured distribution channel management system and rely more upon a personal relationship with their distributors. Another possible explanation is that their size probably constrains them to have a very limited number of distributors; therefore, having a distribution channel management system is not a necessity. The size of the company also restricts their manufacturing capacity; they might, in fact, be producing for only one or two large manufacturers and rely upon fostering a personal relationship. Scott and Bruce (1987) studied the stages of growth of small companies and found that small companies generally have a single operating unit and operate in one market with very few channels of distribution. This confirms our finding and explains why the companies in our dataset did not consider distribution channel management an important determinant of marketing capability.

The other items measuring marketing capability dropped from the CFA model are C4, C5, and C6. These items were measuring the dimension "marketing communication" and have low loading on marketing capability.

C4: Developing and executing advertising programs

C5: Managing brand image and processes

C6: Managing corporate image and reputation

This indicates that Canadian small- and medium-sized manufacturing companies do not consider spending financial resources on advertising their products and creating a known brand in the market. This dimension was considered to be an important measure of marketing capability but, probably, more relevant for large companies. Small companies have limited budgets and have to rely more upon their personal relationship to popularize their product.

Market information management was measured by three items and only C7 was found to have low loading on marketing capability. The other items dropped are C14 and C15 measuring the dimension "Identifying customer needs."

C7: Gathering information about customers and competitors

C14: Recognizing the requirements of customers

C15: Understanding the factors influencing customer choices

The respondents considered analyzing market information important for their organization but they did not consider gathering information about customers and competitors to be essential. They did consider tracking customer needs to be important but did not consider it to be essential to learn about the requirements of their customers and analyzing the buying decision processes of their customers. Overall, it appears that the respondents do not consider customer research to be an important activity. This confirms the findings of Meziou (1991), who studied the adoption of marketing concept in 176 small manufacturing companies in the US and found that small manufacturing firms do not conduct customer research, which is a major weakness of the small companies. To conclude, the analysis of the data indicates that small-and medium-sized Canadian manufacturing companies put emphasis upon developing marketing management skills, effective marketing programs, and overall marketing planning skills. They do not consider marketing communication and distribution channel management to be important for their organization.

6.1.2 R&D Capability

The R&D capability has four dimensions – selection of technology, operation of technology, maintenance of technology, and modification of technology. These dimensions are measured by 10 items. The correlation analysis showed significant correlation between R&D capability and TCP, and the measurement model also indicated statistically significant association between these two. All 10 items measuring R&D capability have high loadings, therefore, all of them are retained in the model.

Studies from other countries have shown that small- and medium-sized companies in the manufacturing sector have played a very important role in developing new products. Studies conducted in the US (Acs *et al.* 1994), Canada (Ceh, 1996), Britain (Rothwell, 1991), and many European countries (Maillat, 1990) indicated that small- and medium-sized firms have performed better than the large companies in R&D productivity and launching new products. Griffy-Brown (2002) examined 5,029 small- and medium-sized companies in the manufacturing sector in Japan and found an increase in spending on R&D and more emphasis upon developing new products and services, developing new sources of demand, and improving efficiency (Figure 25).

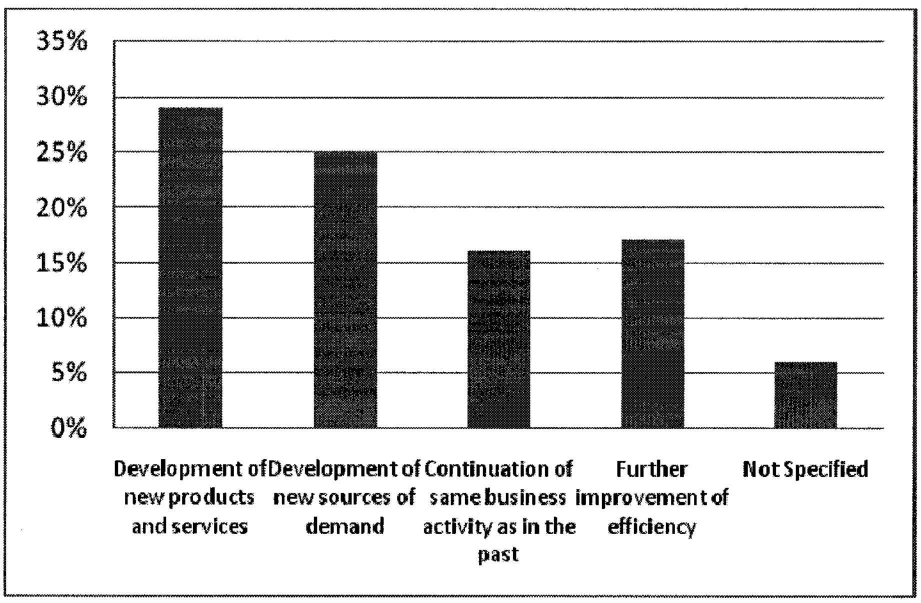

Figure 25: Strategies for Business Development for Japanese SMEs

Source: (Griffy-Brown, 2002

Bagchi-Sen and Macpherson (1999) compared the competitive characteristics of Canadian and US small- and medium-sized companies in the manufacturing sector and found Canadian companies to be more innovative than the US companies and give priority to developing new and improved products. To conclude, the results of this study also show that small- and medium-sized Canadian manufacturing companies place higher emphasis on R&D productivity and consider all the four dimensions of R&D capability very important for TCP.

6.1.3 Manufacturing Capability

The manufacturing capability was measured by ten items across four dimensions – quality, cost, flexibility, and dependability. The correlation analysis indicated no association between manufacturing capability and TCP. The CFA model showed that two items (E8 and E10) have low loading. Interestingly, these two items were measuring the dimension of "flexibility." In this study, the items measuring manufacturing flexibility asked about the emphasis placed upon manufacturing a variety of products in different sizes

E8: Increase the variety of sizes

E10: Increase the variety of products

After these two items were dropped from the model the good fit model was attained. The new manufacturing capability score is calculated excluding the two items measuring flexibility. The correlation analysis now indicates a significant association with TCP. The CFA results suggest that the companies in the dataset do not consider flexibility to be important for their organization. The literature, on the other hand, suggested that developing manufacturing flexibility is essential to survive in today's competitive business environment (Gerwin, 1993). Studies have found that manufacturing flexibility positively influences growth in sales, net profit, and market share (Swamidass and Newell, 1987; Bolwijn and Kumpe, 1990; Tannous, 1996). Li (2000) studied the manufacturing capability of 300 manufacturing firms in China. The presence of manufacturing flexibility was found to be critical for increase in sales revenue and market share. Another interesting outcome of that study was that high performers considered manufacturing flexibility to be critical, whereas low performers put more emphasis upon cost efficiency. Porter (1980) has also mentioned that companies that emphasized upon achieving cost efficiency generally have low performance. To conclude, the small- and medium-sized Canadian manufacturing companies put emphasis upon the three dimensions of manufacturing capability which are quality, cost and dependability. One of the factors responsible for the poor TCP of the Canadian manufacturing companies can be the lack of importance given to manufacturing flexibility. This is a serious concern and needs more detailed investigation.

6.1.4 Integration Capability

Integration is defined as a "process of interdepartmental interaction and interdepartmental collaboration that brings departments together into a cohesive organization" (Kahn and Mentzer, 1998). The ability of an organization to effectively integrate its functional units with its partners is its integration capability. There are two types of integration – internal integration and external integration (Chen *et al.*, 2007). In this study, integration capability is the average of 12 items measuring internal and external integration. The CFA results indicate that the items having low loadings on integration capability are A8, A9, A10, A11, and A12. All these items are measuring external integration, i.e. the extent to which a company communicates, collaborates, and coordinates with the external alliance partners.

A8 How often does one or more of the functional departments hold joint meetings with the alliance partner(s)?

A9 How often does one or more of the functional departments communicate (using phone, email, fax, etc.) with the alliance partner(s)?

A10 How often does one or more of the functional departments exchange information about customers, competitors, or the general business environment with the alliance partner(s)?

A11 Do you and your alliance partner(s) follow collective goals?

A12 Do you and your alliance partner(s) share a common vision?

Nakata *et al* (2006) conducted a survey of 260 innovation managers in manufacturing firms in Japan and Korea to identify the antecedents of new product performance. The results indicated that cross-functional integration influences new product performance, which supports our findings. The literature also suggests the importance of interaction and coordination among the functional units for a variety of reasons – sharing market information (Jaworski and Kohli, 1993; Narver and Slater, 1990; Day, 1994; Olson *et al.*, 1995), converting knowledge into value creating processes (Zahra *et al.*, 2000; Zahra and Nielson, 2002), synthesizing acquired external knowledge (Henderson and Cockburn, 1994), refining existing competencies and developing new ones (Zahra *et al.*, 2000), and raising the level of trust, which allows an effective use of capabilities (Zahra and Neilson, 2002). The literature on competitive advantage also suggests that the functional capabilities of a firm can become a source of competitive advantage when the functions are integrated (Day and Wensley, 1988). To conclude, small- and medium-sized Canadian manufacturing companies in the dataset do not consider external integration to be essential but focus upon internal integration.

6.2 Strategic Alliances

Strategic alliances have become very important in today's hyper-competitive business environment, and they have become a persistent method of doing business (BarNir and Smith, 2002). In the dataset, among the small-sized companies, 116 companies have one or more than one type of functional strategic alliances, whereas 80 companies do not have any of the three types of functional strategic alliances examined in this study. Among the medium-sized companies, 20 companies have one or more than one type of functional strategic alliances, and 11 companies do not have any functional strategic alliance. The formation of an alliance is contingent upon the benefits perceived by the alliance partners. The characteristics considered to be most appealing are technological knowledge, market position, and human resources. Small companies have to make themselves appealing to other companies and demonstrate their usefulness to the potential alliance partners. Approximately 60 percent small-sized companies and 65 percent medium-sized companies do have strategic alliances. However, it would be interesting to explore in the future why a significant number of companies do not have any form of alliance and whether they fail to find alliance partners or they prefer to do business without an alliance.

This study found that a manufacturing alliance is the most popular form of alliance, followed by marketing and R&D alliances. The reason for the popularity of manufacturing alliances could be the high labour cost in Canada and the lack of cost-efficient manufacturing processes. Successful commercialization requires the development of new products at a low manufacturing cost to outperform the competition and to have an optimal profit margin.

Table 42: Effect of Manufacturing Alliance on Manufacturing Capability

Manufacturing Alliance	**Manufacturing Capability Score**
Companies not having manufacturing alliance	4.02
Companies having manufacturing alliance	3.98

The analysis of the data indicated that there is no significant difference in the manufacturing capability score of the companies having a manufacturing alliance and those not having a manufacturing alliance (Table 42). In this study, we did not collect data regarding the objectives of forming strategic alliances and whether the manufacturing-related alliances are with domestic companies or international companies. The interpretation is, therefore, based upon our understanding of the problems faced by Canadian companies in the manufacturing sector. Forrest (1990) also posited that the formations of manufacturing-related alliances are due to lack of manufacturing expertise.

There is no significant difference in the marketing capabilities of the companies having marketing alliances and those not having a marketing alliance. The explanation for this finding is that one of the main objectives of the company forming a marketing alliance is to successfully introduce new products in new markets (Borys and Jemison, 1989).

Table 43: Effect of Marketing Alliance on Marketing Capability

Marketing Alliance	Marketing Capability Score
Companies not having a marketing alliance	3.74
Companies having a marketing alliance	3.71

The alliance partner is expected to have in-depth information about the target market and be familiar with the specific needs, likes, and dislikes of the customers in that market. The transfer of this tacit knowledge generally takes a long time, therefore, the formation of a marketing alliance probably does not improve marketing capability (Table 43). It was found that companies having an R&D alliance have a significantly higher R&D capability score compared to those who do not have an R&D alliance (Table 44). An R&D alliance positively influences R&D capability because the objectives of an R&D alliance are generally to share the R&D cost, transfer technological knowledge (BarNir and Smith, 2002), and effectively respond to the customers' needs by successfully commercializing technology (Lee and Vonortas, 2002).

Table 44: Effect of R&D Alliance on R&D Capability

R&D Alliance	R&D Capability Score
Companies not having R&D alliance	3.89**
Companies having R&D alliance	4.21**

** Significant at 0.01 level

In Canada 97.7 percent of the companies are small-sized companies (0-99 employees) and only 2 percent of the companies are medium-sized companies (100-499 employees). The various government agencies in Canada prefer to link them together, and they have not studied them separately (Munn-Venn and Mitchell, 2005). Many researchers have disagreed with combining small- and medium-sized companies for study, because the characteristics of small companies are different from medium-sized companies (Guthrie and Munn-Venn, 2005). We could not find any empirical study that examined small- and medium-sized companies separately, therefore, in this study, we separated them to study the extent to which they differ in terms of TCP and organizational capabilities. The small companies are further divided into five groups to extract more information about them.

The literature suggests that medium-sized companies will probably have better technology commercialization because they have more resources and capabilities, compared to small-sized companies. The results of this study confirmed that there is a significant different in TCP, and that the medium-sized companies have higher TCP. In terms of organizational capabilities, we could not find any significant difference between the small- and medium-sized companies. This study provides the much needed empirical evidence that the medium-sized companies have higher TCP than small-sized companies, although further investigation is required to examine why medium-sized companies have significantly higher TCP. The results also support the argument that government policies, and federal and provincial programs should be tailored separately for small- and medium-sized companies after investigating their heterogeneous requirements and the factors impeding technology commercialization.

The regrouping of the companies in the small-sized category failed to reveal any significant difference in TCP or organizational capability among the groups. Interestingly, out of 198 small companies in the dataset, 119 companies have less than 20 employees and 46 companies have 20-39 employees. Overall, 83.3 percent of the small companies have less than 40 employees, which indicate the need to redefine the small-sized category.

6.3 Organizational Resources

In this study, we have asked the respondents about the availability of three types of organizational resources: financial resources, human resources, and physical facilities. The literature suggests that small firms have a hard time in arranging financial resources to commercialize technology (Industry Canada, 2006).

Table 45: Availability of Financial Resources

	F1 (Financial Resources)					
Group	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	**TOTAL**
Small-sized companies (0-99 employees)	12 (6.34%)	25 (13.22%)	54 (28.57%)	56 (29.62%)	42 (22.22%)	189
Medium-sized companies (100-499 employees)		2 (6.45%)	7 (22.58%)	12 (38.71%)	10 (32.26%)	31

The results of this study do not confirm the Industry Canada report since, as shown in Table 45, most small- and medium-sized companies are sometimes, often, or always able to arrange the required financial capital. This is very encouraging and indicates that the lack of financial capital is not the major hurdle. Bagchi-Sen and Macpherson (1999) conducted a survey of small- and medium-sized manufacturing firms in the US and Canada and found similar results. The results of their study also indicated that Canadian firms have fewer problems than do firms in the US in accessing financial capital. The recommendation of the panel formed by the Minister of Industry in 2005 emphasizing the importance of the availability of financial capital is still justified for two reasons: 1. a large number of companies are still not "always" able to arrange the required capital 2. it is found in this study that there exists a linear relationship between availability of financial resources and TCP. TCP improves with the increase in financial resources, and there is a significant difference in the TCP of companies who are always or often able to arrange financial resources and those who never or rarely able to arrange it.

Most respondents in this study do not consider a shortage of physical facilities to be impeding their TCP, but they have expressed their concern over the shortage of skilled personnel with functional expertise. The unavailability of skilled personnel is also considered to be impeding commercialization performance in the Industry Canada report as well as in the CBoC report. The small- and medium-sized companies generally face a shortage of skilled people having functional expertise, which results in below average performance of the companies. In this study, the respondents were asked how often they feel the shortage of highly skilled personnel, and their replies confirmed the concerns of the Industry Canada report and the CBoC report.

Table 46: Shortage of Skilled Personnel with Functional Expertise

	F2 (Human Resources)					
Group	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**	**TOTAL**
Small-sized companies (0-99 employees)	9 (4.76%)	30 (15.87%)	68 (35.97%)	54 (28.57%)	28 (14.81%)	189
Medium-sized companies (100-499 employees)		4 (12.90%)	13 (41.94%)	12 (38.71%)	2 (6.45%)	31

Table 46 shows that most respondents have indicated the shortage of skilled personnel as a problem. The relationship between availability of skilled personnel and TCP is not linear, but the t-test indicates that there is a significant difference in the TCP score of companies that never face a shortage and those that always face a shortage. This issue certainly requires immediate attention, and the policies of the government should focus upon encouraging students to go for higher education. At the same time there should be a focus on attracting skilled personnel from other countries to immigrate to Canada.

7 CONCLUSION

This study focused on the exigent issue of technology commercialization performance (TCP) of the small and medium sized Canadian manufacturing companies. Reports from organizations such as Industry Canada and the CBoC have indicated the poor performance of Canadian companies in bringing new products, processes, or services to the market. A report of the standing committee on Industry, Science, and Technology presented to Parliament in February 2007, also highlighted the inability of Canadian manufacturing companies to compete in the global business environment.

This study analyzed the issue of TCP from an organizational capabilities perspective. The literature links performance of the companies with specific functional capability, but the association between TCP and all functional capabilities should be examined. Functional capabilities are termed organizational capabilities in this study because this not only takes into account the various functional capabilities but also encompasses the capability of the company to integrate all the functions. This is considered to be essential for strong TCP. The questions examined in this study are:

- What organizational capabilities are required for technology commercialization?
- To what extent do strategic alliances help in building organizational capabilities?

- What role does firm size play in technology commercialization?

- What kind of organizational resources are required for technology commercialization?

The four types of organizational capabilities – marketing capability, R&D capability, manufacturing capability, and integration capability have positive association with TCP. As mentioned earlier, in the literature review it is essential to examine the combined influence of all organizational capabilities on TCP. The influence of each organizational capability on TCP changes when all of them are tested together. The statistical results of the full model indicate that R&D capability and the extent to which the functions are integrated have statistically significant association with TCP. In a technology-intensive industry, the companies require strong R&D capability and the capability to integrate their marketing and manufacturing business function with the R&D function so that they can share their functional capabilities to improve TCP. Therefore, the non-significant association of marketing capability and manufacturing capability with TCP, as shown in the full model, does not mean that they do not influence TCP. Thus, it is essential for the companies to develop functional capabilities and integrate the business functions to improve TCP.

The results of this study demonstrate the influence of strategic alliances on R&D capability. The companies having an R&D alliance have significantly higher TCP than those companies that do not have an R&D alliance. We did not observe any significant association between the two other types of strategic alliances (marketing and manufacturing) and the respective capabilities. The government should provide the resources required to facilitate the formation of R&D alliances, both domestic and international, by Canadian companies.

This study contributes to the debate of whether or not small- and medium-sized companies should be treated separately. In this study we have found a significant difference in the TCP of small- and medium-sized companies. It is suggested that the classification of Canadian companies into small- and medium-sized companies based upon the number of employees should be reconsidered, because the existing categorization does not seem to be relevant in Canada, which has 97.7 percent small-sized companies.

The availability of organizational resources plays an important role in improving TCP. In this study, we examined three types of organizational resources – financial resources, human resources, and physical facilities. The results indicated a linear association between the availability of financial resources and TCP. Most companies (70.97 percent of medium-sized companies and 51.31 percent of small-sized companies) indicated that they are often or always able to arrange financial resources, which is very promising. The results of this study could not establish a statistically significant association between TCP and the availability of skilled personnel with functional expertise, but it does confirm the shortage of skilled personnel in Canada.

7.1 Limitations and Future Research

In this survey we have asked the respondents to compare their technology commercialization performance with the industry standards. The assumption was that the senior management is aware of the industry standards and by not asking direct questions about their performance, we can increase the response rate. Most respondents would probably hesitate to provide information about their actual technology commercialization performance but if we ask them to compare their company's performance not with their competitors, but with the industry standards then they might provide the required information. The limitation of this design is that we are not getting data about the actual technology commercialization performance of the companies but relying upon the judgment of the respondents.

Another limitation of this study is that while designing the questionnaire we have asked the respondents to indicate the importance placed by their company on various items measuring different dimensions of organizational capabilities. It would have been more useful to collect information about their actual capabilities rather than relying on perceived importance but the respondents might possibly get biased and give high scores to their companies. Therefore, in spite of limitations of using "importance" scale, we considered it more relevant for this study.

In this study we have asked only three questions related to the functional strategic alliances formed by the companies. This definitely provided information about the type of functional alliances preferred by the small- and medium-sized Canadian manufacturing companies and threw some light upon the impact of functional strategic alliances on functional capabilities. This, however, requires an in-depth investigation to examine the impact of functional alliances on TCP. It would also be interesting to explore in future research the motives and the perceived benefits expected from different types of functional strategic alliances.

The results of this study demonstrate the importance of organizational capabilities in improving TCP and why it is not just important to have the functional capabilities but the capability to integrate the functions. We focused upon only two types of industries (Computer and electronic product industry, Electrical equipment appliance and component industry), therefore, the results of this study cannot be generalized to other industries. It is suggested that future research needs to be undertaken in other industries to examine the association between TCP and various organizational capabilities.

The results of this study indicate that small- and medium-sized companies have significantly different TCP. However, the low response rate from medium-sized companies did not allow us to perform advanced statistical analysis to understand the reasons for their relatively better TCP than small-sized companies. Future research could target only the medium-sized companies in technology intensive industries of the manufacturing sector, which will provide a clear picture of TCP in medium-sized companies and how the various organizational capabilities are associated with TCP.

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APPENDIX 1: Survey Questionnaire

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An Empirical Study to Determine the Role of Organizational Capabilities in Technology Commercialization Performance

This questionnaire should be completed by a senior executive familiar with the functional capabilities of the company. If you do not want to answer any question then please proceed to the next question. I would be very grateful if you try to answer all the questions. I assure you that your responses will not be disclosed to any outside party. If you wish to receive the summary of research findings, please provide your mailing address in the "Request for Research findings" form provided on a separate page or write an email to me.

Should you require additional information, please do not hesitate to call me at 613-520-2600 ext 6327 or send an email to bmukerji@connect.carleton.ca. You are also welcome to contact either of my thesis supervisors: Professor Vinod Kumar at 613-520-2379 (e-mail: vinod_kumar@carleton.ca) or Professor Uma Kumar at 613-520-6601 (e-mail: uma_kumar@carleton.ca) for further information.

Thank you very much for your participation and completing this questionnaire. Your input is very much appreciated.

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An Empirical Study to determine the Role of Organizational Capabilities in Technology Commercialization Performance

Survey Questionnaire

1. What is your position within the company? ______________________

2. What products do you produce?
____
____

3. How many employees do you have in your company? [ ]

4. Ownership of the company ☐ Canadian ☐ US ☐ Other ______
(Please Specify)

5. Do you have the following functions in your organization? (Please check all that applies)

☐ R&D ☐ Manufacturing ☐ Marketing

6. Do you have marketing related strategic alliance with another company? Yes [ ] No [ ]

7. Do you have R&D related strategic alliance with another company? Yes [ ] No [ ]

8. Do you have manufacturing related strategic alliance with another company? Yes [ ] No [ ]

A. Integration Capability

Integration is the process by which *at least two* of the functions (marketing, R&D, manufacturing) coordinates and deploys its different capabilities either developed internally or acquired from external sources to efficiently and effectively commercialize technology.

