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AN INVESTIGATION OF THE SIMULTANEOUS IMPACT OF LAUNCH AND LOGISTICS STRATEGIES ON NEW PRODUCT PERFORMANCE

By

Gilbert Ngarih Nyaga

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ABSTRACT

AN INVESTIGATION OF THE SIMULTANEOUS IMPACT OF LAUNCH AND LOGISTICS STRATEGIES ON NEW PRODUCT PERFORMANCE

By

Gilbert Ngarih Nyaga

This research investigates how firms' logistics and launch strategies impact new product performance under different competitive, demand, product, and firms characteristics. Specifically, the research examines new product launch in companies that deal with durable and non-durable consumer products. Based on data from three case studies, a simulation model is developed to examine the overall and interaction effects of logistics strategies, launch strategies, demand characteristics, product characteristics, and firm resources on new product performance. New product performance is examined in terms of customer service (as measured by order and case fill rates), average system inventory, and profitability.

Results from simulation experiments indicate that logistics strategy is a major determinant of new product performance while launch strategy affects inventory and profitability but not customer service. Logistics and launch strategy have a significant interaction effect on performance. Moreover, demand uncertainty, competitive environment, product characteristics, and firm resources impact new product performance either directly or interactively.

Managerial implications are discussed and a framework identifying appropriate strategy in different situations is provided. Suggestions for future research are also provided.

Dedicated to my sister, **Agnes Mairu** who taught me how to write my name and sacrificed her studies so that I continue with mine.

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CHAPTER I: INTRODUCTION

1.0 Introduction

Although the importance of logistics capabilities in the attainment of firms' competitive goals is underscored in many studies (Bowersox et al. 1989; MSUGLRT 1995; Fawcett et al. 1997; Daugherty et al. 1998; Stank et al. 2003; Zacharia and Mentzer 2004), the impact of these capabilities on new product performance is rarely addressed (Bowersox et al. 1999; Di Benedetto 1999; Hart and Tzokas 2000; Calantone et al. 2005). This research seeks to fill the gap by examining the impact of logistics strategies on new product performance. Specifically, the research examines new product launch process in three companies that deal with durable and non-durable consumer products. Based on data from these case studies, a simulation model is developed to examine the overall and interaction effects of logistics strategies, launch strategies, demand characteristics, and firm size on new product performance.

1.1 Background

The decisions and activities necessary to deliver a new product to its target market have been referred to under the collective terms of launch strategy, market entry, product launch, product introduction, or market launch (Hultink and Hart 1998). Extant literature shows that new product launch is the most expensive, risky and time-consuming stage in the new product development process (Guiltinan 1999; Droge et al. 2000; Calantone et al. 2005). Product delivery process greatly impacts new product performance (Cooper and Kleinschmidt 1993) while distribution support is critical where market acceptance is difficult to achieve and diffusion is slow (Guiltinan 1999). Consequently, logistics capabilities can improve new product launch success and minimize losses from unsuccessful launches (Calantone et al. 2005). Companies can reduce the cost of new product launch by prioritizing inventory deployment and emphasizing flexible and responsive logistics capabilities to mitigate risks associated with demand uncertainties (Fisher 1997; Pagh and Cooper 1998; Bowersox et al. 1999; Di Benedetto 1999). However, few studies have examined the simultaneous effect of launch strategies and logistics strategies on new product performance in different competitive and demand situations.

A few studies have developed conceptual frameworks to examine the role of logistics and supply chain strategies in new product launch process. For example, Fisher (1997) examines the type of supply chain strategy that is most suitable for given products. He identifies two product categories, functional and innovative products, and two supply chain strategies, efficient and responsive strategies. He posits that functional products require efficient supply chain processes while innovative products require responsive supply chain processes. Therefore, he recommends that companies introducing new products should match their supply chain strategies to the appropriate product type.

Bowersox et al. (1999) posit that firms adopt two alternative strategies when launching new product: traditional anticipatory launch strategies and lean launch strategies. Traditional launch is demand forecasts driven and is based on anticipatory logistics (push) while lean launch is premised on principles of postponement supported by response-based logistics (pull) and supply chain capabilities. The authors argue that lean launch strategy enhances new product introduction by minimizing out-of-stock potential, allowing greater flexibility in product variant, and reducing inventory exposure. Closs et al. (1998) empirically compared anticipatory and response-based strategies under conditions of demand uncertainty and concluded that response-based strategies outperform anticipatory strategies in terms of customer service delivered. However, there are no empirical tests to validate Bowersox et al. (1999)'s conceptualizations.

Calantone et al. (2005) further explore Bowersox et al.'s (1999) arguments by presenting an assessment of potential pitfalls of traditional anticipatory launch strategy and ways in which the alternative lean launch mitigates those problems. Using two company cases (Dell Computers and Benetton), the authors demonstrate the successful application of lean launch methods supported by flexible supply chain capabilities. However, the study does not assess the impact of prevailing competitive environment and stipulations are not empirically tested.

This research seeks to empirically test relationships and conceptualizations stipulated in the aforementioned studies, and present a comprehensive framework to help in quantitatively determining the simultaneous impact of firms' logistics and launch strategies, competitor response, product characteristics, and demand characteristics on new product performance.

1.1.1 New Product Performance

Several measures of new product performance are examined in extant literature. These measures have been categorized as financial performance (i.e., profits, sales, costs, etc.), market acceptance/share (i.e., market position, sales levels, sales performance compared to competition, etc.), and technical performance (i.e., product quality, technical performance, etc.) (Montoya-Weiss and Calantone 1994; Green, Barclay and Ryan 1995; Hultink and Robben 1999). The performance measures examined in this research are: customer service, average system inventory, and profitability. These measures have been widely used in past studies (Chow et al. 1994; Closs et al. 1998; Glasserman and Wang 1998; Song 1998; Gunasekaran et al. 2001; Bowersox et al. 2002; Haughton 2002; Griffis et al. 2004).

Customer service is measured in terms of order fill rate (percentage of customer orders filled complete within a specific time frame) and case fill rate (percentage of cases that are delivered complete within a specified time period). Average system inventory is examined in terms of system-wide inventory holdings at a given stage and time in the logistics system (Closs et al. 1998). Profitability is derived from total sales less the product cost, inventory carrying cost, transportation cost, and stockout penalty.

1.1.2 Logistics Strategy

According to the Council of Supply Chain Management Professionals (CSCMP), logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements (www.cscmp.org). Thus, logistics strategy can be viewed as a set of objectives, decisions and activities associated with logistics management. In previous studies, two types of logistics strategy relating to new product introduction are examined: anticipatory and response-based strategies (Fisher 1997; Bowersox et al. 1999; Calantone et al. 2005).

In anticipatory strategy, sufficient pre-introduction inventory is deployed in the distribution channels so as to meet forecasted demand. Although forecasting techniques have improved significantly in recent years, it is almost impossible to predict with absolute precision the expected sales and likely performance of a new product when introduced in the market. Thus, anticipatory logistics strategy has several risks and cost implications, which can negatively affect financial and market results whether the launch is a success or failure (Bowersox et al. 1999; Calantone et al. 2005). These include high inventory carrying costs due to overstocking, lost sales due to inventory shortages (under-stocking), and limited product variation, which may lead to customer dissatisfaction.

In a response-based strategy, a flexible logistics system capable of responding rapidly to changes in actual demand requirements is used to support limited inventory commitment during new product introduction. The strategy enables better management of risks associated with demand uncertainties through flexible and responsive delivery capabilities supported by upstream supply chain coordination (Bowersox et al. 1999). The strategy is based on postponement principles (Zinn and Bowersox 1988; Cooper 1993; Pagh and Cooper 1998; Waller et al. 2000). Postponement reduces the risk of improper inventory deployment and the need to stock inventory for all product variations, which contributes to reduction in inventory carrying costs. Consequently, response-based strategy mitigates cost concerns associated with anticipatory strategy. However, smaller shipment quantities and flexible responses result in shipment cost increases, which if not well planned can significantly increase the cost of launch.

Bowersox et al. (1999) posit that four strategic issues in new product literature have significant implications on logistics processes: what to launch, where to launch, when to launch, and how to launch. These are related to Hultink et al. (1998)'s launch strategy classification where the first three relate to the *what*, *where*, and *when to launch* strategic decision questions while *how to launch* is similarly stipulated as a tactical decision question. First, *what to launch* raises the question of the ability of existing logistics processes to support the new product deployment. For example, if the product is perishable, can the current logistics system support its delivery to customers on time and in good condition? Second, *where to launch* addresses accessibility of markets via existing logistics systems. For example, a firm might avoid a market that has poor infrastructure since logistics costs at launch may be excessive. However, where infrastructure is good, the new product deployment can be effectively planned and executed at minimal logistics costs. Third, *when to launch* hinges on capacity of existing logistics systems to support the anticipated scale of launch. For example, even if production capacity can be ramped up to meet seasonal demand, the volume deployed may be constrained by the capacity of existing logistics system. Finally, *how to launch* reflects the firms' launch strategy.

The foregoing discussion indicates that logistics strategy influences new product launch planning and performance. Indeed, as Di Benedetto (1999) posits, most successful new product launches are characterized by greater perceived involvement of the logistics functions in marketing, sales, distribution, and sales planning. Integrating logistics functions with other internal functions of the firm is expected to improve coordination of products flow and consequently improve the firm's ability to handle new product demand uncertainties. Moreover, this coordination is important when handling product recalls and other reverse logistics functions. Consequently, logistics strategy is stipulated to directly impact new product performance. However, this has not been empirically tested. Indeed, there is no empirical comparison of anticipatory and response-based logistics strategies in new product launch literature.

1.1.3 Launch Strategy

Launch strategy is defined as decisions and activities necessary to present a product to its target market and begin to generate income from sales (Choffray and Lilien 1984; Yoon and Lilien 1985; Green et al. 1995; Hultink et al. 1998). Several studies have attempted to determine a generic launch strategy. For example, Hultink et al. (1997; 1998) posit that managers generally make one set of launch decisions prior to beginning of new product development (strategic decisions) and another set of decisions after conceptualization and development of the product is complete (tactical decisions). Strategic decisions address the *what*, *where*, *when*, and *why* questions while tactical decisions address the *how to launch* question. Green et al. (1995) posit that launch strategy consists of three managerial decisions that affect the product's long-term performance, viz., timing of entry, magnitude of investment, and competitive emphasis. Hultink and Robben (1999) classify launch decisions into three categories, namely, strategic/market decisions, timing-related decisions, and marketing mix decisions.

These launch strategy conceptualizations can be viewed as different ends of the same spectrum. For example, the studies concur that entry timing is an important launch strategy component. Moreover, marketing mix decisions are integral to launch strategy. The magnitude of investment component stipulated in Green et al. (1995) is not only a strategic decision, but is also related to marketing mix decisions (i.e., promotion expenditure, distribution coverage, etc.). Therefore, to comprehensively examine and understand launch strategy, it is important to address both strategic and tactical decisions. This research examines distribution aspects of launch strategy in both strategic and tactical context. Specifically, the research focuses on scale of launch as it impacts new product performance. Distribution decisions are viewed in terms of launch size (i.e. *where to launch*). Calantone et al. (2002) differentiate between large size and small size launch strategy. They refer to these as fat and lean, respectively. In other studies, large size launch where new product is introduced in all markets simultaneously is referred to as national launch while small size launch in which product is only introduced in select markets only, then gradually introduced in the remaining markets is referred to as rollout strategy (Bronnenberg and Mela 2004).

In fat launch, a firm introduces new product in all markets simultaneously. For example, if a firm has delineated its customer market into ten segments, and it launches new product in all ten segments, then this is fat or national launch. In lean or rollout launch, a firm introduces new product in select markets only then sequentially launches in other markets. For example, if a firm in the above case launched new product in only three of the ten segments, then another three, two, and two sequentially, then this is lean or rollout launch. In this research, the terms national and rollout launch are used instead of fat and lean launch, respectively so as to distinguish launch strategy from logistics strategies.

Launch strategy is expected to directly impact new product performance. Consequently, these alternative launch strategies will result in different new product performance. However, no test has been done to determine which strategy is better in which situations.

1.1.4 Interaction between Logistics Strategy and Launch Strategy

Although past studies suggest that logistics strategy and launch strategy directly impact new product performance, there are no studies examining the interaction effect between these strategies. According to Bowersox et al. (1999) and Calantone et al. (2005), rollout launch is associated with response-based logistics system while national launch is associated by anticipatory logistics. However these relationships have not been empirically tested. Moreover, the conceptualization of launch strategy adopted in this research differs from that posited by Bowersox et al. (1999) and Calantone et al. (2005).

The view adopted in this research clearly distinguishes launch strategy dimensions from logistics strategy dimensions. For rollout launch, firms can either produce sufficient new product inventory to deploy to selected market segments based on demand forecast or adopt a market-responsive approach in which production and inventory deployment is done only after customer orders are received. Similarly, in national launch, firms can deploy inventory to market based on forecasted demand or by responding to customer orders. Thus, examining effectiveness of the four possible combinations of logistics strategy and launch strategy may yield important managerial and theoretical insights.

A 2x2 matrix is used to identify the possible outcomes of interaction between launch strategy and logistics strategy, as shown below.

Figure 1.1: Logistics Strategy x Launch Strategy Matrix

		Logistics strategy	
		Anticipatory	*Response-based*
Launch Strategy	*Rollout*	Opportunity loss?	Okay?
	National	Inefficiency?	Insufficient capacity?

In the top left box, firms adopt rollout launch supported by anticipatory logistics. For example, a firm launches new product in three out of ten market segments by producing sufficient inventory to meet forecasted demand in those segments, and then deploying the inventory into the distribution system in anticipation of forecasted sales. This approach has two major risks. First, the firm may incur high inventory carrying cost since inventory is deployed into the distribution system before commencement of sales. If product fails, the firm will incur inventory carrying cost due to overstock, obsolescence cost, and write-off costs as well as opportunity cost for tying capital in deployed inventory. Secondly, if product is successful, the firm will have lost an opportunity to increase sales, market share, and customer loyalty. If competitors respond quickly to the new introduction, opportunity losses may have significant long term implications. Consequently, it is expected that rollout launch supported by anticipatory logistics has a high risk of opportunity loss.

In the bottom left box, firms adopt national launch supported by anticipatory logistics system. For example, a firm launches new product in all market segments by deploying sufficient inventory into the distribution system based on demand forecasts. This approach has several cost implications. First, under uncertain demand environment, the firm may overstock in some markets, or worse, in all markets thereby incurring high inventory carrying costs and associated opportunity costs. Second, if product succeeds in some market segments and fails in others, the firm may have to transship inventory from poorly performing market segments to those segments with high demand and inventory shortage. Finally, if new product is a failure, the company will incur high obsolescence and write-off cost. Since launch is done in multiple market segments, the cumulative inventory carrying costs may be extremely high, making this approach highly inefficient.

In the top right box, firms adopt rollout launch supported by response-based logistics. For example, a firm launches new product in three out of ten market segments by deploying new product into the distribution system only upon receiving customer orders. Since market segments in which new product is introduced are few, it is expected that the firm will manage a response-based logistics system more effectively. In other words, it is easier and more efficient to manage a market-responsive logistics system when serving a small market than when serving a large market. Therefore, it is expected that supporting rollout launch with a response-based logistics is most appropriate.

In the bottom right box, firms adopt national launch supported by response-based logistics. For example, a firm launches new product in all market segments by deploying inventory into the distribution system only upon receiving orders from the customers. The challenge with this approach is that managing a response-based logistics system for all its customers may be extremely expensive and inefficient. Furthermore, the firm may not have sufficient capacity (i.e., ramping up manufacturing or distribution capacity) to respond appropriately to increased customer orders from many segments. Therefore, it is expected that national launch supported by response-based logistics will have insufficient capacity problems.

This research makes an important contribution by testing proposed interaction outcomes, and identifying the combination of logistics and launch strategies that impacts new product performance most significantly. Moreover, the research tests how these interactions affect performance under different competitive and demand conditions.

1.1.5 Environmental Factors

Several environmental factors are stipulated to impact new product performance. This study examines two factors: competitive response and demand uncertainty. Competitive response is a set of decisions made by a firm in response to an observed new product launch (Hultink and Langerak 2002), and have the effect of reducing demand for the new product. They are influenced by several drivers. First, characteristics of new product launch strategy such as product newness (innovativeness) triggers retaliatory behavior from competitors especially in highly competitive markets (Kuester et al. 1999; Debruyne et al. 2002). Second, industry factors such as market structure influence the intensity and speed of response (Bowman and Gatignon 1995; Debruyne et al. 2002). For example, competitor response is more rapid and aggressive in markets exhibiting high growth rates (Yoon and Lilien 1985). Third, market signaling, which refers to a set of signals generated by the scope, intensity, and competitiveness of a new product launch is stipulated to influence competitive response (Heil and Walters 1993). Finally, competitive response tends to take longer when switching costs are high, market growth is slow, time required for developing new products is long, and when reacting firm's market share is high (Bowman and Gatignon 1995). Although past studies demonstrate that competitive response influences new product performance, no study has been done to investigate its moderating effect on the impact of launch strategy and logistics strategy on new product performance.

Demand for new products may be highly unpredictable. As a result, responsive logistics processes are desirable since they enable better management of uncertainty. For example, firms introducing new to market (first time) products tend to rely on forecasts based on potential customer surveys and focus groups. These forecasts are susceptible to high margin of error, which can have significant impact on launch cost and performance. Thus, when making launch decisions, it is expected that firms will take cognizance of prevailing demand uncertainty.

1.1.6 Product Characteristics

Extant literature shows that the main product characteristic influencing new product launch planning is product advantage. Product advantage refers to the bundle of tangible and intangible benefits that a product offers to its customers that are unique and superior to competitive brands (Cooper and Kleinschmidt 1987; Montoya-Weiss and Calantone 1994; Li and Calantone 1998). Cooper and Kleinschmidt (1987) found that product advantage was the number one factor influencing new product commercial success. Other studies suggest that product advantage is associated with incumbent's competitive response and market acceptance, which may affect new product performance (Yap and Souder 1994; Hultink and Robbin 1999; Kuester et al. 1999; Debruyne et al. 2002). Consequently, it is stipulated that product advantage has a direct impact on new product performance.

1.1.7 Firm Resources

Firm resources enable firms to implement strategies that provide competitive advantage in the market place. Broadly perceived, they refer to the tangible and intangible assets that firms use to develop and implement their strategies (Ray et al. 2004). According to the resource-based view of the firm, firm performance differences arise because firms possess unique resources and capabilities that are rare, valuable, inimitable, and non-substitutable, which enable them to appropriate above normal returns (Wernerfelt 1984; Barney 1991; Peteraf 1993). Therefore, firms leverage their resources and capabilities to realize superior profits and sustainable competitive advantage (Barney 1991; Peteraf 1993; Day 1994). In this research, it is stipulated that firms' resource endowment impacts new product performance. For example, a firm's transportation and warehouse capacity may dictate how much inventory (and where) is deployed in the market place, which directly affects new product performance.

1.2 Research Objectives

The overall objective of this research is to understand how logistics strategies affect new product introduction, the interaction between logistics and launch strategies, and the moderating effect of demand factors on new product performance. The effect may vary with type of product and industry. Thus, the study examines companies dealing with durable and non-durable consumer goods. Based on the case studies, a simulation model is developed to enable realization of three main research objectives:

1. To examine how logistics and launch strategies affect new product performance.

2. To examine the relationship between logistics strategy and launch strategy during new product introduction, and how this interaction affects performance.
3. To identify optimal combination of logistics and launch strategies that result in most successful new product launch under different competitive and demand situations.

1.3 Research Questions

To realize these objectives, the study addresses the following main research questions:

1. What effects do logistics and launch strategies have on new product performance?
2. What is the interaction effect between logistics and launch strategies on new product performance?
3. How do competitive and demand situations affect the impact of logistics and launch strategies on new product performance?
4. What effect does product characteristic have on new product performance?
5. What effect do firm resources have on new product performance?

1.4 Research Method

The research is done in two phases. First, case studies of companies that regularly launch new products (the representation firms market durable consumer products and non-durable consumer products) are done. Each case study identifies the firm's new product launch process including logistics strategies employed. Past studies have used case study research to examine dynamics present within single settings (Eisenhardt 1989; Miles and Huberman 1994; Yin 2003). According to Yin (2003:13), a case study is "an empirical inquiry that investigates a contemporary phenomenon within its real-context, especially when the boundaries between phenomenon and context are not clearly evident." The aim is to investigate contextual conditions that might be pertinent to the phenomena under study.

In the second phase, a simulation design modeled after data from case studies is developed. Simulation modeling technique is widely applied to many problems and systems that are difficult to feasibly construct or experiment upon in 'real world' or that are too complex to model analytically (Rees et al. 2002). It is a tool for planning and analysis that models real-world settings and estimates outcomes given a set of situational characteristics (Closs et al. 1998). Unlike most analytic models, simulation models can accommodate dynamic interrelationships and assumptions are less restrictive (Marucheck and McClelland 1992). This means that simulation analysis enables a more detailed assessment of interrelationships between logistics and launch strategies under different competitive and demand situations. Input and output variables, as well as uncontrollable factors for the simulation model were determined from the case studies. The resulting simulation model was subjected to rigorous verification and validation process as stipulated by Sargent (2000).

The research is done in five stages. First, case study interviews are conducted to collect data from selected firms. Second, new product launch process flows of the studied companies are mapped. Third, a system dynamic simulation model is developed, based on the mapped process flows and ideas derived from extant literature. Fourth, simulation runs are conducted to generate data, which is used to test study hypotheses. Finally, analysis and discussion of research findings is done. MANOVA and ANOVA are used to analysis data.

1.5 Justification of Study

New products play a significant role in a firm's growth and competitiveness. Studies show that recently introduced products account for a significant portion of firm's profits (Debruyne et al. 2002). Indeed, new product performance is positively related to overall organizational performance (Montoya-Weiss and Calantone 1994; Griffin and Page 1996; Hultink et al. 1998). For example, Griffin (1997) posits that new product performance accounts for one-fourth of variability in organizational performance while Terwiesch et al. (1998) report that new product performance explains, depending upon the market context, about 30 percent of organizational profitability variance. Product launch is the most demanding new product development phase in terms of time, finances, and managerial resources (Bowersox et al. 1999; Debruyne et al. 2002). Cooper and Kleinschmidt (1988) posit that 54 percent of all new product expenditures are spent on market launch compared to 39 percent spent on product development and 7 percent on pre-development activities. In spite of the demonstrated importance of the launch stage, there is limited research on the issue especially with respect to logistics strategy effects.

Thus, this study makes four important contributions. First, it investigates the role of logistics strategies in enabling successful new product launch. This is crucial considering the growing importance of logistics capabilities as sources of sustainable competitive advantage in contemporary business operations (Olavarietta and Ellinger 1994; MSUGLRT 1994; Fawcett et al. 1997; Lynch et al. 2000). Second, it considers interaction effect between logistics and launch strategies in influencing new product performance. Third, it considers environmental factors that moderate the impact of logistics and launch strategies on new product performance. Finally, the research employs simulation modeling, which allows researchers to understand the impact of multiple decision factors and identify appropriate alternatives. Thus, it demonstrates the use of simulation analysis in new product launch research.

1.6 Organization of Chapters

Chapter 1 provided an overview of dissertation focus including research motivation, objectives, questions, and justification. Chapter 2 presents a review of relevant literature leading to conceptual model and research hypotheses. Chapter 3 discusses research design, including research approaches used in the study – case study and simulation analysis. Chapter 4 presents simulation data analysis and results as well as research findings. Chapter 5 discusses implications of research findings, research contribution, limitations, and suggestions for future research.

CHAPTER II: LITERATURE REVIEW

2.0 Introduction

This chapter presents a review of literature on factors associated with new product performance and highlights major research findings and gaps. The chapter is organized into four sections: (a) review of issues related to new product launch, (b) determinants of new product performance, (c) discussion of models and techniques for launch analysis used in the study, and (d) conceptual model and research hypotheses. The chapter concludes with a summary of key literature gaps, which the study addresses.

2.1 Issues Related to New Product Launch

Past studies indicate that new product launch represents the largest investment, most expensive, risky, and time consuming phase in the entire new product development process (Urban and Hauser 1993; Guiltinan 1999; Droge et al. 2000; Calantone et al. 2005). As Guiltinam (1999) suggests, this is attributed to a combination of production and marketing expenditures incurred once a decision to launch is approved. Most new product studies examine either the marketing component (market entry, promotions, etc) or development process (proficiency of technical skills, new product development teams, etc) (Montoya-Weiss and Calantone 1994; Henard and Szymanski 2001). The role of logistics functions in the launch process has received limited attention (Bowersox et al. 1999; Di Benedetto 1999). Di Benedetto (1999) posits that greater involvement of logistics functions in marketing, sales, distribution, inventory, and service planning during launch can greatly enhance new product performance. Indeed, logistics capabilities are highly intertwined with launch processes such as entry timing, distribution planning, promotion planning, etc. Therefore, this research seeks to advance new product launch knowledge by examining the simultaneous impact of launch and logistics strategies on new product performance.

New product performance is the degree of market success attained by a product at market maturity or the point at which product market boundaries change (Green et al. 1995). Most common measures of performance include profitability, market share, unit sales, customer loyalty, etc. Three performance measures that are easier to model are examined in this research: customer service, system inventory, and profitability. These measures have been successfully applied in past studies (Chow et al. 1994; Glasserman and Wang 1998; Closs et al. 1998; Song 1998; Bowersox, et al. 2002).

2.2 Determinants of New Product Performance

Extant literature shows that several factors impact new product performance (Cooper and Kleinschmidt 1987; Montoya-Weiss and Calantone 1994; Yap and Souder 1994; Henard and Szymanski 2001). Cooper and Kleinschmidt (1987) identified the key new product success factors as product advantage (i.e., innovativeness), proficiency of predevelopment activities (i.e., initial screening, marketing research, business analysis, etc.), and protocol (i.e., clear definition of target market, product specifications, etc.). Other factors included proficiency of technological and market-related activities, technological synergy, marketing synergy, and market potential.

Yap and Souder (1994) identify seven factors that influence new product development, and commercial success or failure. These are project synergies (i.e., marketing, engineering and production skill synergies), skills level (i.e., project manager's management and marketing skills, manufacturing skills, etc.), technology sources (i.e., licensing, key personnel, etc.), product characteristics (i.e., product features, compatibility, etc.), market characteristics (i.e., market growth, number of competitors, etc.), entry strategies (i.e., pricing, distribution, positioning, etc.), and organizational characteristics (i.e., interdepartmental communication, top management involvement, etc.). These factors are similar to those suggested by Cooper and Kleinschmidt (1987). For example, both studies suggest that market characteristics, technology aspects, product characteristics, synergies, and launch proficiency determine new product success.

Subsequent meta-analysis studies by Montoya-Weiss and Calantone (1994) and Henard and Szymanski (2001) build on these classifications to develop a more refined taxonomy of determinants of new product performance. Montoya-Weiss and Calantone (1994) conducted a meta-analysis of antecedents of new product performance in which they classify the determinants discussed in literature into four categories. These categories are strategic factors (i.e., product advantage, technology and market synergies, company resources, etc.), development process factors (i.e., protocol, speed to market, technical proficiency, top management support, etc.), market environment factors (i.e., market competitiveness, market potential, etc.), and organizational factors (i.e., degree of coordination and cooperation between and within firms, firm structure, organizational climate, etc.). These factors are similar to those identified by Cooper and Kleinschmidt (1987) and Yap and Souder (1994). However, the classification is more succinct.

Henard and Szymanski (2001) also classify the determinants into four categories, namely, product characteristics (i.e., product advantage, technological sophistication, price, etc.), firm strategy characteristics (i.e., timing of entry, magnitude of resources deployed, marketing and technological synergies, etc.), firm process characteristics (i.e., interfunctional coordination, proficiency, etc.), and market characteristics (i.e., market potential, competitive intensity, demand characteristics, etc.). This classification is a refinement of Montoya-Weiss and Calantone (1994). The only difference is that predictors are placed in different categories. For example, Montoya-Weiss and Calantone (1994) classify product advantages under strategic factors while Henard and Szymanski (2001) classify them under products characteristics.

Most studies focus on main effects while ignoring interrelationships among determinant variables (Henard and Szymanski 2001). Interactions between determinant variables are expected to yield different performance outcomes. For example, new product development processes directly affect product characteristics while market characteristics such as competitive intensity may strongly influence a firm's strategy and launch budget. Consequently, it is important to examine interaction effects in detail. The study addresses this gap by examining interaction effect of logistics and launch strategies, product characteristics, demand characteristics, and firm size.

2.2.1 Logistics Strategy

Logistics processes are inherently intertwined with new product introduction. Bowersox et al. (1999) posit that four strategic issues in new product literature have significant implications on logistics processes: the *what*, *where*, *when* and *how to launch*. These are related to Hultink et al.'s (1997; 1998) strategic-tactical launch strategy decision questions. However, in spite of demonstrated importance of logistics functions during new product launch, the role of logistics is substantially under-researched

(Bowersox et al. 1999, Di Benedetto 1999, Guiltinan 1999, Calantone et al. 2005). Thus, more research is required to establish the extent to which logistics strategies impact new product performance.

