



# An innovative supply chain performance measurement system incorporating Research and Development (R&D) and marketing policy



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## ABSTRACT

Various performance measurement techniques have been developed and applied in their respective fields, but the existing performance measurement methods have failed to provide significant assistance in the context of marketing strategies and innovation levels of a firm. In this paper, we have considered an important aspect of marketing policy involving examining the decision of a firm to distribute products and services to its consumer. The model developed in this paper is an extension to the Bass diffusion model which is generalized to incorporate the effects of marketing policy of the firm. In order to examine our model, computer simulation is conducted in order to measure the effect of innovation level and distribution of products and services on the change in the sales of a firm from its previous products and supply chain system. The performance measurement was developed by examining firm's level of innovation achieved by their Research and Development (R&D) performances, and sales of the products and services.

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## 1. Introduction

The concept of supply chain management (SCM) represents the most advanced state in the evolutionary development of purchasing, procurement and other supply chain activities (Thomas & Griffin, 1996). The operational level of SCM integrates activities like seeking of raw materials and production, marketing and distribution of goods. The highest level of integration of these activities is achieved through SCM. With the evolution of time, the operational activities have individually become “virtual business” entities and their integration has become more significant making SCM critical. A supply chain is a network of organizations involved in different processes and activities producing value in the form of products and services for the ultimate customer (Chen, 2008). SCM appears to treat all organizations within the value chain as a unified ‘virtual business’ entity. It includes activities such as planning, product design and development, sourcing, manufacturing, fabrication, assembly, transportation, warehousing, distribution, and post delivery customer support. In a truly ‘integrated’ supply chain, the final consumers pull the inventory through the value chain instead of the manufacturer pushing the items to the end users. Businesses today are facing intense international competitions, demanding and sophisticated customers, and diverse transforming technological change to succeed in a global market. As a result, the aim of firms is no longer to develop and produce high

quality products at the right-time, but to use scientific information to explore the market. While much research attention has been focused on understanding how knowledge within firms contributes to performance differences, little is known about the performance enhancement offered by supply chain knowledge (Min & Zhou, 2002). This is puzzling given the strong focus on the reasons why some firms outperform others (Nag, Hambrick, & Chen, 2007), coupled with the increasing importance of the supply chain. Some even argue that rivalry is becoming more “supply chain versus supply chain” and less “firm versus firm” (Slone, 2004).

The performance of the firms can be improved significantly by understanding the information provided by the supply chain. The procurement and usage of this information is hindered by many different barriers. These barriers include inability to capture customer's feedback, improper maintenance of selective data, poor market research leading to failure in assessment of market changes and unstandardized performance measurement within a firm. In this connection, firms require a performance measurement system in order to proactively react to these barriers. This calls for the need to devise a PMS which provides integrated, precise and helpful information to boost efficiency and to periodically check the performance of the supply chain in the firm (Ahmed & Abdalla, 2002; Bhagwat & Sharma, 2007; Brookes & Backhouse, 1998). Existing research in PMS's does not have the scope for quantifying Research and Development (R&D) in terms of innovation level and in optimizing the marketing policy of the firm, that is the decision of the firm to sell products and services at their own stores or retailers in a supply chain. R&D, innovation and productivity

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**Notation**

$i, j$	subscripts representing the level of innovation (in time $t$ and $t - \delta$ respectively)	$Z$	number of units sold cumulatively by the firm through its own stores at the present level of innovation.
$p$	coefficient of innovation	$b$	deviation coefficient of order by the retailer to the firm
$q$	coefficient of imitation	$pr_k$	product selling price at the own store at innovation level $k$
$S$	cumulative sales of product	$g(t, t')$	units sold in the time period $(t, t')$
$N$	potential market of product	$\xi$	change in the innovation level
$Sr$	set-up and ordering cost for the retailer	$\alpha$	coefficient of performance coefficient factor fairness
$D_i$	demand of the product at innovation level $i$	$\beta$	coefficient of consumer feedback
$D_j$	demand of the product at innovation level $j$	$\mu$	coefficient of innovation incentive
$h_s$	holding cost for the firm	$\lambda$	innovation incentive factor
$\phi_r$	current sum of set up and other costs for retailer	$f(t)$	rate of change of installed base fraction
$\phi_s$	current sum of set up and other costs for store	$F(t)$	installed base fraction
$h_r$	holding cost for the retailer	$S_a$	adoption rate
$d_r(S_i)$	discount rate to the retailer	$x$	cumulative sales at current innovation level
$P_i$	performance factor at innovation level $i$	$\Delta x$	rate of change of cumulative sales
$P_j$	performance factor at innovation level $j$		