Please indicate the importance of the following items in your organization. Answer each question on a scale of 1 (never) to 5 (always) by circling the appropriate number. If the statement is not applicable to your company, mark "√" in the given box.

		Never	Rarely	Sometimes	Often	Always	Not Applicable
1	How often do you form committees having members from the functional departments?	1	2	3	4	5	☐
2	How often do the functional departments hold joint meetings?	1	2	3	4	5	☐
3	How often do the functional departments communicate (using phone, email, fax etc.)?	1	2	3	4	5	☐
4	How often do functional departments exchange information about customers, competitors or general business environment?	1	2	3	4	5	☐
5	Do the functional departments follow collective goals?	1	2	3	4	5	☐
6	Do the functional departments amicably share organizational resources?	1	2	3	4	5	☐
7	Do the functional departments follow a common vision?	1	2	3	4	5	☐
8	How often does one or more of the functional departments hold joint meetings with the alliance partner(s)?	1	2	3	4	5	☐

9	How often does one or more of the functional departments communicate (using phone, email, fax etc.) with the alliance partner(s)?	1	2	3	4	5	☐
10	How often does one or more of the functional departments exchange information about customers, competitors or general business environment with the alliance partner(s)?	1	2	3	4	5	☐
11	Do you and your alliance partner(s) follow collective goals?	1	2	3	4	5	☐
12	Do you and your alliance partner(s) share a common vision?	1	2	3	4	5	☐

B. Technology Commercialization Performance

Technology Commercialization is a process through which economic value is extracted from knowledge through the production and sale of new or significantly improved goods or services.

In comparison to your industry standards, please answer the following questions on a scale of 1 (lower) to 5 (higher) by circling the appropriate number. Consider only those products which have stayed in the market for at least one year.

		Lower	Slightly Lower	Same	Slightly higher	Higher
1	Compared to your industry standards the number of new products you have introduced in last three years.	1	2	3	4	5
2	Compared to your industry standards the	1	2	3	4	5

	number of radically new products you have introduced in last three years.					
3	Compared to your industry standards the number of new services you have introduced in last three years.	1	2	3	4	5
4	Compared to your industry standards the number of patents you have filed in last three years.	1	2	3	4	5
5	Compared to your industry standards the number of new processes you have introduced in last three years.	1	2	3	4	5
6	Compared to your industry standards the time it takes for your company to develop a new product or service	1	2	3	4	5
7	Once your company has developed a new product or service then compared to your industry standards the time it takes on average to introduce the new product or service in the market.	1	2	3	4	5
8	Compared to your industry standards, on average, the ratio between sales achieved from the new product or service and the expenditure incurred to develop a new product or service.	1	2	3	4	5

C. Marketing Capability

Marketing capability has been defined as the integrative processes designed to apply the collective knowledge, skills, and resources of the company to the market-related needs of the business, enabling the business to add value to its goods and services and meet competitive demands.

Please indicate the importance of the following items in your organization. Rate each statement on a scale of 1 to 5 (**1 = Not important, 2 = somewhat important, 3 = important, 4 = very**

important and 5 = extremely important) by circling the appropriate number. If the statement is not applicable to your company, mark "√" in the given box.

		Not Important				Extremely Important	Not Applicable
1	Developing strong relationships with distributors	1	2	3	4	5	☐
2	Attracting and retaining the best distributors	1	2	3	4	5	☐
3	Providing high levels of service support to distributors	1	2	3	4	5	☐
4	Developing and executing advertising programs	1	2	3	4	5	☐
5	Managing brand image and processes	1	2	3	4	5	☐
6	Managing corporate image and reputation	1	2	3	4	5	☐
7	Gathering information about customers and competitors	1	2	3	4	5	☐
8	Using market research skills to develop effective marketing programs	1	2	3	4	5	☐
9	Tracking customer wants and needs	1	2	3	4	5	☐
10	Making full use of marketing research information	1	2	3	4	5	☐
11	Analyzing market information	1	2	3	4	5	☐
12	Marketing planning skills	1	2	3	4	5	☐

13	Developing marketing management skills and processes	1	2	3	4	5	☐
14	Recognizing the requirements of the customers	1	2	3	4	5	☐
15	Understanding the factors influencing customers choice	1	2	3	4	5	☐

D. R&D Capability

R&D capability is defined as the ability to identify technological needs, select technology to fulfill those needs, modify the selected technology to align with other technologies, and operate and maintain the acquired technology.

Please indicate the importance of the following items in your company. Rate each statement on a scale of 1 to 5 (**1 = Not important, 2 = somewhat important, 3 = important, 4 = very important and 5 = extremely important**) by circling the appropriate number. If the statement is not applicable to your company, mark "√" in the given box.

		Not Important				**Extremely Important**	**Not Applicable**
1	Mastering the operation of technology	1	2	3	4	5	☐
2	Mastering the maintenance of technology	1	2	3	4	5	☐
3	Mastering the repair of technology when breakdown occurs	1	2	3	4	5	☐
4	Mastering the maintenance of technology to produce consistently high quality products	1	2	3	4	5	☐
5	Mastering the identification of technological needs	1	2	3	4	5	☐

6	Mastering the selection of technology meeting the technological needs	1	2	3	4	5	☐
7	Mastering the modification of technology acquired from another company (e.g., process modification)	1	2	3	4	5	☐
8	Mastering the modification of technology in developing a product	1	2	3	4	5	☐
9	Mastering the development of a new product or process using new technology	1	2	3	4	5	☐
10	Mastering the co-development of a production process with the technology supplier	1	2	3	4	5	☐

E. Manufacturing Capability

Manufacturing capability is considered a multi-dimensional construct essentially having four dimensions that illustrate the manufacturing prowess of the firm. These dimensions are low manufacturing cost, manufacturing high quality products, efficient delivery and the flexibility to produce range of products.

Please indicate the importance of the following items in your company. Rate each statement on a scale of 1 to 5 (**1 = Not important, 2 = somewhat important, 3 = important, 4 = very important and 5 = extremely important**) by circling the appropriate number. If the statement is not applicable to your company, mark "√" in the given box.

		Not Important				Extremely Important	Not Applicable
1	Improve post-sales services (e.g. installation, warranty, repair etc.)	1	2	3	4	5	☐
2	Emphasis upon quality control	1	2	3	4	5	☐
3	Maintain product reliability	1	2	3	4	5	☐
4	Maintain due date delivery	1	2	3	4	5	☐
5	Reduce the manufacturing cost	1	2	3	4	5	☐
6	Reduce the waste of purchased material	1	2	3	4	5	☐
7	Reduce the inventory level	1	2	3	4	5	☐
8	Increase the variety of sizes	1	2	3	4	5	☐
10	Increase the variety of products	1	2	3	4	5	☐
11	Be responsive to customer requirements by improving existing products	1	2	3	4	5	☐

F. Organizational Resources Availability

Efficient and effective commercialization of technology requires various organizational resources to develop capabilities.

Please answer the following questions on a scale of 1(Never) to 5 (always) by circling the appropriate number.

		Never	Rarely	Sometimes	Often	Always
1	Are you always able to arrange the required financial capital to commercialize any new technology?	1	2	3	4	5
2	Do you face the shortage of highly skilled personnel with functional expertise (marketing, R&D and manufacturing) in your organization?	1	2	3	4	5
3	Do you feel the lack of physical facilities impede commercialization of new technology?	1	2	3	4	5

Other Comments:

We would highly appreciate any additional information or comments.

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APPENDIX 2: Cover Letter

«GreetingLine»

My name is Bhasker Mukerji and I am a PhD candidate at Eric Sprott School of Business, Carleton University in Ottawa, Canada. I am currently working on my thesis which focuses upon the role of organizational capabilities in technology commercialization performance. In the reports published in 2005 and 2006, the Conference Board of Canada and Industry Canada have expressed their concern that Canadian companies are not very successful in commercializing new technology by developing new products or processes. I am very much optimistic that the results of this study will help the Canadian companies to gain in-depth understanding of the impact of organizational capabilities. It will also be very useful for the government in making policies to boost commercialization.

I am writing this letter to kindly request you to participate in the study by completing the enclosed questionnaire and returning it in the prepaid envelope provided.

Your responses will be kept confidential and will not be disclosed to any outside parties. The questionnaire should take about 8 to 10 minutes to complete. I request you to respond to the questions frankly because your response will determine the success of this study.

There are no foreseen risks to the participants of this study. The research findings from this study will be presented in the final PhD thesis report and in a series of papers to be submitted to conferences and academic journals. The data will be aggregated and the research findings from this study will also be shared with the interested participants. The data will be stored both in hard copy (filled out questionnaires) and electronic copy (file with all the responses) with only the researcher having access to it. The data will not be destroyed and might be used for future analysis related to the topic of the present study.

Should you require additional information, please do not hesitate to contact me, Bhasker Mukerji at 613-520-2600x6327 or by email: bmukerji@connect.carleton.ca. You are also welcome to contact either of my supervisor(s) Prof. Vinod Kumar (vinod_kumar@carleton.ca), phone 613-520-2379 or Prof. Uma Kumar, phone 613-520-6601 (uma_kumar@carleton.ca) for further information. If you would like a summary of the results of this study, please provide your contact information in the space provided or attach your business card. This research project has been reviewed and approved by the Carleton University Research Ethics Committee. If you have any questions or concerns, please contact ethics@carleton.ca.

I thank you for taking the time to complete the questionnaire. Yours and your organization's support in my endeavor is greatly acknowledged. Thank you very much for your participation.

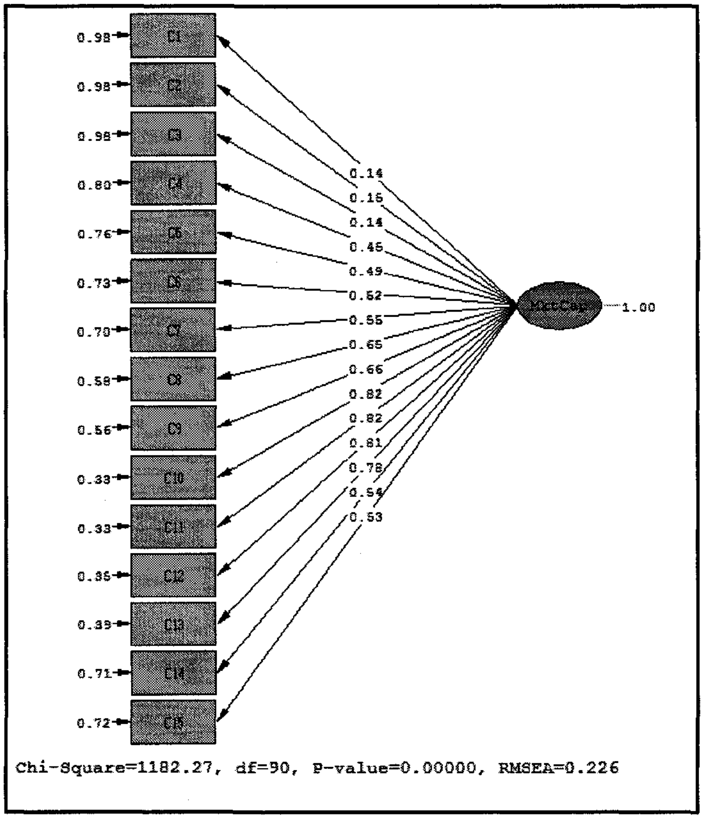
Sincerely,

Bhasker Mukerji

bmukerji@connect.carleton.ca

Eric Sprott School of Business

APPENDIX 3: Primary Marketing Capability Model



L I S R E L 8.72

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Karl G. Jöreskog & Dag Sörbom

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The following lines were read from file G:\Data Analysis\Mkt Capability\MktCap-CFA.SPJ:

Observed Variables
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10
C11 C12 C13 C14 C15
Correlation Matrix from file 'D:\Data Analysis\Mkt Capability\MktCap.txt'
Sample Size = 229
Latent Variables MktCap
Relationships
C1 = MktCap
C2 = MktCap
C3 = MktCap
C4 = MktCap
C5 = MktCap
C6 = MktCap
C7 = MktCap
C8 = MktCap
C9 = MktCap
C10 = MktCap
C11 = MktCap
C12 = MktCap
C13 = MktCap
C14 = MktCap
C15 = MktCap
Path Diagram
End of Problem

Sample Size =   229

Goodness of Fit Statistics

Degrees of Freedom = 90
Minimum Fit Function Chi-Square = 1342.57 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 1182.27 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 1092.27
90 Percent Confidence Interval for NCP = (985.01 ; 1206.96)

Minimum Fit Function Value = 5.66
Population Discrepancy Function Value (F0) = 4.61
90 Percent Confidence Interval for F0 = (4.16 ; 5.09)
Root Mean Square Error of Approximation (RMSEA) = 0.226
90 Percent Confidence Interval for RMSEA = (0.21 ; 0.24)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 5.24
90 Percent Confidence Interval for ECVI = (4.79 ; 5.73)
ECVI for Saturated Model = 1.01
ECVI for Independence Model = 15.78

Chi-Square for Independence Model with 105 Degrees of Freedom = 3709.16
Independence AIC = 3739.16
Model AIC = 1242.27
Saturated AIC = 240.00
Independence CAIC = 3806.25
Model CAIC = 1376.44
Saturated CAIC = 776.67

Normed Fit Index (NFI) = 0.64
Non-Normed Fit Index (NNFI) = 0.59
Parsimony Normed Fit Index (PNFI) = 0.55
Comparative Fit Index (CFI) = 0.65
Incremental Fit Index (IFI) = 0.65
Relative Fit Index (RFI) = 0.58

Critical N (CN) = 22.91

Root Mean Square Residual (RMR) = 0.17
Standardized RMR = 0.17
Goodness of Fit Index (GFI) = 0.60
Adjusted Goodness of Fit Index (AGFI) = 0.47
Parsimony Goodness of Fit Index (PGFI) = 0.45

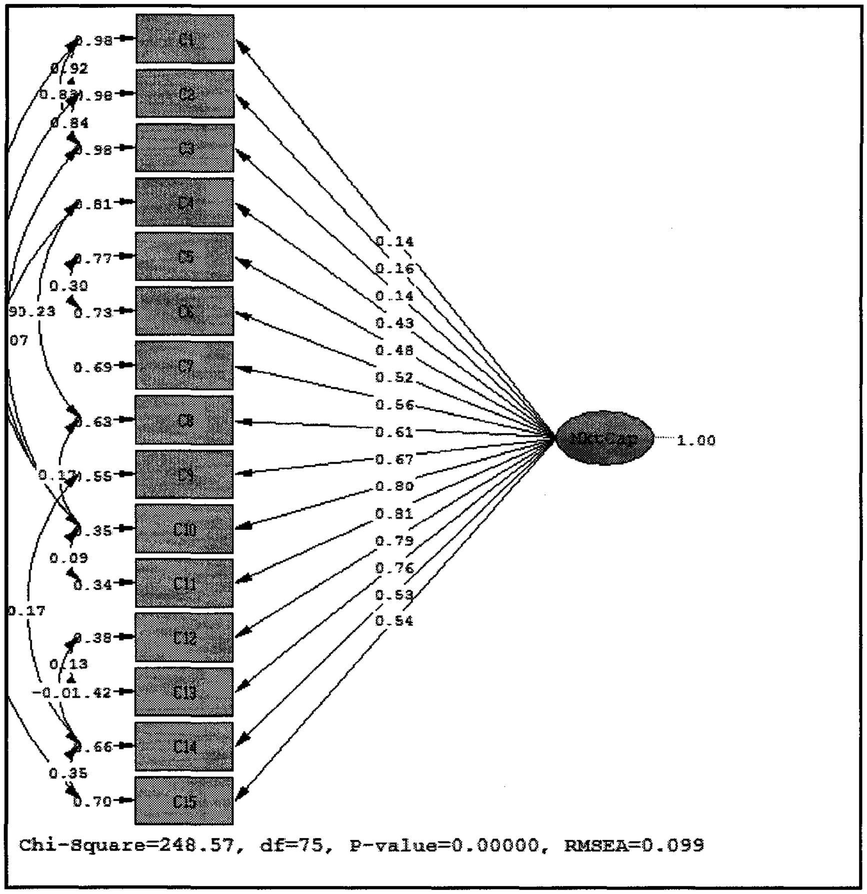
The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
C2	C1	208.8	0.92
C3	C1	171.9	0.84

C3	C2	174.0	0.84
C4	C1	11.9	0.20
C4	C2	8.7	0.17
C4	C3	10.6	0.19
C5	C1	8.0	0.16
C5	C3	11.3	0.19
C5	C4	24.1	0.26
C6	C2	10.8	0.18
C6	C5	38.5	0.31
C8	C4	25.7	0.24
C10	C1	16.3	-0.16
C10	C2	19.3	-0.18
C10	C3	18.1	-0.17
C10	C8	27.5	0.17
C11	C3	8.3	-0.12
C11	C5	10.3	-0.12
C11	C6	9.5	-0.11
C11	C10	22.8	0.13
C12	C9	17.4	-0.14
C13	C7	11.7	-0.13
C13	C10	9.7	-0.09
C13	C12	25.8	0.15
C14	C6	12.3	0.17
C14	C7	8.3	0.14
C14	C8	16.4	-0.18
C14	C9	45.2	0.29
C14	C12	14.0	-0.14
C15	C4	14.5	-0.19
C15	C7	8.4	0.14
C15	C8	10.3	-0.14
C15	C9	21.4	0.20
C15	C14	85.9	0.45

Time used: 0.094 Seconds

APPENDIX 4: Marketing Capability Model



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The following lines were read from file D:\Data Analysis\Mkt Capability\MktCap-CFA1.spj:
Observed Variables
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10
C11 C12 C13 C14 C15
Correlation Matrix from file 'D:\Data Analysis\Mkt Capability\MktCap.txt'
Sample Size = 229
Latent Variables MktCap
Relationships
C1 = MktCap
C2 = MktCap
C3 = MktCap
C4 = MktCap
C5 = MktCap
C6 = MktCap
C7 = MktCap
C8 = MktCap
C9 = MktCap
C10 = MktCap
C11 = MktCap
C12 = MktCap
C13 = MktCap
C14 = MktCap
C15 = MktCap
Set the error covariance C2 and C1 free
Set the error covariance C3 and C1 free
Set the error covariance C3 and C2 free
Set the error covariance C6 and C5 free
Set the error covariance C8 and C4 free
Set the error covariance C10 and C1 free
Set the error covariance C10 and C2 free
Set the error covariance C10 and C3 free
Set the error covariance C10 and C8 free
Set the error covariance C11 and C10 free
Set the error covariance C13 and C12 free
Set the error covariance C14 and C9 free
Set the error covariance C14 and C12 free
Set the error covariance C15 and C4 free
Set the error covariance C15 and C14 free
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 75
Minimum Fit Function Chi-Square = 239.81 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 248.57 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 173.57
90 Percent Confidence Interval for NCP = (129.53 ; 225.22)

Minimum Fit Function Value = 1.01
Population Discrepancy Function Value (F0) = 0.73
90 Percent Confidence Interval for F0 = (0.55 ; 0.95)
Root Mean Square Error of Approximation (RMSEA) = 0.099
90 Percent Confidence Interval for RMSEA = (0.085 ; 0.11)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 1.43
90 Percent Confidence Interval for ECVI = (1.24 ; 1.65)
ECVI for Saturated Model = 1.01
ECVI for Independence Model = 15.78

Chi-Square for Independence Model with 105 Degrees of Freedom = 3709.16
Independence AIC = 3739.16
Model AIC = 338.57
Saturated AIC = 240.00
Independence CAIC = 3806.25
Model CAIC = 539.83
Saturated CAIC = 776.67

Normed Fit Index (NFI) = 0.94
Non-Normed Fit Index (NNFI) = 0.94
Parsimony Normed Fit Index (PNFI) = 0.67
Comparative Fit Index (CFI) = 0.95
Incremental Fit Index (IFI) = 0.95
Relative Fit Index (RFI) = 0.91

Critical N (CN) = 106.15

Root Mean Square Residual (RMR) = 0.076
Standardized RMR = 0.076
Goodness of Fit Index (GFI) = 0.88
Adjusted Goodness of Fit Index (AGFI) = 0.80
Parsimony Goodness of Fit Index (PGFI) = 0.55

APPENDIX 5: Modified Marketing Capability Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\Mkt Capability\MktCap-CFA3.spj:

Observed Variables
C1 C2 C3 C4 C5 C6 C7 C8 C9 C10
C11 C12 C13 C14 C15
Correlation Matrix from file 'D:\Data Analysis\Mkt Capability\MktCap.txt'
Sample Size = 229
Latent Variables MktCap
Relationships
C8 = MktCap
C9 = MktCap
C10 = MktCap
C11 = MktCap
C12 = MktCap
C13 = MktCap

Set the error covariance C10 and C8 free
Set the error covariance C9 and C12 free
Set the error covariance C10 and C13 free
Path Diagram
End of Problem

Sample Size = 229

Correlation Matrix

	C8	C9	C10	C11	C12	C13
C8	1.00					
C9	0.34	1.00				
C10	0.66	0.54	1.00			
C11	0.50	0.53	0.75	1.00		
C12	0.53	0.43	0.68	0.70	1.00	
C13	0.52	0.51	0.58	0.66	0.73	1.00

Number of Iterations = 11
LISREL Estimates (Maximum Likelihood)
Measurement Equations
C8 = 0.61*MktCap, Errorvar.= 0.63 , R^2 = 0.37

(0.061) (0.062)
9.97 10.13
C9 = 0.63*MktCap, Errorvar.= 0.61 , R^2 = 0.39
(0.060) (0.059)
10.38 10.20
C10 = 0.85*MktCap, Errorvar.= 0.28 , R^2 = 0.72
(0.055) (0.038)
15.60 7.25
C11 = 0.84*MktCap, Errorvar.= 0.29 , R^2 = 0.71
(0.054) (0.034)
15.68 8.73
C12 = 0.83*MktCap, Errorvar.= 0.31 , R^2 = 0.69
(0.054) (0.036)
15.37 8.52
C13 = 0.83*MktCap, Errorvar.= 0.31 , R^2 = 0.69
(0.055) (0.039)
15.06 7.94

Error Covariance for C10 and C8 = 0.14
(0.038)
3.77
Error Covariance for C12 and C9 = -0.09
(0.033)
-2.79
Error Covariance for C13 and C10 = -0.12
(0.026)
-4.80
Correlation Matrix of Independent Variables
MktCap

1.00

Goodness of Fit Statistics

Degrees of Freedom = 6
Minimum Fit Function Chi-Square = 14.36 (P = 0.026)
Normal Theory Weighted Least Squares Chi-Square = 14.08 (P = 0.029)
Estimated Non-centrality Parameter (NCP) = 8.08
90 Percent Confidence Interval for NCP = (0.73 ; 23.07)
Minimum Fit Function Value = 0.061
Population Discrepancy Function Value (F0) = 0.034
90 Percent Confidence Interval for F0 = (0.0031 ; 0.097)
Root Mean Square Error of Approximation (RMSEA) = 0.075
90 Percent Confidence Interval for RMSEA = (0.023 ; 0.13)