Three studies have addressed issues related to logistics strategy's role during new product introduction. The first study, Fisher (1997), examines the most suitable match between supply chain strategy and type of products. The author posits that developing an effective supply chain strategy requires managers to take cognizance of the nature of demand for the product being launched. For example, managers should consider such factors as product life cycle, demand predictability, product variety, and market standards for lead times and service (p.106). Based on the demand pattern, he classifies products as functional and innovative product. Functional products include staples that people buy in a wide range of retail outlets such as grocery stores and gas stations. The demand for these products tends to be stable and predictable, their life cycles tend to be long, and as a result, they tend to be characterized by stiff competition, which leads to low profit margins. Innovative products on the other hand tend to have unpredictable demand and shorter life cycles, and generally have higher profit margins.

These product characteristics engender different supply chain strategies. For example, the fairly predictable demand for functional products and low profit margins means that companies tend to focus more on profit maximizing supply chain activities with least costs. However, innovative products have high profit margins and uncertain demand, which increases the cost of lost sales and over-supplies (obsolescence cost). Efficient supply chain processes aim at supplying predictable demand efficiently at the lowest possible cost while market-responsive supply chain process aim at responding quickly to unpredictable demand in order to minimize stock-outs, forced markdowns, and obsolete inventory. Therefore, functional products require efficient supply chain processes while innovative products require market-responsive processes. Companies introducing new products should match their supply chain strategies to appropriate product types since different products have unique delivery requirements, demand characteristics, and profitability potential. Fisher's (1997) arguments underscore the need to examine the impact of logistics strategies on new product performance. Moreover, environmental conditions under which a specific match results in maximal performance have not been investigated.

The second study, Bowersox et al. (1999), builds on Fisher's (1997) ideas and argues that firms launching new products adopt two alternative strategies: traditional anticipatory launch strategies and lean launch strategies. Anticipatory strategy entails sufficient pre-introduction inventory deployment in the distribution channels so as to meet forecasted demand. It is based on anticipatory logistics (push), in which inventory to support projected sales are deployed into the distribution channel in anticipation of expected sales. Lean launch strategy is based on postponement principles supported by responsive logistics (pull) and supply chain capabilities. In this approach, only limited inventory is deployed in the distribution channel during introduction rollout since flexible logistics system can support rapid response in case of early product success. The authors conclude that lean strategy enhances new product performance by minimizing out-of-stock potential, allowing greater flexibility in product variant selection, and reducing inventory exposure. However, although supported in literature, these arguments have not been empirically tested. Moreover, the study focuses on logistics and supply chain strategies during new product launch but gives limited attention to environmental factors that may have profound impact on both logistics strategy and launch proficiency.

The third study, Calantone et al. (2005), builds on Bowersox et al.'s (1999) arguments. The authors examine potential pitfalls of traditional anticipatory launch strategy and how the alternative lean launch mitigates those pitfalls. Like Fisher (1997), the authors posit that optimal performance can be realized by matching launch strategy (or supply chain strategy) to market demand (which is related to product characteristics). The authors cite two company cases (Dell Computers and Benetton) to make their arguments and recommend greater inclusion of distribution and logistics functions in launch planning. While the propositions make intuitive sense and are supported in literature, no empirical or in-depth qualitative analysis has been done. This research will empirically test these propositions.

Bowersox et al. (1999) and Calantone et al. (2005) highlight three major risks associated with anticipatory launch strategy. First, since this approach is premised on demand forecasting, it is susceptible to uncertainties that accompany forecasts. As a result, there is a risk of lost sales in case of under-stocking or high carrying cost in case of overstocking. Secondly, pre-introduction inventory commitment makes it difficult to redeploy inventory from markets recording low success or outright failure to those that are highly successful. In addition, it may not be possible to ramp up production to meet demand requirements arising in some markets and even if this were possible, the distribution system may not be able to cope with requirements in different market segments. Consequently, there is likely to be inventory shortages in some markets and excess inventory in other segments. Thirdly, due to demand uncertainty and attendant challenges of accommodating forecast variance, anticipatory launch may be restricted to one product variation. This is likely to negatively affect performance since customers are increasingly demanding greater variety in product offering or product features.

Response-based strategy is shown to be a better strategy than anticipatory approach because it enables better management of risks associated with demand uncertainties (Bowersox et al. 1999). The strategy is premised on principles of postponement (Alderson 1950; Bucklin 1965; Zinn and Bowersox 1988; Cooper 1993; Pagh and Cooper 1998; Waller et al. 2000). Postponement reduces risk and uncertainty costs tied to differentiation that occurs during manufacturing and logistics operations (Pagh and Cooper 1998). Moreover, postponement allows a company to be flexible in developing different versions of a product as needed to meet changing customer needs and to differentiate a product (Waller et al. 2000). In new product launch, postponement enables reduction in risks associated with improper inventory deployment and the need to stock inventory for all product variations. Consequently, the strategy mitigates cost concerns associated with anticipatory strategy and enables a company to offer diverse product variants (Calantone et al. 1999). However, response-based strategy requires efficient coordination and extensive information sharing between departments and firms in the supply chain. In addition, shipment cost may increase substantially due to smaller shipment quantities and flexible responses, which if not well planned, may erode profits.

The three studies underscore the importance of logistics in new product introduction and make plausible propositions for further research. Specifically, the issue of matching logistics and launch strategies under different market environments needs to be tested empirically. Only one study, Closs et al. (1998), empirically compares anticipatory and response-based supply chain strategies. The authors show that demand uncertainty affects supply chain performance and that response-based strategy outperforms anticipatory strategy in terms of customer service under conditions of demand uncertainty. This means that anticipatory and response-based strategies result in different performance outcomes under different demand situations, which supports arguments by Bowersox et al. (1999) and Calantone et al. (2005). Therefore, it is important to examine not only the main effects of logistics strategy on new product performance but also effects of interaction with other factors and moderating effect of demand characteristics.

2.2.2 Launch Strategy

Broadly perceived, launch strategy refers to the set of decisions and activities necessary to present a product to its target market and begin to generate income from sales (Choffray and Lilien 1984; Green and Ryans 1990; Green et al. 1995; Hultink et al. 1998; Hultink and Robben 1999; Kotler 2003). Most studies tend to focus on a few elements that collectively constitute launch strategy. Consequently, there is no consensus on how to operationalize launch strategy concept (Hultink and Robben 1999). For example, Green and Ryans (1990) examine four launch strategy variables, namely, timing of entry, magnitude of marketing investment, magnitude of research and development (R&D) investment, and product's competitive advantage. Green et al. (1995) operationalize launch strategy in terms of three decision components, namely, timing of entry, magnitude of investment (i.e., R&D and promotion expenditures, etc.), and competitive positioning (i.e., price, product quality, etc.), which affect long-term performance of the product in the marketplace.

Hultink et al. (1998) distinguish between strategic and tactical launch decisions. Based on a survey of over 600 managers of manufacturing firms in Netherlands, UK, and USA, the authors posit that strategic launch decisions encompass elements of project's product strategy, market strategy, and firm strategy. These decisions, which address the *what*, *when*, *where*, and *why to launch* questions, set the strategic context and competitive scope into which the new product is launched (Biggadike 1979; Cooper 1993; Henard and Szymanski 2001). Strategic decisions are more important, involve substantial resource commitment and are difficult to alter once decisions have been made (Debruyne et al. 2002). Tactical decisions are the marketing mix decisions such as pricing, branding, advertising and promotion, and distribution (these capture the *how to launch* question). The authors conclude that managers tend to use a set of options across different contexts, and that different strategies lead to different performance outcomes.

Hultink and Robben (1999) examine three launch decisions, namely, strategic/market decisions, timing-related decisions, and marketing mix decisions. They conclude that launch decisions that affected market acceptance of new consumer products were relative product innovativeness, entry timing, and competitor reactions. They also note that some launch decisions are more important in attaining new product success for consumer products than for industrial products and vice versa, implying that launch strategies will have different impact on new product performance depending on the nature of product.

Calantone et al. (2005) conceptualize launch strategy in terms of launch size. Depending on the size of market served, launch strategy is viewed as either fat (large launch size) or lean (small launch size). According to this view, firms can either distribute new product in select market segments only (lean launch) or in all market segments (fat launch). The main premise is that firms will seek to size their launch according to their resource capabilities and market needs. Thus, lean-fat launch dichotomy can be viewed as a continuum where in one extreme, new product is launched in one market segment while in the other, the product is launched in all market segments.

The type of launch strategy adopted is stipulated to directly impact performance. Furthermore, since the scale of launch is directly related to logistics activities (i.e. distribution centers and network, truck fleet, etc.), it is argued that there is an interaction between launch and logistics strategy, which will directly impact performance.

2.2.3 Environmental Factors

In this research, two environmental factors are examined: competitive response and demand variability. Porter (1980) posits that competitors are motivated to react if a competitor or product entry is viewed as threatening. Competitive response is a set of decisions made by a firm in response to an observed new product launch (Hultink and Langerak 2002). They are influenced by factors such as product innovativeness (Gatignon and Xuereb 1997; Kuester et al. 1999; Debruyne et al. 2002), market structure and organization position (Bowman and Gatignon 1995), market growth rates (Yoon and Lilien 1985), market signaling (Heil and Walters 1993), time required to develop a new product and switching costs (Bowman and Gatignon 1995).

First, product characteristics such as product newness (innovativeness) triggers retaliatory behavior from competitors especially in highly competitive markets (Montoya-Weiss and Calantone 1994; Kuester et al. 1999; Debruyne et al. 2002). Debruyne et al. (2002) present a comprehensive review of literature on the impact of product newness on competitor response and concludes that competitor response is greater for radically new products than incrementally new products. Radically new products are technologically superior and represent a discontinuity within an industry while incremental innovations are logical extensions to existing knowledge and established designs (Ali 1994; Gatignon and Xuereb 1997; Debruyne et al. 2002). Radically new products tend to attract greater attention during launch and may have significant consequences in an industry as a whole. Since they are relatively new and are not comparable to existing products, they tend to create uncertainty concerning the success and consequences of innovation and uncertainty concerning the target market (Debruyne et al. 2002). Robinson (1988) empirically showed that innovative products are associated with greater competitor response since they threaten the incumbents.

Second, market growth rate affects reactive behavior of competing firms (Bowman and Gatignon 1995; Kuester et al 1999; Debruyne et al. 2002). Bowman and Gatignon (1995) showed that competitor response is faster and more intense in fast growth markets because in these markets, firms seek to establish a larger market share as early as possible or aggressively defend their already acquired share. Moreover, as Kuester et al. (1999) posit, high growth markets signify potential profitability thereby presenting the industry buyers with an incentive to invest and defend their market position more vigorously. Robinson (1988) found that competitor response tends to be more rather than less frequent in high growth market. The author argues that this may be due to entrants who point out overlooked opportunities (i.e., the new product creates a new market or causes an expansion of an existing market), incumbent sales that fall below expected sales (i.e., as incumbents sales decline, they respond by attacking the new product), and a longer time horizon which helps incumbents to justify the cost of reacting (this is related to product life cycle). Hultink and Lingerak (2002) found that market growth significantly moderates the effect on the relationship between the entrants' launch decisions and the market signals that are perceived by the incumbents. Other studies examining the impact of market growth on competitor response include Porter (1980), Day and Wensley (1988), and Shankar (1999).

Third, the degree of market concentration is stipulated to influence competitor response. For example, Porter (1980) posits that increased market concentration is associated with increased competitor response since incumbents suffer market share loss and reduced profitability with entry of new firms. In a study of effects of market characteristics and strategy on performance of 100 original and reformulated new industrial products, Yoon and Lilien (1985) showed that the number of competitors in the market place significantly affects new product performance. This argument should hold for new product entry relative to existing ones. Kuester et al. (1999) found that greater market concentration is associated with less retaliatory from incumbents, and that larger incumbents are less inclined to retaliate strongly. This finding contrasts Porter's (1980) arguments, and is consistent with other studies including Gatignon et al. (1990) and Bowman and Gatignon (1995), who argue that firms in highly concentrated markets focus more on profit maximization and less on market share hence their slow retaliation. Thus, there is no consensus on the effect of market concentration on competitor response.

Fourth, several studies have examined the influence of market signaling on competitor response. According to Hultink and Langerak (2002), the scope, intensity, and competitiveness of a new product launch generate a set of market signals that explain competitive reactions from incumbents. In other words, attributes of new product launch trigger different interpretations by an incumbent regarding motives and intentions behind the new product entry (Heil and Walters 1993). These interpretations form the basis of incumbents' response strategy and actions. Heil and Walters (1993) examined three market signals – hostility, commitment, and consequences – and concluded that hostility and consequence signals significantly trigger stronger competitive reactions. They define signaling hostility as extent to which approaches used by a firm to introduce new product is perceived as hostile while consequence signal refers to incumbents' perception of the impact of a new product entry on their profitability. Kuester et al. (1999) combined hostility and consequence signals into a new construct called 'threat' and found that threat is a significant predictor of reaction speed. They conclude that when competitors are threatened based on a given product mix, they tend to retaliate with the same instrument. Other studies such as Smith et al. (1989) show that actions perceived to be threatening are associated with shorter response times. Thus, market signals by new product entry will tend to invite response from incumbents.

Finally, competitive response tends to take longer when switching costs are high, time required to develop new products is long, and when reacting firm's market share is high (Bowman and Gatignon 1995). Consistent with the findings in previous studies, it is expected that competitor response will directly impact new product performance and also moderate the impact of launch strategy and logistics strategy on performance.

The second environmental factor examined is demand variability. According to Fisher (1997), product demand pattern affects the type of supply chain strategy adopted. Demand for new products is highly unpredictable and can vary significantly from the average level. For example, firms introducing new to market (first time) products tend to rely on forecasts based on potential customer surveys and focus groups. These forecasts are susceptible to high margin of error, which makes it very difficult to plan before hand. In cases where a product is an innovation of existing brand, the margin of error in the forecast is likely to be lower since the demand for incremental product can be benchmarked on the existing product demand. However, although demand uncertainty is examined as a moderator factor in new product literature (Gatignon and Xuereb 1997), there are no studies investigating its influence on the launch and logistics strategy-new product performance linkage. Demand variability affects firms' ability to fulfill customer orders, which in turn impacts new product performance. Thus, it is a major consideration when making launch decisions.

2.2.4 Product Characteristics

According to Henard and Szymanski (2001), product characteristics encompass elements pertaining to the new product such as price, innovativeness, and manager's perceptions of how well the product meets customer needs. Past studies show that new product attributes such as quality, reliability, newness, and uniqueness are important indicators of a firm's ability to meet customer needs (Li and Calantone 1998). These attributes enable a new product to provide both tangible and intangible benefits to its customers that are superior to competitive brands (Li and Calantone 1998; Lee and O'Connor 2003). To the extent that product attributes (i.e., innovativeness, reliability, unique features, perceived value, etc.) offer advantages over competitor brands, then they constitute product advantage (Lee and O'Connor 2003).

Extant literature shows that product advantage impacts new product performance (Cooper and Kleinschimdt 1987; Li and Calantone 1998). For example, new product's innovativeness influences incumbent's competitive response (Kuester et al. 1999; Debruyne et al. 2002). Hultink and Robbin (1999) found that product innovativeness and penetration pricing among other factors positively impacted market acceptance of a new product. Yap and Souder (1994) posit that under low market uncertainty, new product's superior performance and unique features conveyed impression to the user that the product will be premium priced, expensive to use, or failure prone due to perceived complexity. In a nutshell, these studies underscore the influence of product advantage on new product performance. However, the influence of product advantage on logistics and launch strategies has not been examined.

2.2.5 Firm Resources

The resource-based view (RBV) of the firm holds that firm strategy is a product of factors endogenous to the firm. It advances the argument that firms possess different resources and capabilities, which enable them to generate profit and build sustainable competitive advantage (Barney 1991). To generate above normal rents, firms must possess unique resources and capabilities that are rare, valuable, inimitable, and non-substitutable (Wernefelt 1984, Barney 1991, Peteraf 1993). These resources must enable the firm to conceive of or implement strategies that improve performance, exploit market opportunities, or neutralize impending threats (Barney 1991). Firm resources include tangible assets (i.e., truck fleet, distribution centers, etc.) and intangible assets (i.e., brand names, trade marks, etc.) (Olavarietta and Ellinger 1997; Fahy 2001). Capabilities are complex bundles of skills and knowledge exercised through organizational processes, which enable firms to coordinate their activities and make use of their resources (Day 1994). Although possessing key resources is critical, it is the manner in which resources are deployed that enables realization of above normal returns (Penrose 1959).

This implies that when planning new product launch, firms take cognizance of their resource endowment and adopt the strategy that enables optimal resource allocation and rent appropriation. Generally, large size firms tend to have greater resources that translate to greater market power, which they can use to gain competitive advantage (Gatignon and Xuereb 1997). However, firms must also have the capability to effectively deploy these resources to improve new product performance. For example, a firm with small launch budget, limited distribution centers, and few trucks may opt to launch its new product in a few market segments whereas a firm with large launch budget and widespread distribution network may launch new product in multiple market segments simultaneously. Thus, it is expected that a firm's resources and capabilities substantially determine its launch and logistics strategies.

2.3 Models and Techniques for Research Analysis

In this research, case study research approach and simulation modeling are used.

2.3.1 Case Study Research

Case study research approach has wide application in many fields including business and social sciences (Gummesson 2000; Yin 2003). Yin (2003) posits that three conditions determine the type of research approach (i.e., case study, survey, archival analysis, etc.), viz., (i) the type of research question posed, (ii) the extent of control an investigator has over actual behavioral events, and (iii) the degree of focus on contemporary as opposed to historical events. In this research, case studies are done of two companies that deal with durable and non-durable consumer goods. When developing a simulation design, it is desirable to have knowledge of the real system processes so that the simulation mimics the real process. Thus, the use of case study research is an important initial step in carrying out a simulation research. Since the main purpose of case studies is to provide sound bases for simulation design, it is important that the case study selection reflect the issue under investigation. The researcher determines whether a single case or multiple cases are to be used (Yin 2003). A single case is suitable when the case represents a critical case to test a well-formulated theory or to reveal a previously inaccessible phenomenon while multiple cases are desirable for generalizability (Ellram 1996).

Case study approach allows use of different information sources (i.e., interviews, expert opinion, etc.), and is preferred when direct observation of events being studied and interviews of persons involved can be done (Yin 2003). According to Gummesson (2000), case studies can be concerned with different functions, relationships, events or processes and may involve study of historical, present, future conditions or mixture of them all. Ellram (1996) provides a detailed analysis of case study application in logistics research. The author states that case study approach can significantly advance logistics research. Consequently, case study approach is appropriate in this research because it provides basis for simulation design and is used in past logistics research.

2.3.2 Simulation Modeling Review

Simulation modeling technique is widely applied to many problems and systems that are difficult to feasibly construct or experiment upon in 'real world' or that are too complex to model analytically (Rees et al. 2002). Computer simulation allows different factors to be modeled into the system. Simulation consists of systems entities, input variables, performance variables, and functional relationships (Maria 1997). The major steps in a simulation modeling are problem identification, collecting real system information and data, formulate and develop a model, design and analyze simulation experiment, validate and verify model, perform simulation runs, and analyze results (Law and Kelton 2000; Law et al. 1994; Maria 1997). The objective of simulation in this research is to model the dynamic behavior of launch processes and to evaluate the consequences of alternative configurations to new product performance.

According to Bowersox and Closs (1989), the model categories used in logistics are: analytic, heuristic, and simulation. Analytic models use mathematical methods to identify the optimal solution to the problem under analysis. Heuristic models use "rule of thumb" procedures developed from a basic knowledge of the problem and are capable of replicating complex problems. Both analytic and heuristic models are deterministic, implying that they do not contain random variables. Simulation models are distinct because of their capability to include stochastic situations. Since logistics planning is characterized by uncertainties and resulting variance, simulation models are best suited for the analysis, which has led to their extensive use. As Marucheck and McClelland (1992) point out, simulation models can accommodate dynamic interrelationships and their assumptions are less restrictive. Consequently, simulation modeling is suitable in this research because it enables a more detailed assessment of interrelationships between launch and logistics strategies in different competitive and market environments.

Simulation approach has been used in many logistics studies. For example, Rodrigues (2004) reviewed several journals for the period 1980 to 2003 to identify articles that primarily use simulation analysis. The author found out that for the eight journals reviewed, there were a total of 115 articles that employed simulation analysis. The journals reviewed were the *European Journal of Operational Research*, *Journal of Business Logistics*, *Decision Sciences*, *Journal of Operations Research*, *International Journal of Physical Distribution and Logistics Management*, *International Journal of Operations and Production Management*, *Management Science*, and *International Journal of Logistics Management*. In all these studies, there is limited focus on new product launch analysis.

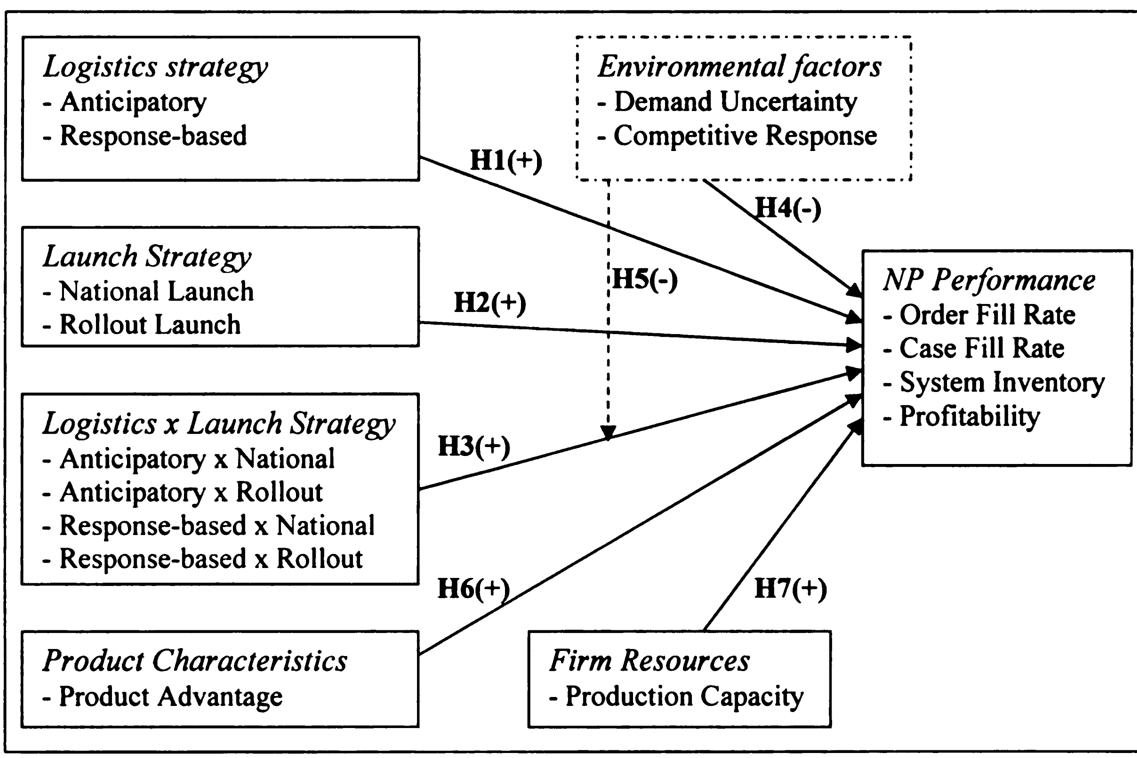
A review of *Journal of Business Logistics* articles for the period 1987 – April 2005 shows that a total of 22 articles were based on simulation analysis. None of these articles explicitly examined new product launch issues or logistics aspects relating to new product introductions. *International Journal of Logistics Management* had two simulation based articles for the period 1998 to April – 2005. One of the articles, Closs et al. (1998) uses simulation analysis to examine supply chain performance under varying information exchange and demand uncertainty conditions. *International Journal of*

Physical Distribution and Logistics Management had 27 simulation based articles for the period 1979 to April 2005. None of these articles examined product introduction related issues, which suggests that application of simulation approach in new product launch research is limited. Thus, this research makes an important contribution to the growing application of simulation modeling in logistics and new product research.

2.4 Conceptual Model and Research Hypotheses

Figure 2.1 shows the conceptual framework used in this research.

Figure 2.1: Conceptual Framework



According to the model, six determinants of new product performance are examined. These factors are based on extant literature as discussed in preceding sections. Their relationship to performance is stipulated in seven study hypotheses. Besides main effects, interaction effects are also examined. Of special interest in this research is interaction between logistics and launch strategy.

Past studies suggest that logistics systems and capabilities impact new product success (Bowersox et al. 1999; Di Benedetto 1999; Guiltinan 1999; Calantone et al. 2005). Logistic strategy is conceptualized as either anticipatory or response-based. As the preceding literature review suggests, each of these strategies result in different new product performance outcomes. For example, anticipatory strategy involves greater inventory deployment in the distribution system therefore it is associated with higher average system inventory, higher inventory carrying costs, and opportunity costs. However, with higher inventory availability, there will be fewer stockout and higher fill rates. Response-based strategy reduces average system inventory and attendant inventory carrying costs, which may increase profitability compared to an anticipatory strategy. However, order processing and delivery costs are higher due to frequent orders and shipments with limited economies of scale. Consequently, it is hypothesized that:

H1a: Logistics strategy directly and positively impacts new product performance.

H1b: Response-based logistics strategy has a greater positive impact on new product performance than anticipatory logistics strategy.

Launch strategy is stipulated to directly impact new product performance. As Green and Ryan (1990) posit, entry (launch) strategy for a new product provides the platform from which sustainable competitive advantage is gained. Past studies have shown that launch strategy type may explain new product performance differentials (Montoya-Weiss and Calantone 1994; Green et al. 1995; Hultink and Robben 1999; Henard and Szymanski 2001). Launch strategy is conceptualized as either national or rollout. The preceding literature review suggests that a national launch strategy requires greater resource commitment, higher inventory, and higher risks a than rollout launch strategy (Calantone et al. 2005). Thus, national launch strategy is associated with greater average system inventory and higher inventory carrying cost as well as greater management complexity given greater market coverage. Rollout launch strategy on the other hand is associated with less average system inventory, lower inventory cost, greater flexibility, and less management challenges given less market coverage. Consequently, it can be argued that rollout launch strategy results in better performance than a national launch strategy. Thus, it is hypothesized that:

H2a: Launch strategy directly and positively impacts new product performance.

H2b: Rollout launch strategy has a greater positive impact on new product performance than national launch strategy.

The interaction between different logistics and launch strategies is stipulated to yield different performance outcomes. For example, national launch supported by an anticipatory logistics strategy is associated with the greatest average system inventory, inventory carrying costs, and risks of write-off in case product fails but has least opportunity loss if product is successful. A rollout launch supported by response-based logistics strategy has the lowest average system, inventory carrying costs, and risks in case product fails but has the highest opportunity loss in case product is highly successful. Results of other strategy interactions fall between the above extremes. Therefore, each of the four combinations of launch and logistics strategies directly and differentially affects new product performance. Therefore, it is hypothesized that:

H3: The interaction between logistics strategy and launch strategy has a direct and positive impact on new product performance.

Demand variability and competitive response impact new product performance (Bowman and Gatignon 1995; Kuester et al. 1999). Demand variability is expected to influence distribution plans and pose significant challenge to inventory management, which may profoundly impact performance. At the same time, intense competitive response to a new product introduction significantly erodes profits and market advantage that a firm gains from its new product sales. However, when competitive response is less intense, a firm is able to build competitive advantage that translates into increased sales, market share, profits, and customer loyalty. Thus, it is stipulated that demand variability and competitive response directly impact performance and moderate the impact of logistics and launch strategies on performance. Thus, it is hypothesized that:

H4a: High demand variability negatively impacts new product performance.

H4b: High competitive response negatively impacts new product performance.

H5a: The greater the demand variability for a new product, the less the impact of:
(i) Logistics strategy on new product performance.
(ii) Launch strategy on new product performance.
(iii) Logistics and launch strategy interaction on new product performance.

H5b: The greater the competitor response to a new product introduction, the less the impact of:
(i) Logistics strategy on new product performance.
(ii) Launch strategy on new product performance.
(iii) Logistics and launch strategy interaction on new product performance.

Extant literature shows that product advantage is a major determinant of new product performance (Cooper and Kleinschimdt 1987; Yap and Souder 1994; Hultink and Robbin 1999; Kuester et al. 1999; Debruyne et al. 2002; Li and Calantone 1998). As the preceding literature review indicates, product advantage is based on product attributes such as quality, unique features, image, etc. These advantages provide the bases for improved performance through greater customer acceptance and subsequent sales. However, they also tend to trigger competitive retaliation. Therefore, product advantage results in greater demand, which may affect a firm's ability to fulfill customer orders.

Moreover, increased demand leads to more sales and profits. In high product advantage situations, firms may maintain higher inventory in distribution system in anticipation of increased sales, which affects inventory carrying cost. Consequently, product advantage is expected to impact new product performance. Therefore, it is hypothesized that:

H6: New product advantage directly and positively impacts new product performance.

Several studies within the resource-based view of the firm framework show that firm resources influence firm strategy formulation, implementation, and performance (Barney 1991, Peteraf 2001; Amit and Schoemaker 1993). When launching a new product, it is expected that firms' resource endowment will dictate the type of launch strategy adopted. This is because resources may enhance or constrain the extent to which firms execute a specific strategy. For example, where resources such as financial budget, distribution facilities, and production capacity are limited, a firm may find it difficult to implement a national launch. Conversely, where similar resources are in abundance, the firm can execute a national launch more efficiently and effectively. Large firms will tend to have more resources than smaller firms, which mean they can implement strategies that smaller firms cannot. Consequently, a firm's production capacity can be used as a surrogate of firm resources. Therefore, it is hypothesized that:

H7: Firms' production capacity directly and positively impacts new product performance.

