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Original Article

# Performance impact of new product development processes for distinct scenarios under different supplier–manufacturer relationships

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**Abstract**

Although supplier involvement in new product development (NPD) projects has become increasingly important for strengthening a firm's competitive position, few studies have investigated the impact of changing research and development (R&D) workloads in NPD. According to the level of design-related characteristics including design-related communication and design-related nature, we identify four types of supplier–manufacturer relationships: sequential mode, passive supplier involvement, active supplier involvement, and strategic development. Differing from qualitative and survey-oriented research, this study proposes a system dynamics model for the quantitative exploration of workload impacts on R&D-system equilibrium under different supplier–manufacturer relationships. We justify experimentally the NPD performances of these supplier–manufacturer relationship configurations under workload impacts and provide managerial insights.


*Keywords:* New-product development; Supplier-relationship management; System dynamics

## 1. Introduction

New product development (NPD) is crucial in various industries for shortening a product's time to market and for improving the product's quality. Because many complex products, such as thin film transistor-liquid crystal displays (TFT-LCDs), digital cameras, and mobile phones require the participation of outside suppliers, practitioners and researchers in the NPD field have grown increasingly convinced that NPD success in manufacturers depends on firms' ability to maintain appropriate relationships with suppliers.

Within the last decade, radical inventions with occasional discontinuities stemming from unanticipated twists and turns along the technology trajectory [6,33] have sharpened customers' purchasing demands; meanwhile, the shortened life-cycles of products have created a high drop-out rate. This is a common phenomenon particularly in high-tech product markets. Such fluctuation in demand has prompted manufacturers, as they engage in the NPD process, either to engage in diverse and constantly changing R&D workloads or, equivalently, to integrate "lumpy" R&D tasks into NPD projects. These fluctuations in R&D workload often weaken manufacturers' adaptive maintenance of R&D

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performances. Therefore, it is widely recognized that suppliers' involvement in NPD is a critical factor in the success of NPD.

Many studies have addressed the benefits of having suppliers participate in NPD projects. This participation helps a firm to achieve reduced costs [3,11,24,30,31,55], improved quality [3,11,24,30,31,55], and shortened product-development time [3,4,8,10,11,24,30,31,53,55]. Researchers have documented that, in the Japanese auto industry, the considerable extent to which suppliers shoulder design responsibilities is an important factor in the industry's superior product-development performance [4,9]. However, research in the field has not paid much attention to detailed design-related characteristics. To our knowledge, there is no single study that proposes a set of supplier–manufacturer relationships based on detailed design-related dimensions. Moreover, a number of studies have investigated effects of supplier involvement on R&D performance, but relatively few studies have quantitatively investigated either how R&D workload affects manufacturers' system performance or the degrees of supplier involvement that minimize negative consequences of sudden shifts in R&D workload. Traditionally, NPD has been viewed as a sequence of separable stages (e.g., design, production, and marketing) driven by technology and customers [49]. It is worth noting that some researchers have proposed a concurrent approach to NPD in contemporary commercial and high-tech industries [32,53]. Replacing the traditional, sequential NPD process is an approach whereby tasks are completed in parallel, both with component suppliers and within a manufacturing firm. Supplier involvement is one of the most critical factors for novel approaches to NPD. Many studies have used qualitative and quantitative methodologies to examine the importance of supplier involvement in NPD. Case-study research is the most common qualitative technique applied to this topic [3,15,26,29,30,40,49], while the two most popular quantitative techniques are analysis of variance (ANOVA) [21,27,44,50] and regression analysis [13,14,19,22,27,35,46]. The case-study design naturally brings forth many limitations regarding chiefly the generalizability of the research results. Moreover, a case study's main weakness is an overall dependence on qualitative analysis that merely ranks the importance of individual factors without quantitatively measuring them. On the other hand, the most common criticism of quantitative techniques is that the resulting research assumes neither multicollinearity nor exact correlation between the independent variables. Despite the breadth and depth of the product-development literature, it must be noted that NPD is a complex and dynamic process involving external R&D workload and internal R&D defects/failures. In product-development scenarios, interactions among various variables would affect the final product-development results. To capture this complexity, the current study adopts a system-dynamics approach that is appropriate for any dynamic system characterized by interdependence, mutual interaction, information feedback, and circular causality [45]; using this approach, the current study constructs and assesses a simulation model that characterizes an NPD system possessing highly complex internal and external dynamics. As mentioned above, this study investigates design-related characteristics-namely, design-related communication (including technology and information exchange) and design-related nature (including design responsibility, supplier influence on specifications, stage of supplier involvement) to identify four types of supplier involvement: sequential-mode supplier involvement, passive supplier involvement, active supplier involvement, and strategic-development supplier involvement. We investigate the effects of R&D workload on a manufacturer's NPD system under various degrees of supplier involvement by employing the system-dynamics approach.

The remainder of this paper is organized as follows. Section 2 reviews relevant literature on supplier involvement. Section 3 proposes an approach to classifying supplier–manufacturer relationships. Section 4 presents our system-dynamics simulation model for examining the changes in system equilibrium that can accompany R&D workloads. Section 5 details the results of our experiment and presents our discussion on the matter. Section 6 concludes the paper.

## 2. Literature review

### 2.1. The dimensions of supplier involvement

Firms in many industries face increasing global competition and growing global markets that demand innovation on an ever more frequent basis and of an ever greater quality. These firms are looking for ways to decrease product-development time and, simultaneously, to improve both product quality and product features and to reduce product costs significantly. One approach taken by many companies to gain competitive advantage is to involve suppliers earlier in the design and development process [30]. Supplier involvement may range from simple consultation on design ideas to making suppliers fully responsible for the design of components, systems, processes, or services they will supply. Over the past decade, the interest in this so-called "supplier involvement in product development" has gained importance and