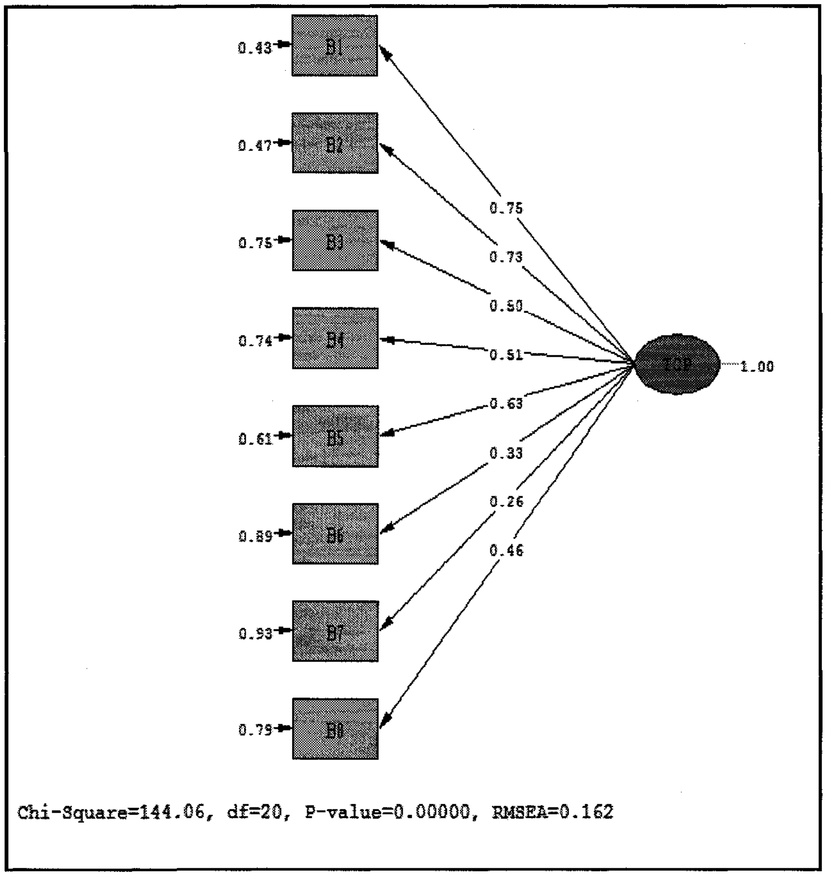
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.17
Expected Cross-Validation Index (ECVI) = 0.19
90 Percent Confidence Interval for ECVI = (0.15 ; 0.25)
ECVI for Saturated Model = 0.18
ECVI for Independence Model = 5.24
Chi-Square for Independence Model with 15 Degrees of Freedom = 1229.50
Independence AIC = 1241.50
Model AIC = 44.08
Saturated AIC = 42.00
Independence CAIC = 1268.34
Model CAIC = 111.16
Saturated CAIC = 135.92
Normed Fit Index (NFI) = 0.99
Non-Normed Fit Index (NNFI) = 0.98
Parsimony Normed Fit Index (PNFI) = 0.40
Comparative Fit Index (CFI) = 0.99
Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.97
Critical N (CN) = 278.50
Root Mean Square Residual (RMR) = 0.020
Standardized RMR = 0.020
Goodness of Fit Index (GFI) = 0.98
Adjusted Goodness of Fit Index (AGFI) = 0.93
Parsimony Goodness of Fit Index (PGFI) = 0.28

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
C11	C10	9.3	0.11
C12	C10	10.2	-0.11

Time used: 0.016 Seconds

APPENDIX 6: Initial Measurement Model of Technology Commercialization Performance



APPENDIX 7: LISREL Output: Initial TCP Measurement Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\TCP\TCP-CFA.SPJ:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8
Correlation Matrix from file 'D:\Data Analysis\TCP\TCP_Corr.txt'
Sample Size = 229
Latent Variables TCP
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
B6 = TCP
B7 = TCP
B8 = TCP
Path Diagram
End of Problem
Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 20
Minimum Fit Function Chi-Square = 141.41 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 144.06 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 124.06
90 Percent Confidence Interval for NCP = (89.65 ; 165.96)
Minimum Fit Function Value = 0.60
Population Discrepancy Function Value (F0) = 0.52
90 Percent Confidence Interval for F0 = (0.38 ; 0.70)
Root Mean Square Error of Approximation (RMSEA) = 0.16
90 Percent Confidence Interval for RMSEA = (0.14 ; 0.19)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00
Expected Cross-Validation Index (ECVI) = 0.74
90 Percent Confidence Interval for ECVI = (0.60 ; 0.92)
ECVI for Saturated Model = 0.30
ECVI for Independence Model = 2.86
Chi-Square for Independence Model with 28 Degrees of Freedom = 662.68
Independence AIC = 678.68

Model AIC = 176.06
Saturated AIC = 72.00
Independence CAIC = 714.45
Model CAIC = 247.62
Saturated CAIC = 233.00
Normed Fit Index (NFI) = 0.79
Non-Normed Fit Index (NNFI) = 0.73
Parsimony Normed Fit Index (PNFI) = 0.56
Comparative Fit Index (CFI) = 0.81
Incremental Fit Index (IFI) = 0.81
Relative Fit Index (RFI) = 0.70
Critical N (CN) = 63.96
Root Mean Square Residual (RMR) = 0.10
Standardized RMR = 0.10
Goodness of Fit Index (GFI) = 0.87
Adjusted Goodness of Fit Index (AGFI) = 0.76
Parsimony Goodness of Fit Index (PGFI) = 0.48

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
B2	B1	15.9	0.22
B5	B3	27.3	0.27
B7	B6	54.0	0.45
B8	B6	16.0	0.23
B8	B7	18.9	0.25

Time used: 0.000 Seconds

APPENDIX 8: LISREL Output: Modified TCP Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\TCP\TCP4.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8
Correlation Matrix from file 'D:\Data Analysis\TCP\TCP_Corr.txt'
Sample Size = 229
Latent Variables TCP
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
Set error covariance B2 and B1 free
Set error covariance B5 and B3 free
Path Diagram
End of Problem

Sample Size = 229

Correlation Matrix

	B1	B2	B3	B4	B5
B1	1.00				
B2	0.61	1.00			
B3	0.34	0.33	1.00		
B4	0.35	0.43	0.20	1.00	
B5	0.43	0.40	0.51	0.41	1.00

Number of Iterations = 7

LISREL Estimates (Maximum Likelihood)

Measurement Equations

B1 = 0.64*TCP, Errorvar.= 0.59 , R^2 = 0.41
(0.079) (0.087)
8.10 6.79

B2 = 0.67*TCP, Errorvar.= 0.55 , R^2 = 0.45
(0.078) (0.087)
8.57 6.31

B3 = 0.45*TCP, Errorvar.= 0.80 , R^2 = 0.20
(0.079) (0.085)
5.74 9.32

B4 = 0.60*TCP, Errorvar.= 0.64 , R^2 = 0.36
(0.073) (0.078)
8.23 8.14

B5 = 0.65*TCP, Errorvar.= 0.58 , R^2 = 0.42
(0.075) (0.082)
8.64 7.09

Error Covariance for B2 and B1 = 0.18
(0.073)
2.50

Error Covariance for B5 and B3 = 0.22
(0.065)
3.32

Correlation Matrix of Independent Variables

TCP

1.00

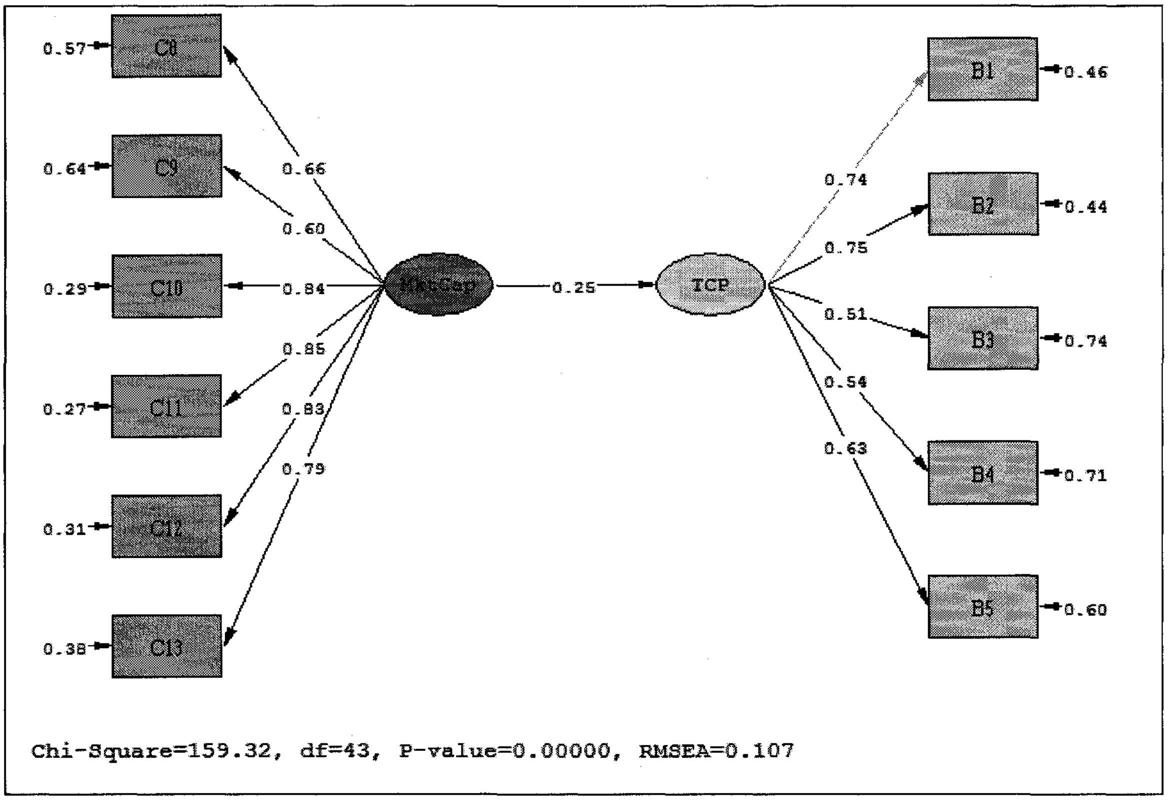
Goodness of Fit Statistics

Degrees of Freedom = 3
Minimum Fit Function Chi-Square = 8.53 (P = 0.036)
Normal Theory Weighted Least Squares Chi-Square = 8.37 (P = 0.039)

Estimated Non-centrality Parameter (NCP) = 5.37
90 Percent Confidence Interval for NCP = (0.22 ; 18.06)
Minimum Fit Function Value = 0.036
Population Discrepancy Function Value (F0) = 0.023
90 Percent Confidence Interval for F0 = (0.00091 ; 0.076)
Root Mean Square Error of Approximation (RMSEA) = 0.08
90 Percent Confidence Interval for RMSEA = (0.017 ; 0.16)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.15
Expected Cross-Validation Index (ECVI) = 0.14
90 Percent Confidence Interval for ECVI = (0.11 ; 0.19)
ECVI for Saturated Model = 0.13
ECVI for Independence Model = 1.76
Chi-Square for Independence Model with 10 Degrees of Freedom = 406.95
Independence AIC = 416.95
Model AIC = 32.37
Saturated AIC = 30.00
Independence CAIC = 439.31
Model CAIC = 86.03
Saturated CAIC = 97.08

Normed Fit Index (NFI) = 0.98
Non-Normed Fit Index (NNFI) = 0.95
Parsimony Normed Fit Index (PNFI) = 0.29
Comparative Fit Index (CFI) = 0.99
Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.93
Critical N (CN) = 316.20
Root Mean Square Residual (RMR) = 0.029
Standardized RMR = 0.029
Goodness of Fit Index (GFI) = 0.99
Adjusted Goodness of Fit Index (AGFI) = 0.93
Parsimony Goodness of Fit Index (PGFI) = 0.20

APPENDIX 9: Initial Marketing capability – TCP Model



L I S R E L 8.72

The following lines were read from file G:\Data Analysis\Mkt Capability\MktCap_TCP4_1.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 C1 C2
C3 C4 C5 C6 C7 C8 C9 C10 C11
C12 C13 C14 C15
Covariance Matrix from file 'D:\Data Analysis\Mkt Capability\MktCap_TCP.txt'
Sample Size = 229
Latent Variables MktCap TCP
Relationships

B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
C8 = MktCap
C9 = MktCap
C10 = MktCap
C11 = MktCap
C12 = MktCap
C13 = MktCap

TCP = MktCap
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 43
Minimum Fit Function Chi-Square = 159.30 (P = 0.00)
Normal Theory Weighted Least Squares Chi-Square = 159.32 (P = 0.00)
Estimated Non-centrality Parameter (NCP) = 116.32
90 Percent Confidence Interval for NCP = (81.43 ; 158.80)

Minimum Fit Function Value = 0.67
Population Discrepancy Function Value (F0) = 0.49
90 Percent Confidence Interval for F0 = (0.34 ; 0.67)
Root Mean Square Error of Approximation (RMSEA) = 0.107
90 Percent Confidence Interval for RMSEA = (0.089 ; 0.12)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 0.87
90 Percent Confidence Interval for ECVI = (0.72 ; 1.05)
ECVI for Saturated Model = 0.56
ECVI for Independence Model = 7.63

Chi-Square for Independence Model with 55 Degrees of Freedom = 1786.97
Independence AIC = 1808.97
Model AIC = 205.32

Saturated AIC = 132.00
Independence CAIC = 1858.17
Model CAIC = 308.19
Saturated CAIC = 427.17

Normed Fit Index (NFI) = 0.91
Non-Normed Fit Index (NNFI) = 0.91
Parsimony Normed Fit Index (PNFI) = 0.71
Comparative Fit Index (CFI) = 0.93
Incremental Fit Index (IFI) = 0.93
Relative Fit Index (RFI) = 0.89

Critical N (CN) = 101.36

Root Mean Square Residual (RMR) = 0.063
Standardized RMR = 0.063
Goodness of Fit Index (GFI) = 0.89
Adjusted Goodness of Fit Index (AGFI) = 0.83
Parsimony Goodness of Fit Index (PGFI) = 0.58

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
B2	B1	22.0	0.30
B5	B2	14.0	-0.21
B5	B3	27.0	0.27
C8	B2	8.5	-0.11
C10	C8	24.2	0.16
C11	C8	9.0	-0.10
C13	C10	25.8	-0.15
C13	C12	21.4	0.14

Time used: 0.125 Seconds

APPENDIX 10: Modified Marketing capability – TCP Model

The following lines were read from file G:\Data Analysis\Mkt Capability\MktCap_TCP4_2.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 C1 C2
C3 C4 C5 C6 C7 C8 C9 C10 C11
C12 C13 C14 C15
Covariance Matrix from file 'D:\Data Analysis\Mkt Capability\MktCap_TCP.txt'
Sample Size = 229
Latent Variables MktCap TCP
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
C8 = MktCap
C9 = MktCap
C10 = MktCap
C11 = MktCap
C12 = MktCap
C13 = MktCap
Set the error covariance B2 and B1
Set the error covariance B5 and B2
Set the error covariance B5 and B3
Set the error covariance C10 and C8
Set the error covariance C11 and C8
Set the error covariance C13 and C10
Set the error covariance C13 and C12
TCP = MktCap
Path Diagram
End of Problem

Sample Size =   229

Covariance Matrix

	B1	B2	B3	B4	B5	C8
B1	1.00					
B2	0.61	1.00				
B3	0.34	0.33	1.00			
B4	0.35	0.43	0.20	1.00		
B5	0.43	0.40	0.51	0.41	1.00	
C8	0.04	-0.07	0.11	-0.07	0.07	1.00
C9	0.12	0.11	0.12	0.10	0.10	0.34
C10	0.14	0.07	0.08	0.03	0.09	0.66
C11	0.13	0.14	0.15	0.17	0.16	0.50
C12	0.17	0.19	0.20	0.13	0.22	0.53
C13	0.19	0.19	0.19	0.22	0.27	0.52

Covariance Matrix

	C9	C10	C11	C12	C13
C9	1.00				
C10	0.54	1.00			
C11	0.53	0.75	1.00		
C12	0.43	0.68	0.70	1.00	
C13	0.51	0.58	0.66	0.73	1.00

Number of Iterations = 13

LISREL Estimates (Maximum Likelihood)

Measurement Equations

B1 = 0.62*TCP, Errorvar.= 0.61 , R^2 = 0.39
(0.083)
7.35

B2 = 0.72*TCP, Errorvar.= 0.48 , R^2 = 0.52
(0.090) (0.10)
8.04 4.72

B3 = 0.45*TCP, Errorvar.= 0.80 , R^2 = 0.20
(0.095) (0.084)
4.68 9.50

B4 = 0.59*TCP, Errorvar.= 0.65 , R^2 = 0.35
(0.097) (0.077)
6.05 8.49

B5 = 0.69*TCP, Errorvar.= 0.52 , R^2 = 0.48
(0.12) (0.088)
5.90 5.90

C8 = 0.63*MktCap, Errorvar.= 0.60 , R^2 = 0.40
(0.065) (0.066)
9.79 9.02

C9 = 0.62*MktCap, Errorvar.= 0.62 , R^2 = 0.38
(0.061) (0.061)
10.11 10.24

C10 = 0.86*MktCap, Errorvar.= 0.26 , R^2 = 0.74
(0.055) (0.039)
15.74 6.81

C11 = 0.86*MktCap, Errorvar.= 0.26 , R^2 = 0.74
(0.054) (0.036)
15.99 7.04

C12 = 0.80*MktCap, Errorvar.= 0.37 , R^2 = 0.63
(0.056) (0.043)
14.14 8.44

C13 = 0.79*MktCap, Errorvar.= 0.38 , R^2 = 0.62
(0.058) (0.050)
13.52 7.58

Error Covariance for B2 and B1 = 0.16
(0.075)
2.13

Error Covariance for B5 and B2 = -0.10
(0.053)
-1.88

Error Covariance for B5 and B3 = 0.20
(0.066)
2.98

Error Covariance for C10 and C8 = 0.12
(0.043)
2.75

Error Covariance for C11 and C8 = -0.05
(0.035)
-1.39

Error Covariance for C13 and C10 = -0.09
(0.027)
-3.39

Error Covariance for C13 and C12 = 0.095
(0.038)
2.49

Structural Equations

TCP = 0.25*MktCap, Errorvar.= 0.94 , R^2 = 0.064
(0.081) (0.23)
3.11 4.05

Correlation Matrix of Independent Variables

MktCap

1.00

Covariance Matrix of Latent Variables

	TCP	MktCap
	--------	--------
TCP	1.00	
MktCap	0.25	1.00

Goodness of Fit Statistics

Degrees of Freedom = 36
Minimum Fit Function Chi-Square = 66.03 (P = 0.0017)
Normal Theory Weighted Least Squares Chi-Square = 63.43 (P = 0.0032)
Estimated Non-centrality Parameter (NCP) = 27.43
90 Percent Confidence Interval for NCP = (9.08 ; 53.62)

Minimum Fit Function Value = 0.28
Population Discrepancy Function Value (F0) = 0.12
90 Percent Confidence Interval for F0 = (0.038 ; 0.23)
Root Mean Square Error of Approximation (RMSEA) = 0.057
90 Percent Confidence Interval for RMSEA = (0.033 ; 0.079)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.30

Expected Cross-Validation Index (ECVI) = 0.52
90 Percent Confidence Interval for ECVI = (0.44 ; 0.63)
ECVI for Saturated Model = 0.56
ECVI for Independence Model = 7.63

Chi-Square for Independence Model with 55 Degrees of Freedom = 1786.97
Independence AIC = 1808.97
Model AIC = 123.43
Saturated AIC = 132.00
Independence CAIC = 1858.17
Model CAIC = 257.59
Saturated CAIC = 427.17

Normed Fit Index (NFI) = 0.96
Non-Normed Fit Index (NNFI) = 0.97

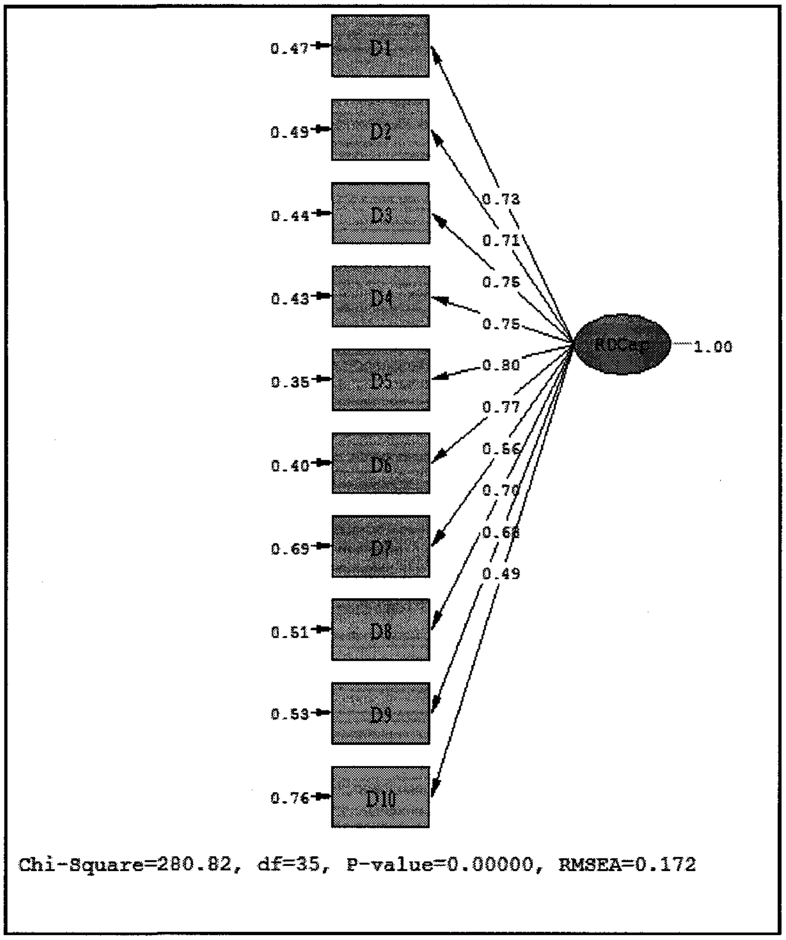
Parsimony Normed Fit Index (PNFI) = 0.63
Comparative Fit Index (CFI) = 0.98
Incremental Fit Index (IFI) = 0.98
Relative Fit Index (RFI) = 0.94

Critical N (CN) = 211.40

Root Mean Square Residual (RMR) = 0.052
Standardized RMR = 0.052
Goodness of Fit Index (GFI) = 0.95
Adjusted Goodness of Fit Index (AGFI) = 0.91
Parsimony Goodness of Fit Index (PGFI) = 0.52

Time used: 0.125 Seconds

APPENDIX 11: Initial Measurement Model of R&D Capability



L I S R E L 8.72

The following lines were read from file D:\Data Analysis\R&D Capability\RD_Cap_test.spj:

Observed Variables
D1 D2 D3 D4 D5 D6 D7 D8 D9 D10
Correlation Matrix from file 'D:\Data Analysis\R&D Capability\RD_Cap_Corr.txt'
Sample Size = 229
Latent Variables RDCap