2.5 Conclusion

This Chapter highlights several research gaps in new product launch literature and presents a conceptual framework for this research. First, literature review shows that the impact of logistics strategy during new product introductions is not adequately addressed.

Most studies addressing the issue have tended to be conceptual in nature and their propositions are not empirically tested. Secondly, past studies have tended to focus on main effects of individual performance determinants while ignoring interaction effects. Thirdly, moderating effects of competitive response and demand uncertainty on the impact of launch and logistics strategies on new product performance has not been addressed. Fourthly, the impact of product advantage and firm resources on new product introduction strategies and performance has not been adequately addressed. Finally, simulation modeling approach is increasingly being used in logistics research. However, a search in major logistics journals indicates that it is rarely applied in new product literature. Simulation offers an effective way to analyze and compare interaction effects between different determinants of new product performance. Consequently, this study seeks to fill these gaps in literature by using case study and simulation modeling to examine the simultaneous impact of launch and logistics strategies, environmental factors, product characteristics, and firm resources on new product performance.

CHAPTER III: RESEARCH METHOD

3.0 Introduction

This research employs two methods: case study approach and simulation modeling. This Chapter discusses how these approaches were applied.

3.1 Case Study Research

Data from case studies of select companies is used to build a simulation model of new product launch process. Two companies that deal with durable consumer products and one that deals with non-durable consumer products are studied with a view to identifying how they conduct their new product launch. Findings from these case studies provide the basis for development of simulated launch process and model parameters.

Case study approach is preferred for several reasons. First, it is necessary to understand how launch process is conducted, why it is conducted in the observed manner, and the implications of the launch process design on the overall performance. Yin (2003) notes that case study approach is appropriate for research problems where the emphasis is on "how" and "why" questions. Given limited empirical studies examining the role of logistics in new product launch processes, there is lack of essential data on the how and why of launch process. Consequently, case studies were necessary in this research.

Secondly, most studies advocate use of case study approach to study organizational processes that do not lend themselves easily to quantitative measures because it enables in depth assessment of process dynamics not possible via other research methods (Eisenhardt 1989; Marginson 2002; Yin 2003). New product launch process brings together supply chain partners such as manufacturers, suppliers, distributors, retailers, and transporters. To understand the interactions between these players during new product introduction, it was necessary to identify and study specific companies that have a long history of successful new product launches. Case studies enabled better understanding of the launch process dynamics, which in turn enabled the development of a realistic, valid, and reliable model.

Finally, case studies enable a better appreciation of dynamics at play during new product launch, which aids in interpretation of results and formulation of theoretical and managerial recommendations. Furthermore, this being a first study, case studies provide insights that are basis for future research propositions.

Case studies proceed in three main steps: case study design, data collection, and data analysis (Eisenhardt 1989; Miles and Huberman 1994; Ellram 1996; Yin 2003).

3.1.1 Case Study Design

Case study design involves development of the questions to be asked and identification of criteria for judging quality of research design. In this study, research questions were open-ended. These types of questions enable respondents to give a detailed narrative of the events and sequences that are then reconstructed to develop a typical launch process flow. Narratives are analytic constructs used to unify groups of events into single stories (Abbot 1990; Griffin 1993; Riessman 1993; Stevenson and Greenberg 1998). They embody sequence and time, and are therefore ideally suited to the development of process theories and explanations (Pentland 1999). Participants not only make sense of their world in narrative terms but they proactively plan and enact narratives that are consistent with their expectations and values. Consequently, narratives can be invaluable sources of insights about organizational processes since explanations that draw upon narrative data tend to be close to the phenomena they purport to explain. As Pentland (1999) states, narratives are like ruts in the road that people follow and thereby re-create.

Abbott (1990) suggests three categories of questions that one can address in a narrative context: the existence and classification of sequential patterns, the antecedents of, and the consequences of these patterns. Riessman (1993:55) suggests use of five to seven broad questions about the topic of inquiry (i.e., "tell me what happened") with supplementary questions to probe further (i.e., "can you tell me more about that"). In this research, interview questions seek general and specific information new product launch information in each company (Refer to Appendix A for Sample Questions).

The first set of questions examines company's new product launch process in general. For example, the respondents were asked to describe how their company plans and executes new product introduction. This is important to the researcher because it provided a general overview of launch process in each company and the context in which specific product launches are conducted. The second set of questions addresses specific product launch activities. Interview respondents are asked to discuss a recent product launch in their company with respect to product characteristics, launch process, logistics processes during the launch, prevailing market characteristics, and performance outcome. Responses to these questions provided the bases for the design of a simulation model that replicates a real product launch process as closely as possible. Pattern matching approach (Eisenhardt 1995; Yin 2003) is used to weave together the processes and events described in interviews into a coherent launch process flow.

3.1.2 Evaluating Quality of Research Design

There are four major criteria of ensuring reliability and validity in case study research: construct validity, internal validity, external validity, and reliability (Eisenhardt 1989; Miles and Huberman 1994; Yin 2003; Hefferman 2004).

Construct validity establishes correct operational measures for concepts being studied. According to Yin (2003), construct validity can be achieved in three steps: use multiple sources of evidence, establish chain of evidence, and have key informants review draft case study report. To ensure construct validity, at least three executives involved in new product development and/or launch in each company are interviewed. The respondents provide detailed information about their company's launch process and the different activities that take place from the time a finished product is ready for market to the time it reaches consumers. These interviews validated assumptions made earlier based on information available in extant literature such as transportation lead times, inventory policies, and supply chain network.

The interviews enabled the researcher to develop a launch process flow showing important linkages and events in the supply chain network. The mapped process flow is considered representative of a typical new product launch in the consumer goods industry as discussed in the interviews. As a final step to achieve construct validity, interview respondents were asked to review the mapped process flow and major assumptions in the model so as to ensure that the process flow is a true representation of the launch process in their companies and industry. The respondents concurred that the mapped process is fairly representative of a typical launch process. Consequently, construct validity is met.

Internal validity requires the researcher to establish causal relationships, whereby certain conditions are shown to lead to other conditions. Researchers can do pattern matching, explanation building, address rival explanations, and/or use logic models (Yin 2003). In this research, pattern matching is done. Launch activities and processes discussed in the interviews and those documented in extant literature are matched to develop reasonable launch process linkages and flows. During interviews, respondents explained the rationale behind most launch process linkages. Therefore, mapped process flows indicate the sequence of events during a typical product launch. To the extent that the mapped launch process flows and linkages represented correct causal relationships, internal validity is met.

External validity establishes the domain to which a study's findings can be generalized (Yin 2003). As Yin (2003) posits, case studies rely on analytical generalizations unlike survey research, which rely on statistical generalizations. In this research, use of three case studies increases replication logic thereby increasing analytical generalizations of the findings. The mapped launch process incorporates information from all case studies and case studies findings are compared with relevant information in extant literature. The comparison shows that mapped process flows are representative of flows in consumer goods industry. Therefore, external validity is achieved.

Finally, reliability requires the researcher to demonstrate that operations of a study such as data collection procedures can be repeated with same results (Eisenhardt 1989; Yin 2003; Hefferman 2004). In this research, three strategies are used to ensure reliability: case study protocol, case study database, and review of interview transcripts to ensure accuracy. A case study protocol contains survey instruments, procedures and general rules to be followed when using the instrument (Yin 2003). According to Yin (2003: 69), a typical protocol should have an overview of case study project (a statement about the project, its objectives, people involved, issues being investigated, etc.), field procedures (sources of information), case study questions (specific questions to guide the data collection), and a guide of case study report (outline, format of the narratives, use and presentation of other documentation). In this research, a case study protocol was developed and followed to the letter during interviews. Before interview appointments, respondents were provided with survey questions and a one-page overview of research objectives, research design, interview procedure, and expected contribution (See APPENDIX A, B, C, and D).

During interviews, key issues discussed are written down. The hand-written interview notes are then transcribed into a word document and stored for future reference. The transcribed notes are double-checked to ensure that all information is noted and accurately recorded. Therefore, reliability is achieved.

3.1.3 Data Collection

Data is collected through face-to-face and telephone interviews with managers in three companies. The interview respondents are provided with interview questions before hand. The interviews take about one and half hours. In each case study, interview respondents are managers involved in logistics and new product processes. For example, respondents in one case study include logistics manager and program manager for supply chain in new product area while in another case study, respondents include heads of operations, new brands and marketing in new product area. These respondents are highly knowledgeable in new product introduction processes. They share insightful information not only about their companies but also about industry trends.

3.1.4 Data Analysis

Case study data analysis involves transcription of interview notes and generation of an analytical diagram of causal relationships and events as well as interpretation of sequences of action that are generalizable across multiple new products launch scenarios. The analytical diagram represents the researcher's interpretation of relationships and sequence of events constituting new product launch process. A within-case and cross-case analysis is done to determine reliability and validity of the results. The case studies findings are presented below.

3.1.5 CASE STUDY I

This case study involved a company that deals with non-durable consumer goods. The company is functionally divided into departments such as marketing, operations, finance, etc. New product development, testing, and commercialization are handled by the marketing department. In this company, new product launch process starts with research (qualitative and quantitative) to determine potential market, requirements to get new product to market in a timely manner, asset requirements for rollout, and production capacity requirements. Engineering division assesses production requirements and determines which manufacturing facilities will be used to make new product and when to produce. Sales division assesses distribution base. Sales teams make new product (sample) presentations to select distributors and retailers. Thereafter, a distribution kick-off team makes presentations throughout the country.

The first production run is based on forecasts but subsequent productions are based on distributor orders (with some cushion inventory added to these orders). This company uses a three-tier distribution system in which the company only supplies to distributors, who then supply the retailers. Generally, orders are shipped weekly or in one to four weeks. The company has limited storage capacity at its manufacturing plants. If extra capacity is needed, the company uses its distributors' capacity. There are more than 500 distributors in the U.S. The company carries 3-4 weeks worth of inventory.

Recently, the company launched a product that was quite new to the market place. Although market for the product category is at mature stage, the company introduced features that were new to the market. The target market was women consumers between ages 21 to 45 years. The product was tested in three market clusters selected based on market issues such as target customer profiles and distribution requirements. Test marketing is done to minimize risks of launch, assess pricing, and to understand market characteristics and consumption behavior. Product performance in these markets would determine the extent of national introduction. Production was done in the Southeast (USA) while one test market was in the Northwest. Thus, transporting the product to this test market was expensive and challenging. For this company, the average shipping distance to distribution facilities is 315 miles. The average lead time is 2 days. According to respondents, high cost of shipping could be minimized if new product production was done in multiple facilities throughout the country.

Generally, competition is stiff at both national (with national brands) and local (with local brands) level. Competition is based on price, packaging, product innovation, brand equity, etc. The industry is heavily regulated. Consequently, price competition is less intense. Companies compete on brand marketing and promotions. The top three brands account for 50% of the U.S. market. Thus, the industry is characterized by high concentration. According to interview respondents, market trends for major brands in the industry do not change abruptly. Therefore, customer demand is relatively predictable and forecasts are fairly dependable. How, this may not be the case for new products.

The company has multiple measures to determine new product success/failure. These include product sales (did the sales meet expectations), brand awareness, customer loyalty to product/brand, feedback from distributors, cost of launch, distribution cost, distribution effectiveness and velocity, etc. The aforementioned product was poorly received in the market place. After three to six months of test marketing, it was clear that the product was bound to fail as sales and distributor orders declined. Most raw materials used for the product were new and had been ordered in advance based on sales forecasts. As a result, the company had excess raw material and finished goods inventory.

In another case, the company successfully launched a new product nationally (nation-wide launch). This product was produced simultaneously in six facilities located in different parts of the country. The new product sales and market share increased substantially within six to eight weeks. According to respondents, nation-wide launch is a risky undertaking. Thus, it is crucial for the company to have sufficient financial resources before undertaking a nation-wide launch.

3.1.6 CASE STUDY II

This case study involved a company that manufactures durable consumer goods (office equipment/furniture). The company operates a make-to-order production model where products are made only upon receipt of customers' orders. New product launch process starts with determination of how and where the product will be manufactured. The company can make new product in three ways: product can be made entirely in the firm's facilities (i.e., from raw material to finished goods), product parts can be purchased from suppliers then assembled in the firms, or production of new product could be outsourced to a contract manufacturer. Next, a product placement analysis and pilot testing is done. This is primarily done in exhibitions at NeoCon, the World's Trade Fair for Interior Design and Facilities Management. Also, product demonstrations are done at dealers' facilities. Once the decision to launch a new product is made, initial production is done based on first order entries from dealers.

In the recent past, the company introduced a product that had many innovative features and was marketed as new, innovative, comfortable, and easy to use. It was very successful. Product demand grew rapidly outstripping production capacity, which led to delays in order fulfillment. Therefore, the company had to expand its production capabilities. Initial four-week's production was for dealers to display and demonstrate to potential customers. Most components and sub-assemblies for the new product were bought from suppliers. The product was launched nationally including in Canada and Central America. Subsequent launches were done in Europe and Asia. According to interview respondents, market placement analysis necessitated the nation-wide launch.

The company handles 10 percent of transportation while the rest is outsourced to third party providers and distributors. Most shipments are less-than-truckload. Typical lead time from manufacturing to ready to ship is 1 day and actual delivery takes 2 days. The distribution network comprises manufacturer, distributors/dealers, and retailers. The company ships product to distributors/dealers and then dealers supply to retailers.

Competition is generally intense but demand is fairly predictable. Competitors generally react to new product introduction by offering similar products. New product success is measured in terms of meeting new product revenue targets, profitability, and customer satisfaction among others. The aforementioned new product launch was successful based on high sales, profits, and customer satisfaction ratings.

3.1.7 CASE STUDY III

This case study involved a large company that deals with durable consumer products. The company has operations or sells products in 30 countries. The company is organized into teams around product categories. New product launch is planned and executed by these product category teams. There are functional units in each area such as marketing, industrial design, manufacturing, purchasing, supply chain, etc. In each product category, there is a process-matrix of activities to be performed by each functional area before and during launch. For example, there are activities and decisions dealing with new product development, product strategy, concept selection, product engineering, production decisions, etc. The marketing team communicates customer requirements and develops retail labels. Production of the new product is forecast driven. Demand forecast are for 12-months with a monthly review.

In the recent past, the company launched a new product that was highly successful and another that did not do as well. The successful product was highly innovative and required new product design and tooling. Therefore, the company had to displace old products at its manufacturing facility to accommodate new product needs. Initial sales target was 150,000 units. Within six months of launch, sales had doubled, thereby outstripping production capacity. By the end of first year since launch, sales exceeded 400,000 units. According to respondents, planning for the new product was conservative, a practice that is common when launching new products. Production of the unsuccessful product was done in Asia. Due to low sales, the company had to cut down production. In addition, the company bought back stock from its distributors so as to create room for successful products. Usually, retailers own the product stock in their channel.

The company typically launches new product nationally. However, there are cases where new product is launched by region, with delays of about 6-8 weeks in accordance with production capacity and retail channel requirements. Generally, the company plans with customers (distributors and retailers) on the quantity and type of product to ship where and when. For example, a major retailer with 1,800 stores (such as Home Depot or Lowe's) may not expect the manufacturing firm to instantly ship new product to all stores. Instead, it may request the manufacturer to have new product shipped to specific stores in a sequential manner, which helps rationalize production.

The company has manufacturing facilities across North America. Each facility ships to the company's only distribution centers in Wisconsin and to major customers (national wholesalers such as Ferguson, regional wholesalers, national retailers such as Home Depot, and regional retailers). However, the company is in the process of changing this model to one where they have regional distribution centers focused on fewer markets so as to reduce total haul length and duration. The company meets the cost of freight to distributors and major customers. The average haul length is 1100 miles. The average order cycle is 14 days. However, there are contractual obligations with some customers to deliver the product in shorter leads times. For example, Home Depot requires deliveries to be done in 7-10 days while Lowe's requires deliveries in 7 days. Total inventory in the system (inventory at the production, storage, and transit systems) ranges from 20 to 40 days.

Competition in the industry is generally stiff. The company is facing competition from local competitors as well as foreign brands especially from Asia. Usually, it takes about a year for competitors to create or copy newly launched product designs. Although demand is fairly stable, it is difficult to plan for or understand demand for a new product. To measure new product launch success, the company uses indicators such as sales, profits, and a Vitality Index of 30 percent. This index measures the target to net sales for a new product.

3.1.8 Key Findings from Case Studies

- Production Capacity – Influences timing and scale of new product introduction. Companies may scale down the number of markets where new product is launched if capacity limitations so demand.
- Logistics Strategy and Inventory Policies – Companies launching new products often adopt either "push" or "pull" logistics strategy. For Push strategy, firms manufacture new products based on demand forecasts and then 'push' the finished products to

distributors and retailers to await sales. In effect, firms deploy inventory to distributors and retailers while maintaining minimal stock at the manufacturing facility. For Pull strategy, firms withhold shipping new products to distributors and retailers until they receive orders so that inventory is held at the companies' plant warehouses or distribution centers. At the same time, firms can adopt either "lean" or "fat" inventory policy. In a Lean policy, firms maintain inventory required to cover one order cycle time while in a Fat policy, firms maintain higher inventory (i.e., buffer inventory) to cover more order cycle times. Fat policy results in greater average system inventory than a Lean policy. The aforementioned Push strategy and Fat policy are characterized by higher inventory in the distribution system and more inventory at the retail level, which reflects anticipatory strategy. On the other hand, Pull strategy and Lean policy are characterized by lower inventory in the distribution system and less inventory at the retail level, which reflects a response-based strategy. Therefore, logistics strategy can be conceptualized as two alternative strategies: Push vs. Pull, and Fat vs. Lean. Transportation lead times from manufacturers to distributors and major retailers range from 2 to 5 days. The main mode of transport is road.

- Launch Strategy – when launching new product, companies adopt either a national strategy (simultaneous nation-wide launch) or a rollout strategy (launch in some markets then to others sequentially until all markets are covered over time).
- Demand Variability – New product demand is highly unpredictable. Generally, new product demand varies significantly from the daily average. This makes planning for and executing new product launch strategies very challenging.

- Competitive Response – Competitors respond to new product launch in many ways, which affects new product's sales and market share. Aggressive competitor response lowers demand for a new product, and if not countered, could lead to product failure.
- Product Advantage – Demand for products that are perceived to have many advantages by the customers tend to grow rapidly, in some cases by up to four times during the year the product is launched (for consumer goods).

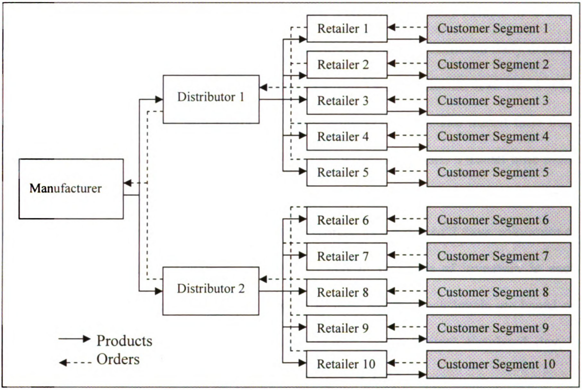
3.2 Simulation Modeling

Supply chain analysis presents a challenge because of system complexity and the large number of variables involved. Thus, analogous models are built to examine specific system variables in a controllable environment. Computer simulation modeling presents a practical basis for representing complex systems and helps to realistically analyze performance trade-offs (Venkateswaran 2004). Computer simulation refers to methods of studying a wide variety of models of real world systems by numerical evaluation using software designed to imitate the system's operations or characteristics (Kelton et al. 2003). This research uses ARENA, a dynamic simulation software tool that combines SIMAN simulation language with a graphics component (Kelton et al. 2003).

3.2.1 Simulation Model

The conceptual supply chain network studied is dynamic multi-echelon, comprising production functions, distribution functions, customer (market) segments, and information flows. Figure 3.1 shows the simulated supply chain network.

Figure 3.1: Supply Chain Network

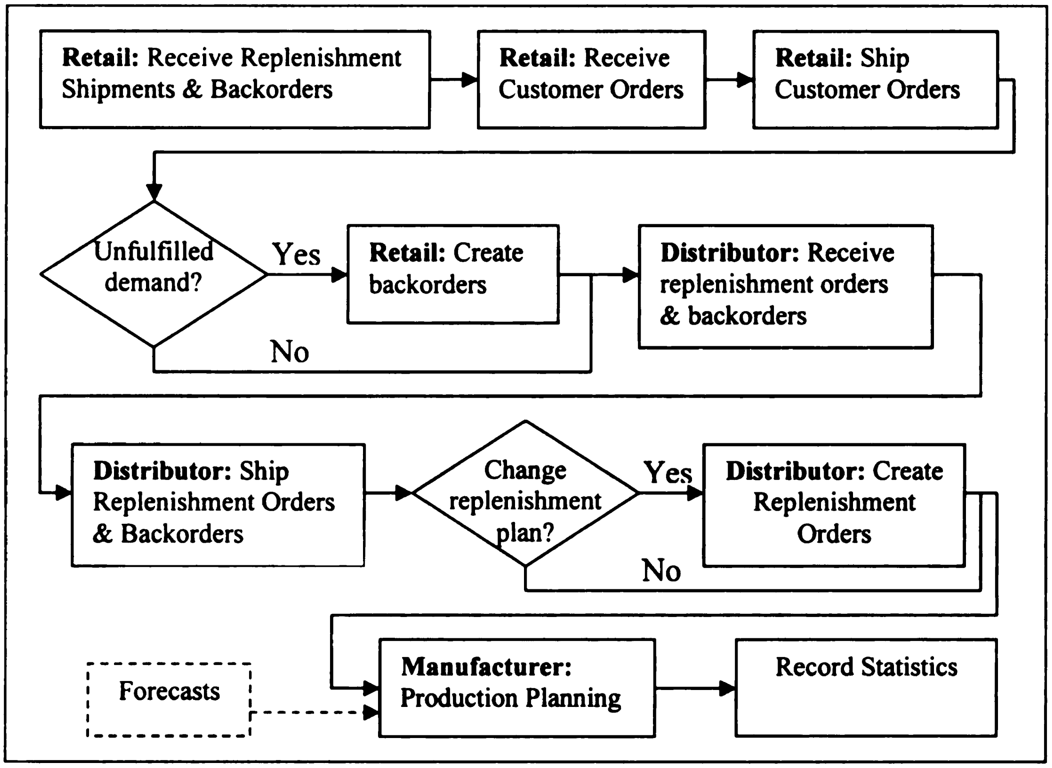


In this network, Manufacturer serves Distributor 1 and Distributor 2. Distributor 1 serves Retailers 1, 2, 3, 4 and 5 exclusively while Distributor 2 serves Retailers 6, 7, 8, 9 and 10 exclusively. Retailers exclusively serve their respective customer segments, i.e., Retailer 1 serves Customer Segment 1 only. Transshipments between distributors or between retailers are not allowed. Demand in each retail location is independent and may vary at each Customer Segment throughout the simulation period.

According to the model, customers place orders (buy) at the retail facility. Retailers acquire inventory supplies from distribution centers, which in turn replenish with supplies from manufacturer. Customer demand and transit lead times follow stochastic distributions. The average daily customer demand was 100 units. Demand was generated using Triangular Distribution in excel. For example, low demand variability was generated with TRIA(75,100,125) while high demand variability was generated with TRIA (0,100,200). In ARENA, TRIA(75,100,125) results in a daily demand with mode of 100, minimum daily demand of 75, and a maximum daily demand of 125. This represents a truncated Normal Distribution. Stochastic lead times were imposed to represent order processing and transportation delays. The transit time from manufacturer to distribution centers is TRIA(2,3,4), which represents a transit time mode of 3 days, minimum of 2 days, and a maximum of 4 days. Transit time from distribution centers to the retailers was TRIA (1,2,3), which represents a mode of 2 days, minimum of 1 day, and a maximum of 3 days. Target and maximum levels of inventory in each location are defined based on logistics strategy tested. Safety stock levels are based on forecasted average daily demand and target levels. On a typical simulated day, a sequence of events take place as summarized in Figure 3.2 below.

At retail level, retailers receive replenishment shipments that were scheduled to arrive (in-transit inventory) at the beginning of the day. These shipments may include backorders from past unfulfilled demand. If backorders are allowed, then all demand is eventually met. However, in this simulation, backorders were not allowed. This is because backorders would add complexity to inventory deployment and customer service thereby making it difficult to identify specific strategy implication on performance. Any unfulfilled orders were disposed and recorded as stock outs. Retailers update their inventory positions after receiving replenishments shipments. After that, customer orders are received at retail locations. If there is sufficient inventory, orders are filled and shipped. If there is no sufficient inventory, partial orders are shipped. The order that remains unfulfilled is considered a backorder. Since backorders are not allowed in this simulation, stock outs are calculated whenever orders are not filled.

Figure 3.2: List of Events



Retailers then evaluate replenishment requirements based on an order-up-to policy. According to order-up-to policy, whenever inventory levels drop below target level, orders are placed to bring the combination of inventory and on-order up to a target level. Target level and reorder point are defined in days of demand at each location depending on inventory management policy and logistics strategy in place. Thus, they are dynamically calculated based on demand forecast information. During each review period, average daily forecasts are recalculated and then multiplied by the defined target level (in days) to obtain the quantity to be maintained at the facility. Inventory is reviewed daily. If inventory is below maximum target level, a replenishment order is created. The quantity ordered is the amount necessary to meet maximum inventory target. Thus, after reviewing replenishment requirements, retailers create replenishment orders to distributors.

At the distribution center, replenishment orders from retailers are received, processed, and shipped in the same manner as customer order fulfillment process at the retail location. Unfulfilled replenishment orders are disposed and recorded as stock outs. Distributor inventory position (including transit-inventory) and replenishment requirements are then evaluated in a similar process to that at retail level. However, target levels vary from those at the retail center depending on inventory and logistics policies. Distributors then create replenishment orders to manufacturer. Manufacturer uses these orders and other forecast information to plan production.

The production phase is treated as a 'black box' where internal processes such as production scheduling are not included in the simulation. Instead, incoming orders (replenishment orders from distributors) are filled depending on capacity availability. Production lead time is incorporated into transit time from plant to distributors. The model assumes that production lead time does not depend on the size of replenishment orders. Product quantities are moved automatically to stock and ready to ship. This model approach allows better investigation of distribution of a new product since effects of production process complexities such as scheduling and set-up are minimized.

The last event is collection of statistics. Fill rates, average inventory, and units sold are computed for each facility. Individual statistics are then aggregated to get performance for the entire supply chain. The system returns to the first event after the last event is complete, repeating the same sequence until the simulation period is over.

3.2.2 Model Verification and Validation

Sargent (2000) presents a comprehensive assessment of model verification and validation approaches. Rodrigues (2004) successfully used this approach. *Model verification* refers to the process of ensuring that computer program of the computerized model is performing as intended (Law and Kelton 2000; Sargent 2000). *Model validation* refers to "substantiation that a computerized model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application of the model" (Sargent 2000:50). Several model validation techniques are discussed in literature including animation, degenerate tests, extreme condition tests, face validity, internal validity, traces, etc (Law and Kelton 2000; Sargent 2000).

According to Sargent (2000), there are four types of validity that should be upheld in a simulation model. First, *conceptual model validity* determines that the theories and assumptions underlying the conceptual model are correct and model representations of the system are reasonable for the intended purpose of the model. To ensure conceptual validity, theories and assumptions underlying the model are tested using mathematical analysis and statistical methods on problem identity. The main validation techniques for this type of validity are face validation and traces. Face validity requires that experts evaluate the model to ensure that on the surface, it seems reasonable for the intended purpose. In this research, model relationships are verified through consultations with managers (case studies) and academic advisors knowledgeable in simulation design. In trace technique, the state of the simulated system (i.e., contents of event list, state of variables, certain statistical counters, etc.) is displayed just after each event occurs and is compared with hand calculations to see whether the program is operating as intended

(Law and Kelton 2000). A log file with each activity performed (i.e., order placements, replenishment requests, inventory shipments, etc.) is created and any errors detected in the model are evaluated and fixed. Thus, conceptual model validity is achieved.

Second, *computerized model verification* ensures that the computer programming and implementation of the conceptual model is correct. Computerized model verification was accomplished by testing if the model was programmed correctly in ARENA simulation language. Traces validation technique discussed above is used. In addition, each program path is subjected to extreme conditions to test whether it performs as expected. The tests were successful, thus, the model is verified.

Third, *operational validity* determines that the model's output behavior has sufficient accuracy for the intended purpose. All validation techniques can be used to establish this validity. In this research, four techniques are used, viz., Degenerate Tests, Extreme Condition Tests, Internal Validity Check, and Parameter Variability–Sensitivity Analysis. The degeneracy of the model's behavior is tested by appropriate selection of values of the input and internal parameters. For example, an increase in lead time in one stage of the model resulted in an increase in backorders and reduced service levels since it mimics a constrained environment. Thus, operational validity is established. Extreme condition tests are done to test if model is plausible for those conditions. The model yielded expected results, thus, operational validity is confirmed. Internal validity is determined by conducting several model replications to establish the amount of internal stochastic variability. High variability may lead to questionable model results. Coefficient of Variation (CV) is used to assess variability (Law and Kelton 2000). In Parameter variability–sensitivity analysis, values of the input and internal parameters of a model are changed to determine the effect upon the model's behavior and its output. Inventory and lead time parameters are altered to check if the resulting effects reflect a real system.

Finally, *data validity* ensures that necessary data for model building, model evaluation and testing, and model experiments are adequate and correct. To assess *data validity*, collected data was tested using internal consistency checks, in consultation with experts (advisors and company managers) and screening for outliers.