growth are related to each other with true state dependency (Elena & Lourdes, 2011). With time, the technology is becoming complex and it demands R&D in firms to develop new products and bring innovative (Gassmann, Enkel, & Chesbrough, 2010). R&D develops the firm's ability to identify, assimilate, and exploit knowledge from the environment while it also generates innovation (Cohen & Levinthal, 1989). An innovation activity may be defined as scientific, technological or financial steps which are intended to or lead to implementation of innovation. A firm's internal R&D is an innovation activity complimentary to knowledge acquisition (Cassiman & Veugelers, 2006). The role of R&D can facilitate an increase in the innovation level and the role of marketing policy in the context of SCM. R&D plays an important role in the development of new products or new supply chain methods in any firm. In any firm, R&D serves the strategic purposes such as the development of intellectual property its control. In a way, R&D helps clients in solving their operational problems as clients buy their research services. Many successful firms have developed methods to cross-link R&D with marketing, engineering, purchasing and manufacturing. R&D is involved at all stages of product development starting from the initial studies, determining the designing attributes, engineering the products, transfer to productions and maintenance and services. These days, businesses are facing intense international competition, demanding and sophisticated customers, and diverse transforming technological change to succeed in a global market. The aim of the firm is no longer to develop and produce high quality products at the right-time, but to use scientific information to explore the market. This can be achieved through firms with well equipped R&D. Therefore, they need to renew their products and services by allocating resources to R&D. Firms are constantly pressured to maintain a flow of new products or new supply chain methods, and R&D is the strategic tool in this regard.

According to Schumann, Ransley, and Prestwood (1995), R&D has four goals: (a) to take advantage of future opportunities in the market (customers, competition, technology) and avoid or minimize the threats, (b) to meet the needs of the firm's stake holders, (c) to utilize the capabilities of the firm, and (d) to fulfil the desires of the staffs of the firm. Current capabilities, which include projects, resources, and the culture of the organization, should be assessed and evaluated against the future desirable state. The difference between the current capabilities and the future desired state necessary to be known to fulfil the firm's vision, mission and goals, and may be closed through innovation

in R&D. R&D effort has long been viewed in both the popular and academic literature as a key determinant and indicator of the technological progressiveness of firms, industries, and even nations. American firms, for example, have been criticized for not devoting a greater share of their R&D to the improvement of manufacturing processes, for under-emphasizing incremental development efforts, and for focusing excessively on short term R&D projects. Japanese policy makers, in contrast, have in the past expressed concern that Japanese manufacturing firms were not conducting enough basic research. These concerns all suggest that the composition of R&D in many national industries may not be socially optimal. Before one can evaluate the optimality of any allocation of R&D, no less than devise appropriate policies, it would be useful to know what drives it (Cohen & Klepper, 1996). There is an urgent need to develop and fit the PMS of the supply chain in context to support R&D and marketing policy of the firms in the measurement system of the supply chain.

Sales and marketing have been described as the key elements in the value chain. With increasing changes in the modern business environment, firms focus more on sales and marketing systems because managing the outbound systems with correctly adopted marketing policy makes it easier to sustain market competition. Sales of products and services can be accomplished through firms' own stores, outside retailers or distribution centres. Outbound systems and sales strategies should be perfectly coordinated to attain competitive advantage. Sales through a firm's own stores assure better performance and control over the market share. It has been widely acknowledged that firms may increase their competitiveness and financial performance by being market oriented, as well as by creating positive bonds with customers (Nordin, 2008). It also ensures easier access to consumer feedback and hence regulates quality and variable demand, but is, however, accompanied by inventory holding costs. Sales through retailers and distribution centres kill the opportunity of product differentiation in the world market. It also involves a risk of poor consumer satisfaction depending on the services provided by the retailers. Sale of products and services through retailers ensure that the product reaches a wider market through advertising and promotion by the retailers.

Thus a firm has a choice in deciding on its sales strategy and organizational management with respect to the final distribution of its products to consumers. The firm and retailers share a contractual relationship, based on revenue sharing contracts (Taylor, 2002). Thus, performance of a firm largely depends on its sales strategy and performance measurement in terms of sales policy

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