Relationships
D1 = RDCap
D2 = RDCap
D3 = RDCap
D4 = RDCap
D5 = RDCap
D6 = RDCap
D7 = RDCap
D8 = RDCap
D9 = RDCap
D10 = RDCap
Path Diagram
End of Problem
Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 35
Minimum Fit Function Chi-Square = 303.38 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 280.82 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 245.82
90 Percent Confidence Interval for NCP = (196.12 ; 302.99)

Minimum Fit Function Value = 1.28
Population Discrepancy Function Value (F0) = 1.04
90 Percent Confidence Interval for F0 = (0.83 ; 1.28)
Root Mean Square Error of Approximation (RMSEA) = 0.17
90 Percent Confidence Interval for RMSEA = (0.15 ; 0.19)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00
Expected Cross-Validation Index (ECVI) = 1.35
90 Percent Confidence Interval for ECVI = (1.14 ; 1.59)
ECVI for Saturated Model = 0.46
ECVI for Independence Model = 11.24
Chi-Square for Independence Model with 45 Degrees of Freedom = 2643.60
Independence AIC = 2663.60
Model AIC = 320.82
Saturated AIC = 110.00
Independence CAIC = 2708.32
Model CAIC = 410.26
Saturated CAIC = 355.97
Normed Fit Index (NFI) = 0.89
Non-Normed Fit Index (NNFI) = 0.87
Parsimony Normed Fit Index (PNFI) = 0.69
Comparative Fit Index (CFI) = 0.90
Incremental Fit Index (IFI) = 0.90

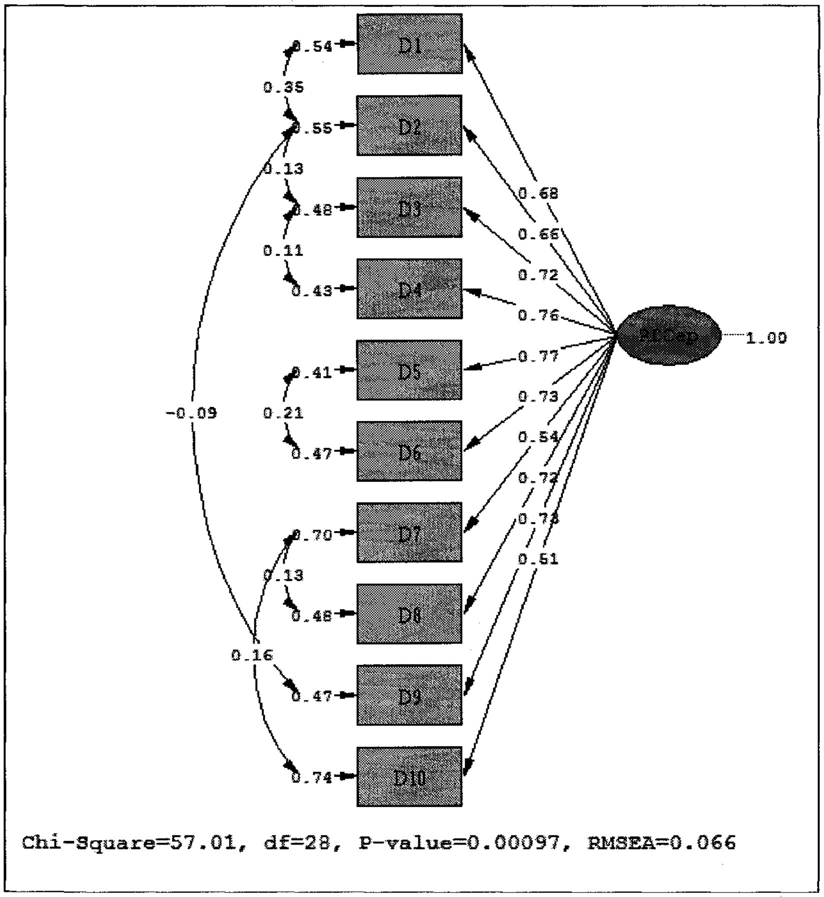
Relative Fit Index (RFI) = 0.85
Critical N (CN) = 45.80
Root Mean Square Residual (RMR) = 0.073
Standardized RMR = 0.073
Goodness of Fit Index (GFI) = 0.81
Adjusted Goodness of Fit Index (AGFI) = 0.70
Parsimony Goodness of Fit Index (PGFI) = 0.51

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
D2	D1	106.5	0.37
D3	D2	16.1	0.14
D4	D3	17.7	0.14
D5	D2	8.0	-0.09
D5	D3	23.0	-0.15
D6	D2	8.4	-0.10
D6	D5	57.6	0.23
D8	D1	14.0	-0.13
D8	D7	17.4	0.17
D9	D2	9.7	-0.12
D9	D8	8.7	0.11
D10	D1	14.6	-0.16
D10	D7	16.5	0.20

Time used: 0.031 Seconds

APPENDIX 12: Modified Model of R&D Capability



L I S R E L 8.72

The following lines were read from file D:\Data Analysis\R&D Capability\RD_Cap1.SPJ:

Observed Variables
D1 D2 D3 D4 D5 D6 D7 D8 D9 D10
Correlation Matrix from file 'D:\Data Analysis\R&D Capability\RD_Cap_Corr.txt'
Sample Size = 229
Latent Variables RDCap
Relationships
D1 = RDCap

D2 = RDCap
D3 = RDCap
D4 = RDCap
D5 = RDCap
D6 = RDCap
D7 = RDCap
D8 = RDCap
D9 = RDCap
D10 = RDCap
Set the Error Covariance D2 to D1 Free
Set the Error Covariance D6 to D5 Free
Set the Error Covariance D3 to D2 Free
Set the Error Covariance D9 to D2 Free
Set the Error Covariance D4 to D3 Free
Set the Error Covariance D8 to D7 Free
Set the Error Covariance D10 to D7 Free
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 28
Minimum Fit Function Chi-Square = 59.07 (P = 0.00054)
Normal Theory Weighted Least Squares Chi-Square = 57.01 (P = 0.00097)
Estimated Non-centrality Parameter (NCP) = 29.01
90 Percent Confidence Interval for NCP = (11.22 ; 54.57)
Minimum Fit Function Value = 0.25
Population Discrepancy Function Value (F0) = 0.12
90 Percent Confidence Interval for F0 = (0.047 ; 0.23)
Root Mean Square Error of Approximation (RMSEA) = 0.066
90 Percent Confidence Interval for RMSEA = (0.041 ; 0.091)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.13
Expected Cross-Validation Index (ECVI) = 0.47
90 Percent Confidence Interval for ECVI = (0.39 ; 0.58)
ECVI for Saturated Model = 0.46
ECVI for Independence Model = 11.24
Chi-Square for Independence Model with 45 Degrees of Freedom = 2643.60
Independence AIC = 2663.60
Model AIC = 111.01
Saturated AIC = 110.00
Independence CAIC = 2708.32
Model CAIC = 231.76
Saturated CAIC = 355.97

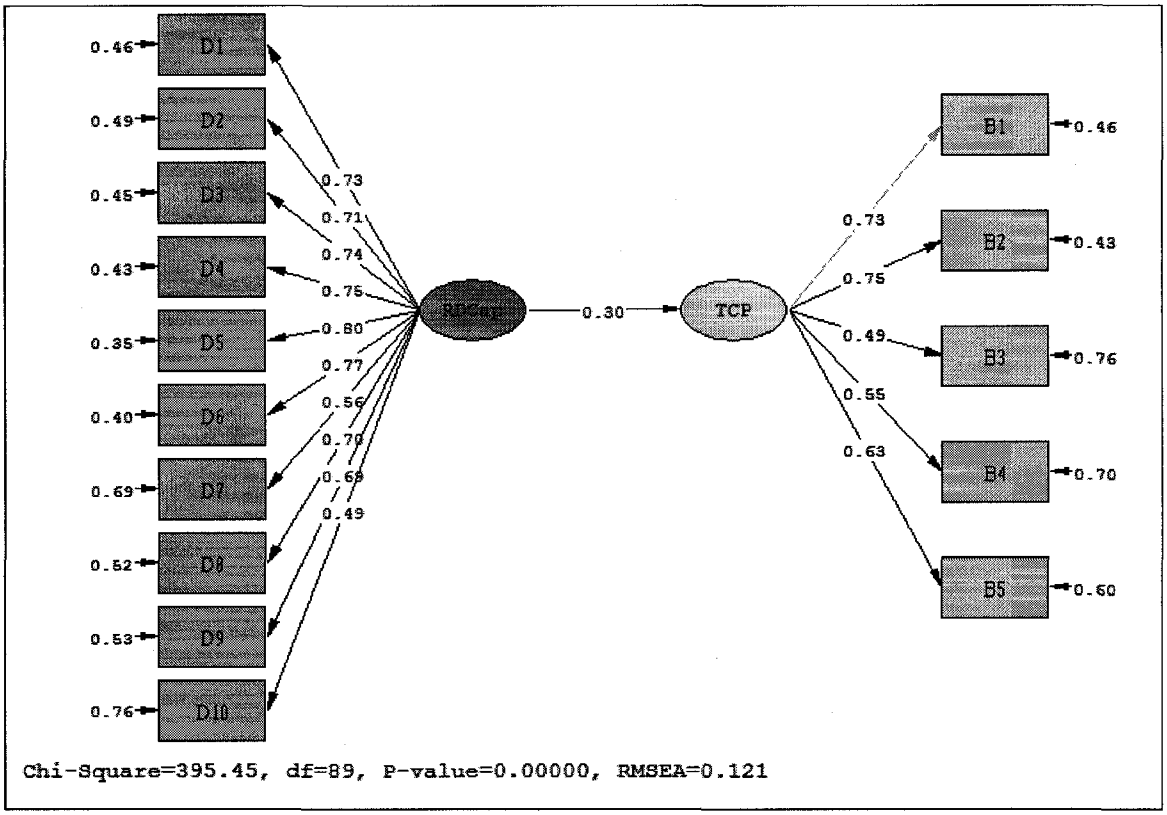
Normed Fit Index (NFI) = 0.98
Non-Normed Fit Index (NNFI) = 0.98
Parsimony Normed Fit Index (PNFI) = 0.61
Comparative Fit Index (CFI) = 0.99
Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.96
Critical N (CN) = 194.72
Root Mean Square Residual (RMR) = 0.035
Standardized RMR = 0.035
Goodness of Fit Index (GFI) = 0.95
Adjusted Goodness of Fit Index (AGFI) = 0.91
Parsimony Goodness of Fit Index (PGFI) = 0.49

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
D10	D1	7.9	-0.09

Time used: 0.031 Seconds

APPENDIX 13: Initial TCP – R&D Capability Model



L I S R E L 8.72

The following lines were read from file E:\Data Analysis\R&D Capability\RD_Cap2_SEM_0.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 D1 D2
D3 D4 D5 D6 D7 D8 D9 D10
Correlation Matrix from file 'E:\Data Analysis\R&D Capability\RDCap_TCP.txt'
Sample Size = 229
Latent Variables TCP RDCap
Relationships
B1 = TCP
B2 = TCP

B3 = TCP
B4 = TCP
B5 = TCP
D1 = RDCap
D2 = RDCap
D3 = RDCap
D4 = RDCap
D5 = RDCap
D6 = RDCap
D7 = RDCap
D8 = RDCap
D9 = RDCap
D10 = RDCap
TCP = RDCap
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 89
Minimum Fit Function Chi-Square = 413.53 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 395.45 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 306.45
90 Percent Confidence Interval for NCP = (248.55 ; 371.89)

Minimum Fit Function Value = 1.74
Population Discrepancy Function Value (F0) = 1.29
90 Percent Confidence Interval for F0 = (1.05 ; 1.57)
Root Mean Square Error of Approximation (RMSEA) = 0.121
90 Percent Confidence Interval for RMSEA = (0.11 ; 0.13)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 1.93
90 Percent Confidence Interval for ECVI = (1.69 ; 2.21)
ECVI for Saturated Model = 1.01
ECVI for Independence Model = 14.17

Chi-Square for Independence Model with 105 Degrees of Freedom = 3327.96

Independence AIC = 3357.96
Model AIC = 457.45
Saturated AIC = 240.00
Independence CAIC = 3425.04
Model CAIC = 596.09
Saturated CAIC = 776.67

Normed Fit Index (NFI) = 0.88
Non-Normed Fit Index (NNFI) = 0.88
Parsimony Normed Fit Index (PNFI) = 0.74
Comparative Fit Index (CFI) = 0.90
Incremental Fit Index (IFI) = 0.90
Relative Fit Index (RFI) = 0.85

Critical N (CN) = 71.46

Root Mean Square Residual (RMR) = 0.071
Standardized RMR = 0.071
Goodness of Fit Index (GFI) = 0.82
Adjusted Goodness of Fit Index (AGFI) = 0.75
Parsimony Goodness of Fit Index (PGFI) = 0.61

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
B2	B1	21.7	0.29
B5	B2	16.1	-0.22
B5	B3	28.4	0.28
D2	D1	106.2	0.36
D3	D2	16.6	0.14
D4	D3	18.4	0.14
D5	D3	22.0	-0.15
D6	D2	8.4	-0.10
D6	D5	56.9	0.23
D7	B2	9.1	-0.13
D8	B5	8.9	0.12
D8	D1	14.1	-0.13
D8	D7	17.5	0.17
D9	D2	10.1	-0.12
D9	D8	8.4	0.11
D10	D1	14.9	-0.16

D10	D7	16.6	0.20

Time used: 0.250 Seconds

APPENDIX 14: Modified TCP – R&D Capability Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\R&D Capability\RD_Cap2_SEM.spj:

```
SYSTEM FILE from file 'D:\Data Analysis\R&D Capability\RD_Cap2_SEM.DSF'
Sample Size = 229
Latent Variables  TCP RDCap
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
D1 = RDCap
D2 = RDCap
D3 = RDCap
D4 = RDCap
D5 = RDCap
D6 = RDCap
D7 = RDCap
D8 = RDCap
D9 = RDCap
D10 = RDCap
Set the error covariance B2 and B1 free
Set the error covariance B5 and B2 free
Set the error covariance B5 and B3 free
Set the error covariance D2 and D1 free
Set the error covariance D3 and D2 free
Set the error covariance D4 and D3 free
Set the error covariance D5 and D3 free
Set the error covariance D6 and D5 free
Set the error covariance D8 and D1 free
Set the error covariance D8 and D7 free
Set the error covariance D9 and D2 free
Set the error covariance D10 and D1 free
Set the error covariance D10 and D7 free

TCP = RDCap
Set the Variance of RDCap to 1.00
Path Diagram
```

End of Problem

Sample Size = 229

Covariance Matrix

	B1	B2	B3	B4	B5	D1
B1	1.00					
B2	0.61	1.00				
B3	0.34	0.33	1.00			
B4	0.35	0.43	0.20	1.00		
B5	0.43	0.40	0.51	0.41	1.00	
D1	0.16	0.22	0.08	0.25	0.21	1.00
D2	0.09	0.12	0.03	0.19	0.15	0.80
D3	0.06	0.12	0.01	0.11	0.17	0.53
D4	0.14	0.16	-0.03	0.16	0.13	0.49
D5	0.16	0.20	0.06	0.17	0.14	0.60
D6	0.13	0.23	0.09	0.18	0.19	0.55
D7	0.08	0.03	0.14	0.14	0.21	0.32
D8	0.07	0.06	0.00	0.17	0.24	0.40
D9	0.21	0.23	0.03	0.28	0.27	0.50
D10	0.11	0.08	0.01	0.11	0.15	0.22

Covariance Matrix

	D2	D3	D4	D5	D6	D7
D2	1.00					
D3	0.64	1.00				
D4	0.51	0.67	1.00			
D5	0.51	0.50	0.59	1.00		
D6	0.48	0.54	0.56	0.77	1.00	
D7	0.37	0.41	0.36	0.47	0.42	1.00
D8	0.43	0.51	0.55	0.55	0.52	0.54
D9	0.39	0.52	0.54	0.53	0.50	0.36
D10	0.28	0.37	0.40	0.38	0.34	0.46

Covariance Matrix

	D8	D9	D10
D8	1.00		
D9	0.57	1.00	
D10	0.45	0.41	1.00

```
Number of Iterations = 22
LISREL Estimates (Maximum Likelihood)
Measurement Equations
   B1 = 0.60*TCP, Errorvar.= 0.64 , R² = 0.36
                 (0.081)
                  7.86
   B2 = 0.72*TCP, Errorvar.= 0.47 , R² = 0.53
     (0.090)       (0.098)
      8.01          4.84
   B3 = 0.42*TCP, Errorvar.= 0.83 , R² = 0.17
     (0.093)       (0.085)
      4.48          9.75
   B4 = 0.60*TCP, Errorvar.= 0.64 , R² = 0.36
     (0.098)       (0.076)
      6.10          8.48
   B5 = 0.71*TCP, Errorvar.= 0.50 , R² = 0.50
     (0.12)        (0.086)
      6.00          5.82
   D1 = 0.71*RDCap, Errorvar.= 0.48 , R² = 0.51
     (0.059)         (0.052)
      12.09           9.13
   D2 = 0.65*RDCap, Errorvar.= 0.57 , R² = 0.42
     (0.061)         (0.056)
      10.59           10.13
   D3 = 0.73*RDCap, Errorvar.= 0.46 , R² = 0.54
     (0.058)         (0.050)
      12.44           9.17
   D4 = 0.74*RDCap, Errorvar.= 0.45 , R² = 0.55
     (0.058)         (0.049)
      12.72           9.12
   D5 = 0.78*RDCap, Errorvar.= 0.39 , R² = 0.61
     (0.057)         (0.046)
      13.71           8.48
   D6 = 0.73*RDCap, Errorvar.= 0.47 , R² = 0.53
     (0.059)         (0.051)
      12.46           9.20
   D7 = 0.54*RDCap, Errorvar.= 0.71 , R² = 0.29
     (0.064)         (0.069)
      8.43            10.29
   D8 = 0.73*RDCap, Errorvar.= 0.47 , R² = 0.53
     (0.059)         (0.051)
      12.40           9.17
   D9 = 0.73*RDCap, Errorvar.= 0.47 , R² = 0.53
     (0.058)         (0.050)
```

12.44 9.45

D10 = 0.52*RDCap, Errorvar.= 0.72 , R^2 = 0.27

(0.064) (0.070)

8.19 10.33

Error Covariance for B2 and B1 = 0.17

(0.073)

2.39

Error Covariance for B5 and B2 = -0.11

(0.052)

-2.20

Error Covariance for B5 and B3 = 0.22

(0.065)

3.29

Error Covariance for D2 and D1 = 0.32

(0.045)

7.00

Error Covariance for D3 and D2 = 0.14

(0.029)

4.96

Error Covariance for D4 and D3 = 0.11

(0.036)

2.95

Error Covariance for D5 and D3 = -0.06

(0.025)

-2.61

Error Covariance for D6 and D5 = 0.20

(0.040)

5.05

Error Covariance for D8 and D1 = -0.08

(0.026)

-3.00

Error Covariance for D8 and D7 = 0.12

(0.042)

2.87

Error Covariance for D9 and D2 = -0.07

(0.028)

-2.54

Error Covariance for D10 and D1 = -0.09

(0.031)

-3.02

Error Covariance for D10 and D7 = 0.14

(0.048)

2.98

Structural Equations

TCP = 0.36*RDCap, Errorvar.= 0.87 , R^2 = 0.13

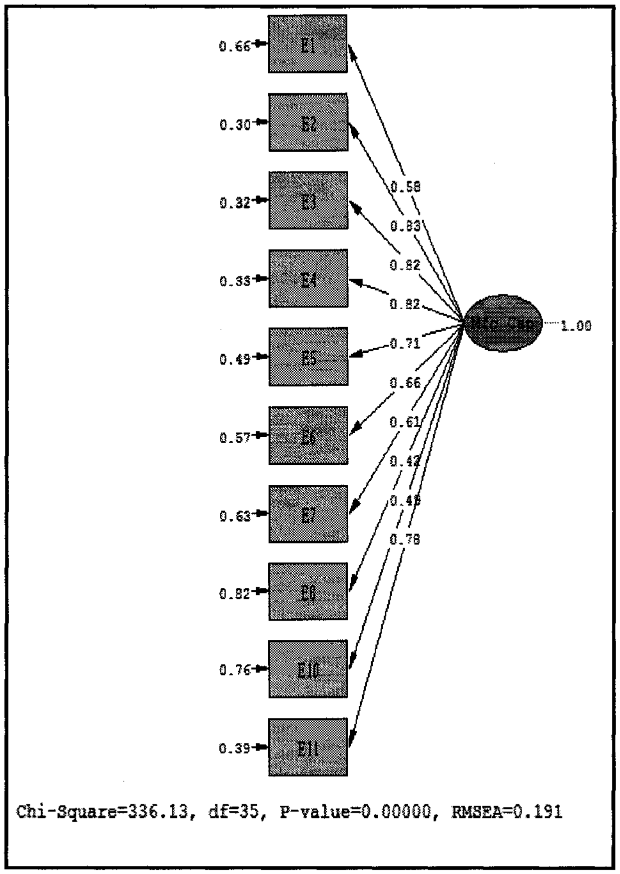
```
      (0.086)        (0.22)
       4.15           3.94
Correlation Matrix of Independent Variables
         RDCap
      --------
         1.00
      Covariance Matrix of Latent Variables
            TCP     RDCap
      --------  --------
   TCP      1.00
 RDCap      0.36      1.00
```

Goodness of Fit Statistics

Degrees of Freedom = 76
Minimum Fit Function Chi-Square = 102.88 (P = 0.022)
Normal Theory Weighted Least Squares Chi-Square = 100.46 (P = 0.032)
Estimated Non-centrality Parameter (NCP) = 24.46
90 Percent Confidence Interval for NCP = (2.44 ; 54.58)
Minimum Fit Function Value = 0.43
Population Discrepancy Function Value (F0) = 0.10
90 Percent Confidence Interval for F0 = (0.010 ; 0.23)
Root Mean Square Error of Approximation (RMSEA) = 0.037
90 Percent Confidence Interval for RMSEA = (0.012 ; 0.055)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.87
Expected Cross-Validation Index (ECVI) = 0.80
90 Percent Confidence Interval for ECVI = (0.70 ; 0.92)
ECVI for Saturated Model = 1.01
ECVI for Independence Model = 14.17
Chi-Square for Independence Model with 105 Degrees of Freedom = 3327.96
Independence AIC = 3357.96
Model AIC = 188.46
Saturated AIC = 240.00
Independence CAIC = 3425.04
Model CAIC = 385.24
Saturated CAIC = 776.67
Normed Fit Index (NFI) = 0.97
Non-Normed Fit Index (NNFI) = 0.99
Parsimony Normed Fit Index (PNFI) = 0.70
Comparative Fit Index (CFI) = 0.99
Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.96
Critical N (CN) = 248.83
Root Mean Square Residual (RMR) = 0.044

Standardized RMR = 0.045
Goodness of Fit Index (GFI) = 0.95
Adjusted Goodness of Fit Index (AGFI) = 0.92
Parsimony Goodness of Fit Index (PGFI) = 0.60