3.2.3 Experimental Factors

This research examines six independent factors: logistics strategy, launch strategy, demand variability, competitive response, product advantage, and production capacity. Demand variability, competitive response, and product advantage are modeled as one variable – Demand Characteristics (refer to "*Demand Characteristics*" section).

1. Logistics Strategy

Logistics strategy is modeled at four levels, representing two alternative strategies: Push vs. Pull and Fat vs. Lean. From case study interviews, it was established that logistics strategy tends to be characterized by the way inventory is deployed and how much inventory is maintained in the distribution system. Push strategy is characterized by forward inventory deployment. Under this strategy, manufacturers push inventory to retailers in anticipation of sales. To mimic this, target and maximum inventory levels at retail facilities are higher than at distribution center. At the retail locations, target and maximum inventory are modeled as 6 days while at distribution centers, target and maximum levels are modeled as 4 days. These represent two order cycle times for retailers and one order cycle time for distribution center.

Pull strategy represents a response-based strategy where minimal inventory is held at retail locations. Under this strategy, companies withhold deployment of inventory to the distribution system until receipt of orders. Pull strategy is modeled by having higher target inventory levels and reorder point at distribution centers compared to retail facilities. Accordingly, it is modeled as reverse of push system – at the retail location, reorder point and target level are 4 days while at the distribution center, reorder point and target level are 6 days. Reorder point and target level are kept the same to reflect an order up to policy in both Pull and Push system. Having same total order cycle time (10 days) for both strategies enables better tests of inventory deployment effects.

Fat strategy involves maintaining inventory levels that are twice (or more) of the inventory required to meet one order cycle. Here, companies maintain minimum inventory level sufficient to cover one order cycle. This reflects a supply chain system with high safety or buffer stock. Thus, in Fat strategy, reorder point is modeled as 3 and 4 days at retail and DC, respectively, and target levels are 7 days at both retail and DC locations. This means that there is sufficient safety stock to cover one order cycle at retail level (3 days lead time) and DC level (4 days lead time).

Lean strategy varies from "Fat" strategy in that target levels are kept the same as reorder points. This reflects a "lean" supply chain where minimal inventory is held at any location in the distribution system. Thus, reorder and target inventory levels at retail and DC are 3 and 4 days, respectively, which represents maximum length of one order cycle in each location.

The four levels enable assessment of effects of deploying inventory to retail locations versus withholding inventory until orders are received. At the same time, it enables assessment of effects of maintaining limited inventory versus keeping larger inventory in the distribution system.

In this study, Push and Fat logistics strategies are surrogates of an anticipatory strategy. This is because in a Push strategy, new product inventory sufficient to meet two order cycles' requirement is 'pushed' to the retail level. In other words, not only is the inventory pushed into the distribution system in anticipation of sales, but sufficient buffer stock is maintained at retail level to minimize stockouts. In a Fat strategy, sufficient buffer inventory is maintained at each supply chain stage. For example, this study models a situation where target levels at distribution and retail facilities are set to one week (sufficient to meet at least two order cycles) and reorder point to one order cycle's worth of inventory. Since anticipatory strategy involves (i) forward deployment of inventory and (ii) higher levels of safety stock at each facility in the distribution system, Push and Fat strategies provide the best estimates of a new product launch performance when an anticipatory strategy is adopted.

On the other hand, Pull and Lean strategies mimic a response-based strategy. Pull strategy is modeled in terms of limited new product inventory deployment to the retail level (sufficient to meet only one order cycle, with a day's worth of safety stock). In a Lean strategy, target level is set equal to one order cycle (in days), which represents very lean inventory in the entire distribution system. Therefore, Pull and Lean strategies represent a situation where (i) new product inventory is only deployed into distribution system according to demand requirements and (ii) limited cycle and safety inventory is maintained in the entire system. This is representative of a responsive logistics strategy.

2. Launch Strategy

Launch strategy was modeled at two levels: national and rollout. National launch represents a system where new product is introduced in all market segments simultaneously. There are ten market segments in the simulation. Therefore, with national launch, new product was deployed in all ten market segments at once. Rollout launch strategy involves sequential launch where new product is introduced to select markets and then introduced in other markets sequentially. To model rollout strategy, new product was introduced in market segments 1 and 6 in the first month, then to 2 and 7 in the third month, 3 and 8 in the fifth month, 4 and 9 in the seventh month, and 5 and 10 in the ninth month, as shown in the table below. Similar stochastic distributions were maintained in each market segment for both national and rollout strategies.

Table 3.1: Product Launch by Month and Market Segment

Month	**Markets where product is launched**	
	National Launch	**Rollout Launch**
1	All segments	1 and 6
2	All segments	1 and 6
3	All segments	1, 2, 6, and 7
4	All segments	1, 2, 6, and 7
5	All segments	1, 2, 3, 6, 7, and 8
6	All segments	1, 2, 3, 6, 7, and 8
7	All segments	1, 2, 3, 4, 6, 7, 8, and 9
8	All segments	1, 2, 3, 4, 6, 7, 8, and 9
9	All segments	All segments
10	All segments	All segments
11	All segments	All segments
12	All segments	All segments

3. Demand Characteristics

a) Demand Uncertainty

Demand uncertainty is modeled in terms of demand variability, which represents variations from daily average demand. High demand variability represents higher uncertainty because when demand variability is high, firms find it difficult to fulfill customer orders and to forecast and plan production. Daily demand is generated independently for each customer segment using TRIA(Min, Mode,Max) distribution in Excel. Daily average demand was modeled as 100 units. Low variability is modeled as TRIA(75,100,125) while high variability is modeled as TRIA(0,100,200). In ARENA, TRIA(75,100,125) represents a daily demand mode of 100 units, daily minimum demand of 75 units, and a maximum daily demand of 125 units. The low and high variability distributions represent 0.1 and 0.4 coefficient of variation (C.V.), respectively. This is typical in consumer goods sector. For example, according to Waller at al. (1999), daily demand variability in consumer products sector is low and may vary from C.V. = 0.1 to 0.3. Moreover, C.V. = 0.4 represents the highest coefficient possible for a mean demand of 100 while maintaining a symmetrical distribution. These extreme variations enable better assessment of demand variation effect.

b) Competitive Response

Daily demand is reduced gradually from time of launch to the end of the year to reflect intense competitive response. According to previous studies, new product introduction triggers retaliatory behavior by the incumbent firms (Robinson 1988; Kuester et al. 1999; Debruyne et al. 2002). When retaliation is intense, demand for new product is greatly reduced. To mimic a situation where competitive response is intense, average demand at both low variability and high variability situations is reduced by 65% from the time of launch to end of the year as Table 3.2 shows.

Table 3.2: Effect of Competitive Response on New Product Demand

Month	Effect Factor
1	1.00
2	0.95
3	0.90
4	0.85
5	0.80
6	0.75
7	0.70
8	0.65
9	0.60
10	0.55
11	0.50
12	0.45

c) Product Advantage

To model effect of new product advantage, demand is gradually increased from time of launch to the end of simulation period. Product advantage reflects customer value, which is the customers' perceived benefits and convenience derived from the new product for the price they pay. Demand for a product with more advantages is stipulated to grow faster and in a larger scale than demand for a low advantage product. To mimic a situation where product advantage is high and consequently demand is growing rapidly, new product demand is modeled as increasing from the time of launch up to the end of simulation. Demand is increased by a factor each month as shown in Table 3.3 below. The effect factors reflect information from interview with managers, which showed that new product demand can increase by more than four times in the first year of launch in consumer goods industry.

Table 3.3: Effect of High Product Advantage on New Product Demand

Month	Effect Factor
1	1.00
2	1.35
3	1.70
4	2.00
5	2.30
6	2.50
7	2.70
8	2.90
9	3.00
10	3.10
11	3.20
12	3.30

4. Firm Resources

In this research, production capacity is used as a surrogate for firm resources (i.e., an indirect measure of resources available to a firm to pursue its strategies). Capacity is modeled at two levels: 70 percent and 100 percent. 100 percent indicates that a firm fulfills all orders while 70 percent capacity indicates that a company is able to fulfill only 70 percent of customer orders. The rationale is that small firms will have limited capacity to meet demand relative to large firms. These percentages are considered representative of typical firm capacities in relation to product demand.

3.2.4 Fixed Parameters

In this simulation, an order-up-to policy is used. The target level and reorder points vary depending on logistics strategy used. Transit lead time between manufacturer and distributors are stochastic with a mode of 3 days, a minimum of 2 days, and a maximum of 4 days. The transit time from distributors to each retail facility is stochastic with a mode of 2 days, a minimum of 1 day, and a maximum of 3 days. These transit times reflect typical lead times in the durable and non-durable consumer goods sector. The review period is modeled as 30 days, again representing typical review period in durable and non-durable consumer goods industry.

3.2.5 Performance Variables

Four performance variables are examined in this research: order fill rate, case fill rate, average system inventory, and profitability. These performance measures are widely used in extant literature (Chow et al. 1994; Glasserman and Wang 1998; Song 1998; Doloi and Jaafari 2001). Order fill rate indicates how well a company is able to complete customer orders. An order with an item missing will be considered incomplete. Therefore, order fill rate measures how many orders are shipped complete. Case fill rate captures the impact of stock outs over time (Rodrigues 2004). It indicates the number of units shipped divided by the total units requested in each order. Order and case fill rates reflect a company's ability to fulfill its delivery promises to customers.

Average system inventory indicates cumulative end of day inventory position (storage and transit) divided by number of days at the distribution and retail locations (Rodrigues 2004). The amount of inventory in the system affects inventory carrying cost and risks associated with excess inventory. Therefore, it is an important performance indicator.

The fourth measure is profitability. It is calculated by subtracting total cost from revenue. Product price (unit price) was set at $10, an arbitrary value. Four costs are computed: production, inventory carrying, transportation, and stockout penalty. Production is modeled as a "black box" – production factors such as scheduling, set-up/changeover time, etc., are not modeled. This is to ensure that scheduling and other production dynamics and constraints to do not affect assessment of distribution and inventory deployment processes in the model. Average system inventory is used to compute production cost per unit taking into consideration production economies of scale. Production cost per unit is reduced as volume increases to reflect production economies. Production costs rates are shown in Table 3.4 below.

Table 3.4: Production Cost Rate

Ave System Inv	Cost/unit
≤5000	$6.50
≤10000	$6.40
≤15000	$6.30
≤20000	$6.20
Else	$6.00

Transportation and inventory carrying costs vary between distributors and retailers. The costs are based on averages in the consumer goods sector as reported in The GMA 2005 Logistics Survey (IBM Business Consulting Services, 2005) and from interviews. According to the GMA 2005 survey, total logistics costs as a percentage of sales averages 6.9 percent in consumer goods industry. Of this, outbound transportation accounts for 40 percent. Thus, the cost of transportation as a percentage of sales is 2.76 percent. Based on the GMA 2005 survey, transportation cost would average $0.276. Since shipments from plant to Distributors are likely to be in bulk (i.e., full truck load), it is expected that average transportation cost will be lower than the average. However, shipments from distributor to retailers are mostly less than truck load; therefore, average transportation is likely to be higher than industry average. Consequently, shipment cost from plant to distributors is modeled as $0.20 while from distributors to retailers is modeled as $0.40. To account for transportation economies of scale, cost per unit is decreased with increase in shipment volume as shown in Table 3.5 below.

Table 3.5: Transportation Cost Rate

Transit inventory	DC cost/unit	Retail cost/unit
≤1000	$0.20	$0.40
≤2000	$0.19	$0.38
≤3000	$0.18	$0.36
≤4000	$0.17	$0.34
≤5000	$0.16	$0.32
Else	$0.15	$0.30

According to the GMA 2005 survey, inventory carrying cost in the consumer goods industry averages 25 percent. However, inventory carrying cost at retail level is expected to be higher than at distribution level because retailers own inventory at a higher cash value than distributors (Lambert and Pohlen 2001). Therefore, inventory carrying cost is modeled as 30 percent at retail level and 15 percent at distributor level. Although high volume is associated with gains from economies of scale, inventory carrying cost is modeled as increasing on a per unit cost basis as inventory volume increases. As Zinszer (1983) points out, there are different costs associated with different inventories. Inventory carrying cost should therefore vary depending on type of inventory. For example, the risk component associated with speculative stock is higher than cycle (transaction) inventory due to financial risks in case price declines and product demand falls as well as additional handling and storage costs (Zinszer 1983).

Similarly, risk component for a new product will be higher than for products with established demand. This is because new product is more susceptible to failure leading to greater write-off cost, product demand decline leading to lower sales and possibly price cuts, and limited secondary markets in case product fails in current market. Therefore, inventory carrying cost for a new product should increase, rather than decrease, with increases in inventory in stock. Risk costs may be so high that they erode any gains from economies of scale. Consequently, companies maintaining higher new product inventory will have higher carrying cost than those with minimal inventory. Table 3.6 shows inventory carrying cost rates used in the model.

Table 3.6: Inventory Carrying Cost Rate

Ave system inventory	DC cost/unit	Retail cost/unit
≤2500	$0.15	$0.30
≤5000	$0.16	$0.31
≤7500	$0.17	$0.32
≤10000	$0.18	$0.33
Else	$0.20	$0.35

Stockout penalty is modeled as fixed rate based on order fill rates as Table 3.7 shows. Several studies have examined stockout costs and penalties (Walter and Grabner 1975, Masters 1987, Corbett 2001). These include explicit cost such as some pre-agreed penalty for stockout (i.e., charged by retailers) and implicit costs such as loss of customer goodwill, lost sales when customers substitute product, etc. For a new product, it is critical that customers get the product when they need it. Therefore, stockout costs are high when dealing with new products and increase with higher levels of stockout both in absolute terms and on a per unit cost basis.

Table 3.7: Stockout Penalty Cost

Order Fill Rate	**Penalty**
≥95% but <100%	$1,500
≥90% but <95%	$3,000
≥85% but <90%	$4,500
<85%	$6,000

3.2.6 Number of Replications

The number of replications in a simulation study represents sample size, which determines the accuracy of stochastic variables. Using Law and Kelton (2000: 512) procedure to calculate the number of replications required to estimate population mean at a specified precision, it is determined that 24 replications would be required per experimental cell. According to this procedure, an approximate expression for the minimum number of replications, $n_a^*(\beta)$, required to obtain an absolute error of β is given by: $n_a^*(\beta) = \min \{i \geq n: t_{i-1,1-\alpha/2}\sqrt{(S^2(n)/i)} \leq \beta\}$. $n_a^*(\beta)$ can be determined by iteratively increasing i by 1 until a value of i is obtained for which $t_{i-1,1-\alpha/2}\sqrt{(S^2(n)/i)} \leq \beta$. For example, to estimate case fill rate with an absolute error, β, of 0.05 and a confidence level, α, of 90%, initial pilot runs were done and initial mean (μ) and standard deviation (S^2) were computed. A $S^2 = 0.02$ was obtained from 24 replications. Critical values of t give $t_{(23,0.5)} = 1.7139$. Using the equation $\{i \geq n: t_{i-1,1-\alpha/2}\sqrt{(S^2(n)/i)} \leq \beta\}$, we obtain a minimum of 24 replications ($n = 24$) to satisfy $t_{i-1,1-\alpha/2}\sqrt{S^2(n)/i} \leq \beta$ requirement. A large sample size indicates that estimated mean is closer to true mean. Thus, large number of replications increases accuracy and confidence in simulation results. In this study, 30 replications are done per experimental cell.

3.2.7 Data Analysis

Multivariate analysis of variance (MANOVA) and univariate analysis of variance (ANOVA) are used to test the main effects and interaction effects stipulated in the hypotheses. MANOVA is a dependence technique that measures differences for two or more metric dependent variables based on a set of categorical (nonmetric) variables acting as independent variables (Hair et al. 1998). MANOVA enables comparison of groups formed by categorical independent variables on group differences in a set of interval dependent variables. ANOVA technique determines whether samples from two or more groups come from populations with equal means. ANOVA tests for differences in means between groups, which can also be done using t-test, is preferred because it is more efficient (gives more information with fewer tests) and allows for detection of interaction effect between two variables. In this research, there are more than two dependent variables (performance measures) and multiple independent variables, which indicate that use of both ANOVA and MANOVA is appropriate.

CHAPTER 4: RESULTS

4.0 Introduction

This chapter discusses study results. The first part discusses MANOVA assumptions, effects of assumption violations, and conformity of study data to the assumptions. The next section presents multivariate and univariate results. This is followed by results of hypotheses tests examining support or lack of support for study hypotheses. The last section discusses results implications.

4.1 MANOVA Assumptions and Data Conformity to Assumptions

MANOVA enables comparison of groups formed by categorical independent variables on group differences in a set of interval dependent variables (Hair et al. 1998). To develop valid results, MANOVA requires five assumptions, namely; (i) observations are statistically independent, (ii) dependent variables follow a multivariate Normal Distribution, (iii) the variance-covariance matrices of the dependent variables are equal for all treatment groups, (iv) linearity and multicollinearity among dependent variables, and (v) absence of outliers.

One of the most stringent assumptions is independence of observations. MANOVA is used where independent variables are categorical and dependent variables are continuous. Violations occur when there is lack of independence among observations for several reasons. For example, violations may occur if there is serial correlation (for measures taken overtime), when information is gathered in a group setting where respondents' common experiences cause a subset of individuals to have answers that are somewhat correlated, or when extraneous and unmeasured effects create dependence among respondents. Since this study used independent simulation replications, independence of observations requirement is satisfied.

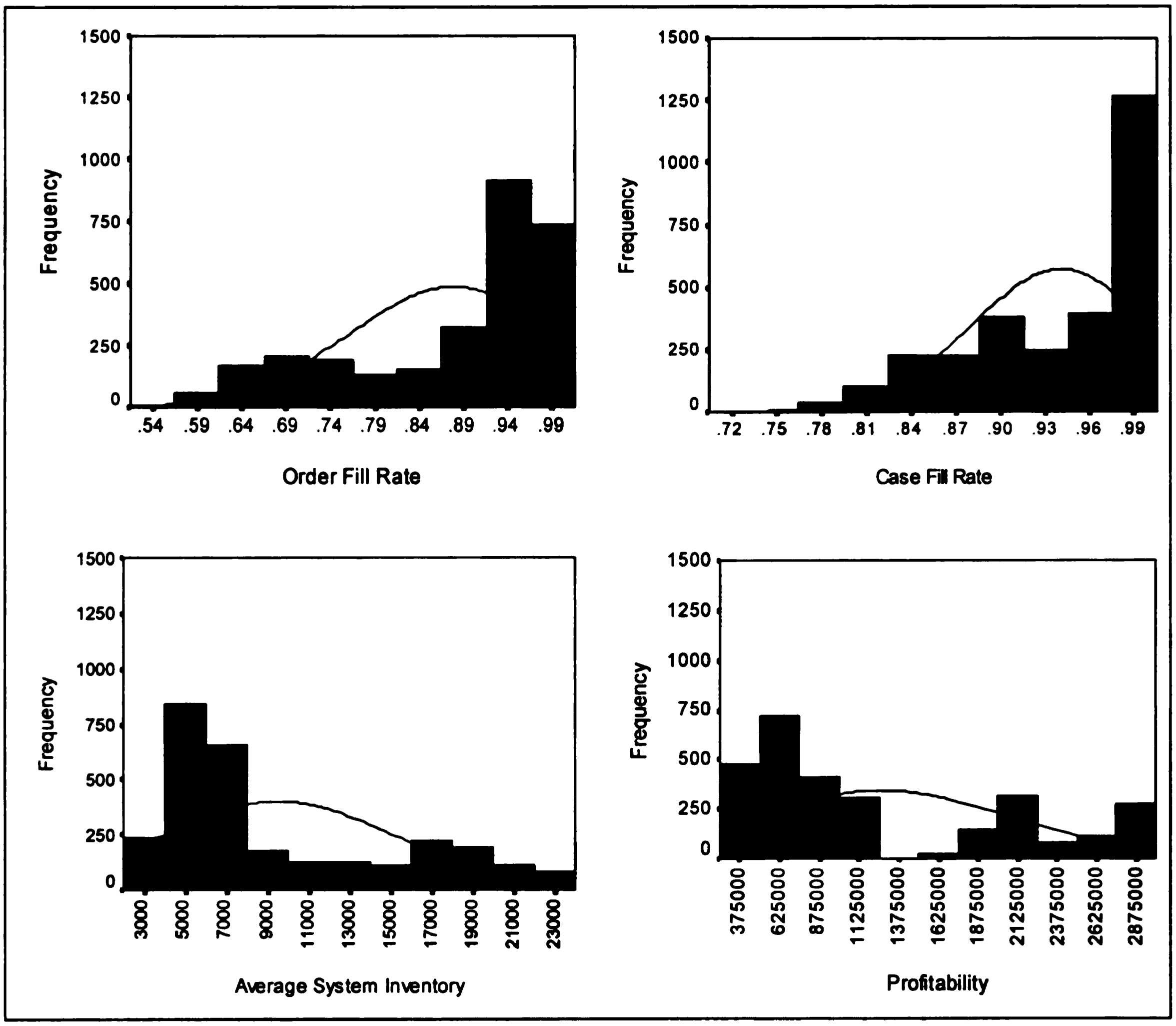
Multivariate normality assumes that joint effect of two variables is normaly distributed. Violations of this assumption have little impact when large samples are used. Violations affect application of Box's M test, which is used to test for equality of covariance matrices. Generally, F-test is robust to non-normality if it is caused by skewness rather than outliers. Skewness and Kurtosis statistics (Table 4.1) and Frequency histograms (Figure 4.1) for dependent variables indicate that there are departures from multivariate normality. However, past studies have shown that MANOVA is robust to departures from multivariate normality when treatments have equal sample sizes (Hair et al. 1998). Frequency histograms (Figure 4.1) show that there are no outliers in the data, which satisfies the fifth assumption.

Table 4.1 - Skewness and Kurtosis Statistics

	Skewness		**Kurtosis**	
	Statistic	Std Error	Statistic	Std Error
Order Fill Rate	-1.002	0.046	-0.307	0.091
Case Fill Rate	-0.760	0.046	-0.616	0.091
Ave System Inventory	0.932	0.046	-0.506	0.091
Profitability	0.783	0.046	-0.930	0.091

Equality of variance-covariance matrices concerns presence of substantial differences in the amount of variance of one group versus another for the same variables. However, violation of this assumption has minimal impact if groups are approximately equal in size. In addition, the assumption may be violated without greatly affecting the level of significance or power. In this study, all groups have same size. Levene's Test of homogeneity of variances is used to test the assumption that each group (category) of independent variables has same variance. Levene's Test is significant for all dependent variables at $p<.001$, which indicates that data fails the assumption of equal variances. Box's M test is used to test for equality of covariance matrices. This measure is very sensitive to departures from normality. Box's M test results (Box's M = 28880.4, F=28.9, df1=950, df2=857109, $p<.001$) indicate that the null hypothesis that covariance matrices of the dependent variables are equal across groups is rejected.

Figure 4.1 - Frequency Histograms for the Dependent Variables



Linearity and multicollinearity among dependent variables was also tested. General linear hypotheses models assume linearity among variables. Therefore, it is important to test for non-linear relationships. To determine if measures are significantly correlated, Bartlett's test of sphericity is used. The test examines correlations among all dependent variables and determines whether, collectively, significant intercorrelation exists. The result, Bartlett's = 178,872 with 9df, $p<.001$, indicates that significant intercorrelations exist, which means that use of MANOVA is appropriate.

The foregoing discussion indicates that study data conformed to most critical requirements and assumptions for MANOVA so the results can be accepted as valid. Consequently, it is appropriate to use MANOVA to test study hypotheses.

4.2 Overall Results

In this study, four independent variables are tested: logistics strategy (4 levels), launch strategy (2 levels), demand characteristics (6 levels), and production capacity (2 levels), resulting in 96 scenarios. Two alternative logistics strategy models are presented: Pull strategy is compared with Push strategy, and Fat strategy is compared with Lean strategy [Refer to Chapter 3, section 3.2.3, *Logistics Strategy*, p.66]. Therefore, although logistics strategy is presented as having 4 levels in profile plots in this Chapter, in effect, there are two alternative levels. Similarly, demand characteristics are modeled in 6 levels. However, as discussed in Chapter 3 [Refer to Chapter 3, section 3.2.3, "*Demand Characteristics*," p.70], there are three demand levels, and for each level, there is a low and high variability situation. Therefore, profile plots in this Chapter show low and high variability results for each demand level.

Each scenario is replicated 30 times, resulting in a total sample size of 2880 observations. There are four dependent variables: order fill rate, case fill rate, average system inventory, and profitability. MANOVA and univariate ANOVA tests are done using SPSS. Table 4.2 gives a summary of multivariate and univariate test results. These results are discussed in detail in subsequent sections.

Table 4.2 - Summary of Significance Test

Effects	Multivariate Results	Univariate Results			
		OFR	*CFR*	*System Inventory*	*Profitability*
Logistics Strategy (LOG)	***	***	***	***	***
Launch Strategy (LAU)	***	*	Ns	***	***
Demand Variability (DEM)	***	***	***	***	***
Production Capacity (CAP)	***	***	***	***	***
LOG * LAU	***	***	***	***	***
LOG * DEM	***	***	***	***	***
LOG * CAP	***	***	***	***	***
LAU * DEM	***	*	***	***	***
LAU * CAP	***	ns	Ns	***	ns
DEM * CAP	***	ns	Ns	***	***
LOG * LAU * DEM	***	*	***	***	***
LOG * LAU * CAP	***	ns	*	ns	*
LOG * DEM * CAP	***	ns	Ns	***	***
LAU * DEM * CAP	ns	ns	Ns	ns	ns
LOG * LAU * DEM * CAP	ns	ns	Ns	ns	ns

**** Significant at p<.001*
** Significant at p<.05*
ns – Not significant

4.3 Multivariate Results

SPSS provides results of four criteria for testing multivariate differences between groups: Wilk's Lambda, Pillai's Trace, Hotelling's Trace, and Roy's Largest Root. Wilk's Lambda examines whether groups are different without being concerned with whether they differ on at least one linear combination of the dependent variables. It is appropriate where assumptions appear to be met. Pillai's Trace has minor differences from Wilk's Lambda. It is the sum of variance that can be explained by the calculation of discriminant variables and is robust when MANOVA assumptions are not met, especially where sample sizes are small, cell sizes are unequal, or covariances are not homogeneous.

Hotelling's Trace has minor differences from Wilk's Lambda and is safely ignored in most cases. Roy's Largest Root measures the differences only on first canonical root. It is most appropriate when all dependent variables are strongly intercorrelated on a single dimension but is most severely affected by violations of MANOVA assumptions. In other words, it is the most powerful test when all assumptions are strictly met and dependent measures are representative of a single dimension of effect. Generally, the best measure to use is one that is most immune to violations of underlying MANOVA assumptions. Consequently, Pillai's Trace is reported in this study. Table 4.3 shows multivariate test results.

Table 4.3 - Multivariate Test Results

Effect	F	Degrees of Freedom		Sig.	Partial Eta Squared	Observed Power
Logistics Strategy (LOG)	1,278	12	8,349	0.000	0.647	1.000
Launch Strategy (LAU)	49,425	4	2,781	0.000	0.986	1.000
Demand Characteristics (DEM)	1,253	4	2,781	0.000	0.643	1.000
Production Capacity (CAP)	289	20	11,136	0.000	0.342	1.000
LOG * LAU	271	12	8,349	0.000	0.280	1.000
LOG * DEM	163	60	11,136	0.000	0.467	1.000
LOG * CAP	57	12	8,349	0.000	0.076	1.000
LAU * DEM	205	20	11,136	0.000	0.269	1.000
LAU * CAP	29	4	2,781	0.000	0.039	1.000
DEM * CAP	70	20	11,136	0.000	0.112	1.000
LOG * LAU * DEM	27	60	11,136	0.000	0.128	1.000
LOG * LAU * CAP	4	12	8,349	0.000	0.005	0.998
LOG * DEM * CAP	7	60	11,136	0.000	0.036	1.000
LAU * DEM * CAP	1	20	11,136	0.116	0.002	0.920
LOG * LAU * DEM * CAP	1	60	11,136	0.199	0.006	0.998

Effect column shows independent variables and interactions between them. The next column shows F-ratio. F-ratio focuses on independent variables and seeks to answers the question "is each independent variable effect significant?" The larger the F statistic, the greater the likelihood that mean differences are due to something other than chance. Degrees of freedom columns indicate the degrees of freedom used to obtain observed significance levels of multivariate test. The next column indicates significance level (p-value), which is the conditional probability that a relationship as strong as the one observed in the data would be present if null hypotheses were true (chance of making Type I error). Typically, results that yield $p<.05$ are considered borderline significant while lower p-values, i.e., $p<.001$ are considered highly significant.

The fifth column shows Partial Eta Squared (partial η^2), the proportion of total variability in dependent variable that is accounted for by variation in independent variable, excluding other factors from total non-error variation (Cohen 1973, Levine and Hullett 2002, Pierce et al. 2004). It is a measure of effect size. Partial η^2 values range from 0 to 1, with larger values indicating stronger effect. The last column, Observed Power, indicates power of test or the ability to reject null hypotheses when it is actually false (chance of making Type II error). High observed power values (i.e., over 0.9) are recommended.