APPENDIX 15: Initial Manufacturing Capability Measurement Model



L I S R E L 8.72

The following lines were read from file D:\Data Analysis\Mfg Capability\Mfg_CFA_New.SPJ:

Observed Variables
E1 E2 E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Mfg Capability\Mfg_Corr.txt'
Sample Size = 229
Latent Variables 'Mfg Cap'
Relationships
E1 = 'Mfg Cap'
E2 = 'Mfg Cap'
E3 = 'Mfg Cap'

E4 = 'Mfg Cap'
E5 = 'Mfg Cap'
E6 = 'Mfg Cap'
E7 = 'Mfg Cap'
E8 = 'Mfg Cap'
E10 = 'Mfg Cap'
E11 = 'Mfg Cap'
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 35
Minimum Fit Function Chi-Square = 276.25 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 336.13 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 301.13
90 Percent Confidence Interval for NCP = (246.09 ; 363.63)
Minimum Fit Function Value = 1.17
Population Discrepancy Function Value (F0) = 1.27
90 Percent Confidence Interval for F0 = (1.04 ; 1.53)
Root Mean Square Error of Approximation (RMSEA) = 0.19
90 Percent Confidence Interval for RMSEA = (0.17 ; 0.21)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00
Expected Cross-Validation Index (ECVI) = 1.59
90 Percent Confidence Interval for ECVI = (1.35 ; 1.85)
ECVI for Saturated Model = 0.46
ECVI for Independence Model = 10.56
Chi-Square for Independence Model with 45 Degrees of Freedom = 2483.88
Independence AIC = 2503.88
Model AIC = 376.13
Saturated AIC = 110.00
Independence CAIC = 2548.60
Model CAIC = 465.58
Saturated CAIC = 355.97
Normed Fit Index (NFI) = 0.89
Non-Normed Fit Index (NNFI) = 0.87
Parsimony Normed Fit Index (PNFI) = 0.69
Comparative Fit Index (CFI) = 0.90
Incremental Fit Index (IFI) = 0.90
Relative Fit Index (RFI) = 0.86
Critical N (CN) = 50.19
Root Mean Square Residual (RMR) = 0.091
Standardized RMR = 0.091

Goodness of Fit Index (GFI) = 0.78
Adjusted Goodness of Fit Index (AGFI) = 0.65
Parsimony Goodness of Fit Index (PGFI) = 0.50

APPENDIX 16: Modified Manufacturing Capability Measurement Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\Mfg Capability\Mfg_CFA_New1.spj:

Observed Variables
E1 E2 E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Mfg Capability\Mfg_Corr.txt'
Sample Size = 229
Latent Variables 'Mfg Cap'
Relationships
E1 = 'Mfg Cap'
E2 = 'Mfg Cap'
E3 = 'Mfg Cap'
E4 = 'Mfg Cap'
E5 = 'Mfg Cap'
E6 = 'Mfg Cap'
E7 = 'Mfg Cap'
E11 = 'Mfg Cap'
Set the error covariance E3 and E2 free
Set the error covariance E6 and E3 free
Set the error covariance E6 and E5 free
Set the error covariance E7 and E6 free
Set the error covariance E7 and E5 free
Path Diagram
End of Problem

Sample Size = 229
Correlation Matrix

	E1	E2	E3	E4	E5	E6
E1	1.00					
E2	0.53	1.00				
E3	0.56	0.79	1.00			
E4	0.43	0.70	0.68	1.00		
E5	0.34	0.57	0.54	0.57	1.00	
E6	0.29	0.45	0.41	0.55	0.63	1.00
E7	0.30	0.42	0.39	0.46	0.62	0.72
E11	0.47	0.65	0.64	0.66	0.51	0.51

Correlation Matrix

	E7	E11

```
        --------  --------
     E7      1.00
    E11      0.43      1.00
Number of Iterations = 8
LISREL Estimates (Maximum Likelihood)
Measurement Equations
     E1 = 0.59*Mfg Cap, Errorvar.= 0.65  , R² = 0.35
        (0.062)              (0.064)
         9.51                10.24
      E2 = 0.84*Mfg Cap, Errorvar.= 0.30  , R² = 0.70
        (0.055)              (0.040)
         15.22                7.36
      E3 = 0.83*Mfg Cap, Errorvar.= 0.31  , R² = 0.69
        (0.056)              (0.041)
         14.93                7.47
      E4 = 0.83*Mfg Cap, Errorvar.= 0.31  , R² = 0.69
        (0.055)              (0.039)
         15.17                7.95
      E5 = 0.66*Mfg Cap, Errorvar.= 0.56  , R² = 0.44
        (0.060)              (0.057)
         11.01                9.89
      E6 = 0.60*Mfg Cap, Errorvar.= 0.64  , R² = 0.36
        (0.062)              (0.064)
         9.61                10.05
      E7 = 0.52*Mfg Cap, Errorvar.= 0.73  , R² = 0.27
        (0.064)              (0.070)
         8.15                10.40
     E11 = 0.79*Mfg Cap, Errorvar.= 0.38  , R² = 0.62
        (0.056)              (0.043)
         13.95                8.84
 Error Covariance for E3 and E2 = 0.088
                          (0.033)
                           2.69

 Error Covariance for E6 and E3 = -0.05
                          (0.024)
                           -2.05
 Error Covariance for E6 and E5 = 0.23
                          (0.047)
                           4.99
 Error Covariance for E7 and E5 = 0.28
                          (0.049)
                           5.61
 Error Covariance for E7 and E6 = 0.40
                          (0.056)
```

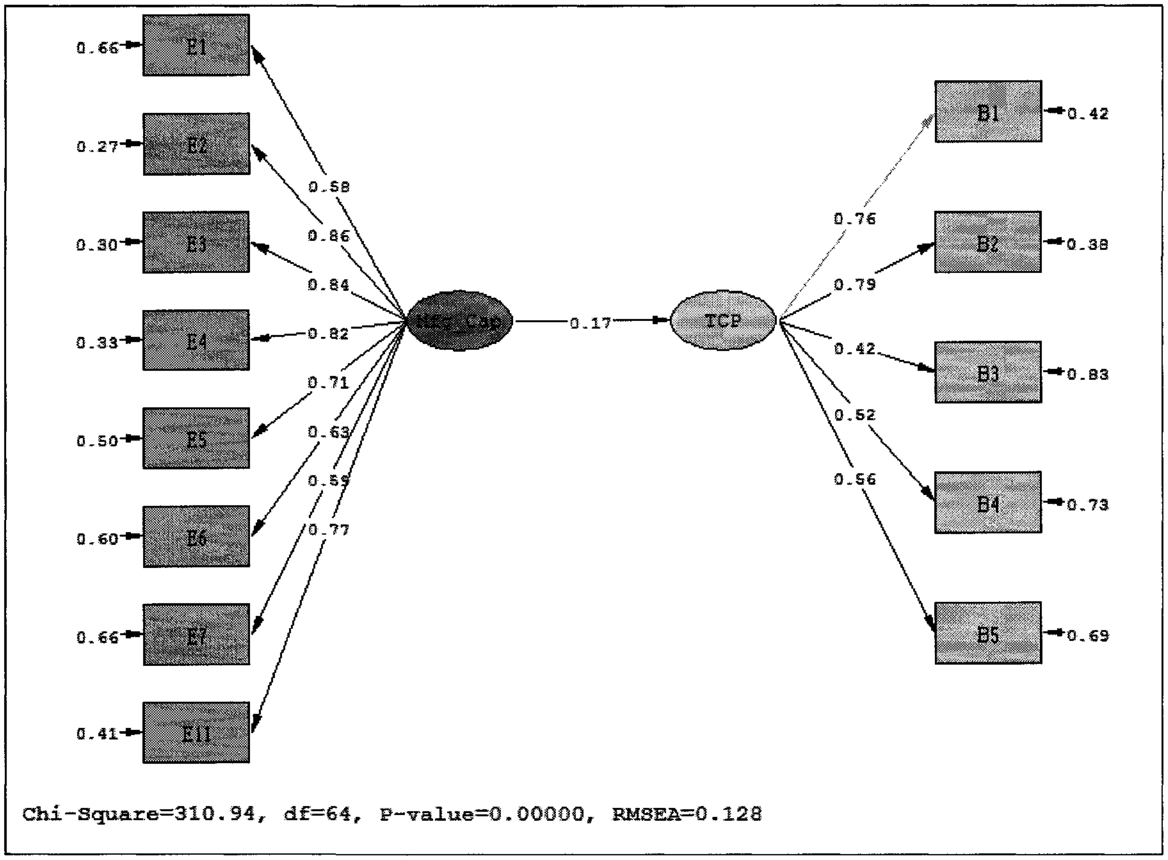
7.27
Correlation Matrix of Independent Variables

Mfg Cap
1.00

Goodness of Fit Statistics

Degrees of Freedom = 15
Minimum Fit Function Chi-Square = 26.23 (P = 0.036)
Normal Theory Weighted Least Squares Chi-Square = 26.94 (P = 0.029)
Estimated Non-centrality Parameter (NCP) = 11.94
90 Percent Confidence Interval for NCP = (1.18 ; 30.50)
Minimum Fit Function Value = 0.11
Population Discrepancy Function Value (F0) = 0.050
90 Percent Confidence Interval for F0 = (0.0050 ; 0.13)
Root Mean Square Error of Approximation (RMSEA) = 0.058
90 Percent Confidence Interval for RMSEA = (0.018 ; 0.093)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.32
Expected Cross-Validation Index (ECVI) = 0.29
90 Percent Confidence Interval for ECVI = (0.25 ; 0.37)
ECVI for Saturated Model = 0.30
ECVI for Independence Model = 8.36
Chi-Square for Independence Model with 28 Degrees of Freedom = 1965.58
Independence AIC = 1981.58
Model AIC = 68.94
Saturated AIC = 72.00
Independence CAIC = 2017.36
Model CAIC = 162.85
Saturated CAIC = 233.00
Normed Fit Index (NFI) = 0.99
Non-Normed Fit Index (NNFI) = 0.99
Parsimony Normed Fit Index (PNFI) = 0.53
Comparative Fit Index (CFI) = 0.99
Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.98
Critical N (CN) = 277.33
Root Mean Square Residual (RMR) = 0.028
Standardized RMR = 0.028
Goodness of Fit Index (GFI) = 0.97
Adjusted Goodness of Fit Index (AGFI) = 0.93
Parsimony Goodness of Fit Index (PGFI) = 0.41

APPENDIX 17: Initial TCP - Manufacturing Capability Model



LISREL 8.72

The following lines were read from file G:\Data Analysis\Mfg Capability\TCP_Mfg_SEM.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 E1 E2
E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Mfg Capability\TCP_Mfg_Corr.txt'
Sample Size = 229
Latent Variables TCP Mfg_Cap

Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
E1 = Mfg_Cap
E2 = Mfg_Cap
E3 = Mfg_Cap
E4 = Mfg_Cap
E5 = Mfg_Cap
E6 = Mfg_Cap
E7 = Mfg_Cap
E11 = Mfg_Cap
TCP = Mfg_Cap
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 64
Minimum Fit Function Chi-Square = 289.59 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 310.94 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 246.94
90 Percent Confidence Interval for NCP = (195.71 ; 305.69)
Minimum Fit Function Value = 1.22
Population Discrepancy Function Value (F0) = 1.04
90 Percent Confidence Interval for F0 = (0.83 ; 1.29)
Root Mean Square Error of Approximation (RMSEA) = 0.128
90 Percent Confidence Interval for RMSEA = (0.11 ; 0.14)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00
Expected Cross-Validation Index (ECVI) = 1.54
90 Percent Confidence Interval for ECVI = (1.32 ; 1.79)
ECVI for Saturated Model = 0.77
ECVI for Independence Model = 10.36
Chi-Square for Independence Model with 78 Degrees of Freedom = 2429.34
Independence AIC = 2455.34
Model AIC = 364.94
Saturated AIC = 182.00

Independence CAIC = 2513.48
Model CAIC = 485.69
Saturated CAIC = 588.98
Normed Fit Index (NFI) = 0.88
Non-Normed Fit Index (NNFI) = 0.88
Parsimony Normed Fit Index (PNFI) = 0.72
Comparative Fit Index (CFI) = 0.90
Incremental Fit Index (IFI) = 0.90
Relative Fit Index (RFI) = 0.85
Critical N (CN) = 77.29

Root Mean Square Residual (RMR) = 0.072
Standardized RMR = 0.072
Goodness of Fit Index (GFI) = 0.83
Adjusted Goodness of Fit Index (AGFI) = 0.76
Parsimony Goodness of Fit Index (PGFI) = 0.59

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
B2	B1	22.9	0.39
B5	B2	17.1	-0.24
B5	B3	39.1	0.34
B5	B4	8.8	0.16
E3	E1	8.7	0.10
E3	E2	37.1	0.17
E6	E2	18.7	-0.14
E6	E3	26.4	-0.17
E6	E5	31.5	0.22
E7	E2	12.9	-0.12
E7	E3	16.3	-0.14
E7	E5	35.9	0.24
E7	E6	82.7	0.39

Time used: 0.219 Seconds

APPENDIX 18: Modified TCP - Manufacturing Capability Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\Mfg Capability\TCP_Mfg_SEM2.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 E1 E2
E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Mfg Capability\TCP_Mfg_Corr.txt'
Sample Size = 229
Latent Variables TCP Mfg_Cap
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
E1 = Mfg_Cap
E2 = Mfg_Cap
E3 = Mfg_Cap
E4 = Mfg_Cap
E5 = Mfg_Cap
E6 = Mfg_Cap
E7 = Mfg_Cap
E11 = Mfg_Cap
Set the error covariance B2 and B1 free
Set the error covariance B5 and B3 free
Set the error covariance B5 and B2 free
Set the error covariance E3 and E2 free
Set the error covariance E6 and E2 free
Set the error covariance E6 and E3 free
Set the error covariance E6 and E5 free
Set the error covariance E7 and E6 free
Set the error covariance E7 and E5 free
TCP = Mfg_Cap
Path Diagram
End of Problem

Sample Size = 229

Correlation Matrix

	B1	B2	B3	B4	B5	E1
	--------	--------	--------	--------	--------	--------
B1	1.00					
B2	0.64	1.00				
B3	0.29	0.29	1.00			
B4	0.35	0.43	0.10	1.00		
B5	0.39	0.36	0.51	0.41	1.00	
E1	0.05	0.10	0.04	0.06	0.07	1.00
E2	0.10	0.09	-0.01	0.12	0.14	0.53
E3	0.08	0.08	-0.02	0.13	0.10	0.56
E4	0.08	0.05	0.02	0.06	0.14	0.43
E5	0.16	0.14	- -	0.16	0.16	0.34
E6	0.13	0.09	0.01	0.12	0.08	0.29
E7	0.06	0.09	- -	0.13	0.06	0.30
E11	0.09	0.09	0.06	0.06	0.08	0.47

Correlation Matrix

	E2	E3	E4	E5	E6	E7
	--------	--------	--------	--------	--------	--------
E2	1.00					
E3	0.79	1.00				
E4	0.70	0.68	1.00			
E5	0.57	0.54	0.57	1.00		
E6	0.45	0.41	0.55	0.63	1.00	
E7	0.42	0.39	0.46	0.62	0.72	1.00
E11	0.65	0.64	0.66	0.51	0.51	0.43

Correlation Matrix

	E11

E11	1.00

Number of Iterations = 14
LISREL Estimates (Maximum Likelihood)
Measurement Equations

B1 = 0.57*TCP, Errorvar.= 0.68 , R^2 = 0.32
(0.085)
7.96

B2 = 0.72*TCP, Errorvar.= 0.47 , R^2 = 0.53
(0.097) (0.11)
7.48 4.20

B3 = 0.33*TCP, Errorvar.= 0.89 , R^2 = 0.11
(0.092) (0.088)

3.62 10.13
B4 = 0.61*TCP, Errorvar.= 0.63 , R^2 = 0.37
(0.11) (0.082)
5.61 7.76
B5 = 0.69*TCP, Errorvar.= 0.53 , R^2 = 0.47
(0.13) (0.093)
5.41 5.69
E1 = 0.58*Mfg_Cap, Errorvar.= 0.66 , R^2 = 0.34
(0.062) (0.064)
9.44 10.31
E2 = 0.85*Mfg_Cap, Errorvar.= 0.28 , R^2 = 0.72
(0.055) (0.040)
15.45 7.08
E3 = 0.83*Mfg_Cap, Errorvar.= 0.31 , R^2 = 0.69
(0.056) (0.042)
14.92 7.44
E4 = 0.83*Mfg_Cap, Errorvar.= 0.31 , R^2 = 0.69
(0.055) (0.038)
15.12 8.17
E5 = 0.66*Mfg_Cap, Errorvar.= 0.56 , R^2 = 0.44
(0.060) (0.057)
11.06 9.88
E6 = 0.63*Mfg_Cap, Errorvar.= 0.59 , R^2 = 0.40
(0.062) (0.063)
10.07 9.42
E7 = 0.52*Mfg_Cap, Errorvar.= 0.73 , R^2 = 0.27
(0.064) (0.070)
8.15 10.40
E11 = 0.78*Mfg_Cap, Errorvar.= 0.39 , R^2 = 0.61
(0.056) (0.043)
13.88 9.03

Error Covariance for B2 and B1 = 0.22
(0.080)
2.70
Error Covariance for B5 and B2 = -0.14
(0.056)
-2.52
Error Covariance for B5 and B3 = 0.29
(0.069)
4.14
Error Covariance for E3 and E2 = 0.085
(0.033)
2.60
Error Covariance for E6 and E2 = -0.07

(0.028)
-2.65
Error Covariance for E6 and E3 = -0.09
(0.029)
-3.16
Error Covariance for E6 and E5 = 0.21
(0.047)
4.49
Error Covariance for E7 and E5 = 0.28
(0.049)
5.60
Error Covariance for E7 and E6 = 0.38
(0.056)
6.85

Structural Equations

TCP = 0.19*Mfg_Cap, Errorvar.= 0.96 , R^2 = 0.035
(0.080) (0.27)
2.33 3.63

Correlation Matrix of Independent Variables

Mfg_Cap
1.00

Covariance Matrix of Latent Variables

	TCP	Mfg_Cap
TCP	1.00	
Mfg_Cap	0.19	1.00

Goodness of Fit Statistics

Degrees of Freedom = 55
Minimum Fit Function Chi-Square = 56.63 (P = 0.41)
Normal Theory Weighted Least Squares Chi-Square = 56.37 (P = 0.42)
Estimated Non-centrality Parameter (NCP) = 1.37
90 Percent Confidence Interval for NCP = (0.0 ; 23.34)

Minimum Fit Function Value = 0.24
Population Discrepancy Function Value (F0) = 0.0058
90 Percent Confidence Interval for F0 = (0.0 ; 0.098)
Root Mean Square Error of Approximation (RMSEA) = 0.010
90 Percent Confidence Interval for RMSEA = (0.0 ; 0.042)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.99

Expected Cross-Validation Index (ECVI) = 0.54
90 Percent Confidence Interval for ECVI = (0.54 ; 0.63)
ECVI for Saturated Model = 0.77
ECVI for Independence Model = 10.36

Chi-Square for Independence Model with 78 Degrees of Freedom = 2429.34
Independence AIC = 2455.34
Model AIC = 128.37
Saturated AIC = 182.00
Independence CAIC = 2513.48
Model CAIC = 289.37
Saturated CAIC = 588.98

Normed Fit Index (NFI) = 0.98
Non-Normed Fit Index (NNFI) = 1.00
Parsimony Normed Fit Index (PNFI) = 0.69
Comparative Fit Index (CFI) = 1.00
Incremental Fit Index (IFI) = 1.00
Relative Fit Index (RFI) = 0.97

Critical N (CN) = 345.40

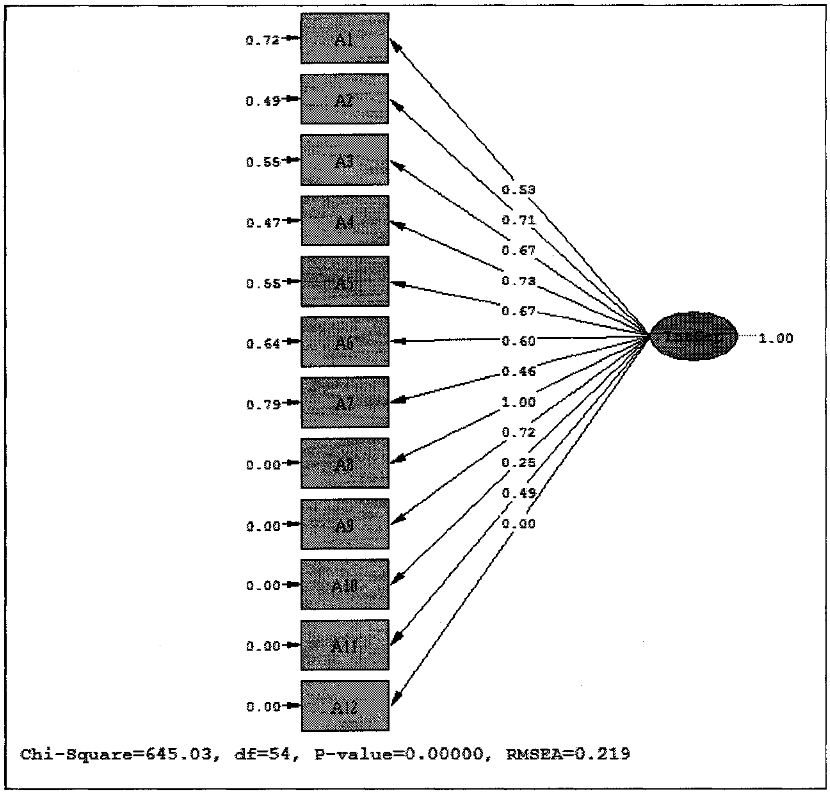
Root Mean Square Residual (RMR) = 0.035
Standardized RMR = 0.035
Goodness of Fit Index (GFI) = 0.96
Adjusted Goodness of Fit Index (AGFI) = 0.94
Parsimony Goodness of Fit Index (PGFI) = 0.58

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
B4	B3	8.4	-0.17

Time used: 0.016 Seconds

APPENDIX 19: Initial Integration Capability Measurement Model



L I S R E L 8.72

The following lines were read from file G:\Data Analysis\New dataset\Int_Cap_CFA.SPJ:

Observed Variables
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10
A11 A12
Correlation Matrix from file 'G:\Data Analysis\New dataset\Int_Corr.txt'
Sample Size = 229
Latent Variables IntCap
Relationships
A1 = IntCap

A2 = IntCap
A3 = IntCap
A4 = IntCap
A5 = IntCap
A6 = IntCap
A7 = IntCap
A8 = IntCap
A9 = IntCap
A10 = IntCap
A11 = IntCap
A12 = IntCap
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 54
Minimum Fit Function Chi-Square = 587.65 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 645.03 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 591.03
90 Percent Confidence Interval for NCP = (512.93 ; 676.58)

Minimum Fit Function Value = 2.58
Population Discrepancy Function Value (F0) = 2.59
90 Percent Confidence Interval for F0 = (2.25 ; 2.97)
Root Mean Square Error of Approximation (RMSEA) = 0.22
90 Percent Confidence Interval for RMSEA = (0.20 ; 0.23)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 3.04
90 Percent Confidence Interval for ECVI = (2.70 ; 3.41)
ECVI for Saturated Model = 0.68
ECVI for Independence Model = 8.41