In MANOVA, interaction terms represent joint effect and must be examined first. There is one four-way interaction, four three-way interactions, six two-way interactions, and four main effects. As Table 4.3 shows, significant three-way interactions (at $p<.001$) are: Logistics Strategy x Launch Strategy x Demand Characteristics (LOG*LAU*DEM), Logistics Strategy x Launch Strategy x Production Capacity (LOG*LAU*CAP), and Launch Strategy x Demand Characteristics x Production Capacity (LAU*DEM*CAP). All two-way interactions are significant at $p<.001$. They are: Logistics Strategy x Launch

Strategy (LOG*LAU); Logistics Strategy x Demand Characteristics (LOG*DEM); Logistics Strategy x Production Capacity (LOG*CAP); Launch Strategy x Demand Characteristics (LAU*DEM); Launch Strategy x Production Capacity (LAU*CAP); and Demand Characteristics x Production Capacity (DEM*CAP). All main effects are significant at $p<.001$. The main effects are Logistics Strategy, Launch Strategy, Demand Characteristics, and Production Capacity. These interaction and main effects are discussed in the following sections.

4.4 Univariate Results

This section discusses univariate test results for main and interaction effects.

4.4.1 Univariate Results: Three-way Interactions

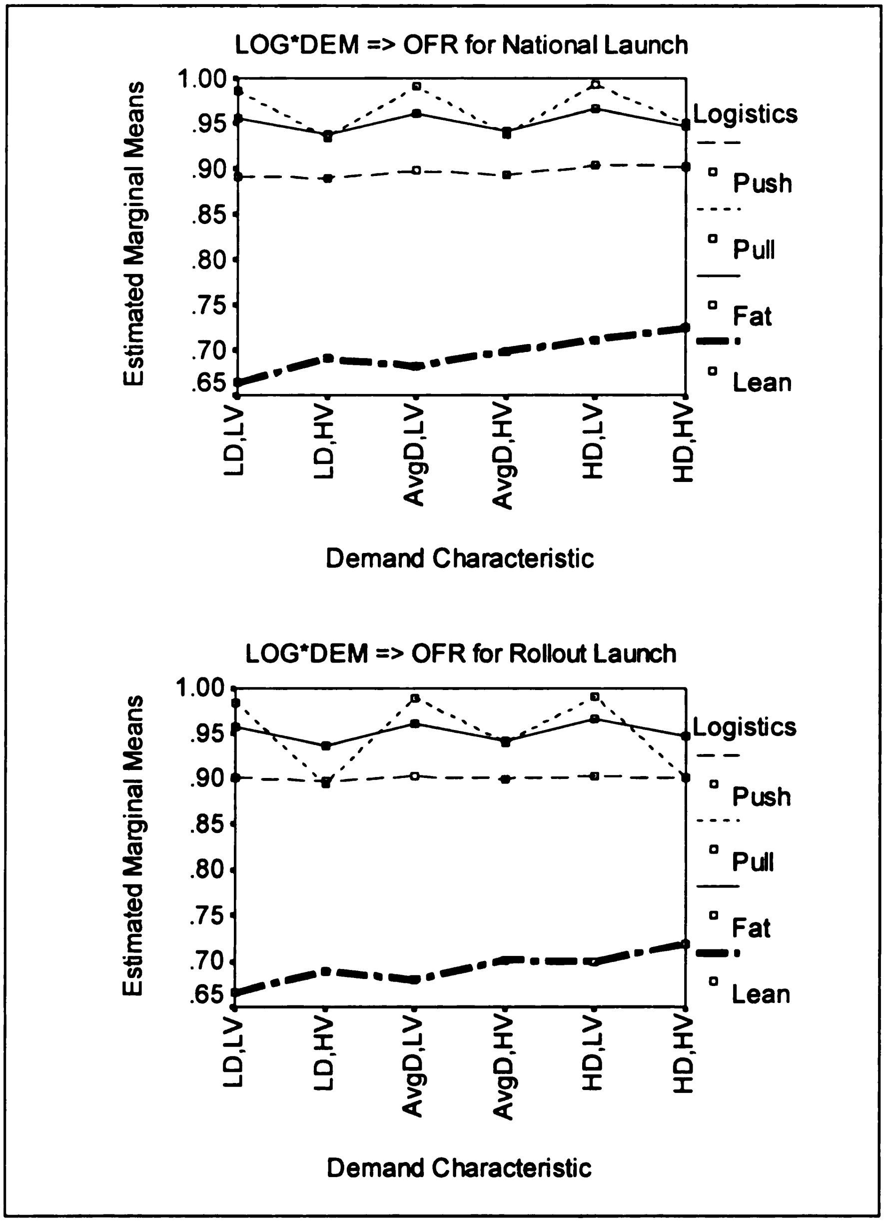
Table 4.5 presents univariate results for significant three-way interactions.

Table 4.4 - Univariate Test for Three-way Interactions

Source of Variation	Dependent Variable	F	Degrees of Freedom		Sig.	Partial Eta Squared	Observed Power
LOGISTIC * LAUNCH * DEMAND	Order Fill Rate	2	15	2,784	0.004	0.012	0.982
	Case Fill Rate	8	15	2,784	0.000	0.041	1.000
	Avg System Inventory	76	15	2,784	0.000	0.290	1.000
	Profitability	3	15	2,784	0.000	0.015	0.996
LOGISTIC * LAUNCH * CAPACITY	Order Fill Rate	1	3	2,784	0.221	0.002	0.392
	Case Fill Rate	3	3	2,784	0.041	0.003	0.669
	Avg System Inventory	2	3	2,784	0.076	0.002	0.581
	Profitability	4	3	2,784	0.011	0.004	0.811
LOGISTIC * DEMAND * CAPACITY	Order Fill Rate	1	15	2,784	0.718	0.004	0.526
	Case Fill Rate	1	15	2,784	0.198	0.007	0.813
	Avg System Inventory	4	15	2,784	0.000	0.024	1.000
	Profitability	6	15	2,784	0.000	0.030	1.000

LOG*LAU*DEM has significant effect on Order Fill Rate (OFR) at $p<.05$ and Case Fill Rate (CFR), Average System Inventory, and Profitability at $p<.001$. Partial η^2 values indicate that a strong effect on average system inventory (partial $\eta^2 = 0.29$) and weak effect on OFR and profitability (partial $\eta^2 = 0.012$ and 0.015, respectively). Figure 4.2 and Figure 4.3 show the profile plots of LOG*LAU*DEM effect on OFR and CFR.

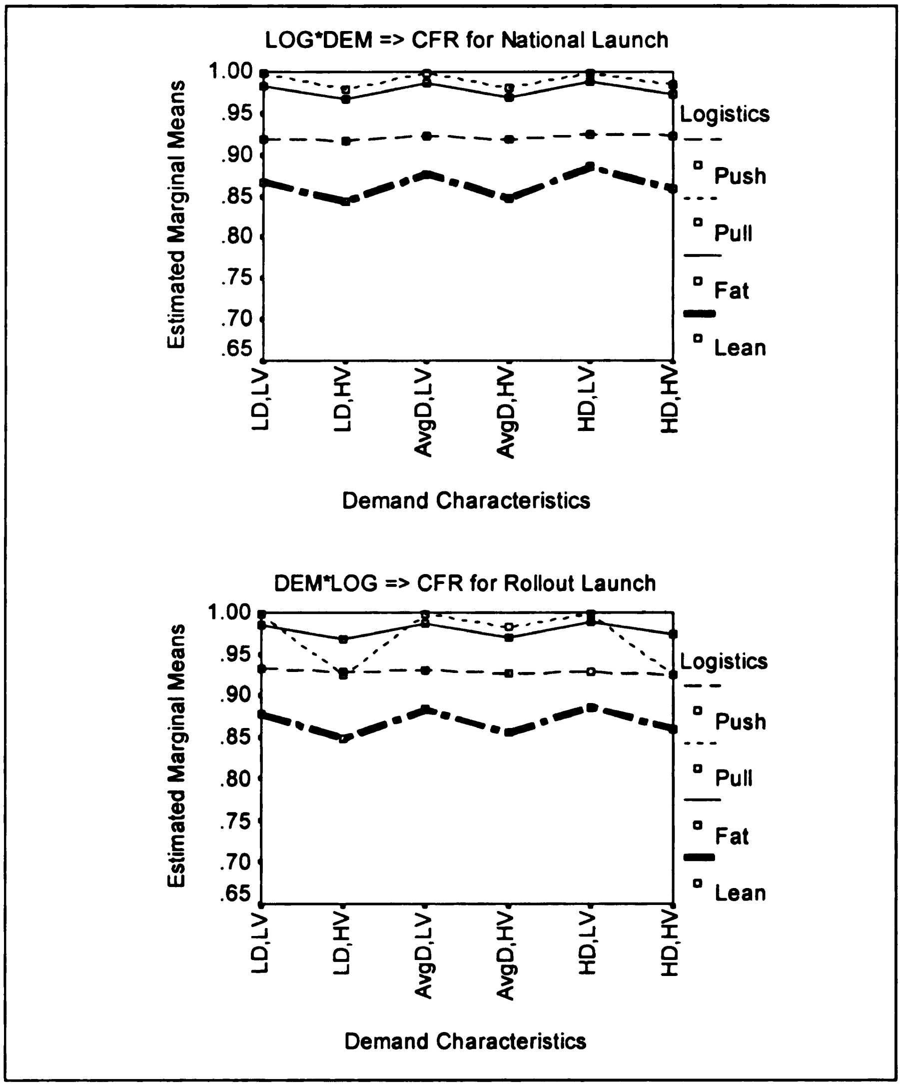
Figure 4.2 - Effect of LOG*LAU*DEM on Order Fill Rate [1]



[1] **Demand Characteristics** levels in all profile plots are: LD=Low demand level (high competitive reaction); LV=Low demand variability; AvgD=Average demand level (low competitive reaction, low product advantage); HD=High demand level (high product advantage); HV=High demand variability. Low and high demand variability are put adjusted to each other for each demand level for ease of interpretations.

Logistics Strategy is presented at 4 levels in all profile plots in this Chapter. However, two alternative strategies are captured: Push vs. Pull or Fat vs. Lean [Refer to Chapter 3, Section 3.2.3, p.66].

Figure 4.3 - Effect of LOG*LAU*DEM on Case Fill Rate



According to these plots, under a Pull logistics strategy, OFR and CFR differ between national and rollout launch when demand variability is high for low and high demand levels. For example, OFR and CFR are highest when Pull logistics strategy is used and demand variability is low, irrespective of demand level (i.e., low, high, average). However, when Pull logistics strategy is used and demand variability is high, OFR and CFR are substantially lower in a rollout launch than a national launch strategy. Profile plots indicate that under a Pull strategy, when demand variability increases from low to high, OFR decreases by about 4 percent for national launch and about 8 percent for rollout launch. Similarly, CFR decreases by about 3 percent for national launch and about 7 percent for rollout launch when demand variability increases from low to high. This shows that Pull logistics strategy is more sensitive to variations in demand and launch strategy. There are no significant differences in OFR and CFR between national and rollout strategy for other logistics strategies (Push, Fat, or Lean), irrespective of demand levels. Therefore, the multivariate significance of LOG*LAU*DEM is attributed to Pull logistics strategy.

Figure 4.4 - Effect of LOG*LAU*DEM on Average System Inventory

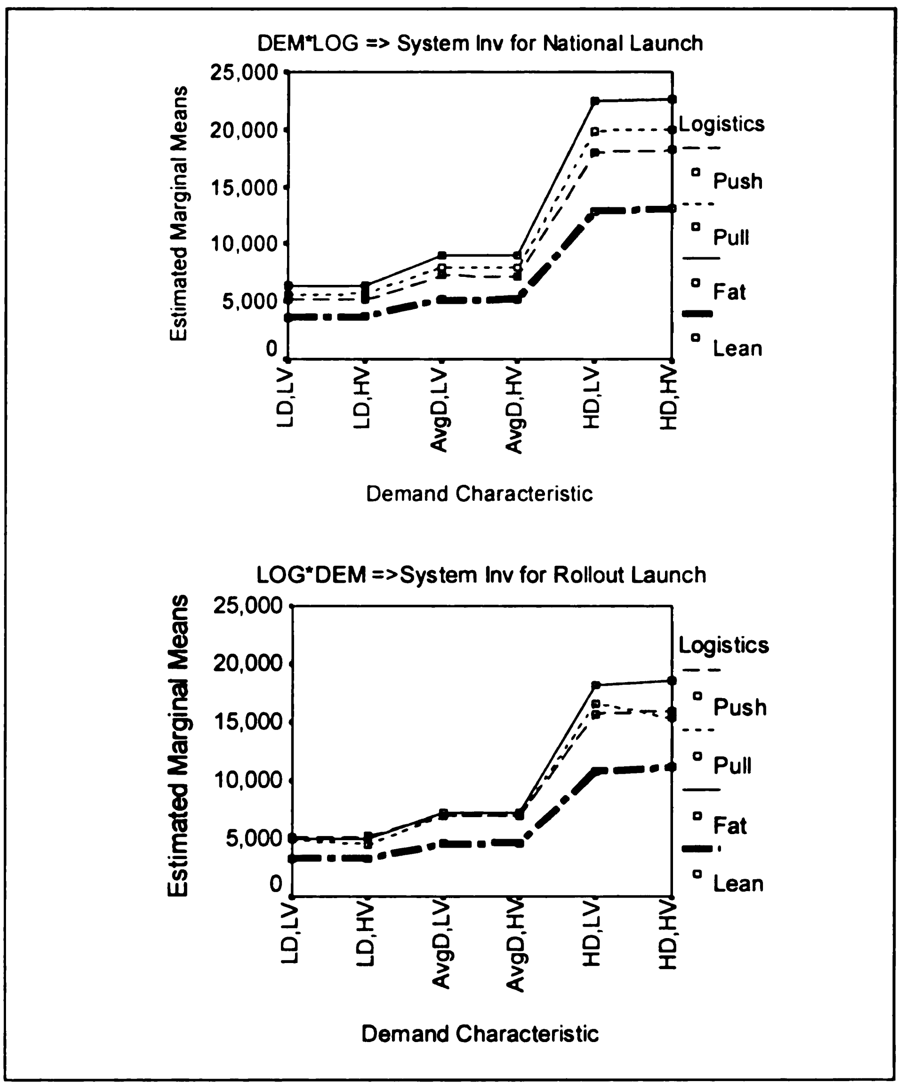


Figure 4.5 - Effect of LOG*LAU*DEM on Profitability

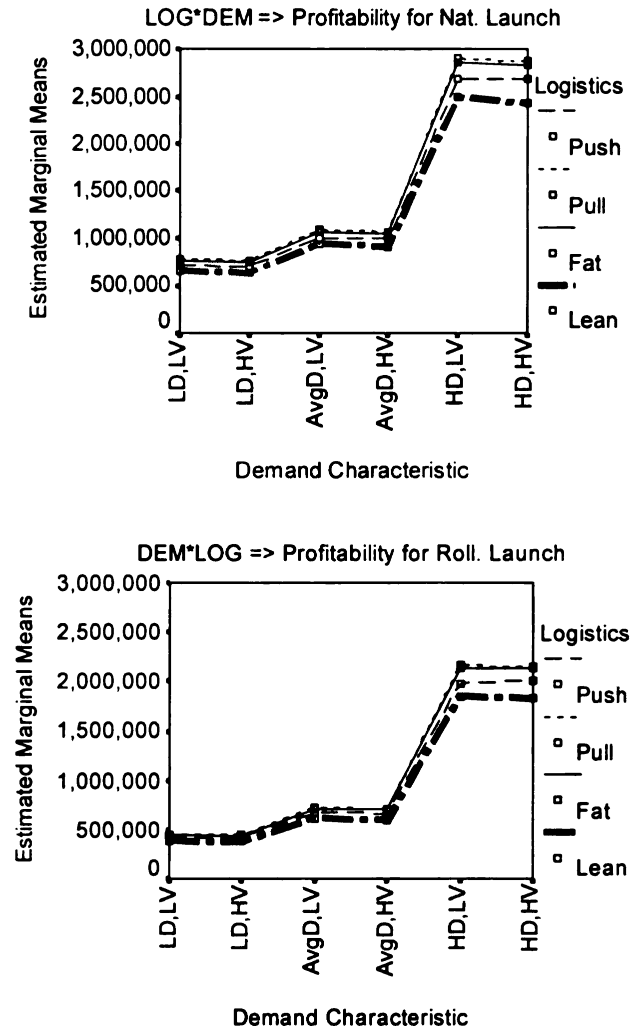
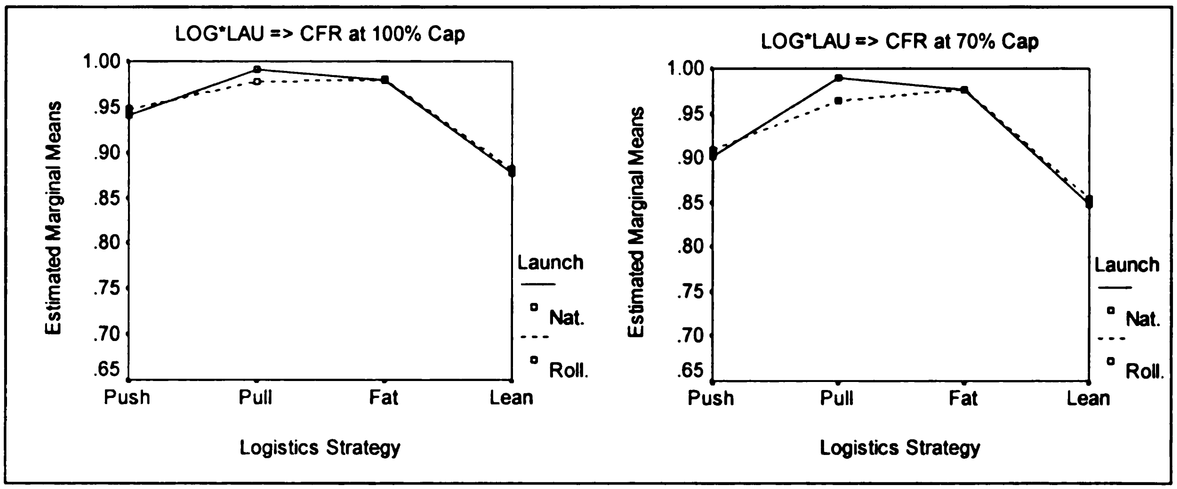


Figure 4.4 and Figure 4.5 show that irrespective of logistics strategy, national launch results in higher average system inventory and profitability than a rollout strategy for all demand levels. Since national launch involves product introduction in all customer segments, it is expected to results in more sales, greater average system inventory, and higher profits than a rollout strategy. At the same time, when demand is either low or average, Push, Pull, and Fat logistics strategies result in almost the same levels of average system inventory when rollout strategy is adopted but different levels

when national launch is adopted. However, when demand is high, Fat logistics strategy results in substantially higher inventory than both Push and Pull strategies. Surprisingly, demand variability does not affect average system inventory and profitability, except under Pull logistics strategy when demand is high. However, the effect seems negligible.

LOG*LAU*CAP significantly affects both CFR and profitability at $p<.05$ but not OFR and average system inventory. However, partial η^2 values (.003 and .004, respectively) indicate that effect is very weak. Figure 4.6 indicates that when Pull logistics strategy is used, rollout strategy results in lower CFR for a 100 percent production capacity than a 70 percent capacity. This shows that Pull logistics strategy is more sensitive to capacity variation and is the main contributing factor to the observed significant results.

Figure 4.6 - Effect of LOG*LAU*CAP on Case Fill Rate [2]

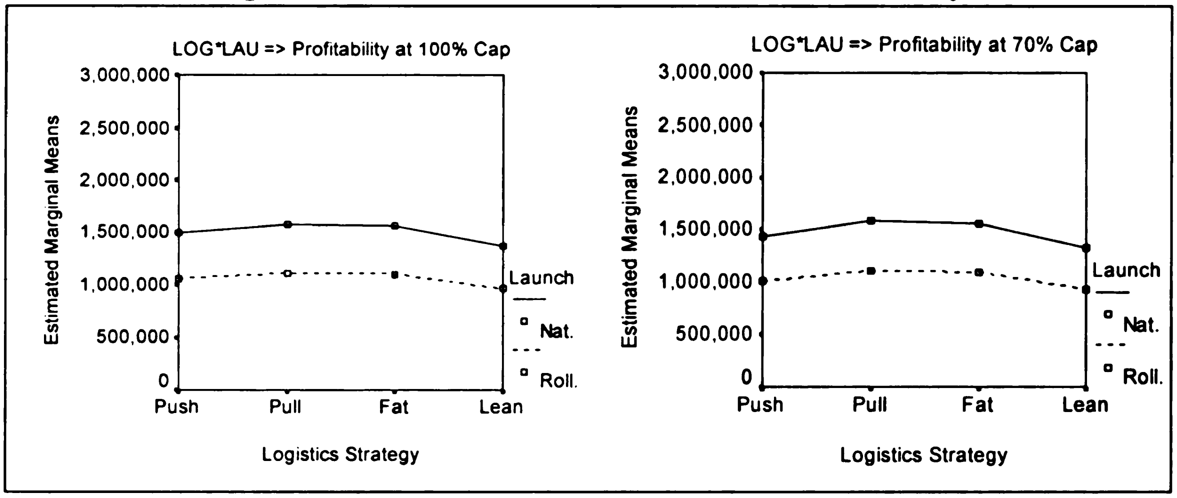


For other logistics strategies, there are no significant differences in CFR between the two levels of capacity under national and rollout launch strategies. Intuitively, larger capacity allows for more orders to be processed than if capacity is constrained, which

[2] **Logistics Strategy** levels represent two alternative strategies: Push vs. Pull (models whether inventory is pushed into the distribution system is held at plant/DC), and Fat vs. Lean (captures the amount of inventory deployed in the distribution system). [Refer to Chapter 3, Section 3.2.3, p.66].

results in higher sales and profits. Consequently, production capacity moderates the effect of interaction between logistics and launch strategies on CFR. Figure 4.7 and Partial η^2 values show that LOG*LAU*CAP effect is negligible.

Figure 4.7 - Effect of LOG*LAU*CAP on Profitability



LOG*DEM*CAP significantly affects average system inventory and profitability (at $p<.001$), but not OFR and CFR. However, partial η^2 values suggest a weak effect on both average system inventory (partial η^2=.024) and profitability (partial η^2=.03). Moreover, marginal means plots (Figure 4.8 and Figure 4.9, next page) show that LOG*DEM*CAP has weak effect on average system inventory and profitability. As expected, average system inventory and profitability are slightly higher when capacity is 100% than when capacity is 70% for all logistics strategies at the same demand level.

Figure 4.8 - Effect of LOG*DEM*CAP on Average System Inventory

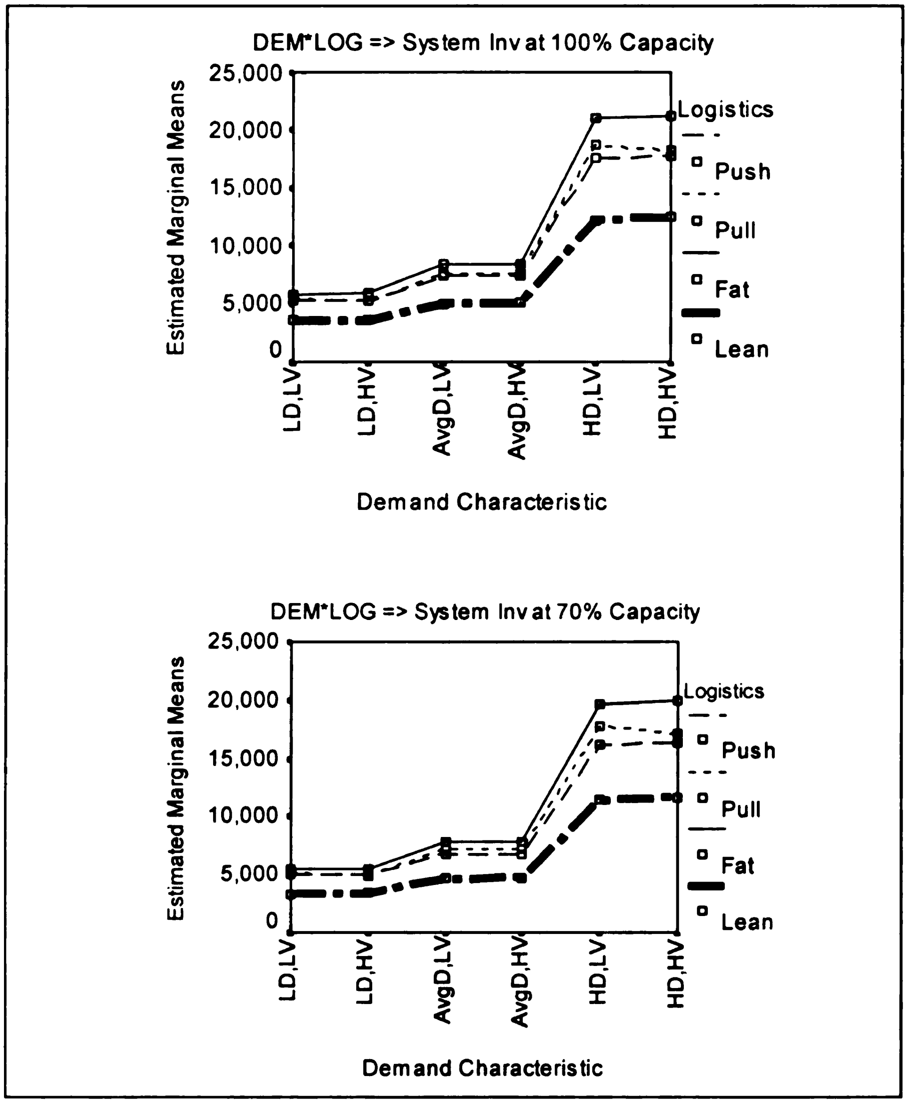
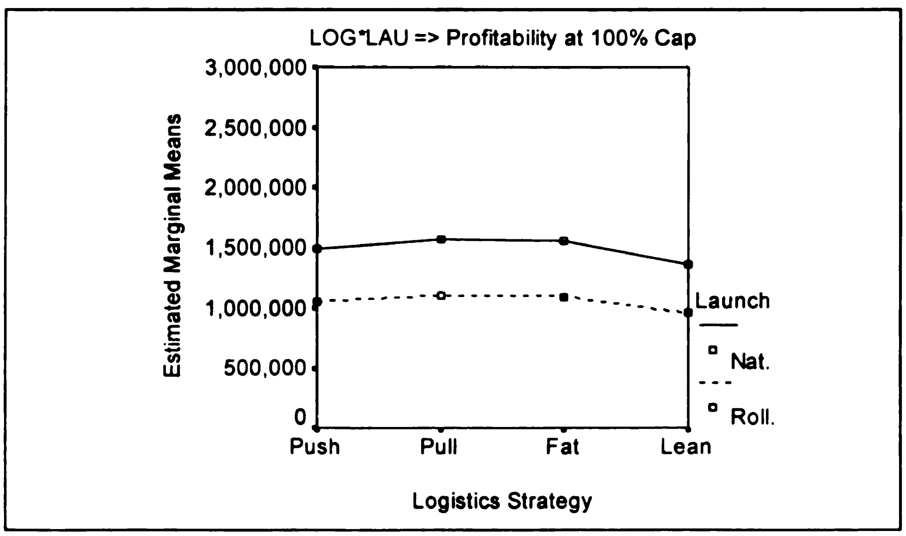
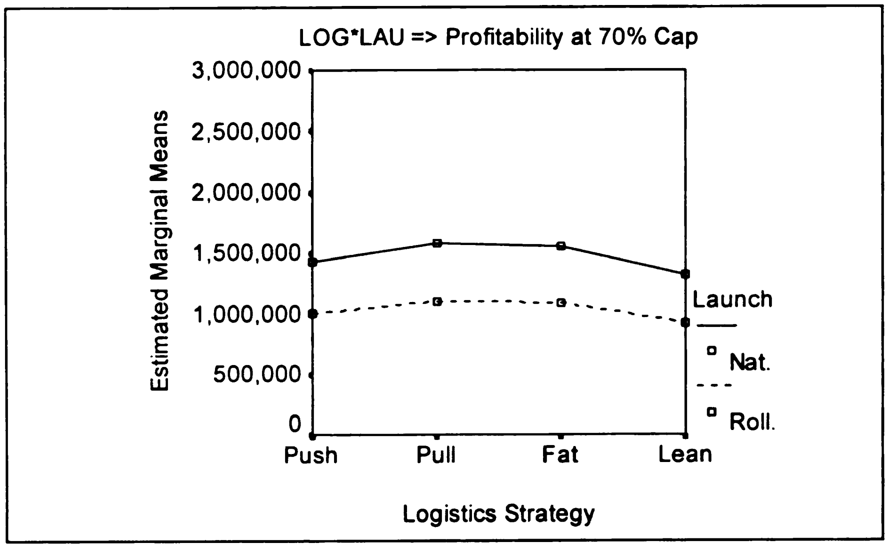


Figure 4.9 - Effect of LOG*DEM*CAP on Profitability *(see continuation next page)*





4.4.2 Univariate Results: Two-way Interactions

Table 4.5 shows univariate results of the two-way interactions.

Table 4.5 - Univariate Test for Two-way Interactions

Source of Variation	Dependent Variable	F	Degrees of Freedom		Sig.	Partial Eta Squared	Observed Power
LOGISTIC * LAUNCH	Order Fill Rate	8	3	2,784	0.000	0.008	0.988
	Case Fill Rate	33	3	2,784	0.000	0.034	1.000
	Avg System Inventory	1,670	3	2,784	0.000	0.643	1.000
	Profitability	85	3	2,784	0.000	0.084	1.000
LOGISTIC * DEMAND	Order Fill Rate	30	15	2,784	0.000	0.138	1.000
	Case Fill Rate	15	15	2,784	0.000	0.073	1.000
	Avg System Inventory	2,804	15	2,784	0.000	0.938	1.000
	Profitability	225	15	2,784	0.000	0.548	1.000
LOGISTIC * CAPACITY	Order Fill Rate	40	3	2,784	0.000	0.041	1.000
	Case Fill Rate	65	3	2,784	0.000	0.065	1.000
	Avg System Inventory	60	3	2,784	0.000	0.060	1.000
	Profitability	68	3	2,784	0.000	0.068	1.000
LAUNCH * DEMAND	Order Fill Rate	3	5	2,784	0.005	0.006	0.907
	Case Fill Rate	11	5	2,784	0.000	0.020	1.000
	Avg System Inventory	2,588	5	2,784	0.000	0.823	1.000
	Profitability	2,129	5	2,784	0.000	0.793	1.000
LAUNCH * CAPACITY	Order Fill Rate	2	1	2,784	0.122	0.001	0.340
	Case Fill Rate	1	1	2,784	0.239	0.000	0.217
	Avg System Inventory	61	1	2,784	0.000	0.022	1.000
	Profitability	4	1	2,784	0.051	0.001	0.495
DEMAND * CAPACITY	Order Fill Rate	0.4	5	2,784	0.832	0.001	0.164
	Case Fill Rate	0.5	5	2,784	0.798	0.001	0.179
	Avg System Inventory	287	5	2,784	0.000	0.340	1.000
	Profitability	13	5	2,784	0.000	0.023	1.000

LOG*LAU significantly affects all dependent variables at $p<.001$. Partial η^2 values indicate that the effect is greatest on average system inventory (.643) and weakest on OFR (.008). As Figure 4.10 and Figure 4.11 show, under Pull logistics strategy, national launch results in higher OFR and CFR than rollout launch. However, when Push, Fat, or Lean strategies are used, both national and rollout launch strategies result in same level of OFR and CFR. This finding is surprising given that both launch strategies have different demand sizes (total market served). OFR and CFR are marginally higher for rollout launch than national launch under a Push strategy.

Figure 4.10 - Effect of LOG*LAU on Order Fill Rate

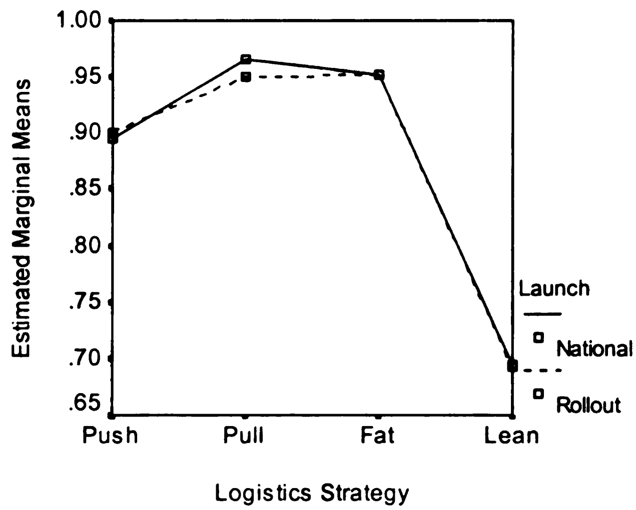


Figure 4.12 indicates that for national launch, average system inventory is highest when Fat logistics strategy is used and lowest when Lean logistics strategy is used. This makes intuitive sense since Fat strategy involves holding greater buffer inventory at various stages in the supply chain. At the same time, Lean strategy has the least inventory since only stock sufficient to meet one order cycle is maintained throughout the distribution system. For rollout launch strategy, the same pattern is observed – Fat logistics strategy results in highest average system inventory while Lean strategy results

in lowest average system inventory. Surprisingly, Push and Pull logistics strategies have the same level of average system inventory when rollout strategy is adopted but different when national launch is adopted.

Figure 4.11 - Effect of LOG*LAU on Case Fill Rate

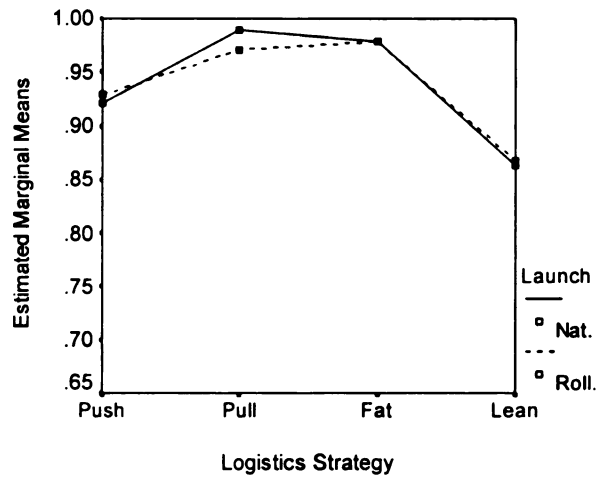
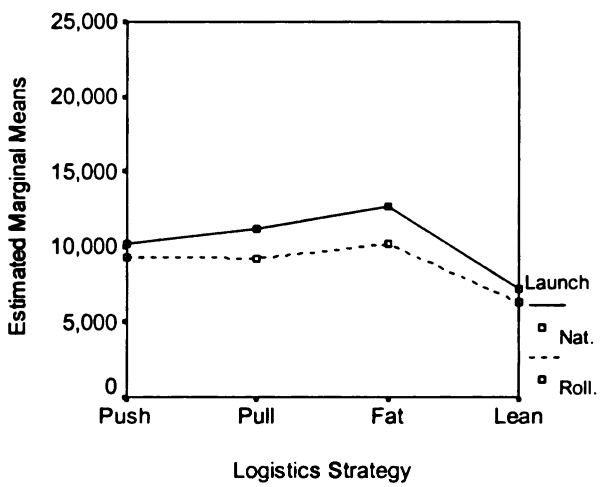
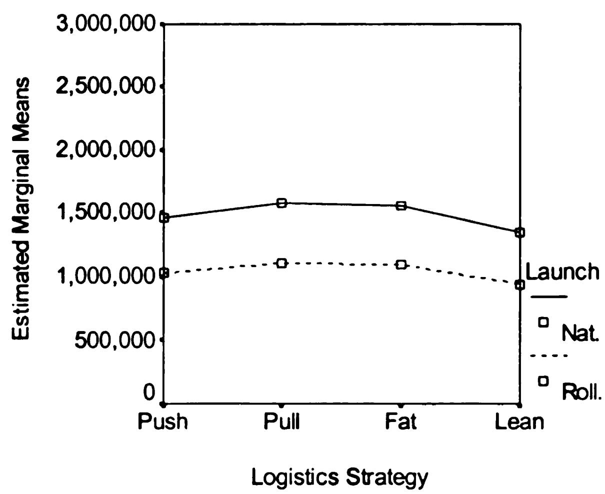


Figure 4.12 - Effect of LOG*LAU on Average System Inventory



As Figure 4.13 indicates, national launch strategy results in higher profits than a rollout launch strategy for all logistics strategies. Unlike rollout strategy, national launch involves product introduction in all market segments. Consequently, there are more sales, and for proportional cost structures, greater profits. Profits are highest when Pull logistics strategy is used in a national launch. Even though both Pull and Push logistics strategies have the same level of average system inventory when rollout strategy is adopted, Pull strategy results in higher profits than Push strategy. This can be attributed to high inventory carrying cost at the retail level in a Push strategy compared to a Pull strategy. Moreover, Push strategy has higher stockouts than Pull strategy as indicated by lower OFR and CFR, which results in lower sales and profits. A surprising finding is that although Fat logistics strategy results in average system inventory that is almost twice that of a Lean logistics strategy for both national and rollout launch strategies, the difference in profitability is relatively smaller. This can be attributed to higher inventory carrying cost for Fat logistics strategy, which significantly reduces profitability even though service levels are high. A Lean strategy on the other hand has lower system inventory and consequently lower inventory carrying cost. However, it results in more stockouts as attested by low OFR and CFR levels.

Figure 4.13 - Effect of LOG*LAU on Profitability



LOG*DEM interaction significantly affects all performance variables at $p<.001$. Partial η^2 values indicate that the effect is greatest on average system inventory (partial $\eta^2 = 0.938$) and profitability (partial $\eta^2 = 0.548$). Figures 4.14 and 4.15 indicate that OFR and CFR are highest when Pull logistics strategy is used and demand variability is low. However, when demand variability is high, Fat logistics strategy results in highest OFR and CFR. This makes intuitive sense. Fat strategy provides buffer inventory necessary to cushion the effect of highly variable demand. Consequently, it is expected to result in better performance when demand variability is high than the alternative Lean strategy.

Figure 4.14 - Effect of LOG*DEM on Order Fill Rate

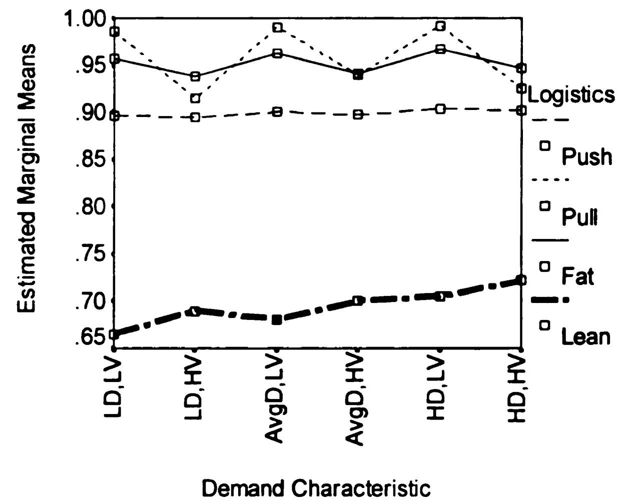
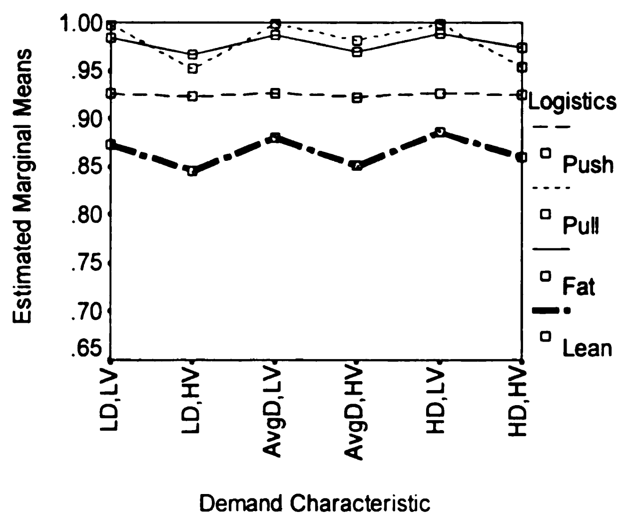


Figure 4.15 - Effect of LOG*DEM on Case Fill Rate



Push logistics strategy results in more uniform OFR and CFR levels irrespective of demand variability. This suggests that Push logistics strategy is more resilient to effects of demand variability compared to Pull strategy. Since Push strategy involves deployment of higher levels of inventory at retail level, any changes in demand are accommodated and fulfilled. As expected, Lean strategy results in lower OFR and CFR than Fat strategy irrespective of demand characteristic. Although Lean strategy has least inventory cost, firms adopting this strategy should consider effects of high stockouts especially when demand variability is high.

Figure 4.16 - Effect of LOG*DEM on Average System Inventory

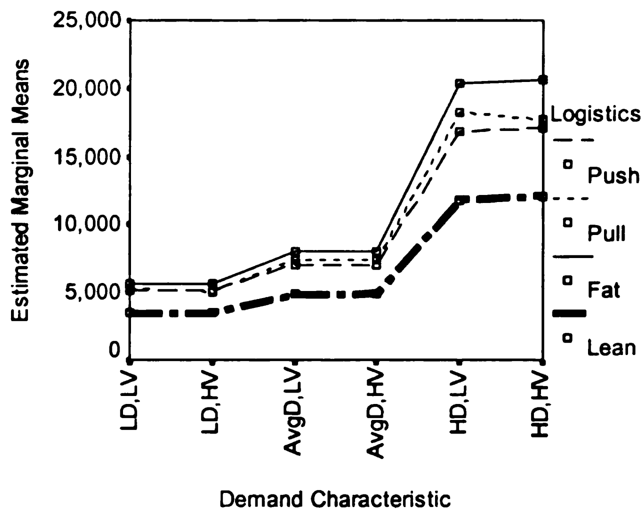
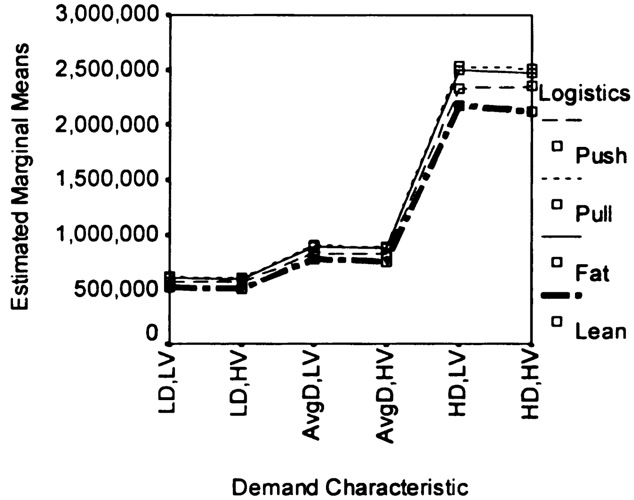


Figure 4.16 (above) and Figure 4.17 (next page) show that differences in average system inventory and profitability between different logistics strategies are most marked when demand is high. Moreover, Pull logistics strategy results in slightly lower average system inventory and profitability if demand variability is high than if it is low. This reinforces an earlier observation that Pull logistics system is more sensitive to demand variability than other logistics strategies.

Figure 4.17 - Effect of LOG*DEM on Profitability



LOG*CAP significantly affects all performance variables at $p<.001$. Partial η^2 values range from .041 to .068, which shows that the effect on all variables is weak. As Figure 4.18 and Figure 4.19 show, effect of capacity on OFR and CFR varies with type of logistics strategy. When Push strategy is used, increasing capacity from 70 percent to 100 percent results in about 5 percent increment for both OFR and CFR. In addition, under Lean strategy, OFR and CFR are higher when capacity is 100 percent than when it is 70 percent. However, when either Pull strategy or Fat strategy is used, increasing capacity results in negligible increases in OFR and CFR.

These results indicate that Push and Lean strategies are more sensitive to capacity variation than Pull and Fat logistics strategies. This can be attributed to the fact that Pull strategy is sufficiently flexible to accommodate changes necessitated by capacity variation while Fat strategy has sufficient buffer inventory to cushion off effects of limited capacity. Push strategy is not flexible enough since replenishing and maintaining large inventory at retail level is strongly affected by constraints at production level. Lean strategy has inventory to meet demand in one order cycle. Therefore, any constraint created by capacity limitation is likely to affect fill rates more severely.

Figure 4.18 - Effect of LOG*CAP on Order Fill Rate

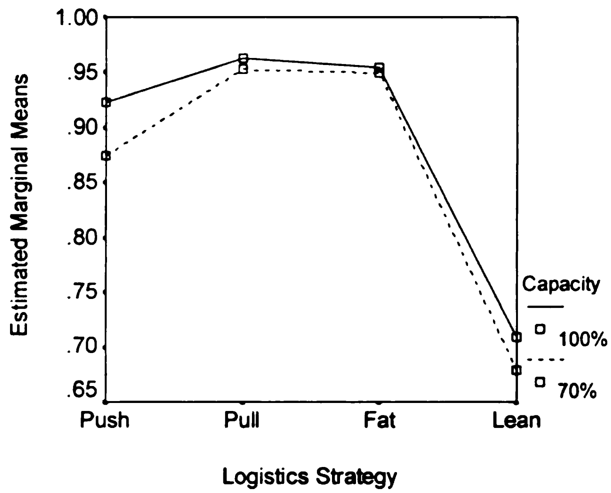
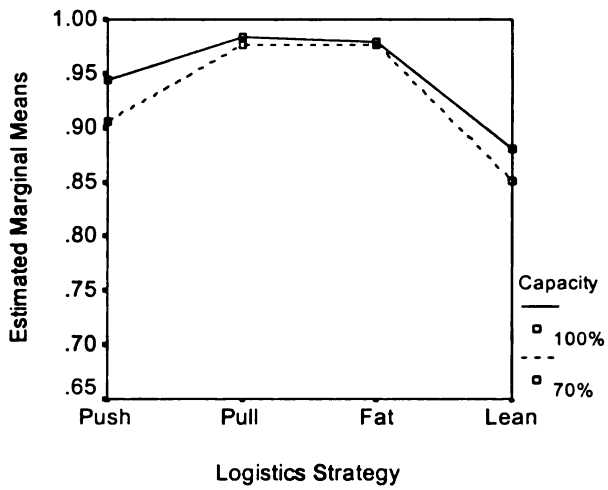


Figure 4.19 - Effect of LOG*CAP on Case Fill Rate



Generally, average system inventory is lower when capacity is 70 percent than when capacity it is 100 percent for all logistics strategies (Figure 4.20). Profitability is also higher when capacity is 100 percent (Figure 4.21). However, for Pull and Fat logistics strategies, the difference in profitability between 100 percent and 70 percent capacity levels is negligible. This implies that type of logistics strategy adopted during new product launch may either exacerbate or mitigate capacity limitation problems, which affects performance.

Figure 4.20 - Effect of LOG*CAP on Average System Inventory

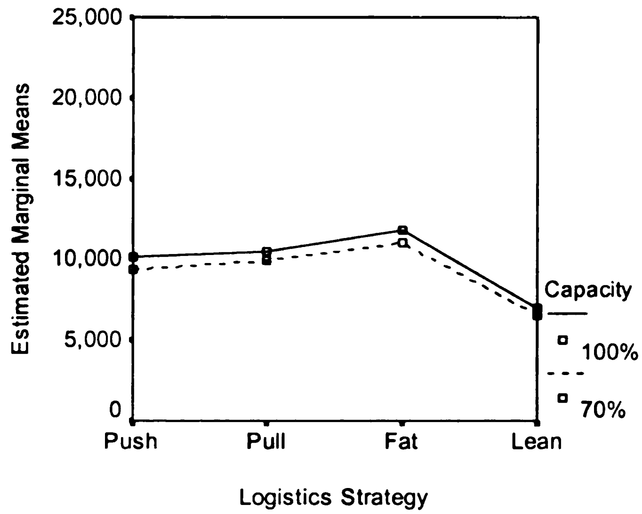
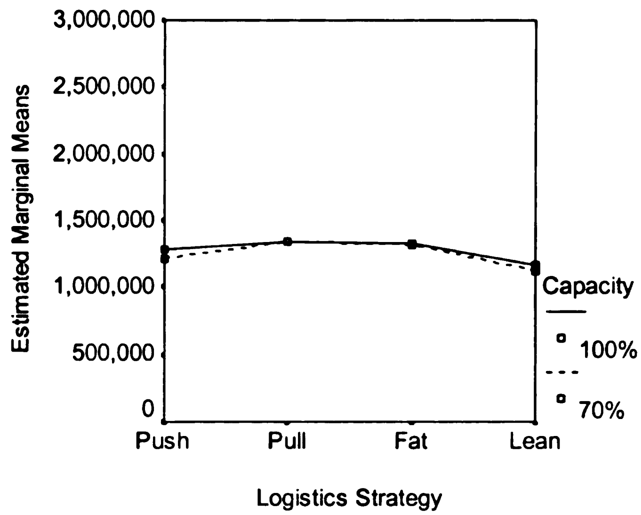


Figure 4.21 - Effect of LOG*CAP on Profitability



LAU*DEM significantly affects OFR at $p<.05$ and other performance variables at $p<.001$. Partial η^2 values for OFR (.006) and CFR (.02) indicate that the effect is very weak. Indeed, profile plots in Figure 4.22 and Figure 4.23 indicate that differences in OFR and CFR between national and rollout strategies at different demand levels are negligible.

Figure 4.22 - Effect of LAU*DEM on Order Fill Rate

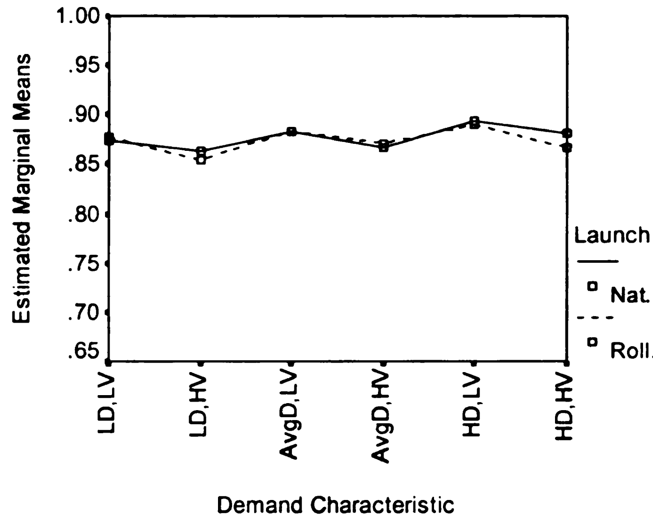


Figure 4.23 - Effect of LAU*DEM on Case Fill Rate

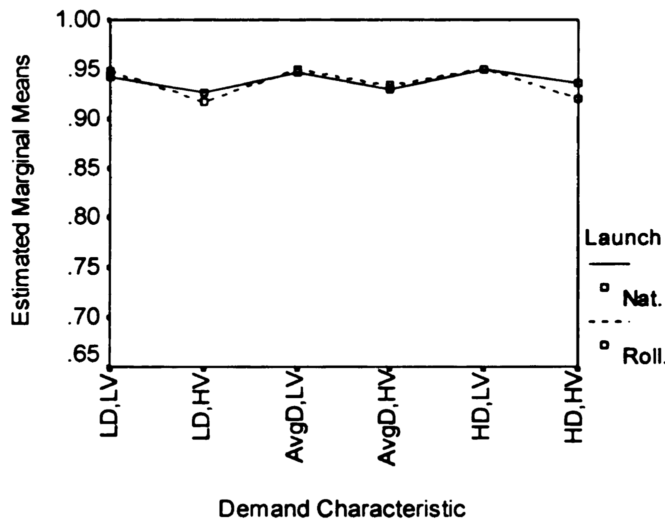


Figure 4.24 and Figure 4.25 show that LAU*DEM significantly affects average system inventory and profitability at $p<.001$. Partial η^2 values indicate a strong effect on average system inventory and profitability (0.823 and 0.793, respectively). As expected, low demand results in lowest average system inventory and profitability while national launch results in higher average system inventory and profitability than a rollout strategy. When demand is high, the difference in average system inventory and profitability between national and rollout launch strategies are greater than when demand is average

or low. Profile plots indicate that demand variability has negligible, if any, effect on average system inventory and profitability.

Figure 4.24 - Effect of LAU*DEM on Average System Inventory

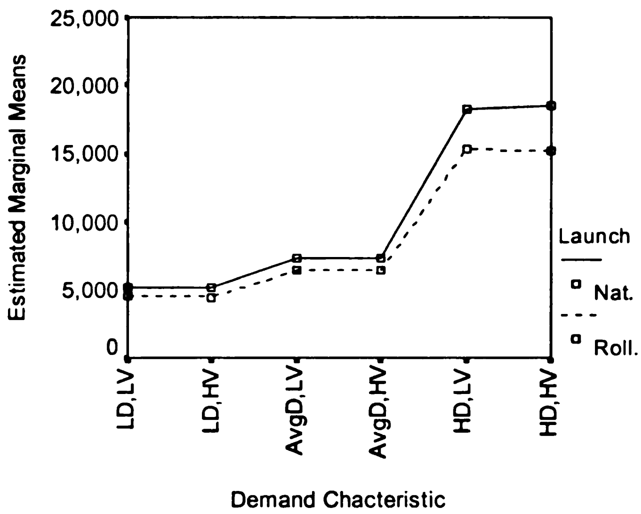
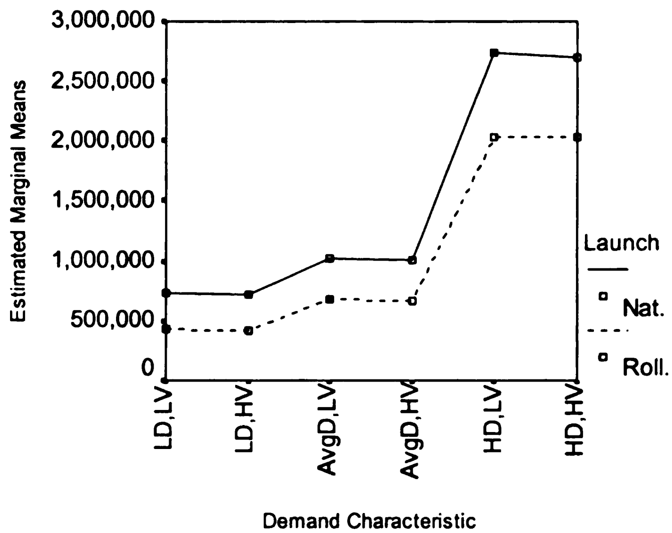
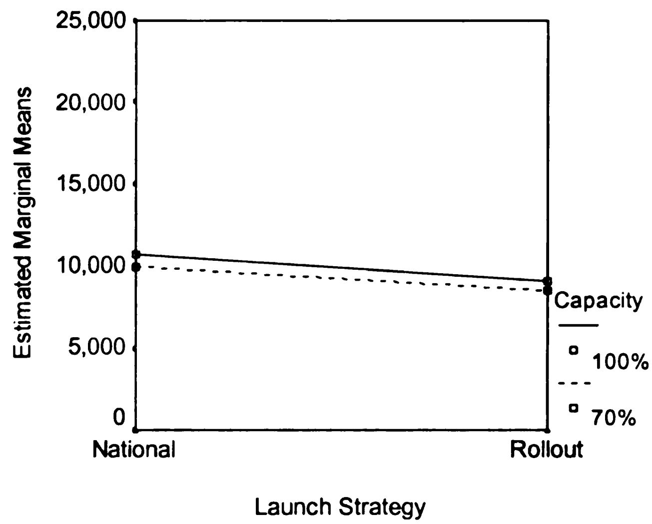


Figure 4.25 - Effect of LAU*DEM on Profitability



LAU*CAP significantly affects average system inventory (at $p<.001$) but does not have significant effect on other performance variables. Examination of marginal means plots (Figure 4.26) indicates that the effect is negligible. Moreover, partial η^2 value (.022) suggests that the effect is weak. National launch involves inventory deployment to more markets than a rollout strategy. Consequently, average system inventory is higher for national launch than rollout launch strategy for same level of capacity.

Figure 4.26 - Effect of LAU*CAP on Average System Inventory



DEM*CAP significantly affects average system inventory and profitability ($p<.001$). However, the effect is stronger on average system inventory (Partial $\eta^2 = .340$) than profitability (Partial $\eta^2 = .023$). When demand is either low or average, both capacity levels (100 percent and 70 percent) result in almost same levels of average system inventory and profitability. However, when demand is high, average system inventory and profitability are higher for 100 percent than a 70 percent capacity as Figures 4.27 and 4.28 indicate. This finding makes intuitive sense. High demand makes it difficult to fulfill customer orders if capacity is limited. Therefore, capacity limitations are expected to affect performance most severely when demand is high than when demand is low.

Figure 4.27 - Effect of DEM*CAP on Average System Inventory

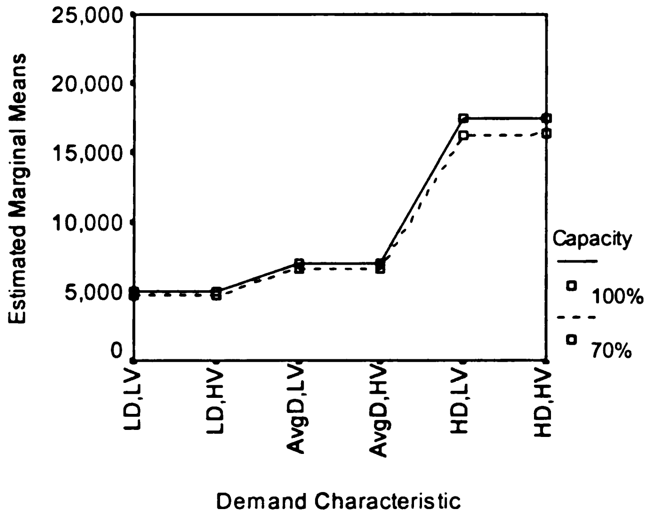
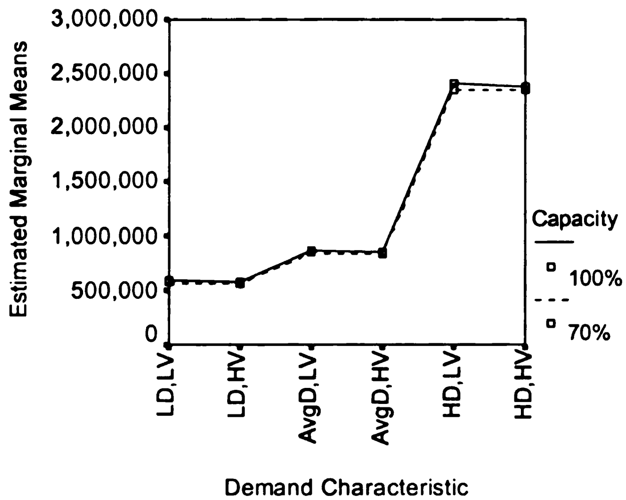


Figure 4.28 - Effect of DEM*CAP on Profitability



4.4.3 Univariate Results: Main Effects

Table 4.7 provides univariate test results for main effects. Except for launch strategy, all independent variables significantly affect performance variables at $p<.001$. However, Partial η^2 values indicate that effect sizes vary, with demand characteristics showing strongest effect on average system inventory and profitability. Overall, logistics strategy has strong effect on all dependent variables.