Chi-Square for Independence Model with 66 Degrees of Freedom = 1892.96
Independence AIC = 1916.96
Model AIC = 693.03
Saturated AIC = 156.00
Independence CAIC = 1970.17

Model CAIC = 799.44
Saturated CAIC = 501.83

Normed Fit Index (NFI) = 0.69
Non-Normed Fit Index (NNFI) = 0.64
Parsimony Normed Fit Index (PNFI) = 0.56
Comparative Fit Index (CFI) = 0.71
Incremental Fit Index (IFI) = 0.71
Relative Fit Index (RFI) = 0.62

Critical N (CN) = 32.45

Root Mean Square Residual (RMR) = 0.14
Standardized RMR = 0.14
Goodness of Fit Index (GFI) = 0.68
Adjusted Goodness of Fit Index (AGFI) = 0.54
Parsimony Goodness of Fit Index (PGFI) = 0.47

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
A2	A1	55.6	0.36
A3	A2	10.0	0.15
A6	A5	26.4	0.22
A7	A5	18.8	0.19
A8	A5	19.0	-0.20
A8	A6	13.9	-0.18
A9	A2	21.2	-0.22
A9	A5	21.3	-0.21
A9	A8	44.4	0.34
A10	A8	13.6	0.21
A11	A1	18.2	-0.23
A11	A2	27.5	-0.26
A11	A3	11.8	-0.18
A11	A8	15.1	0.21
A11	A9	35.6	0.32
A11	A10	8.4	0.17
A12	A1	12.0	-0.18
A12	A2	25.0	-0.25
A12	A5	18.7	-0.21
A12	A8	14.1	0.20

A12	A9	38.5	0.33
A12	A10	8.2	0.17
A12	A11	162.4	0.70

Time used: 0.266 Seconds

APPENDIX 20: Modified Integration Capability Measurement Model

L I S R E L 8.72

The following lines were read from file G:\Data Analysis\New dataset\Int_Cap_CFA3.spj:

Observed Variables
A1 A2 A3 A4 A5 A6 A7 A8 A9 A10
A11 A12
Correlation Matrix from file 'G:\Data Analysis\New dataset\Int_Corr.txt'
Sample Size = 229
Latent Variables IntCap
Relationships
A1 = IntCap
A2 = IntCap
A3 = IntCap
A4 = IntCap
A5 = IntCap
A6 = IntCap
A7 = IntCap
Set the error covariance A2 and A1
Set the error covariance A3 and A2
Set the error covariance A6 and A5
Set the error covariance A7 and A5
Set the error covariance A7 and A6

Path Diagram
End of Problem

Sample Size = 229

Correlation Matrix

	A1	A2	A3	A4	A5	A6
A1	1.00					
A2	0.63	1.00				
A3	0.37	0.50	1.00			

A4	0.41	0.51	0.49	1.00		
A5	0.36	0.48	0.45	0.50	1.00	
A6	0.25	0.45	0.40	0.44	0.61	1.00
A7	0.24	0.31	0.27	0.38	0.56	0.50

Correlation Matrix

	A7
A7	1.00

Number of Iterations = 11

LISREL Estimates (Maximum Likelihood)

Measurement Equations

A1 = 0.53*IntCap, Errorvar.= 0.72 , R^2 = 0.28
(0.070) (0.076)
7.62 9.41
A2 = 0.71*IntCap, Errorvar.= 0.49 , R^2 = 0.51
(0.067) (0.068)
10.59 7.30
A3 = 0.67*IntCap, Errorvar.= 0.55 , R^2 = 0.45
(0.068) (0.069)
9.96 7.96
A4 = 0.73*IntCap, Errorvar.= 0.47 , R^2 = 0.53
(0.065) (0.063)
11.30 7.36
A5 = 0.67*IntCap, Errorvar.= 0.55 , R^2 = 0.45
(0.066) (0.067)
10.17 8.17
A6 = 0.60*IntCap, Errorvar.= 0.64 , R^2 = 0.36
(0.069) (0.072)
8.78 8.87
A7 = 0.46*IntCap, Errorvar.= 0.79 , R^2 = 0.21
(0.072) (0.081)
6.40 9.76

Error Covariance for A2 and A1 = 0.25
(0.055)
4.47
Error Covariance for A3 and A2 = 0.019
(0.044)
0.42
Error Covariance for A6 and A5 = 0.20
(0.055)
3.71

Error Covariance for A7 and A5 = 0.25
(0.057)
4.40
Error Covariance for A7 and A6 = 0.22
(0.058)
3.84

Correlation Matrix of Independent Variables

IntCap

1.00

Goodness of Fit Statistics

Degrees of Freedom = 9
Minimum Fit Function Chi-Square = 9.41 (P = 0.40)
Normal Theory Weighted Least Squares Chi-Square = 9.40 (P = 0.40)
Estimated Non-centrality Parameter (NCP) = 0.40
90 Percent Confidence Interval for NCP = (0.0 ; 12.04)

Minimum Fit Function Value = 0.041
Population Discrepancy Function Value (F0) = 0.0017
90 Percent Confidence Interval for F0 = (0.0 ; 0.053)
Root Mean Square Error of Approximation (RMSEA) = 0.014
90 Percent Confidence Interval for RMSEA = (0.0 ; 0.077)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.76

Expected Cross-Validation Index (ECVI) = 0.21
90 Percent Confidence Interval for ECVI = (0.21 ; 0.26)

ECVI for Saturated Model = 0.25
ECVI for Independence Model = 4.25

Chi-Square for Independence Model with 21 Degrees of Freedom = 954.40
Independence AIC = 968.40
Model AIC = 47.40
Saturated AIC = 56.00
Independence CAIC = 999.44
Model CAIC = 131.64
Saturated CAIC = 180.14

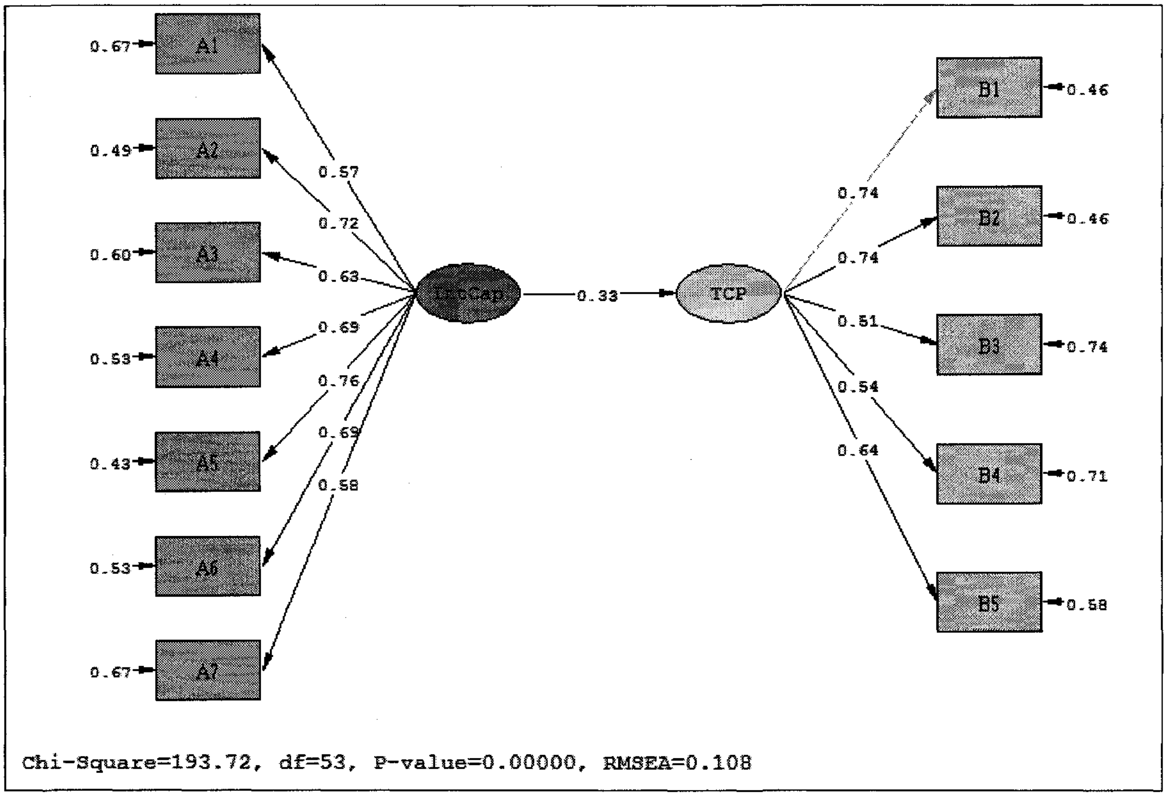
Normed Fit Index (NFI) = 0.99
Non-Normed Fit Index (NNFI) = 1.00
Parsimony Normed Fit Index (PNFI) = 0.42
Comparative Fit Index (CFI) = 1.00
Incremental Fit Index (IFI) = 1.00
Relative Fit Index (RFI) = 0.98

Critical N (CN) = 525.85

Root Mean Square Residual (RMR) = 0.019
Standardized RMR = 0.019
Goodness of Fit Index (GFI) = 0.99
Adjusted Goodness of Fit Index (AGFI) = 0.96
Parsimony Goodness of Fit Index (PGFI) = 0.32

Time used: 0.328 Seconds

APPENDIX 21: Initial TCP-Integration Capability Model



LISREL 8.72

The following lines were read from file G:\Data Analysis\New dataset\Int_TCP_SEM.SPJ:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 A1 A2
A3 A4 A5 A6 A7 A8 A9 A10 A11
A12
Correlation Matrix from file 'G:\Data Analysis\New dataset\Int_TCP_corr.txt'
Sample Size = 229

Latent Variables IntCap TCP
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
A1 = IntCap
A2 = IntCap
A3 = IntCap
A4 = IntCap
A5 = IntCap
A6 = IntCap
A7 = IntCap
TCP = IntCap
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 53
Minimum Fit Function Chi-Square = 183.26 (P = 0.00)
Normal Theory Weighted Least Squares Chi-Square = 193.72 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 140.72
90 Percent Confidence Interval for NCP = (101.91 ; 187.11)

Minimum Fit Function Value = 0.80
Population Discrepancy Function Value (F0) = 0.62
90 Percent Confidence Interval for F0 = (0.45 ; 0.82)
Root Mean Square Error of Approximation (RMSEA) = 0.108
90 Percent Confidence Interval for RMSEA = (0.092 ; 0.12)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 1.07
90 Percent Confidence Interval for ECVI = (0.90 ; 1.27)
ECVI for Saturated Model = 0.68
ECVI for Independence Model = 6.92

Chi-Square for Independence Model with 66 Degrees of Freedom = 1553.44

Independence AIC = 1577.44
Model AIC = 243.72
Saturated AIC = 156.00
Independence CAIC = 1630.64
Model CAIC = 354.56
Saturated CAIC = 501.83

Normed Fit Index (NFI) = 0.88
Non-Normed Fit Index (NNFI) = 0.89
Parsimony Normed Fit Index (PNFI) = 0.71
Comparative Fit Index (CFI) = 0.91
Incremental Fit Index (IFI) = 0.91
Relative Fit Index (RFI) = 0.85

Critical N (CN) = 100.34

Root Mean Square Residual (RMR) = 0.066
Standardized RMR = 0.066
Goodness of Fit Index (GFI) = 0.88
Adjusted Goodness of Fit Index (AGFI) = 0.82
Parsimony Goodness of Fit Index (PGFI) = 0.60

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
B2	B1	23.1	0.30
B5	B2	13.2	-0.20
B5	B3	24.4	0.26
A2	A1	46.9	0.31
A5	B2	9.3	-0.11
A5	A2	8.1	-0.12
A6	A1	17.8	-0.19
A6	A5	14.5	0.16
A7	A2	11.5	-0.15
A7	A5	19.4	0.19
A7	A6	9.4	0.14

Time used: 0.266 Seconds

APPENDIX 22: Modified TCP-Integration Capability Model

The following lines were read from file G:\Data Analysis\New dataset\Int_TCP_SEM1.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 A1 A2
A3 A4 A5 A6 A7 A8 A9 A10 A11
A12
Correlation Matrix from file 'G:\Data Analysis\New dataset\Int_TCP_corr.txt'
Sample Size = 229
Latent Variables IntCap TCP
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
A1 = IntCap
A2 = IntCap
A3 = IntCap
A4 = IntCap
A5 = IntCap
A6 = IntCap
A7 = IntCap
Set the error covariance B2 and B1
Set the error covariance B5 and B2
Set the error covariance B5 and B3
Set the error covariance A2 and A1

Set the error covariance A5 and A2
Set the error covariance A6 and A1
Set the error covariance A6 and A5
Set the error covariance A7 and A2
Set the error covariance A7 and A5
Set the error covariance A7 and A6
TCP = IntCap
Path Diagram

End of Problem

Sample Size = 229

Correlation Matrix

	B1	B2	B3	B4	B5	A1
B1	1.00					
B2	0.61	1.00				
B3	0.34	0.33	1.00			
B4	0.35	0.43	0.19	1.00		
B5	0.43	0.40	0.51	0.41	1.00	
A1	0.17	0.20	0.10	0.23	0.28	1.00
A2	0.10	0.12	0.15	0.17	0.23	0.63
A3	0.21	0.14	0.16	0.18	0.19	0.37
A4	0.14	0.15	0.08	0.15	0.11	0.41
A5	0.17	0.04	0.12	0.16	0.20	0.36
A6	0.20	0.18	0.18	0.09	0.18	0.25
A7	0.12	0.03	0.17	0.11	0.15	0.24

Correlation Matrix

	A2	A3	A4	A5	A6	A7
A2	1.00					
A3	0.50	1.00				
A4	0.51	0.49	1.00			
A5	0.48	0.45	0.50	1.00		
A6	0.45	0.40	0.44	0.61	1.00	
A7	0.31	0.27	0.38	0.56	0.50	1.00

Number of Iterations = 12

LISREL Estimates (Maximum Likelihood)

Measurement Equations

B1 = 0.62*TCP, Errorvar.= 0.62 , R^2 = 0.38
(0.083)

7.43
B2 = 0.70*TCP, Errorvar.= 0.50 , R^2 = 0.50
(0.089) (0.098)
7.93 5.12
B3 = 0.45*TCP, Errorvar.= 0.80 , R^2 = 0.20
(0.096) (0.086)
4.64 9.32
B4 = 0.59*TCP, Errorvar.= 0.65 , R^2 = 0.35
(0.098) (0.078)
6.04 8.38
B5 = 0.70*TCP, Errorvar.= 0.51 , R^2 = 0.49
(0.12) (0.087)
5.96 5.79
A1 = 0.57*IntCap, Errorvar.= 0.68 , R^2 = 0.32
(0.070) (0.075)
8.15 9.12
A2 = 0.72*IntCap, Errorvar.= 0.48 , R^2 = 0.52
(0.065) (0.064)
11.12 7.49
A3 = 0.68*IntCap, Errorvar.= 0.54 , R^2 = 0.46
(0.065) (0.064)
10.47 8.48
A4 = 0.72*IntCap, Errorvar.= 0.49 , R^2 = 0.51
(0.064) (0.061)
11.22 7.90
A5 = 0.67*IntCap, Errorvar.= 0.55 , R^2 = 0.45
(0.067) (0.069)
9.91 8.07
A6 = 0.61*IntCap, Errorvar.= 0.62 , R^2 = 0.38
(0.067) (0.070)
9.11 8.88
A7 = 0.47*IntCap, Errorvar.= 0.78 , R^2 = 0.22
(0.073) (0.082)
6.36 9.61

Error Covariance for B2 and B1 = 0.17
(0.074)
2.35
Error Covariance for B5 and B2 = -0.09
(0.052)
-1.78

Error Covariance for B5 and B3 = 0.19
(0.067)
2.89
Error Covariance for A2 and A1 = 0.22
(0.055)
3.97
Error Covariance for A5 and A2 = 0.00
(0.038)
-0.01
Error Covariance for A6 and A1 = -0.10
(0.040)
-2.38
Error Covariance for A6 and A5 = 0.19
(0.054)
3.59

Error Covariance for A7 and A2 = -0.03
(0.042)
-0.63
Error Covariance for A7 and A5 = 0.25
(0.058)
4.30
Error Covariance for A7 and A6 = 0.21
(0.059)
3.60

Structural Equations

TCP = 0.36*IntCap, Errorvar.= 0.87 , R^2 = 0.13
(0.091)   (0.22)
3.94   3.97

Correlation Matrix of Independent Variables

IntCap

1.00

Covariance Matrix of Latent Variables

	TCP	IntCap
	--------	--------
TCP	1.00	
IntCap	0.36	1.00

Goodness of Fit Statistics

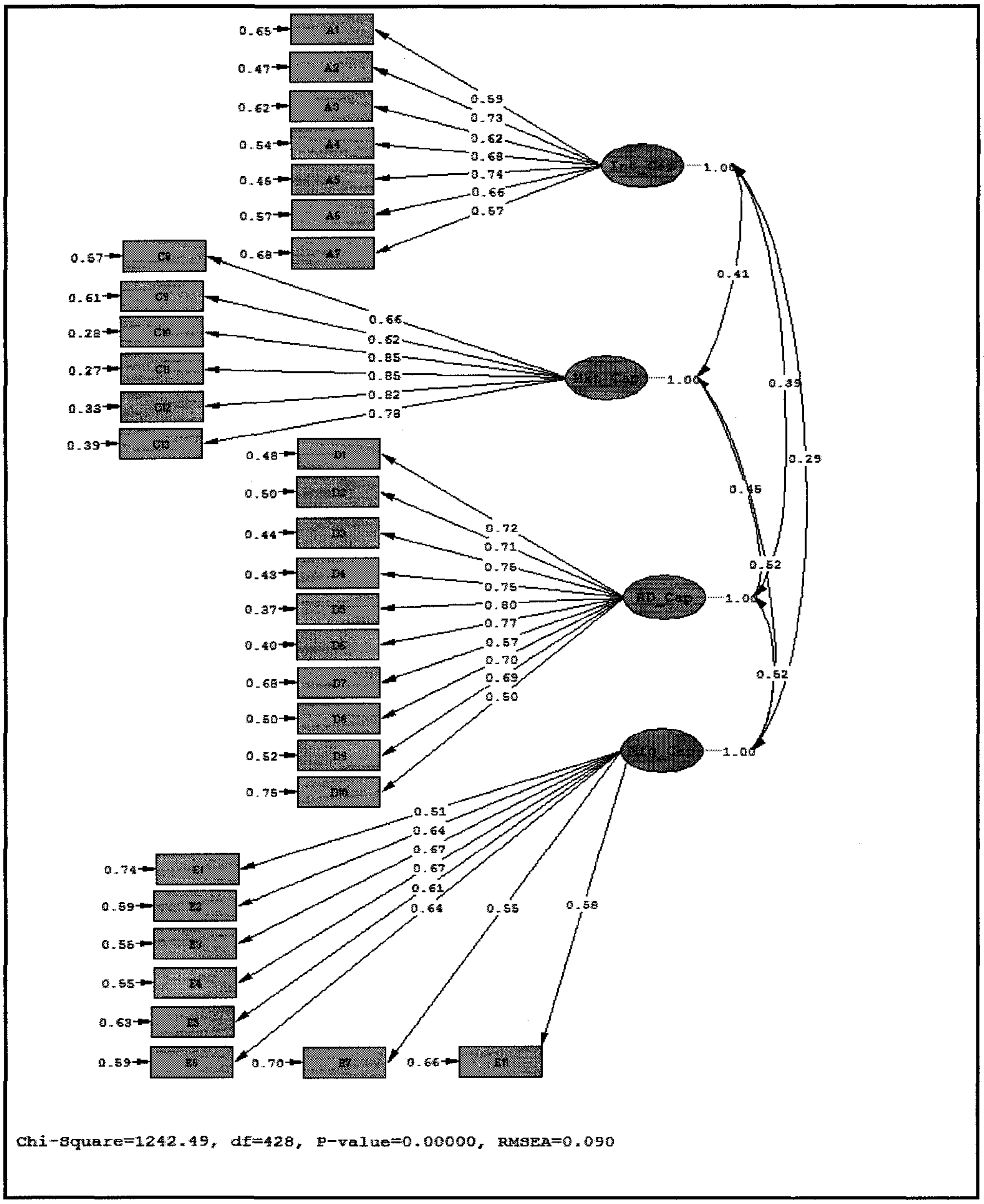
Degrees of Freedom = 43
Minimum Fit Function Chi-Square = 56.77 (P = 0.078)
Normal Theory Weighted Least Squares Chi-Square = 54.79 (P = 0.11)
Estimated Non-centrality Parameter (NCP) = 11.79
90 Percent Confidence Interval for NCP = (0.0 ; 34.92)
Minimum Fit Function Value = 0.25
Population Discrepancy Function Value (F0) = 0.052
90 Percent Confidence Interval for F0 = (0.0 ; 0.15)
Root Mean Square Error of Approximation (RMSEA) = 0.035
90 Percent Confidence Interval for RMSEA = (0.0 ; 0.060)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.83
Expected Cross-Validation Index (ECVI) = 0.55
90 Percent Confidence Interval for ECVI = (0.50 ; 0.65)
ECVI for Saturated Model = 0.68
ECVI for Independence Model = 6.92
Chi-Square for Independence Model with 66 Degrees of Freedom = 1553.44
Independence AIC = 1577.44
Model AIC = 124.79
Saturated AIC = 156.00
Independence CAIC = 1630.64
Model CAIC = 279.97
Saturated CAIC = 501.83
Normed Fit Index (NFI) = 0.96
Non-Normed Fit Index (NNFI) = 0.99
Parsimony Normed Fit Index (PNFI) = 0.63
Comparative Fit Index (CFI) = 0.99
Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.94
Critical N (CN) = 271.95
Root Mean Square Residual (RMR) = 0.041
Standardized RMR = 0.041
Goodness of Fit Index (GFI) = 0.96

Adjusted Goodness of Fit Index (AGFI) = 0.93
Parsimony Goodness of Fit Index (PGFI) = 0.53
The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
A5	B2	8.2	-0.10

Time used: 0.250 Seconds

APPENDIX 23: Initial Organizational Capabilities Measurement Model



LISREL 8.72

The following lines were read from file D:\Data Analysis\Full Model\Full_Model_CFA_New.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 A1 A2
A3 A4 A5 A6 A7 A8 A9 A10 A11
A12 C1 C2 C3 C4 C5 C6 C7 C8
C9 C10 C11 C12 C13 C14 C15 D1 D2
D3 D4 D5 D6 D7 D8 D9 D10 E1
E2 E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Full Model\Full_Model_Corr.txt'
Sample Size = 229
Latent Variables TCP Int_Cap Mkt_Cap RD_Cap Mfg_Cap
Relationships
A1 = Int_Cap
A2 = Int_Cap
A3 = Int_Cap
A4 = Int_Cap
A5 = Int_Cap
A6 = Int_Cap
A7 = Int_Cap
C8 = Mkt_Cap
C9 = Mkt_Cap
C10 = Mkt_Cap
C11 = Mkt_Cap
C12 = Mkt_Cap
C13 = Mkt_Cap
D1 = RD_Cap
D2 = RD_Cap
D3 = RD_Cap
D4 = RD_Cap
D5 = RD_Cap
D6 = RD_Cap
D7 = RD_Cap
D8 = RD_Cap
D9 = RD_Cap
D10 = RD_Cap
E1 = Mfg_Cap
E2 = Mfg_Cap
E3 = Mfg_Cap
E4 = Mfg_Cap
E5 = Mfg_Cap
E6 = Mfg_Cap
E7 = Mfg_Cap
E11 = Mfg_Cap

Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 428
Minimum Fit Function Chi-Square = 1244.44 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 1242.49 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 814.49
90 Percent Confidence Interval for NCP = (712.76 ; 923.84)

Minimum Fit Function Value = 5.25
Population Discrepancy Function Value (F0) = 3.44
90 Percent Confidence Interval for F0 = (3.01 ; 3.90)
Root Mean Square Error of Approximation (RMSEA) = 0.090
90 Percent Confidence Interval for RMSEA = (0.084 ; 0.095)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 5.82
90 Percent Confidence Interval for ECVI = (5.39 ; 6.28)
ECVI for Saturated Model = 4.19
ECVI for Independence Model = 42.85

Chi-Square for Independence Model with 465 Degrees of Freedom = 10093.69
Independence AIC = 10155.69
Model AIC = 1378.49
Saturated AIC = 992.00
Independence CAIC = 10294.33
Model CAIC = 1682.60
Saturated CAIC = 3210.25

Normed Fit Index (NFI) = 0.88
Non-Normed Fit Index (NNFI) = 0.91
Parsimony Normed Fit Index (PNFI) = 0.81
Comparative Fit Index (CFI) = 0.92
Incremental Fit Index (IFI) = 0.92
Relative Fit Index (RFI) = 0.87

Critical N (CN) = 96.03

Root Mean Square Residual (RMR) = 0.079

Standardized RMR = 0.079
Goodness of Fit Index (GFI) = 0.75
Adjusted Goodness of Fit Index (AGFI) = 0.71
Parsimony Goodness of Fit Index (PGFI) = 0.64

APPENDIX 24: Modified Organizational Capabilities Measurement Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\Full Model\Full_Model_CFA_New1.spj:

Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 A1 A2
A3 A4 A5 A6 A7 A8 A9 A10 A11
A12 C1 C2 C3 C4 C5 C6 C7 C8
C9 C10 C11 C12 C13 C14 C15 D1 D2
D3 D4 D5 D6 D7 D8 D9 D10 E1
E2 E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Full Model\Full_Model_Corr.txt'
Sample Size = 229
Latent Variables TCP Int_Cap Mkt_Cap RD_Cap Mfg_Cap
Relationships
A1 = Int_Cap
A2 = Int_Cap
A3 = Int_Cap
A4 = Int_Cap
A5 = Int_Cap
A6 = Int_Cap
A7 = Int_Cap
C8 = Mkt_Cap
C9 = Mkt_Cap
C10 = Mkt_Cap
C11 = Mkt_Cap
C12 = Mkt_Cap
C13 = Mkt_Cap
D1 = RD_Cap
D2 = RD_Cap
D3 = RD_Cap
D4 = RD_Cap
D5 = RD_Cap
D6 = RD_Cap
D7 = RD_Cap
D8 = RD_Cap
D9 = RD_Cap
D10 = RD_Cap
E1 = Mfg_Cap
E2 = Mfg_Cap

E3 = Mfg_Cap
E4 = Mfg_Cap
E5 = Mfg_Cap
E6 = Mfg_Cap
E7 = Mfg_Cap
E11 = Mfg_Cap
Set the error covariance A2 and A1 free
Set the error covariance A7 and A5 free
Set the error covariance C10 and C8 free
Set the error covariance C13 and C10 free
Set the error covariance C13 and C12 free
Set the error covariance D2 and D1 free
Set the error covariance D3 and D2 free
Set the error covariance D5 and D3 free
Set the error covariance D6 and D5 free
Set the error covariance E3 and E2 free
Set the error covariance E6 and E5 free
Set the error covariance E7 and E5 free
Set the error covariance E7 and E6 free
Path Diagram
End of Problem

Sample Size = 229

Correlation Matrix

	A1	A2	A3	A4	A5	A6
A1	1.00					
A2	0.63	1.00				
A3	0.37	0.50	1.00			
A4	0.41	0.50	0.48	1.00		
A5	0.35	0.47	0.45	0.47	1.00	
A6	0.24	0.43	0.37	0.45	0.59	1.00
A7	0.24	0.31	0.27	0.37	0.57	0.49
C8	0.20	0.21	0.06	0.16	0.10	0.08
C9	0.25	0.28	0.15	0.24	0.24	0.27
C10	0.33	0.29	0.23	0.26	0.27	0.17
C11	0.27	0.29	0.26	0.29	0.25	0.15
C12	0.36	0.28	0.17	0.15	0.17	0.04
C13	0.32	0.28	0.24	0.16	0.18	0.12
D1	0.17	0.19	0.18	0.16	0.27	0.22
D2	0.09	0.14	0.12	0.14	0.17	0.14

D3	0.14	0.21	0.06	0.13	0.12	0.23
D4	0.12	0.23	0.01	0.18	0.15	0.22
D5	0.20	0.26	0.13	0.10	0.20	0.19
D6	0.26	0.32	0.15	0.14	0.24	0.25
D7	0.27	0.23	0.09	0.11	0.25	0.19
D8	0.24	0.29	0.09	0.16	0.23	0.26
D9	0.30	0.33	0.17	0.28	0.40	0.31
D10	0.15	0.14	0.01	0.06	0.06	0.16
E1	0.11	0.09	0.10	0.09	0.17	0.13
E2	0.11	0.19	0.09	0.13	0.14	0.17
E3	0.09	0.13	0.02	0.19	0.15	0.18
E4	0.09	0.17	0.11	0.12	0.23	0.10
E5	0.17	0.14	-0.05	0.02	0.16	0.10
E6	0.09	0.09	-0.04	0.15	0.13	0.10
E7	0.06	0.11	-0.05	0.11	0.08	0.04
E11	0.19	0.19	0.11	0.20	0.19	0.23

Correlation Matrix

	A7	C8	C9	C10	C11	C12
A7	1.00					
C8	0.11	1.00				
C9	0.18	0.34	1.00			
C10	0.18	0.66	0.54	1.00		
C11	0.21	0.50	0.53	0.75	1.00	
C12	0.08	0.53	0.43	0.68	0.70	1.00
C13	0.07	0.52	0.51	0.58	0.66	0.73
D1	0.20	0.10	0.34	0.24	0.24	0.25
D2	0.12	0.10	0.34	0.23	0.22	0.23
D3	0.07	0.07	0.37	0.22	0.26	0.24
D4	0.09	0.05	0.37	0.17	0.21	0.15
D5	0.10	0.11	0.42	0.32	0.32	0.27
D6	0.12	0.14	0.39	0.32	0.30	0.28
D7	0.14	0.15	0.28	0.26	0.28	0.21
D8	0.22	0.11	0.31	0.26	0.27	0.23
D9	0.28	0.19	0.36	0.34	0.36	0.30
D10	0.03	0.19	0.26	0.27	0.22	0.20
E1	0.07	0.10	0.38	0.24	0.29	0.24
E2	0.11	0.20	0.26	0.23	0.22	0.22
E3	0.07	0.23	0.35	0.30	0.28	0.16
E4	0.05	0.23	0.36	0.31	0.31	0.25
E5	0.14	0.24	0.22	0.20	0.26	0.24
E6	0.02	0.22	0.35	0.22	0.27	0.22
E7	0.09	0.19	0.20	0.17	0.24	0.14

E11	0.16	0.22	0.53	0.30	0.29	0.25

Correlation Matrix

	C13	D1	D2	D3	D4	D5
C13	1.00					
D1	0.22	1.00				
D2	0.21	0.80	1.00			
D3	0.28	0.53	0.64	1.00		
D4	0.19	0.49	0.51	0.67	1.00	
D5	0.34	0.60	0.51	0.50	0.59	1.00
D6	0.35	0.55	0.48	0.54	0.56	0.77
D7	0.22	0.32	0.37	0.41	0.36	0.47
D8	0.29	0.40	0.43	0.51	0.55	0.55
D9	0.33	0.50	0.39	0.52	0.54	0.53
D10	0.25	0.22	0.28	0.37	0.40	0.38
E1	0.33	0.28	0.35	0.49	0.38	0.29
E2	0.28	0.24	0.23	0.30	0.36	0.25
E3	0.22	0.29	0.24	0.32	0.36	0.31
E4	0.30	0.10	0.16	0.21	0.18	0.11
E5	0.29	0.05	0.08	0.23	0.25	0.06
E6	0.27	0.07	0.15	0.27	0.31	0.18
E7	0.20	0.07	0.13	0.23	0.28	0.14
E11	0.33	0.26	0.25	0.25	0.28	0.31

Correlation Matrix

	D6	D7	D8	D9	D10	E1
D6	1.00					
D7	0.42	1.00				
D8	0.52	0.54	1.00			
D9	0.50	0.36	0.57	1.00		
D10	0.34	0.46	0.44	0.41	1.00	
E1	0.33	0.31	0.35	0.33	0.29	1.00
E2	0.30	0.11	0.25	0.22	0.19	0.37
E3	0.26	0.20	0.27	0.32	0.27	0.33
E4	0.13	0.16	0.19	0.14	0.17	0.29
E5	0.17	0.17	0.22	0.22	0.25	0.21
E6	0.22	0.37	0.25	0.21	0.30	0.29
E7	0.12	0.18	0.26	0.26	0.19	0.31
E11	0.29	0.21	0.19	0.27	0.19	0.31

Correlation Matrix

	E2	E3	E4	E5	E6	E7
E2	1.00					
E3	0.60	1.00				
E4	0.49	0.53	1.00			
E5	0.31	0.33	0.41	1.00		
E6	0.29	0.29	0.43	0.56	1.00	
E7	0.23	0.25	0.29	0.55	0.57	1.00
E11	0.37	0.42	0.37	0.31	0.37	0.27

Correlation Matrix

	E11
E11	1.00

Number of Iterations = 25

LISREL Estimates (Maximum Likelihood)

Measurement Equations

```
A1 = 0.52*Int_Cap, Errorvar.= 0.73  , R² = 0.27
   (0.067)             (0.074)
    7.70                9.96

A2 = 0.70*Int_Cap, Errorvar.= 0.52  , R² = 0.48
   (0.062)             (0.059)
    11.22               8.75

A3 = 0.63*Int_Cap, Errorvar.= 0.60  , R² = 0.40
   (0.064)             (0.064)
    9.92                9.40

A4 = 0.69*Int_Cap, Errorvar.= 0.53  , R² = 0.47
   (0.062)             (0.059)
    11.10               8.84

A5 = 0.73*Int_Cap, Errorvar.= 0.46  , R² = 0.54
```

(0.061) (0.056)
12.02 8.18

A6 = 0.68*Int_Cap, Errorvar.= 0.54 , R^2 = 0.46
(0.062) (0.060)
10.92 8.93

A7 = 0.53*Int_Cap, Errorvar.= 0.72 , R^2 = 0.28
(0.067) (0.073)
7.94 9.81

C8 = 0.60*Mkt_Cap, Errorvar.= 0.64 , R^2 = 0.36
(0.062) (0.064)
9.68 9.98

C9 = 0.64*Mkt_Cap, Errorvar.= 0.59 , R^2 = 0.41
(0.060) (0.058)
10.69 10.19

C10 = 0.86*Mkt_Cap, Errorvar.= 0.26 , R^2 = 0.74
(0.054) (0.037)
15.96 6.85

C11 = 0.86*Mkt_Cap, Errorvar.= 0.27 , R^2 = 0.73
(0.054) (0.035)
15.94 7.59

C12 = 0.78*Mkt_Cap, Errorvar.= 0.39 , R^2 = 0.61
(0.057) (0.045)
13.72 8.81

C13 = 0.79*Mkt_Cap, Errorvar.= 0.37 , R^2 = 0.62
(0.058) (0.048)
13.67 7.76

D1 = 0.66*RD_Cap, Errorvar.= 0.56 , R^2 = 0.44
(0.060) (0.056)
11.03 9.98

D2 = 0.63*RD_Cap, Errorvar.= 0.59 , R^2 = 0.40
(0.060) (0.055)
10.44 10.61

D3 = 0.76*RD_Cap, Errorvar.= 0.42 , R^2 = 0.58
(0.057) (0.046)

13.32 9.05

D4 = 0.77*RD_Cap, Errorvar.= 0.40 , R^2 = 0.60
(0.057) (0.044)
13.63 9.15

D5 = 0.77*RD_Cap, Errorvar.= 0.41 , R^2 = 0.59
(0.057) (0.047)
13.46 8.69

D6 = 0.73*RD_Cap, Errorvar.= 0.47 , R^2 = 0.53
(0.058) (0.050)
12.47 9.40

D7 = 0.57*RD_Cap, Errorvar.= 0.67 , R^2 = 0.33
(0.062) (0.065)
9.26 10.32

D8 = 0.72*RD_Cap, Errorvar.= 0.48 , R^2 = 0.52
(0.058) (0.050)
12.44 9.60

D9 = 0.72*RD_Cap, Errorvar.= 0.48 , R^2 = 0.52
(0.058) (0.050)
12.41 9.61

D10 = 0.52*RD_Cap, Errorvar.= 0.73 , R^2 = 0.27
(0.063) (0.069)
8.30 10.45

E1 = 0.54*Mfg_Cap, Errorvar.= 0.71 , R^2 = 0.29
(0.067) (0.072)
8.08 9.83

E2 = 0.64*Mfg_Cap, Errorvar.= 0.59 , R^2 = 0.41
(0.066) (0.067)
9.75 8.84

E3 = 0.68*Mfg_Cap, Errorvar.= 0.54 , R^2 = 0.46
(0.064) (0.064)
10.63 8.42

E4 = 0.67*Mfg_Cap, Errorvar.= 0.55 , R^2 = 0.45
(0.064) (0.063)
10.56 8.72

E5 = 0.51*Mfg_Cap, Errorvar.= 0.74 , R^2 = 0.26
(0.068) (0.075)
7.48 9.95

E6 = 0.54*Mfg_Cap, Errorvar.= 0.70 , R^2 = 0.30
(0.067) (0.072)
8.16 9.75

E7 = 0.43*Mfg_Cap, Errorvar.= 0.81 , R^2 = 0.19
(0.069) (0.079)
6.25 10.24

E11 = 0.61*Mfg_Cap, Errorvar.= 0.63 , R^2 = 0.37
(0.065) (0.067)
9.32 9.37

Error Covariance for A2 and A1 = 0.27
(0.052)
5.19

Error Covariance for A7 and A5 = 0.18
(0.049)
3.65

Error Covariance for C10 and C8 = 0.15
(0.038)
3.84

Error Covariance for C13 and C10 = -0.11
(0.025)
-4.44

Error Covariance for C13 and C12 = 0.11
(0.038)
2.93

Error Covariance for D2 and D1 = 0.37
(0.046)
8.06

Error Covariance for D3 and D2 = 0.14
(0.029)
4.72

Error Covariance for D5 and D3 = -0.07
(0.025)
-2.79

Error Covariance for D6 and D5 = 0.21
(0.040)
5.25

Error Covariance for E3 and E2 = 0.16
(0.050)
3.26

Error Covariance for E6 and E5 = 0.28
(0.057)
4.99

Error Covariance for E7 and E5 = 0.33
(0.060)
5.51

Error Covariance for E7 and E6 = 0.33
(0.059)
5.63

Correlation Matrix of Independent Variables

	Int_Cap	Mkt_Cap	RD_Cap	Mfg_Cap
Int_Cap	1.00			
Mkt_Cap	0.41 (0.06) 6.36	1.00		
RD_Cap	0.39 (0.07) 5.92	0.47 (0.06) 8.09	1.00	
Mfg_Cap	0.32 (0.07) 4.34	0.55 (0.06) 9.66	0.57 (0.06) 9.88	1.00

Goodness of Fit Statistics

Degrees of Freedom = 415
Minimum Fit Function Chi-Square = 797.99 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 757.27 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 342.27
90 Percent Confidence Interval for NCP = (269.01 ; 423.35)

Minimum Fit Function Value = 3.37
Population Discrepancy Function Value (F0) = 1.44
90 Percent Confidence Interval for F0 = (1.14 ; 1.79)
Root Mean Square Error of Approximation (RMSEA) = 0.059
90 Percent Confidence Interval for RMSEA = (0.052 ; 0.066)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.014

Expected Cross-Validation Index (ECVI) = 3.88
90 Percent Confidence Interval for ECVI = (3.57 ; 4.22)
ECVI for Saturated Model = 4.19
ECVI for Independence Model = 42.85

Chi-Square for Independence Model with 465 Degrees of Freedom = 10093.69
Independence AIC = 10155.69
Model AIC = 919.27
Saturated AIC = 992.00
Independence CAIC = 10294.33
Model CAIC = 1281.52
Saturated CAIC = 3210.25

Normed Fit Index (NFI) = 0.92
Non-Normed Fit Index (NNFI) = 0.96
Parsimony Normed Fit Index (PNFI) = 0.82
Comparative Fit Index (CFI) = 0.96
Incremental Fit Index (IFI) = 0.96
Relative Fit Index (RFI) = 0.91

Critical N (CN) = 145.03

Root Mean Square Residual (RMR) = 0.069
Standardized RMR = 0.069
Goodness of Fit Index (GFI) = 0.83
Adjusted Goodness of Fit Index (AGFI) = 0.80
Parsimony Goodness of Fit Index (PGFI) = 0.69

The Modification Indices Suggest to Add the

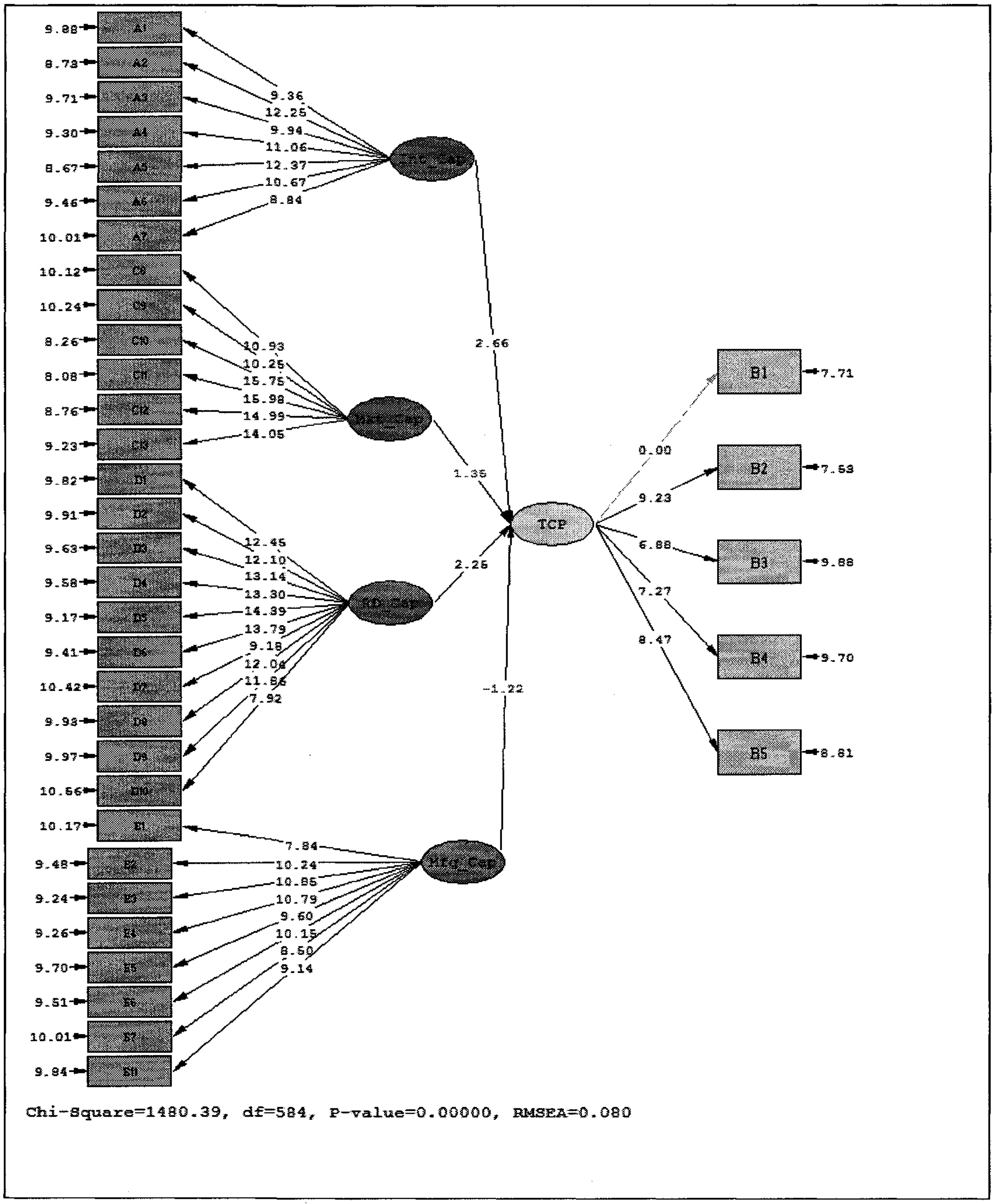
Path to	from	Decrease in Chi-Square	New Estimate
C9	RD_Cap	20.8	0.29
C9	Mfg_Cap	29.0	0.40
D4	Mkt_Cap	10.7	-0.18
D9	Int_Cap	16.0	0.24
E1	RD_Cap	18.8	0.35
E4	RD_Cap	21.5	-0.36

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
D4	D3	13.2	0.12
D8	D1	10.1	-0.09
D8	D7	14.1	0.15
D9	D2	9.3	-0.08
D10	D1	11.8	-0.11
D10	D7	13.6	0.18
E1	D3	9.6	0.11
E5	A4	8.9	-0.12
E5	D5	12.3	-0.10
E6	D7	19.7	0.18
E11	C9	22.9	0.21

Time used: 0.203 Seconds

APPENDIX 25: Initial TCP- Organizational Capabilities Model



L I S R E L 8.72

The following lines were read from file D:\Data Analysis\Full Model\Full_Model_SEM_New_0.spj:

```
Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 A1 A2
A3 A4 A5 A6 A7 A8 A9 A10 A11
A12 C1 C2 C3 C4 C5 C6 C7 C8
C9 C10 C11 C12 C13 C14 C15 D1 D2
D3 D4 D5 D6 D7 D8 D9 D10 E1
E2 E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Full Model\Full_Model_Corr.txt'
Sample Size = 229
Latent Variables  TCP Int_Cap Mkt_Cap RD_Cap Mfg_Cap
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
A1 = Int_Cap
A2 = Int_Cap
A3 = Int_Cap
A4 = Int_Cap
A5 = Int_Cap
A6 = Int_Cap
A7 = Int_Cap
C8 = Mkt_Cap
C9 = Mkt_Cap
C10 = Mkt_Cap
C11 = Mkt_Cap
C12 = Mkt_Cap
C13 = Mkt_Cap
D1 = RD_Cap
D2 = RD_Cap
D3 = RD_Cap
D4 = RD_Cap
D5 = RD_Cap
D6 = RD_Cap
D7 = RD_Cap
D8 = RD_Cap
```