Table 4.6 - Univariate test for Main Effects

Source of Variation	Dependent Variable	F	Degrees of Freedom		Sig.	Partial Eta Squared	Observed Power
LOGISTIC	Order Fill Rate	6,411	3	2,784	0.000	0.874	1.000
	Case Fill Rate	2,705	3	2,784	0.000	0.745	1.000
	Avg System Inventory	40,246	3	2,784	0.000	0.977	1.000
	Profitability	2,906	3	2,784	0.000	0.758	1.000
LAUNCH	Order Fill Rate	4	1	2,784	0.043	0.001	0.525
	Case Fill Rate	2	1	2,784	0.135	0.001	0.320
	Avg System Inventory	24,939	1	2,784	0.000	0.900	1.000
	Profitability	68,499	1	2,784	0.000	0.961	1.000
DEMAND	Order Fill Rate	35	5	2,784	0.000	0.060	1.000
	Case Fill Rate	85	5	2,784	0.000	0.133	1.000
	Avg System Inventory	229,197	5	2,784	0.000	0.998	1.000
	Profitability	176,547	5	2,784	0.000	0.997	1.000
CAPACITY	Order Fill Rate	225	1	2,784	0.000	0.075	1.000
	Case Fill Rate	354	1	2,784	0.000	0.113	1.000
	Avg System Inventory	4,004	1	2,784	0.000	0.590	1.000
	Profitability	267	1	2,784	0.000	0.088	1.000

Logistics strategy strongly impacts performance as demonstrated by partial η^2 values that range from 0.745 to 0.977. Figure 4.29 indicates that Pull strategy results in higher OFR and CFR than Push strategy and Fat strategy results in higher OFR and CFR than Lean strategy. Figure 4.30 shows that average system inventory is highest when Fat strategy is used and lowest under Lean strategy. Pull strategy results in slightly higher inventory than Push strategy. Figure 4.31 indicates that Pull strategy results in slightly higher profitability than other strategies while Lean strategy has the lowest.

Surprisingly, although Lean strategy results in average system inventory level that is almost half that of Fat strategy, and substantially lower fill rates, it results in profits that are fairly close to those of other strategies. This can be attributed to significant savings in inventory cost and associated efficiencies. Pull strategy results in significantly better performance than Push strategy. For example, Pull strategy improves OFR and CFR by 6 percent and profitability by 8 percent while average system inventory increases by 4 percent compared to a Push strategy.

Figure 4.29 - Effect of Logistics Strategy on Order and Case Fill Rate

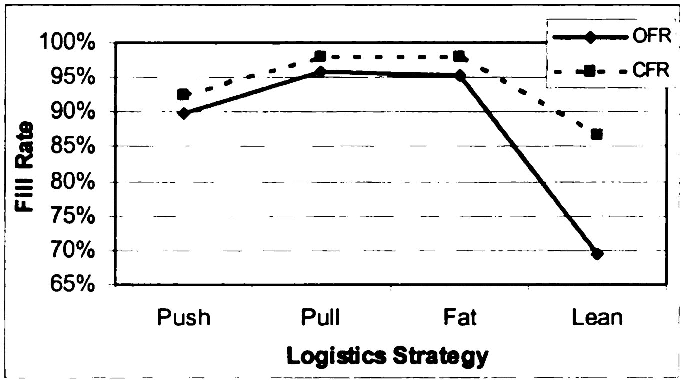


Figure 4.30 - Effect of Logistics Strategy on Average System Inventory

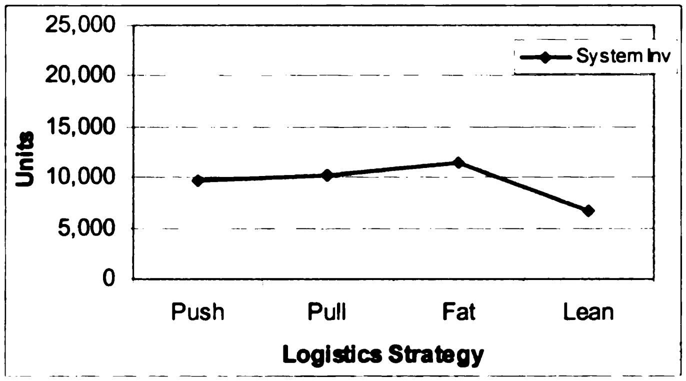
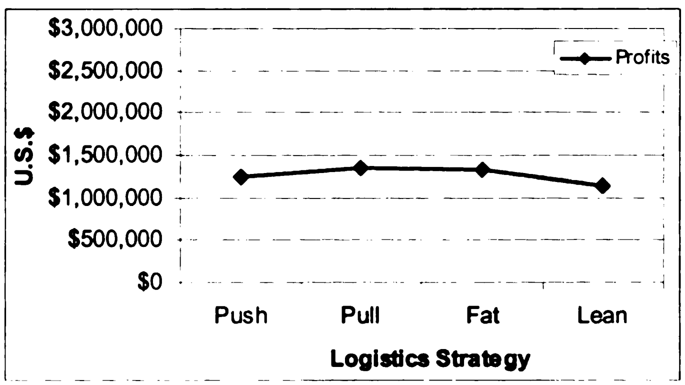


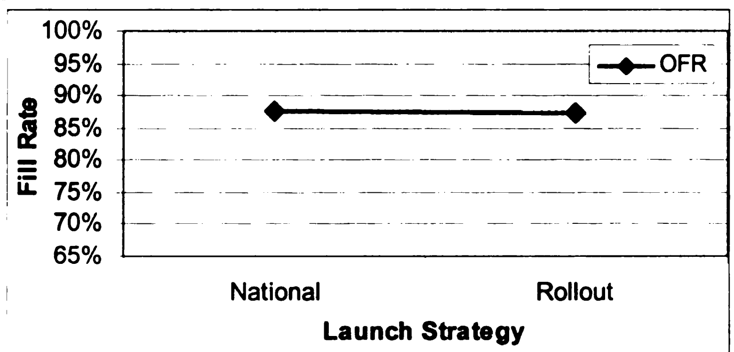
Figure 4.31 - Effect of Logistics Strategy on Profitability



Although Lean logistics strategy reduces inventory cost, it results in lowest fill rates and profitability. In this study, Lean strategy was modeled to mimic a situation where deployed inventory is only sufficient to cover one order cycle. Results indicate that increasing buffer inventory at each supply chain facility may substantially improve performance. For example, maintaining buffer inventory sufficient to cover one order cycle at both distribution and retail levels (Fat strategy) on average improves OFR by 26 percent, CFR by 11 percent, profitability by 16 percent, and increases average system inventory by 68 percent. However, the marked increase in average system inventory implies that inventory carrying cost increases substantially. Therefore, the challenge is to identify appropriate mix of buffer inventory in the system that results in optimal profits and fill rates while maintaining inventory carrying cost at reasonable levels.

Launch strategy significantly affects OFR at $p<.05$, average system inventory at $p<.001$, and profitability at $p<.001$ but not CFR. The effect on average system inventory and profitability is very strong as attested by high partial η^2 values (0.9 and 0.961, respectively) but effect on OFR is very weak, indeed negligible as demonstrated by low partial η^2 (0.001) and marginal means plot (Figure 4.32).

Figure 4.32 - Effect of Launch Strategy on Order Fill Rate



As expected, national launch strategy results in greater average system inventory (Figure 4.33) and profitability (Figure 4.34) than rollout strategy. National launch improves profitability by 45 percent over rollout launch for a 19 percent increase in system inventory (over rollout strategy). This suggests that although there are risks such as higher costs of inventory incase of product failure, national launch strategy is better than a rollout strategy in terms of profitability.

Figure 4.33 - Effect of Launch Strategy on Average System Inventory

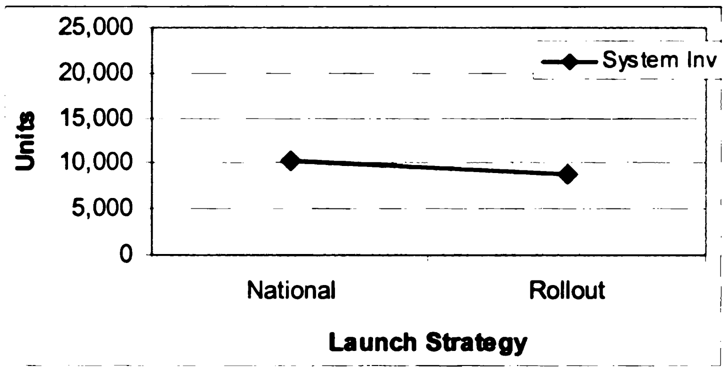
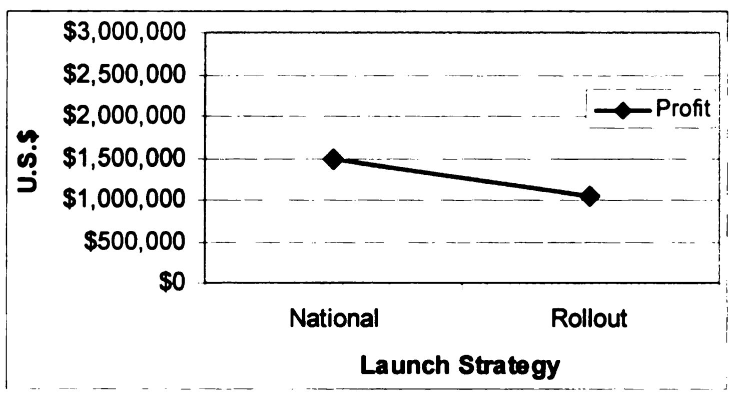


Figure 4.34 - Effect of Launch Strategy on Profitability

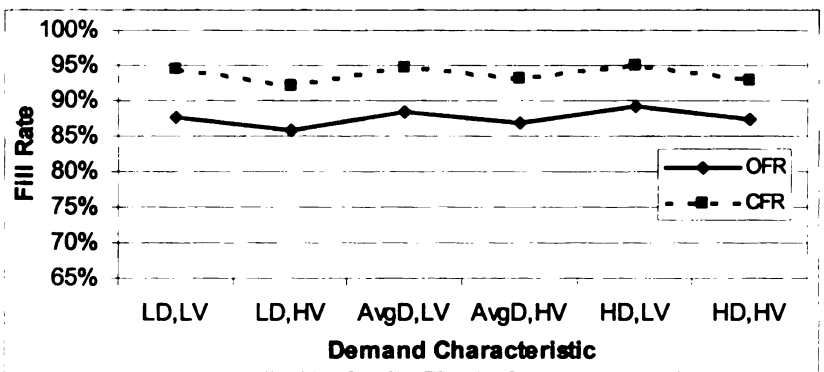


Demand Characteristics significantly affects all dependent variables at $p<.001$. Partial η^2 values indicate that demand characteristic strongly impacts average system inventory and profitability (partial $\eta^2 = 0.998$ and 0.997, respectively) but has weak effect on OFR and CFR (partial $\eta^2 = 0.06$ and 0.133, respectively). Figure 4.35 shows that demand variability affects OFR and CFR but not average system inventory (Figure 4.36) and profitability (Figure 4.37). High demand variability results in lower OFR and CFR (decrease of about 3%) for all demand levels. There is negligible difference in OFR and

CFR between low, average and high demand levels, implying that demand size has negligible effect on fill rates.

Figure 4.36 and Figure 4.37 indicate that there are marked differences in average system inventory and profitability at different demand levels. Intense competitive response leads to reduced demand, sales and profits. As a result, firms adjust their inventories in the distribution system to reflect reduced customer orders and sales. Thus, lower average system inventory and profits are expected when competitive response is intense because increased competition reduces demand for the product (reduced market share), assuming proportionate costs.

Figure 4.35 - Effect of Demand Characteristics on Order and Case Fill Rate



When a new product has many advantages that customers like, demand grows substantially, more sales are made, and profits increase. In addition, firms expand their inventories at retail and distribution locations so as to cope with increased demand. For example, Figures 4.36 and 4.37 show that in high product advantage situations, average system inventory and profitability increase by 159 percent and 164 percent, respectively, over low product advantage situations.

This suggests that firms should place greatest emphasis in communicating the advantages of a new product to customers so as to realize increased growth.

Furthermore, companies introducing new products must develop a mechanism of wading off competitive response effect. For example, firms could increase advertising and promotions budget, ensure inventory availability, etc.

Figure 4.36 - Effect of Demand Characteristics on Average System Inventory

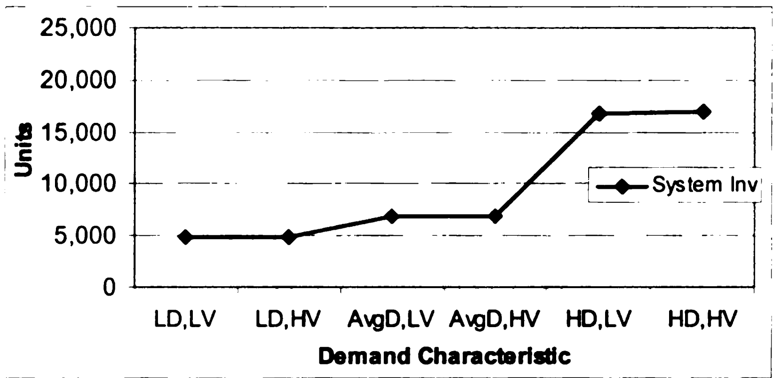
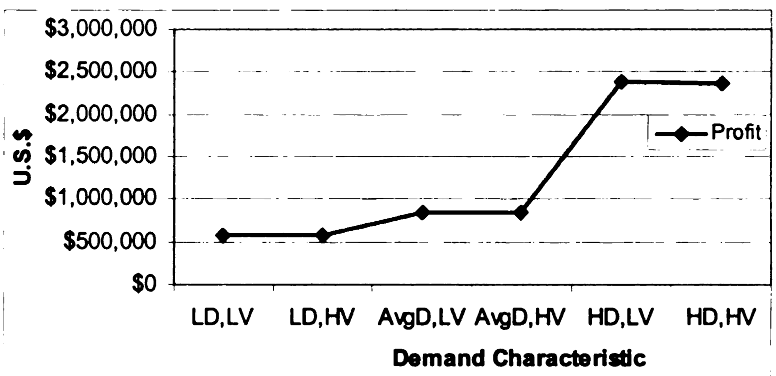


Figure 4.37 - Effect of Demand Characteristics on Profitability



Production capacity significantly affects all dependent variables at $p<.001$. Partial η^2 values indicate that effect is greatest on average system inventory (partial $\eta^2 = 0.59$). As expected, capacity constraints limit the number of orders that can be processed and filled, which lowers fill rates, sales, and ultimately profits. Consequently, as Figures 4.38, 4.39 and 4.40 indicate, OFR, CFR, average system inventory, and profitability are higher when capacity is 100 percent than when it is 70 percent. However, performance differences between the two levels of capacity are not high, especially profitability. For example, order fill rate decreases by less than 5 percent when capacity decreases from 100 percent to 70 percent. This suggests that expanding production capacity from 70 percent to 100 percent does not necessary yield better results.

Figure 4.38 - Effect of Production Capacity on Order and Case Fill Rate

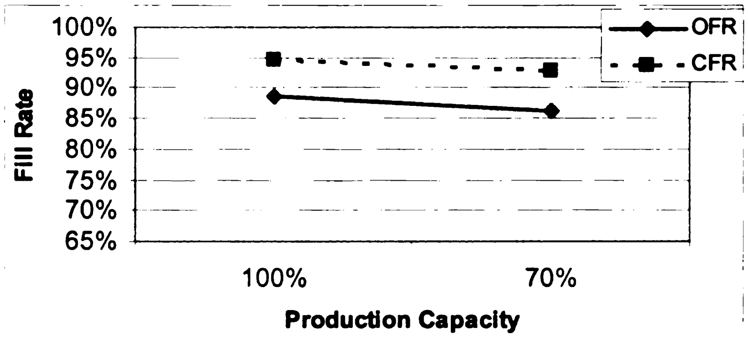


Figure 4.39 - Effect of Production Capacity on Average System Inventory

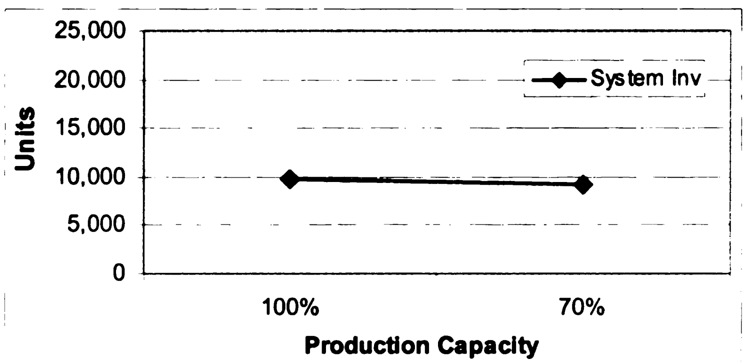
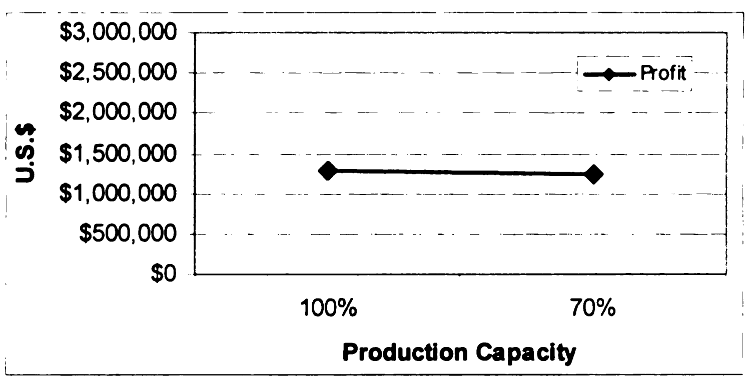


Figure 4.40 - Effect of Production Capacity on Profitability



4.5 Hypotheses Testing

In this sub-section, study hypotheses are evaluated in light of preceding analysis of results so as to determine and discuss their statistical support or lack of support. A summary of hypotheses tests is provided in Table 4.5 (end of sub-section).

4.5.1 Hypotheses H1a

This hypothesis states that, "*Logistics strategy directly and positively impacts new product performance.*" All tests indicate that Logistics strategy significantly and strongly impacts performance. Multivariate and univariate test results indicate that effects of Logistics strategy on OFR, CFR, average system inventory, and profitability are all statistically significant at $p<.001$. Moreover, evaluation of partial η^2 values and marginal means plots of Logistics strategy effect on performance variables (Figures 4.30, 4.31, and 4.32) suggests a strong effect. Therefore, Hypothesis H1a is supported.

4.5.2 Hypotheses H1b

This hypothesis states that, "*Response-based logistics strategy has a greater positive impact on new product performance than anticipatory logistics strategy.*" Logistics strategy was examined at four levels: Push, Pull, Fat, and Lean. Past studies stipulate that firms adopt either anticipatory or response-based logistics strategy. In this study, Push and Fat strategies represent anticipatory strategy (characterized by sufficient deployment of inventory in the distribution channels in anticipation of sales) while Pull and Lean represent a response-based strategy (involves deployment of inventory into the distribution system only upon receipt of customer orders). Interaction and main effect plots (Figures 4.2 – 4.21, 4.30 – 4.32) indicate that response-based logistics strategy has greater positive impact on new product performance than anticipatory strategy. Under a response-based strategy, fill rates and profits are relatively higher than in anticipatory strategy. Therefore, H1b is supported.

4.5.3 Hypotheses H2a

This hypothesis states that, "*Launch strategy directly and positively impacts new product performance.*" Multivariate results (Table 4.3) indicate that the effect of Launch strategy is statistically significant at $p<.001$. However, univariate results (Table 4.6) show that the effect is statistically significant on order fill rate ($p<.05$), average system inventory ($p<.001$), and profitability ($p<.001$) but not on case fill rate. In addition, partial η^2 values show that the effect is strongest on average system inventory and profitability but very weak on OFR. Therefore, H2a is partially supported.

4.5.4 Hypotheses H2b

This hypothesis states that, "*A rollout launch strategy has a greater positive impact on new product performance than a national launch strategy.*" Examination of marginal means plot (Figure 4.33) shows that there is no significant difference in order fill rate between national and rollout launch strategy. Although rollout strategy results in lower average system inventory (Figure 4.34) than a national launch, profitability is substantially lower for rollout strategy compared to a national launch. Consequently, there is no sufficient evidence to indicate that rollout strategy has greater positive impact on performance than national launch strategy. Therefore, H2b is not supported.

4.5.5 Hypotheses H3

This hypothesis states that, "*The interaction between logistics strategy and launch strategy has a direct and positive impact on new product performance.*" Multivariate results (Table 4.3) show that the effect of interaction between logistics and launch strategies is statistically significant at $p<.001$. Univariate results (Table 4.5) also show that interaction between logistics and launch strategies is statistically significant at $p<.001$ for all performance variables. Therefore, H3 is supported.

4.5.6 Hypotheses H4a

This hypothesis states that, "*High demand variability negatively impacts new product performance.*" Demand variability is modeled as variation from mean demand for all demand levels (low, average, high). According to main effect analysis, demand variability significantly affects OFR and CFR (Figure 4.36) but not average system inventory and profitability (Figures 4.37 and 4.38). OFR and CFR are lower when demand variability is high than when it is low irrespective of level of demand. However, there is no noticeable difference in average system inventory and profitability between low and high demand variability. Therefore, H4a is partially supported.

4.5.7 Hypotheses H4b

This hypothesis states that, "*High competitive response negatively impacts new product performance.*" Although demand characteristics significantly affect new product performance as multivariate (Table 4.3) and univariate (Table 4.6) results show, the effect of competitive response, represented by low demand level, is significant on average system inventory (Figure 4.37) and profitability (Figure 4.38) but not on order and case fill rates (Figure 4.36). When demand is low (intense competitive response), profitability and average system inventory are lower than when demand is either average or high. However, there is no noticeable change in order and case fill rates. It is expected that with decreased demand, fill rates should either increase or not change much since demand is reduced, which means less challenge of fulfilling it. To the extent that profitability decreases and there is no noticeable change in OFR and CFR with increased competitive reaction, H4b is supported.

4.5.8 Hypotheses H5a

This hypothesis states that, "*The greater the demand variability for a new product, the less the impact of:*

(i) Logistics strategy on new product performance.

(ii) Launch strategy on new product performance.

(iii) Logistics and launch strategies interaction on new product performance."

This hypothesis stipulates that demand variability moderates effect of logistics strategy, launch strategy, and their interaction on new product performance. Examination of three-way interaction between logistics strategy, launch strategy, and demand characteristics (Figures 4.2, 4.3, 4.4, and 4.5) indicate that demand variability moderates the effect on OFR and CFR but not on average system inventory and profitability. In addition, profile plots of two-way interactions between logistics strategy and demand characteristics (Figures 4.14, 4.15, 4.16, and 4.17), and launch strategy and demand characteristics (Figures 4.22, 4.23, 4.24, and 4.25) show that demand variability has a significant moderating effect for OFR and CFR but negligible effect for average system inventory and profitability. Therefore, H5a is partially supported.

4.5.9 Hypotheses H5b

This hypothesis states that, "*The greater the competitor response to the new product introduction, the less the impact of:*

(i) Logistics strategy on new product performance.

(ii) Launch strategy on new product performance.

(iii) Logistics and launch strategies interaction on new product performance."

According to this hypothesis, competitive response moderates the impact of logistics strategy, launch strategy, and their interaction on new product performance. Competitive response is modeled in terms of decreasing new product demand throughout the year. Multivariate results (Table 4.3) show that the effect of demand characteristics is statistically significantly at $p<.001$. Univariate results (Table 4.6) also show that the effect on all performance variables is statistically significant at $p<.001$. However, examination of two-way interactions between demand characteristics and logistics strategy (Figures 4.14, 4.15, 4.16, and 4.17), and demand characteristics and launch strategy (Figures 4.22, 4.23, 4.24, and 4.25) indicate that these interactions significantly affect average system inventory and profitability but have negligible effect on OFR and CFR. Furthermore, examination of three-way interaction between logistics strategy, launch strategy, and demand characteristics (Figures 4.2, 4.3, 4.4, and 4.5) on performance yields similar results – that interaction effect is significant on average system inventory and profitability but not on OFR and CFR. Intense competitive reaction decreases sales and profits but may not necessarily affect customer service. Therefore, H5b is partially supported.

4.5.10 Hypotheses H6

This hypothesis states that, "*New product advantage directly and positively impacts new product performance.*" New product advantage was modeled in terms of high demand (i.e. demand for the new product more than triples by the end of the year the product is introduced). Therefore, new product advantage is represented by high demand level under demand characteristics variable. According to marginal means plots (Figures 4.36, 4.37 and 4.38), high product advantage results in substantial increases in average system inventory and profitability. The increase in inventory and profitability is expected as demand increases. However, there is no marked increase in OFR and CFR. That order and case fill rates do not decrease despite increases in demand and challenges of fulfilling it compared to average demand situations suggest that, indeed, high product advantage directly and positively impacts performance. Therefore, H6 is supported.

4.5.11 Hypotheses H7

This hypothesis states that, "*Firms' manufacturing and distribution capacity directly and positively impacts new product performance.*" Capacity is used as surrogate for firm size. Production capacity is modeled at two levels, 100 percent and 70 percent, representing large and small/medium sized firms, respectively. Distribution capacity was not modeled. Modeling distribution capacity would have made the model design more complicated while adding little value to the study since production capacity captured the size factor. Multivariate results (Table 4.3) indicate that effect of capacity is statistically significant at $p<.001$. In addition, univariate results (Table 4.6) show that the effect is significant at $p<.001$ for all performance variables. According to marginal means plots, new product performance is better when capacity is 100 percent than when it is 70 percent. Therefore, H7 is supported.

Table 4.7: Summary of Hypotheses Tests

HYPOTHESES	RESULTS
H1a: Logistics strategy directly and positively impacts new product performance.	**Supported**
H1b: Response-based logistics strategy has a greater positive impact on new product performance than anticipatory logistics strategy.	**Supported**
H2a: Launch strategy directly and positively impacts new product performance.	Partially Supported
H2b: A rollout launch strategy has a greater positive impact on new product performance than a national launch strategy.	*Not supported*
H3: The interaction between logistics strategy and launch strategy has a direct and positive impact on new product performance.	**Supported**
H4a: High demand variability negatively impacts new product performance.	Partially Supported
H4b: High competitive reaction negatively impacts new product performance.	**Supported**
H5a: The greater the demand variability for a new product, the less the impact of:	
(i) Logistics strategy on new product performance.	Partially Supported
(ii) Launch strategy on new product performance.	Partially Supported
(iii) Logistics and launch strategy interaction on new product performance.	Partially Supported
H5b: The greater the competitor response to the new product introduction, the less the impact of:	
(i) Logistics strategy on new product performance.	Partially Supported
(ii) Launch strategy on new product performance.	Partially Supported
(iii) Logistics and launch strategy interaction on new product performance.	Partially Supported
H6: New product advantage directly and positively impacts new product performance.	**Supported**
H7: Firms' manufacturing and distribution capacity directly and positively impacts new product performance.	**Supported**

4.6 Discussion of Results

The main objectives of this research are to examine how logistics and launch strategies affect new product performance, to examine the interaction between the two strategies during new product introduction, and to identify the combination of logistics and launch strategies that results in optimal new product performance given prevailing competitive and demand situations. To realize these objectives, the research examines effects of logistics strategy, launch strategy, their interaction, demand variability, competitive response, product advantage, and production capacity on new product performance. Analysis of results suggests several findings.

First, logistics strategy strongly impacts new product performance. Two sets of logistics strategy alternatives were examined. These represented anticipatory and response-based logistics strategies. First, results show that logistics strategy has the strongest effect overall of all independent variables. Partial η^2 values for effect of logistics strategy on all dependent variables are greater than 0.745, indicating large effect size. None of the other independent variables has high partial η^2 values for all dependent values tested. Results also show that interaction between logistics and other independent variables such as launch strategy, demand, and capacity significantly affects new product performance. Therefore, it can be argued that logistics strategy is the most critical determinant of new product success among the tested variables, which underscores stipulations in extant literature that logistics is a key determinant of new product performance.

Results indicate that Pull strategy outperforms Push strategy. A comparison of Push and Pull strategy indicates that Pull strategy results in better customer service (higher fill rates) and profitability than Push strategy for comparable average system inventory. This implies that although forward deployment of inventory may reduce stockout problem, it results in higher inventory carrying cost and shortages when there is capacity constraints. Moreover, Pull strategy provides greater flexibility in inventory deployment. Fat strategy results in better customer service (higher fill rates) than Lean strategy. Average system inventory under Fat strategy is 68 percent higher than under Lean strategy yet profitability for Fat strategy is only 16 percent higher. This implies that under Fat strategy, firms incur high costs of inventory which significantly erodes profit gains. Under a Lean strategy, inventory is kept to a minimum. This results in lower costs. However, stockouts are more frequent. Consequently, although Fat strategy provides better customer service, it has high risks and opportunity costs that make Lean strategy more suitable for new product introduction. Generally, maintaining sufficient inventory to cover one order cycle or slightly higher provides many performance benefits than maintaining large safety stock levels. Therefore, firms can realize better new product performance if they adopted a Lean strategy coupled with a Pull strategy, than a Fat strategy coupled with Push strategy.

Second, launch strategy impacts new product performance. It impacts average system inventory and profitability but not customer service. Results indicate that national launch outperforms rollout launch in terms of profitability. However, national launch demands more inventory deployment and greater coordination between supply chain partners since it covers more market segments. As a result, it is associated with higher average system inventory and more sales. If product succeeds, national launch provides opportunities for a firm to build strong market presence and realize greater sales and profits. However, if product fails, firms adopting this strategy incur high cost of inventory including storage, handling, write-off, and obsolescence. In other words, national launch exposes firms to greater risks than rollout strategy but opportunity loss in terms of lost sales if product succeeds is quite high. Consequently, whenever possible, firms should consider launching products nationally especially for high advantage products. National launch strategy is more appropriate when demand is fairly stable, product advantage is high, and competitive response likely to be slow.

Third, interaction between logistics and launch strategies impact new product performance. Results indicate that under Push strategy, national and rollout strategies result in almost the same level of customer service. However, under a Pull strategy, national launch outperforms rollout strategy in terms of customer service and profitability. There are no differences in level of customer service between national and rollout strategies for both Fat and Lean strategies. However, Fat strategy had significantly higher average system inventory and profits under national than rollout strategy. Similarly, Lean strategy results in higher average system inventory and profitability under national launch than under rollout launch. This finding suggests that when launching new product, firms must consider the simultaneous impact of logistics and launch strategies.

Generally, national launch supported by anticipatory logistics strategy provides many opportunities to leverage economies of scale in production, transportation, and warehousing. These cannot be realized under rollout strategy supported by response-based logistics. However, there are high risks such as inventory obsolescence and write-off in case product fails when national launch supported by anticipatory logistics is adopted. National launch supported by response-based logistics strategy seems to yield better performance in terms of profitability. Therefore, when launching new products, companies should consider the simultaneous impact of logistics and launch strategies, and adopt a combination of strategies that results in optimal performance.

Fourth, demand characteristics have strong impact on performance. In this study, demand variability, competitive response, and product advantage are considered. Results indicate that demand variability affects OFR and CFR but not average system inventory and profitability. High demand variability results in lower customer service. The effect is greater when strategies that results in lower service levels (lower OFR and CFR) are used. For example, the effect is greater under a Push strategy than a Pull strategy, and under a Lean strategy that a Fat strategy. This is because when demand is highly variable, firms' ability to plan for and deploy inventory to fulfill customer orders in a timely manner is greatly reduced. However, when demand variability is low, firms can plan in advance for expected orders and deploy inventory accordingly. At the same time, demand variability has greater effect on service when rollout launch is adopted than when national launch is adopted. Demand variability has significant interaction with capacity. Results indicate that high demand variability under capacity constraints results in poorest new product performance. When launching new product launch, it is important that firms evaluate demand uncertainty and adopt strategies that minimize its negative effects.

Results indicate that when competitive response is intense thereby reducing new product demand, firms lose sales and realize lower profits. Moreover, if a firm deploys sufficient inventory in the distribution system in anticipation of sales, and intense competitive reaction causes demand for the new product to shrink significantly, then the firm is left with large inventory culminating in high inventory carrying and write-off costs. Therefore, competitive response to new product introduction must be addressed and measures taken to counter competitor actions at the earliest. Firms must aggressively counter competitor actions through measures such as heavy investment in marketing and promotion as well as efficient logistics operations to ensure product availability when customers demand it.

When demand is high due to high product advantages, firms realize significantly higher profits irrespective of logistics and launch strategies used. High product advantage is associated with more customer orders, more sales, and ultimately more profit as new product gains greater acceptance. Firms can gain from economies of scale in production, transportation, and warehousing given the large and growing demand associated with high product advantage. Therefore, anticipatory and national launch strategies seem appropriate since they provide better opportunities to leverage economies of scale. It is also important for firms to consider simultaneous effect of other factors that interact with demand when launching new product that has high product advantages.

Finally, production capacity directly impacts new product performance and interacts significantly with logistics strategy. For example, increasing production capacity results in higher customer service when Lean strategy is used but has negligible effect under Fat logistics strategy. However, interaction between capacity and launch strategy has negligible effect on new product performance. Large capacity provides for greater inventory and profits than smaller capacity irrespective of launch strategy used. Capacity constraints limit the number of orders that can be processed and filled, which lowers customer service and profits. Therefore, logistics strategies characterized by greater stock-outs are affected more by capacity limitations than those characterized by lower stock-outs. Fat strategy is characterized by high inventory in the distribution system. Such inventory acts as a buffer when orders cannot be processed promptly. Indeed, companies often use inventory to mitigate capacity problems. Therefore, when launching new product, it is important that firms consider implications and possibilities of expanding capacity as demand grows.

Research findings are summarized in Tables 4.8 and 4.9 below. Implications of these findings for managers and researchers are discussed in the next chapter.

Table 4.8 – Summary of Results Matrix 1

	Logistics Strategy	
	Anticipatory	**Response-based**
National Launch Strategy	- High inventory carrying cost - High sales, profits, and market share if product succeeds. - High costs due to overstock, write-off, etc, if product fails. - Economies of scale in production, transportation, and warehousing. - Appropriate for high product advantage situations. High risk when demand variability is high.	- Lower inventory carrying cost. - Expensive due to increased orders and small, frequent shipments (inefficient). - Insufficient capacity to support flexible order fulfillment in multiple markets. - Stockouts in many markets - Lower service levels. Better in high competitive response situations.
Rollout Launch Strategy	- High inventory carrying cost. - Lost sales if product succeeds. - High inventory cost if product fails. High risk of competitors capturing the markets not served.	- More targeted. - Higher service levels. - Lower cost of implementation. - High transportation cost due to small, frequent shipments. Appropriate when demand is highly variable.

Table 4.9 – Summary of Results Matrix 2

	Logistics Strategy		Launch Strategy	
	Anticipatory	**Response-based**	**National Launch**	**Rollout Launch**
High Competitive Response	- High cost due to excess inventory. - Some economies of scale in transportation, warehousing, etc. - Greater market presence. - High risk of inventory, i.e. obsolescence, write-off, etc.	- Lower inventory. - Lower inventory costs – lower risks of write-off, obsolescence, etc. - More appropriate than anticipatory strategy.	- Lower service level than rollout. - Higher inventory cost. - Enables countering of competitors in all markets. - Greater market presence.	- Higher customer service levels. - Lower inventory, lower cost. - More appropriate to reduce risk incase product fails. - High risk of competitors capturing markets not served.
High Demand Variability	- High service levels due to higher safety stock. - Higher costs.	- Higher stockouts – greater challenges in execution as variability increases.	- Higher service levels. - Higher challenging to implement as variability increases. - Higher costs.	-Lower service levels – no economies of scale. -Lower profits
High Product Advantage	- Higher inventory costs. - More sales, market share, profits. - Gains from economies of scale (ordering, production, transportation, warehousing).	- More stockouts and lower service levels. - Higher profits with lower costs. - Higher risk of lost sales. - Expensive to implement, lacks economies of scale benefits.	- Higher customer service than rollout strategy. - Higher inventory. - Economies of scale gains in ordering, transportation, warehousing, etc. - More appropriate.	- Lower service levels. - Lower inventory, causing more stockouts. - Higher lost sales.
Production Capacity	- Allows for production economies.	- Lower service levels	- Higher inventory cost. - Allows for greater economies of scale.	- Lower inventory cost. - Lower profit.

CHAPTER 5: IMPLICATIONS AND CONCLUSION

5.0 Introduction

This chapter presents implications of the research findings. The first section discusses managerial implications. This is followed by research contribution. Then a discussion of study limitations and directions for future research is presented. Finally, a conclusion summarizing main issues in the Chapter is presented.

5.1 Managerial Implications

The research findings have several managerial implications. First, when planning and launching a new product, it is important for managers to engage logistics personnel as early as possible in the process. Study results indicate that logistics strategy strongly impacts all performance variables, which means logistics processes are a critical determinant of new product performance [Refer to p.105-106]. However, in some companies, logistics personnel are not involved in new product development process until late in the process (Tracy 2004). In other cases, as was observed during interviews, personnel with limited expertise in logistics such as marketing and operations managers are asked to develop, plan, and execute logistics activities during new product launch. These managers lack the expertise required to develop requisite logistics plans. Engaging logistics personnel early in the new product launch helps the company to identify logistics resource requirements in advance and make appropriate plans to acquire them or allocate them. In addition, logistics professionals possess expertise and perspective necessary to provide sound input regarding decision trade-offs during launch.

Companies can also employ logistics service provides to help them with planning logistics operations during launch.

Secondly, managers should evaluate logistics strategies and adopt a strategy that results in best performance in different market and competitive situations. Results indicate that response-based strategy is better than anticipatory strategy [Refer to p.107-108]. For example, Pull strategy, which is response-driven, outperforms Push strategy, which is anticipatory-driven in terms of profitability. At the same time, although Fat strategy results in better customer service than Lean launch, it is associated with higher inventory carrying cost and associated management and handling costs. Indeed, Lean strategy has greater profits per unit than Fat strategy, suggesting that if slightly higher inventory than that tested in the model were kept as safety stock in Lean strategy, it would yield better results than Fat strategy. Moreover, response-based strategy not only lowers inventory carrying cost but also reduces risks associated with new product failure. The strategy encourages better response to customer orders while maintaining low average system inventory. Consequently, managers should identify their companies' primary goals and seek the strategy that best allows realization of those goals. For example, if primary goal is profitability, a response-based strategy is preferred while if superior customer service is the main goal, then an anticipatory strategy is recommended.

Third, logistics strategy interacts strongly with other independent variables. For example, a National launch supported by Fat logistics strategy results in higher average system inventory than a rollout launch supported by Fat logistics strategy. In addition, a national launch supported by Pull logistics strategy results in higher profitability than a national launch supported by other logistics strategies [Refer to p.96-97]. This means that managers should take into consideration the simultaneous impact of logistics strategy, launch strategy, and other independent factors when planning and implementing a new product introduction.

Where competitive response is intense, managers should adopt a rollout launch supported by response-based logistics strategy. This allows the company to respond more appropriately to customer needs and provides necessary flexibility to adjust inventory deployment as market demands. However, when product advantage is high and demand is growing rapidly, a national launch supported by response-based logistics strategy is recommended since it yields higher profitability. Yet, since risks associated with anticipatory strategy such as obsolescence and write-off costs in case of product failure are minimized when demand is growing rapidly, an anticipatory logistics strategy may be considered. The strategy allows firms to leverage economies of scale in production and distribution, which results in reduced cost and high profits.

Fourth, managers should carefully consider the costs and risks associated with national launch strategy against rollout launch strategy. Launch strategy does not significantly affect customer service as measured by order and case fill rate [Refer to Figure 4.32, p.109]. Thus, considerations regarding which launch strategy to adopt should focus on the average system inventory and associated costs, and profitability implications [Refer to p.109-110]. National launch requires greater inventory commitment and resources than rollout strategy. If new product is successful, national launch provides an opportunity for firms to establish early market dominance, realize greater sales and profits, and recoup new product development cost sooner. However, if product fails, national launch exposes the firm to higher costs of handling excess inventory that is not sold, write-off costs, transshipment cost where necessary, and high capital costs for inventory held in the distribution system. In such cases, rollout strategy is preferable.

However, it is important to note that the type of launch strategy to adopt may be dictated by supply chain partners. For example, major retailers with national presence would prefer stocking a new product in all markets. Such retailers may influence the launch strategy adopted. Furthermore, retail shelve allocation is done periodically. For a firm launching new product, it would mean whenever possible, timing of launch would be made to coincide with the period when shelve spaces are allocated at retail levels. This may encourage firms to launch nationally rather than through sequential rollout. Whichever the case, national launch offers more opportunities than rollout strategy and is recommended.

Fifth, demand characteristic significantly impacts new product performance and moderates the effect of logistics strategy and launch strategy on performance. Demand variability affects customer service but does not affect average system inventory and profitability. Generally, customer service is lower when demand variability is high and higher when demand variability is low [Refer to Figure 4.35, p.111]. This means that managers must seek ways to mitigate demand variability problem when launching new product. Study results indicate that response-based logistics strategy is more sensitive to demand variability than anticipatory strategy [Refer to p.97-98]. Anticipatory logistics is characterized by greater safety stock in the distribution system, which means that firms can utilize this stock to hedge against shortages occasioned by demand variability. Response-based logistics strategy does not provide this option. Instead, firms rely on system flexibility to respond to varying customer orders. Therefore, to deal with demand variability, managers should evaluate logistics strategies in the context of other factors such as launch strategy, competitive environment, etc., so as to adopt the strategy that, collectively, minimizes negative effects of demand variability.

Sixth, managers should develop mechanisms to anticipate and appropriately counter competitor actions when launching new product. Competitive response has a negative effect on new product performance [Refer to p.111-112]. As study results indicate, reduced demand due to competitor response erodes profits and undermines product success. Thus, managers could increase advertising and promotions in markets where competitive response is intense. In addition, managers may consider deploying more inventories in markets facing more intense competition than those with less intense competitor response. This ensures that customers readily access the new product.

Seventh, high product advantage provides opportunities for greater sales and ultimately profits. The main challenge when product advantage is high is to cope with increasing demand. A response-based logistics strategy results in higher profitability while an anticipatory strategy results in higher average system inventory when product advantage is high [Refer to p.99-100]. Although response-based strategy results in higher profitability, managers should consider anticipatory strategy by determining the cost savings from production and distribution economies against inventory costs. To the extent that savings are high, national launch supported by anticipatory strategy may be adopted too. Given that demand is increasing substantially, national launch is most appropriate in high advantage situations.

Eighth, results show that product advantage has greater impact on demand and product performance than competitive response in terms of profitability [Refer to Figure 4.37, p.112]. For example, increase in profitability when product advantage is high is greater than relative decrease in profitability when competitive response is high. Thus, firms gain more by promoting new product advantages than they would if they invested resources toward countering competitive response. In other words, managers should pay greater attention to and channel more resources toward mechanisms of communicating and promoting product advantages even as they counter competitive actions.

Finally, although large capacity enables a firm to fulfill its demand requirements, study results indicate that the difference in performance between 100 percent and 70 percent capacity is minimal [Refer to Figure 4.40, p.113]. For example, average profits decrease when capacity decreases from 100 percent to 70 percent for both national and rollout strategies. This shows that capacity expansion in case of product success should be done cautiously since it does not improve performance substantially. Production capacity is used as a surrogate for firm size. Generally, a company with more resources is expected to allocate larger budget to new product launch. However, such investment will not be meaningful if channeled towards capacity expansion. Instead, managers should channel resources toward activities that raise demand or counter competitor actions such as promotions.

Table 5.1 presents a matrix that summarizes the best logistics strategy, launch strategy, and combination of logistics and launch strategy for each demand characteristic, competitive response, product advantage, and production capacity situations. The matrix provides a snap shot view of strategies that managers should pay more attention to when launching a new product.

Table 5.1 - Best Strategy Matrix

		Logistics Strategy		**Launch Strategy**		***Interaction*: Logistics Strategy x Launch Strategy**			
	Level	*Antic.*	*Resp.*	*Nat.*	*Roll.*	*Antic.*Nat.*	*Antic.*Roll.*	*Resp.*Nat.*	*Resp.*Roll.*
Demand Variability	*Low*		*	*				*	
	High	*			*		*		
Competitive Response	*Low*	*		*		*		*	
	High		*		*				*
Product Advantage	*Low*		*	*				*	
	High		*	*		*		*	
Production Capacity	*100%*	*		*		*	*	*	
	70%		*		*				*

* Represents best strategy   Antic. = Anticipatory   Roll. = Rollout
Resp. = Response-based   Nat. = National

As Table 5.1 shows, when demand variability is low, response-based logistics strategy and national launch strategy should be adopted. However, when demand variability is high, anticipatory logistics strategy and rollout launch strategy should be adopted. Therefore, in high demand variability situations, managers should adopt a rollout strategy supported by anticipatory logistics while in low demand variability situations national launch supported by response-based strategy should be adopted.

When competitive response is high, rollout launch supported by response-based logistics is most suitable. A rollout strategy allows firms to identify and target markets with greater potential and less competitive pressure while Response-based logistics provides flexibility necessary to counter competitor action or respond appropriately to demand with greater efficiency. However, when competitive response is low, national launch supported either by anticipatory or response-based logistics strategy is preferable.

When product advantage is high, a national launch supported by response-based strategy is recommended. A Response-based strategy results in higher profitability than Anticipatory strategy. It also results in higher customer service (i.e., fill rates) when demand variability is low. However, anticipatory logistics may offer cost savings through economies of scale, which may translate to lower cost especially if new product turnover is high. Thus, national launch supported by anticipatory logistics strategy may be considered as a viable alternative in high product advantage situations. When product advantage is low, rollout strategy supported by response-based logistics strategy is better.

Production capacity is a surrogate for firm size. Response-based strategy is preferable when there are capacity limitations. Moreover, a national launch requires larger capacity (and resource endowment) than a rollout launch, which a large firms can sustain more than a small/medium size firm.

The preceding results and discussions lead to managerial decision options shown in Table 5.2 and Table 5.3.

Table 5.2 - Strategy Analysis Chart 1

Decision Determinant	Product Advantage	Competitive Response	Demand Variability	Firm Resources	Best Strategy
Profitability	High	High	High	Large	National x Response-based
				Small	
			Low	Large	
				Small	
		Low	High	Large	National x Anticipatory
				Small	
			Low	Large	National x Response-based
				Small	
	Low	High	High	Large	Rollout x Response-based
				Small	
			Low	Large	
				Small	
		Low	High	Large	Rollout x Anticipatory
				Small	
			Low	Large	Rollout x Response-based
				Small	

Table 5.2 shows that product advantage followed by competitive response is the leading factor with regard to profitability. Firm resources (capacity) have negligible effect on profitability. Demand variability has a weak effect on profitability. Therefore, where profitability is the main consideration, managers should focus on product advantage and to a lesser extent, competitive response. When product advantage is high, national launch is preferred but when it is low, rollout launch is preferred. Anticipatory strategy performs better than a response-based strategy when demand variability is high. Therefore, in high demand variability situations, anticipatory strategy may be considered.

Table 5.3 - Strategy Analysis Chart 2

Decision Determinant	Demand Variability	Firm Resources	Product Advantage	Competitive Response	Best Strategy
Service	High	Large	High	High	National x Anticipatory
				Low	
			Low	High	
				Low	
		Small	High	High	Rollout x Anticipatory
				Low	
			Low	High	
				Low	
	Low	High	High	High	National x Response-based
				Low	
			Low	High	
				Low	
		Low	High	High	Rollout x Response-based
				Low	
			Low	High	
				Low	

Table 5.3 shows that when primary objective is to provide high customer service (i.e., high fill rates), managers should pay more attention to demand variability and firm's resource endowment. Product advantage and competitive response have negligible impact on fill rates. Results indicate that anticipatory logistics strategy results in better performance than response-based strategy when demand variability is high. Therefore, when demand variability is high and a firm has large capacity or resource endowment,

national launch supported by anticipatory strategy is recommended. However, when demand variability is low, response-based logistics strategy is preferable.

5.2 Research Contribution

This study makes several research contributions. First, whereas past studies have stipulated most propositions tested in this study, none of them is empirically tested. Therefore, the study makes an important contribution by empirically testing individual and simultaneous effects of logistics and launch strategies on new product performance. In addition, the study examines interaction between these strategies and demand, competitive, product, and firm characteristics. These are issues previously discussed but never empirically tested in a single study.

Second, the study examines simultaneous effect of different determinants of new product performance. Past studies tend to examine these determinants in isolation. However, these factors impact performance both individually and interactively. Examining interaction effects provides a sound basis for managerial decision making and an important foundation for future research.

Third, simulation research has not been widely applied in new product research. Yet, simulation offers many benefits for in depth analysis of new product development and launch situations that are difficult to analyze using other techniques. Indeed, most studies on new product launch have tended to be qualitative. This study demonstrates that applying simulation approach can greatly enhance our understanding of major factors and relationships in new product launch. Future research can build on the study findings and methodology to advance new product launch knowledge.

Finally, this study makes suggestions that managers will find useful. These suggestions are based on thorough and sound tests of main and interaction effects. Study assumptions are based on interviews with managers and careful evaluation of extant literature. Thus, the findings have a direct application in managerial decision making.

5.3 Limitations and Opportunities for Future Research

First, in simulation research, researchers make certain assumptions to limit the scope of analysis so as to make detailed investigation of phenomena in question. For example, in this study, assumptions are made regarding inventory policies, transit lead times, and stochastic demand distribution. However, these assumptions limit the scope of issues and situations examined, and resulting findings may be specific to certain scenario. Although assumptions are based on interviews with managers and extant literature, they may be too limiting. For example, the assumption that demand distribution and transit lead times follow a triangular distribution pattern may not apply in some industries and product launch situations. Therefore, future research should examine different industries and demand distributions.

Second, this study modeled a simple supply chain network consisting of one manufacturer, two distributors, and ten retailers dealing with one product. This may not capture major dynamics at play during new product launch especially for large companies with multiple networks of suppliers, distributors, and products. A more comprehensive supply chain network that includes suppliers and more products should be considered in future research.

Third, production was treated as a "black box" where incoming orders are filled without regard to production factors such as scheduling, set-up/change-over times, etc. Complexities in production process might provide additional insights regarding new product launch dynamics. For example, variations in production lead time, raw material availability, and process efficiency might affect distribution effectiveness for a new product. It might also have different effects if there is product variation. Thus, future research should consider production parameters in detail.

Fourth, this study is based on consumer goods industry. However, individual industries tend to have different dynamics that may not reflect events in other industries. For example, lead times and demand patterns in consumer goods industry may be different from those in high-tech sector. Future research should investigate other industries too.

Fifth, retail and market segments were modeled as portraying similar characteristics. For example, markets segments were modeled as similar in size with similar demand distributions. However, markets can have different characteristics, which may require companies to institute strategies tailored to individual markets. Future research may consider testing variations in market segments and demand characteristics.

Sixth product value density may affect distances to which a new product is deployed or the market coverage for a new product. It would be interesting to see how launching new products that have low value density compares with high value density products from a logistics viewpoint. Future research should examine value density.

Finally, this study considers four performance variables. However, other performance variables such as cycle time, market share gains, and customer loyalty may provide more insights and show different results. Therefore, future research should consider other ways of measuring new product performance.

5.4 Conclusion

The preceding discussion pinpoints key managerial implications, research contributions, and opportunities for future research. This study empirically tested and confirmed some propositions stipulated in extant literature. It also highlighted important findings that managers and researchers will find useful. The study makes important contributions in advancing new product launch knowledge, especially as far as logistics processes and strategies are concerned. Managers should consider the managerial suggestions while future research should build on these findings.

APPENDICES

APPENDIX A: QUESTIONNAIRE

MICHIGAN STATE UNIVERSITY

Department of Marketing & Supply Chain Management

INTERVIEW QUESTIONS

These questions are designed to provide a general idea about your company's new product launch processes and about a recent launch activity. You need not do specific research on any of the questions prior to the interview.

1. **General Questions**
   a) At what level do you manage new product launch in your company or SBU?
   b) Could you walk me through your company's new product launch process?
   c) Do you have a launch process diagram? If so, could you provide me with a copy?
   d) How do you manage capacity (manufacturing/distribution) during launch?

2. **Think about the most recent new product launch in your company or SBU:**
   a) Product characteristics
      i. What were the product's main advantages over competitor brands?
      ii. What did you expect customers to think of your product?
      iii. What was the nature of demand for the product and brand?
   b) Launch process
      i. What launch strategy did you adopt/apply? Why?
      ii. What was the scale of entry (size, in how many markets)? Why?
      iii. What influenced your entry timing? Why?
      iv. Did you face any capacity problems?
   c) Logistics processes
      i. What logistics strategy did you adopt? Why?
      ii. What was the nature of your distribution channel/supply chain network?
   d) Market characteristics
      i. Generally, what was the nature of competition in the industry?
      ii. How did competitors react to your newly launched product?
      iii. How predictable is customer demand in the industry?
   e) Performance
      i. Generally, how do you measure success/failure?
      ii. Was the launch a success or failure? Why?

APPENDIX B: COVER LETTER

[Date ....]

[Dr./Mr./Ms. ....]
[Address ....]

[Dear ....]

I am a doctoral candidate in the Department of Marketing and Supply Chain Management at Michigan State University. I am working on my dissertation, in which I investigate logistics processes during new product launch. Specifically, I examine how the integration of launch and logistics strategies under various competitive and demand situations impacts firms' new product performance. I would like to explore this question at two different firms, one in durable and another in non-durable consumer goods. I selected your firm because it not only deals with durable/non-durable consumer goods, but also firm has a long history of successfully introducing new products to the market.

In order to complete my dissertation, I need your assistance. I would like to interview you at your company location. I have attached a brief summary of my research that describes what I am investigating and why this may be beneficial to you and your firm. Also attached are the questions I intend to use to guide the interview, which will last about one hour. As a V.P. /director /manager /supervisor, you have considerable experience and knowledge about your company's product launch processes. Therefore, your input will be most helpful.

I will maintain your anonymity and will keep your responses completely confidential. I will also be happy to send you a research results summary report.

If you agree to participate, I would like to schedule an appointment with you at your most convenient time. Please contact me by email: nyaga@bus.msu.edu or by phone: (517) 353-6381.

I know your time is valuable. I greatly appreciate your consideration and look forward to hearing from you soon.

Sincerely,

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APPENDIX C: RESEARCH IN BRIEF

Title: *An Investigation of the Simultaneous Impact of Launch and Logistics Strategies on New Product Performance*

What is the research about?
This research investigates how firms' launch and logistics strategies impact new product performance under different competitive and customer demand environments. New product introduction is the most expensive, risky and time-consuming phase of new product development process. Consequently, it significantly impacts new product success. To reduce the costs incurred during introduction, companies prioritize inventory deployment and adopt flexible logistics systems to mitigate demand uncertainty risks. However, the impact of such an approach on product and firm performance is not fully understood. Moreover, its effectiveness under various competitive and customer demand environments is not known. Thus, two important questions arise from this: what launch and logistics strategies result in minimal product introduction costs and optimal new product performance under different competitive and demand conditions? What combinations of launch and logistics strategies result in best new product performance?

How is the research conducted?
I will conduct the research in two phases. First, I will interview managers at two companies in durable and non-durable consumer goods industries. The select companies should have a long history in developing and introducing new products to market. The purpose of the manager interviews is to understand new product launch processes and dynamics. I will then develop a product launch process diagram and supply chain network that mirrors these companies' launch processes. Second, based on the diagram and information about competition and customer demand from the interviews, I will design a simulation model to generate data that I will then use to empirically test the research questions. Data from interviews are important because they provide real-system baseline for the simulation model, thereby making it more realistic.

How does it benefit you and your company?
First, I will provide a summary report of research findings. In addition, I will be happy to present the results verbally to you/your company if you wish. Secondly, I will make recommendations regarding how companies can leverage logistics functions to make new product introductions more successful. Furthermore, I will prepare an easy to apply framework for identifying appropriate launch and logistics strategies to adopt in different competitive and demand conditions. Such a framework will be useful to you as decision-maker and to your company's competitiveness. Thirdly, since I will base the simulation model on the information you provide, I expect the results to be closely applicable to your company. Thus, the findings could have immediate benefits to you and your company's operations.

What do I need from you?
I request to interview at least three managers in your company, representing senior level, middle level, and lower level management. The managers should be responsible for new product development, product introduction, or logistics/distribution operations. I have enclosed the interview questions. I will keep your responses confidential and will maintain your anonymity.

APPENDIX D: CONSENT FORM

MICHIGAN STATE UNIVERSITY
Department of Marketing & Supply Chain Management

INTERVIEW CONSENT FORM

Dear Sir/Madam,

You have been selected to participate in this research because we believe you have experience and knowledge about new product launch processes in your company that will be insightful to the study. The research investigates the simultaneous impact of logistics strategies, launch strategies, competition, and customer demand on new product performance. First, case studies of select companies are done to enable the researchers understand how new product launch is conducted in real-world. Second, a simulation model based on case studies findings will be developed to generate data that will be used to examine and test the performance outcomes.

Your company has been selected for the case study purpose because it has a long history of developing and launching new products. Your knowledge of launch processes in your firm will be helpful in designing a representative simulation model. Participation in the study will require you to answer open ended questions about a recent new product launch in your company. Your responses will be kept confidential and will not be linked to you personally.

The interview will take approximately one hour. You can refuse to answer any question or stop the interview at any time. No audio-recorder will be used. Participation in the study will not result in any negative consequences for you. Your privacy will be protected to the maximum extent allowable by law.

If you have questions about the study, please contact: Dr. David J. Closs, The John H. McConnell Chair in Business Administration, N370 Business College Complex, East Lansing, MI 48824; phone: (517) 355-6381; email: closs@bus.msu.edu.

In case you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact - anonymously, if you wish – Peter Vasilenko, Ph.D., Director of the Human Subject Protection Programs at Michigan State University: (517) 355-2180, fax: (517) 432-4503, email: irb@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824.

****

I have read this consent form and I agree to take part in this research.

______________________________ ________________

Participant Signature Date

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