D9 = RD_Cap
D10 = RD_Cap
E1 = Mfg_Cap
E2 = Mfg_Cap
E3 = Mfg_Cap
E4 = Mfg_Cap
E5 = Mfg_Cap
E6 = Mfg_Cap
E7 = Mfg_Cap
E11 = Mfg_Cap
TCP = Int_Cap Mkt_Cap RD_Cap Mfg_Cap
Path Diagram
End of Problem

Sample Size = 229

Goodness of Fit Statistics

Degrees of Freedom = 584
Minimum Fit Function Chi-Square = 1496.12 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 1480.39 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 896.39
90 Percent Confidence Interval for NCP = (786.78 ; 1013.66)

Minimum Fit Function Value = 6.31
Population Discrepancy Function Value (F0) = 3.78
90 Percent Confidence Interval for F0 = (3.32 ; 4.28)
Root Mean Square Error of Approximation (RMSEA) = 0.080
90 Percent Confidence Interval for RMSEA = (0.075 ; 0.086)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.00

Expected Cross-Validation Index (ECVI) = 6.94
90 Percent Confidence Interval for ECVI = (6.48 ; 7.43)
ECVI for Saturated Model = 5.62
ECVI for Independence Model = 47.51

Chi-Square for Independence Model with 630 Degrees of Freedom = 11188.25
Independence AIC = 11260.25
Model AIC = 1644.39
Saturated AIC = 1332.00
Independence CAIC = 11421.25
Model CAIC = 2011.12
Saturated CAIC = 4310.53

Normed Fit Index (NFI) = 0.87

Non-Normed Fit Index (NNFI) = 0.91
Parsimony Normed Fit Index (PNFI) = 0.80
Comparative Fit Index (CFI) = 0.91
Incremental Fit Index (IFI) = 0.91
Relative Fit Index (RFI) = 0.86

Critical N (CN) = 106.57

Root Mean Square Residual (RMR) = 0.075
Standardized RMR = 0.075
Goodness of Fit Index (GFI) = 0.74
Adjusted Goodness of Fit Index (AGFI) = 0.71
Parsimony Goodness of Fit Index (PGFI) = 0.65

APPENDIX 26: Modified TCP-Organizational Capabilities Model

L I S R E L 8.72

The following lines were read from file D:\Data Analysis\Full Model\Full_Model_SEM_New.spj:

```
Observed Variables
B1 B2 B3 B4 B5 B6 B7 B8 A1 A2
A3 A4 A5 A6 A7 A8 A9 A10 A11
A12 C1 C2 C3 C4 C5 C6 C7 C8
C9 C10 C11 C12 C13 C14 C15 D1 D2
D3 D4 D5 D6 D7 D8 D9 D10 E1
E2 E3 E4 E5 E6 E7 E8 E10 E11
Correlation Matrix from file 'D:\Data Analysis\Full Model\Full_Model_Corr.txt'
Sample Size = 229
Latent Variables  TCP Int_Cap Mkt_Cap RD_Cap Mfg_Cap
Relationships
B1 = TCP
B2 = TCP
B3 = TCP
B4 = TCP
B5 = TCP
A1 = Int_Cap
A2 = Int_Cap
A3 = Int_Cap
A4 = Int_Cap
A5 = Int_Cap
A6 = Int_Cap
A7 = Int_Cap
C8 = Mkt_Cap
C9 = Mkt_Cap
C10 = Mkt_Cap
C11 = Mkt_Cap
C12 = Mkt_Cap
C13 = Mkt_Cap
D1 = RD_Cap
D2 = RD_Cap
D3 = RD_Cap
D4 = RD_Cap
D5 = RD_Cap
D6 = RD_Cap
D7 = RD_Cap
```

D8 = RD_Cap
D9 = RD_Cap
D10 = RD_Cap
E1 = Mfg_Cap
E2 = Mfg_Cap
E3 = Mfg_Cap
E4 = Mfg_Cap
E5 = Mfg_Cap
E6 = Mfg_Cap
E7 = Mfg_Cap
E11 = Mfg_Cap
Set the error covariance B2 and B1 free
Set the error covariance B5 and B3 free
Set the error covariance A2 and A1 free
Set the error covariance A7 and A5 free
Set the error covariance C10 and C8 free
Set the error covariance C13 and C10 free
Set the error covariance C13 and C12 free
Set the error covariance D2 and D1 free
Set the error covariance D3 and D2 free
Set the error covariance D5 and D3 free
Set the error covariance D6 and D5 free
Set the error covariance D10 and D7 free
Set the error covariance E3 and E2 free
Set the error covariance E6 and E5 free
Set the error covariance E7 and E5 free
Set the error covariance E7 and E6 free
TCP = Int_Cap Mkt_Cap RD_Cap Mfg_Cap
Path Diagram
End of Problem

Sample Size = 229

Correlation Matrix

	B1	B2	B3	B4	B5	A1
B1	1.00					
B2	0.61	1.00				
B3	0.34	0.33	1.00			
B4	0.35	0.43	0.20	1.00		
B5	0.43	0.40	0.51	0.41	1.00	
A1	0.18	0.20	0.10	0.23	0.28	1.00

A2	0.10	0.13	0.15	0.18	0.23	0.63
A3	0.21	0.15	0.17	0.18	0.19	0.37
A4	0.13	0.14	0.08	0.15	0.12	0.41
A5	0.16	0.04	0.12	0.15	0.19	0.35
A6	0.17	0.17	0.17	0.08	0.19	0.24
A7	0.12	0.03	0.17	0.10	0.14	0.24
C8	0.04	-0.07	0.11	-0.07	0.07	0.20
C9	0.12	0.11	0.12	0.10	0.10	0.25
C10	0.14	0.07	0.08	0.03	0.09	0.33
C11	0.13	0.14	0.15	0.17	0.16	0.27
C12	0.17	0.19	0.20	0.13	0.22	0.36
C13	0.19	0.19	0.19	0.22	0.27	0.32
D1	0.16	0.22	0.08	0.25	0.21	0.17
D2	0.09	0.12	0.03	0.19	0.15	0.09
D3	0.06	0.12	0.01	0.11	0.17	0.14
D4	0.14	0.16	-0.03	0.16	0.13	0.12
D5	0.16	0.20	0.06	0.17	0.14	0.20
D6	0.13	0.23	0.09	0.18	0.19	0.26
D7	0.08	0.03	0.14	0.14	0.21	0.27
D8	0.07	0.06	- -	0.17	0.24	0.24
D9	0.21	0.23	0.03	0.28	0.27	0.30
D10	0.11	0.08	0.02	0.11	0.15	0.15
E1	- -	0.05	0.01	0.06	0.08	0.11
E2	0.04	0.03	-0.02	0.12	0.12	0.11
E3	0.01	0.01	-0.02	0.04	0.07	0.09
E4	0.04	-0.01	0.05	0.05	0.14	0.09
E5	0.13	0.06	-0.01	0.13	0.16	0.17
E6	0.08	0.02	0.01	0.10	0.08	0.09
E7	-0.01	0.01	0.02	0.10	0.09	0.06
E11	0.04	0.03	0.08	0.03	0.04	0.19

Correlation Matrix

	A2	A3	A4	A5	A6	A7
A2	1.00					
A3	0.50	1.00				
A4	0.50	0.48	1.00			
A5	0.47	0.45	0.47	1.00		
A6	0.43	0.37	0.45	0.59	1.00	
A7	0.31	0.27	0.37	0.57	0.49	1.00
C8	0.21	0.06	0.16	0.10	0.08	0.11
C9	0.28	0.15	0.24	0.24	0.27	0.18
C10	0.29	0.23	0.26	0.27	0.17	0.18
C11	0.29	0.26	0.29	0.25	0.15	0.21

C12	0.28	0.17	0.15	0.17	0.04	0.08
C13	0.28	0.24	0.16	0.18	0.12	0.07
D1	0.19	0.18	0.16	0.27	0.22	0.20
D2	0.14	0.12	0.14	0.17	0.14	0.12
D3	0.21	0.06	0.13	0.12	0.23	0.07
D4	0.23	0.01	0.18	0.15	0.22	0.09
D5	0.26	0.13	0.10	0.20	0.19	0.10
D6	0.32	0.15	0.14	0.24	0.25	0.12
D7	0.23	0.09	0.11	0.25	0.19	0.14
D8	0.29	0.09	0.16	0.23	0.26	0.22
D9	0.33	0.17	0.28	0.40	0.31	0.28
D10	0.14	0.01	0.06	0.06	0.16	0.03
E1	0.09	0.10	0.09	0.17	0.13	0.07
E2	0.19	0.09	0.13	0.14	0.17	0.11
E3	0.13	0.02	0.19	0.15	0.18	0.07
E4	0.17	0.11	0.12	0.23	0.10	0.05
E5	0.14	-0.05	0.02	0.16	0.10	0.14
E6	0.09	-0.04	0.15	0.13	0.10	0.02
E7	0.11	-0.05	0.11	0.08	0.04	0.09
E11	0.19	0.11	0.20	0.19	0.23	0.16

Correlation Matrix

	C8	C9	C10	C11	C12	C13
C8	1.00					
C9	0.34	1.00				
C10	0.66	0.54	1.00			
C11	0.50	0.53	0.75	1.00		
C12	0.53	0.43	0.68	0.70	1.00	
C13	0.52	0.51	0.58	0.66	0.73	1.00
D1	0.10	0.34	0.24	0.24	0.25	0.22
D2	0.10	0.34	0.23	0.22	0.23	0.21
D3	0.07	0.37	0.22	0.26	0.24	0.28
D4	0.05	0.37	0.17	0.21	0.15	0.19
D5	0.11	0.42	0.32	0.32	0.27	0.34
D6	0.14	0.39	0.32	0.30	0.28	0.35
D7	0.15	0.28	0.26	0.28	0.21	0.22
D8	0.11	0.31	0.26	0.27	0.23	0.29
D9	0.19	0.36	0.34	0.36	0.30	0.33
D10	0.19	0.26	0.27	0.22	0.20	0.25
E1	0.10	0.38	0.24	0.29	0.24	0.33
E2	0.20	0.26	0.23	0.22	0.22	0.28
E3	0.23	0.35	0.30	0.28	0.16	0.22
E4	0.23	0.36	0.31	0.31	0.25	0.30

E5	0.24	0.22	0.20	0.26	0.24	0.29
E6	0.22	0.35	0.22	0.27	0.22	0.27
E7	0.19	0.20	0.17	0.24	0.14	0.20
E11	0.22	0.53	0.30	0.29	0.25	0.33

Correlation Matrix

	D1	D2	D3	D4	D5	D6
D1	1.00					
D2	0.80	1.00				
D3	0.53	0.64	1.00			
D4	0.49	0.51	0.67	1.00		
D5	0.60	0.51	0.50	0.59	1.00	
D6	0.55	0.48	0.54	0.56	0.77	1.00
D7	0.32	0.37	0.41	0.36	0.47	0.42
D8	0.40	0.43	0.51	0.55	0.55	0.52
D9	0.50	0.39	0.52	0.54	0.53	0.50
D10	0.22	0.28	0.37	0.40	0.38	0.34
E1	0.28	0.35	0.49	0.38	0.29	0.33
E2	0.24	0.23	0.30	0.36	0.25	0.30
E3	0.29	0.24	0.32	0.36	0.31	0.26
E4	0.10	0.16	0.21	0.18	0.11	0.13
E5	0.05	0.08	0.23	0.25	0.06	0.17
E6	0.07	0.15	0.27	0.31	0.18	0.22
E7	0.07	0.13	0.23	0.28	0.14	0.12
E11	0.26	0.25	0.25	0.28	0.31	0.29

Correlation Matrix

	D7	D8	D9	D10	E1	E2
D7	1.00					
D8	0.54	1.00				
D9	0.36	0.57	1.00			
D10	0.46	0.44	0.41	1.00		
E1	0.31	0.35	0.33	0.29	1.00	
E2	0.11	0.25	0.22	0.19	0.37	1.00
E3	0.20	0.27	0.32	0.27	0.33	0.60
E4	0.16	0.19	0.14	0.17	0.29	0.49
E5	0.17	0.22	0.22	0.25	0.21	0.31
E6	0.37	0.25	0.21	0.30	0.29	0.29
E7	0.18	0.26	0.26	0.19	0.31	0.23
E11	0.21	0.19	0.27	0.19	0.31	0.37

Correlation Matrix

	E3	E4	E5	E6	E7	E11
E3	1.00					
E4	0.53	1.00				
E5	0.33	0.41	1.00			
E6	0.29	0.43	0.56	1.00		
E7	0.25	0.29	0.55	0.57	1.00	
E11	0.42	0.37	0.31	0.37	0.27	1.00

Number of Iterations = 27

LISREL Estimates (Maximum Likelihood)

Measurement Equations

```
B1 = 0.62*TCP, Errorvar.= 0.61  , R² = 0.39
                   (0.080)
                    7.65

B2 = 0.65*TCP, Errorvar.= 0.58  , R² = 0.42
   (0.074)           (0.079)
    8.72              7.32

B3 = 0.45*TCP, Errorvar.= 0.80  , R² = 0.20
   (0.093)           (0.084)
    4.82              9.50

B4 = 0.61*TCP, Errorvar.= 0.63  , R² = 0.37
   (0.098)           (0.076)
    6.22              8.32

B5 = 0.67*TCP, Errorvar.= 0.56  , R² = 0.44
   (0.11)            (0.077)
    6.32              7.22


A1 = 0.52*Int_Cap, Errorvar.= 0.73  , R² = 0.27
   (0.067)               (0.073)
```

7.85 9.93

A2 = 0.70*Int_Cap, Errorvar.= 0.52 , R^2 = 0.48
(0.062) (0.059)
11.26 8.75

A3 = 0.64*Int_Cap, Errorvar.= 0.60 , R^2 = 0.40
(0.063) (0.064)
10.03 9.37

A4 = 0.69*Int_Cap, Errorvar.= 0.53 , R^2 = 0.47
(0.062) (0.059)
11.10 8.87

A5 = 0.73*Int_Cap, Errorvar.= 0.47 , R^2 = 0.53
(0.061) (0.057)
11.95 8.28

A6 = 0.68*Int_Cap, Errorvar.= 0.54 , R^2 = 0.46
(0.062) (0.060)
10.89 8.98

A7 = 0.53*Int_Cap, Errorvar.= 0.72 , R^2 = 0.28
(0.067) (0.073)
7.90 9.84

C8 = 0.60*Mkt_Cap, Errorvar.= 0.64 , R^2 = 0.36
(0.062) (0.064)
9.63 10.00

C9 = 0.64*Mkt_Cap, Errorvar.= 0.59 , R^2 = 0.41
(0.060) (0.058)
10.67 10.19

C10 = 0.86*Mkt_Cap, Errorvar.= 0.26 , R^2 = 0.74
(0.054) (0.038)
15.88 6.94

C11 = 0.86*Mkt_Cap, Errorvar.= 0.27 , R^2 = 0.73
(0.054) (0.035)
15.94 7.61

C12 = 0.78*Mkt_Cap, Errorvar.= 0.39 , R^2 = 0.61
(0.057) (0.044)
13.78 8.76

C13 = 0.79*Mkt_Cap, Errorvar.= 0.37 , R^2 = 0.63
(0.058) (0.048)
13.79 7.68

D1 = 0.67*RD_Cap, Errorvar.= 0.55 , R^2 = 0.45
(0.060) (0.056)
11.21 9.93

D2 = 0.63*RD_Cap, Errorvar.= 0.59 , R^2 = 0.40
(0.060) (0.055)
10.44 10.62

D3 = 0.76*RD_Cap, Errorvar.= 0.42 , R^2 = 0.58
(0.057) (0.046)
13.34 9.01

D4 = 0.77*RD_Cap, Errorvar.= 0.40 , R^2 = 0.60
(0.057) (0.044)
13.68 9.11

D5 = 0.77*RD_Cap, Errorvar.= 0.40 , R^2 = 0.60
(0.057) (0.047)
13.49 8.63

D6 = 0.73*RD_Cap, Errorvar.= 0.47 , R^2 = 0.53
(0.058) (0.050)
12.54 9.35

D7 = 0.56*RD_Cap, Errorvar.= 0.69 , R^2 = 0.31
(0.062) (0.067)
8.93 10.35

D8 = 0.72*RD_Cap, Errorvar.= 0.49 , R^2 = 0.51
(0.058) (0.050)
12.28 9.64

D9 = 0.73*RD_Cap, Errorvar.= 0.47 , R^2 = 0.53
(0.058) (0.050)
12.48 9.58

D10 = 0.51*RD_Cap, Errorvar.= 0.74 , R^2 = 0.26
(0.064) (0.071)
7.96 10.47

```
E1 = 0.54*Mfg_Cap, Errorvar.= 0.71  , R² = 0.29
  (0.067)              (0.072)
   8.12                 9.82

E2 = 0.64*Mfg_Cap, Errorvar.= 0.59  , R² = 0.41
  (0.066)              (0.067)
   9.75                 8.84

E3 = 0.68*Mfg_Cap, Errorvar.= 0.53  , R² = 0.47
  (0.064)              (0.063)
   10.68                8.40

E4 = 0.67*Mfg_Cap, Errorvar.= 0.55  , R² = 0.45
  (0.064)              (0.063)
   10.52                8.76

E5 = 0.50*Mfg_Cap, Errorvar.= 0.75  , R² = 0.25
  (0.068)              (0.075)
   7.40                 9.97

E6 = 0.54*Mfg_Cap, Errorvar.= 0.71  , R² = 0.29
  (0.067)              (0.072)
   8.11                 9.78

E7 = 0.43*Mfg_Cap, Errorvar.= 0.81  , R² = 0.19
  (0.069)              (0.079)
   6.23                 10.25

E11 = 0.61*Mfg_Cap, Errorvar.= 0.63  , R² = 0.37
  (0.065)              (0.067)
   9.37                 9.35


Error Covariance for B2 and B1 = 0.21
                   (0.065)
                    3.19

Error Covariance for B5 and B3 = 0.21
                   (0.062)
                    3.39

Error Covariance for A2 and A1 = 0.26
                   (0.052)
                    5.10
```

Error Covariance for A7 and A5 = 0.18
(0.049)
3.73

Error Covariance for C10 and C8 = 0.15
(0.038)
3.92

Error Covariance for C13 and C10 = -0.11
(0.025)
-4.50

Error Covariance for C13 and C12 = 0.11
(0.038)
2.80

Error Covariance for D2 and D1 = 0.37
(0.046)
8.04

Error Covariance for D3 and D2 = 0.14
(0.029)
4.81

Error Covariance for D5 and D3 = -0.07
(0.025)
-2.83

Error Covariance for D6 and D5 = 0.20
(0.040)
5.16

Error Covariance for D10 and D7 = 0.18
(0.050)
3.51

Error Covariance for E3 and E2 = 0.16
(0.050)
3.24

Error Covariance for E6 and E5 = 0.29
(0.057)
5.04

Error Covariance for E7 and E5 = 0.33

(0.060)
5.54

Error Covariance for E7 and E6 = 0.34
(0.060)
5.65

Structural Equations

TCP = 0.25*Int_Cap + 0.14*Mkt_Cap + 0.28*RD_Cap - 0.17*Mfg_Cap, Errorvar.= 0.80 , R^2 = 0.20

(0.097)	(0.10)	(0.11)	(0.12)	(0.20)
2.60	1.37	2.57	-1.41	4.04

Correlation Matrix of Independent Variables

	Int_Cap	Mkt_Cap	RD_Cap	Mfg_Cap
Int_Cap	1.00			
Mkt_Cap	0.41	1.00		
	(0.06)			
	6.38			
RD_Cap	0.39	0.46	1.00	
	(0.07)	(0.06)		
	5.93	8.04		
Mfg_Cap	0.32	0.55	0.56	1.00
	(0.07)	(0.06)	(0.06)	
	4.34	9.66	9.83	

Covariance Matrix of Latent Variables

	TCP	Int_Cap	Mkt_Cap	RD_Cap	Mfg_Cap
TCP	1.00				
Int_Cap	0.36	1.00			
Mkt_Cap	0.28	0.41	1.00		
RD_Cap	0.35	0.39	0.46	1.00	
Mfg_Cap	0.15	0.32	0.55	0.56	1.00

Goodness of Fit Statistics

Degrees of Freedom = 568
Minimum Fit Function Chi-Square = 1001.14 (P = 0.0)
Normal Theory Weighted Least Squares Chi-Square = 930.62 (P = 0.0)
Estimated Non-centrality Parameter (NCP) = 362.62
90 Percent Confidence Interval for NCP = (282.89 ; 450.25)

Minimum Fit Function Value = 4.22
Population Discrepancy Function Value (F0) = 1.53
90 Percent Confidence Interval for F0 = (1.19 ; 1.90)
Root Mean Square Error of Approximation (RMSEA) = 0.052
90 Percent Confidence Interval for RMSEA = (0.046 ; 0.058)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.30

Expected Cross-Validation Index (ECVI) = 4.75
90 Percent Confidence Interval for ECVI = (4.42 ; 5.12)
ECVI for Saturated Model = 5.62
ECVI for Independence Model = 47.51

Chi-Square for Independence Model with 630 Degrees of Freedom = 11188.25
Independence AIC = 11260.25
Model AIC = 1126.62
Saturated AIC = 1332.00
Independence CAIC = 11421.25
Model CAIC = 1564.91
Saturated CAIC = 4310.53

Normed Fit Index (NFI) = 0.91
Non-Normed Fit Index (NNFI) = 0.95
Parsimony Normed Fit Index (PNFI) = 0.82
Comparative Fit Index (CFI) = 0.96
Incremental Fit Index (IFI) = 0.96
Relative Fit Index (RFI) = 0.90

Critical N (CN) = 154.72

Root Mean Square Residual (RMR) = 0.066
Standardized RMR = 0.066
Goodness of Fit Index (GFI) = 0.82
Adjusted Goodness of Fit Index (AGFI) = 0.79
Parsimony Goodness of Fit Index (PGFI) = 0.70

The Modification Indices Suggest to Add the

Path to	from	Decrease in Chi-Square	New Estimate
C9	RD_Cap	20.9	0.29
C9	Mfg_Cap	29.5	0.40
D4	Mkt_Cap	10.8	-0.18
D9	Int_Cap	16.4	0.24
E1	RD_Cap	18.0	0.34
E4	RD_Cap	20.9	-0.36

The Modification Indices Suggest to Add an Error Covariance

Between	and	Decrease in Chi-Square	New Estimate
A6	A1	8.5	-0.12
A7	A6	7.9	0.12
D4	D3	12.1	0.11
D8	D1	11.1	-0.09
D8	D7	13.3	0.14
D9	D2	8.5	-0.08
E1	D3	9.8	0.11
E5	A4	9.4	-0.12
E5	D5	12.6	-0.10
E6	D7	16.8	0.16
E11	C9	22.7	0.21

Time used: 0.313 Seconds