A dynamic decision support system to predict the value of customer for new product development

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A B S T R A C T

In recent years, firms have focused on how to enter markets and meet customer requirements by improving product attributes and processes to boost their market share and profits. Consequently, market-driven product design and development has become a popular topic in the literature. However, past research neither covers all of the major influencing factors that together drive customers to make purchase decisions, nor connects these various influencing factors to customer purchasing behavior. Past studies further fail to take the time value of money and customer value into consideration. This study proposes a decision support system to (a) predict customer purchasing behavior given certain product, customer, and marketing influencing factors, and (b) estimate the net customer lifetime value from customer purchasing behavior toward a specific product. This will not only enable decision-makers to compare alternatives and select competitive products to launch on the market, but will also improve the understanding of customer behavior toward particular products for the formulation of effective marketing strategies that increase customer loyalty and generate greater profits in the long term. Decision-makers can also make use of the system to build up confidence in new product development in terms of idea generation and product improvement. The application of the proposed system is illustrated and confirmed to be sensible and convincing through a case study.

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1. Introduction

Decisions on new product development are crucial but complex. New product development is regarded as a competitive weapon that helps firms to survive and succeed in dynamic markets. Lucrative new products play an important role not only in penetrating markets, but also building and retaining customer relationships and yielding profits. However, new product development, from idea creation to product introduction, requires inter-departmental communication among designers, engineers, and marketing personnel. Furthermore, to achieve a competitive edge in a market, sensible decisions must be made about various aspects of new product development, such as product attributes, customer segment, and promotion and marketing strategies. These decisions are inter-linked and will ultimately affect profitability. It is challenging to reach a consensus among the various parties involved in product development, who have different responsibilities and concerns. Decision aids such as a decision support system are thus of benefit in solving such decision problems.

In recent years, many conventional and market-based decision support systems for product design have been developed [1,22,23,29,66]. These highlight the key areas that ought to be

considered in making decisions on new product development, including customer requirements, customer satisfaction, market demand, product quality, product design, and pricing. In particular, Gao et al.[20] stated that the timely response to market changes and customer needs becomes one of the competitive advantages. They proposed a novel process model for concurrent product design. Within feature-based part design and process planning, the dynamic change, model reduction, path search and time consumption of concurrent design process are analyzed, which helps improve the overall design process and shorten the product development cycle. However, no decision support system takes all of the key areas into account at the same time. Further, existing systems are insufficient and unconvincing in their ability to determine the most lucrative products among alternatives. Some disregard the influence of customer behavior and satisfaction, and most fail to take the time value of money into consideration. A new, comprehensive decision support system that overcomes these shortcomings is needed to help firms make more sensible and reliable decisions on new product development.

In response to this need, this study proposes a decision support system for new product development that consists of two sub-models: a customer purchasing behavior (CPB) model and a net customer lifetime value (NCLV) estimation model. The system predicts customer purchasing behavior using a system dynamics approach based on three pieces of information: product

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attractiveness, customer preferences and satisfaction, and marketing strategy. It also estimates the long-term NCLV based on Markov analysis. This can help managers to determine which product will be most lucrative to launch and the kinds of marketing strategies that should be adopted for the new product. It also helps improve new product development in the future by collating up to date information on market and product attributes.

This section has given the general background to the study. Section 2 discusses the literature on new product development and related decision support systems. The methodology for the development of the proposed decision support system is presented in Section 3. Section 4 introduces the proposed system and discusses its findings. Some concluding remarks are offered in Section 5.

2. Literature review

2.1. Importance of customer relationships in new product development

From the modern management perspective, maximizing customer value is the key to surviving fierce competition in the business world. Hence, many firms actively engage in developing new products. By delivering value through new products, firms satisfy customers and generate profits. It has been empirically established that customer satisfaction leads to customer loyalty and, in the long term, to profitability [24,45]. It is clear that new products are a crucial driver of customer satisfaction, and that customer satisfaction plays a key role in business sustainability. This suggests that new product development and relationship marketing are associated, especially as customer relationship management is a core relationship marketing tool in the delivery of customer value through products [16]. According to Chan and Li [13], CRM is an effective instrument with which companies can enhance their competitive advantages and improve customer satisfaction and loyalty.

2.2. Current approaches to new product development

To survive and succeed in the current business environment, firms usually focus on several areas to improve their new product development, such as identifying customer needs for continuous new product development [37,40], improving product quality [32,57,58], and accelerating the process of commercialization [40,58,66]. Stanley and Warfield [57] integrated design, engineering, and manufacturing information to provide product information across and beyond the entire enterprise, which extended into the supplier and customer base. Xu et al.[65] applied a polychromatic sets approach to conceptual design. Shu and Wang [55] discussed the key elements of product lifecycle modeling and proposed a framework for it. They also discussed the relationship and evolvement of product models at different stages of the product life cycle. Xu [64] enhanced our awareness of the quality of products and suggested exploring the roles of service-oriented architecture, RFID, agents, workflow management, and the Internet of Things (IoT) as enablers to improve the value of customer in new product development. Further, numerous decision support systems are available in the literature that aid product classification [43], single product design [6,42,66], product line design [1,30,67], and market-based product development [1,12,22,23,29,44].

2.3. Decision support systems for market-based product development

We discuss decision support systems for market-based product development, because customer requirements are often aligned with new product success, and new product development and relationship marketing issues are inseparable. Although some market-based decision support systems for new product development [1,12,22,23,29,44] consider both design and market information, the influencing factors that they include vary widely.

The following three areas, which cover various influencing factors, have been identified as significant and requisite in making new product development decisions. However, none of the currently available decision support systems considers all of these areas concurrently.

(a) Product attributes specified by designers [27,66]: the product itself is the major stimulus that influences customer affect, cognition, and behavior. Customers may evaluate product attributes in terms of their own values, beliefs, and past experiences when they purchase [56]. However, it is unlikely that customers will make a purchase based on product attributes alone. Their requirements and satisfaction are also vital, as is and marketing competence.

(b) Customer requirements and satisfaction [23,37,40]: capturing the voice of customers is essential in manufacturing products that have a high value for customers. Satisfying customer needs not only enables firms to build and retain customer relationships successfully, but also encourages positive word of mouth communication among customers, which in turn influences market demand.

(c) Marketing competence [17,36]: marketing activities usually serve as a catalyst to make customers recognize products and induce them to purchase. It also influences whether the purchase and use of a product is likely to be rewarding [46]. Thus, high-quality marketing campaigns are likely to improve the market share gained from the introduction of new products. Conversely, poor marketing planning and execution have been blamed for the failure of new products [14].

Most current decision support systems help managers select the best new product among alternatives in terms of market share, return maximization, or product development time minimization. However, the measurement of market share or return maximization excludes the time value of money, whereas that of product development time minimization disregards market demand and the effect on customer behavior of relationship marketing. These shortcomings may affect the outcome of new product development.

The shortcomings of existing systems can be overcome by modeling customer purchasing behavior in a way that takes into account the impacts of all of the important areas discussed, and by calculating the NCLV to aid the selection of the best new product to launch. This study proposes a decision support system for new product development that performs these tasks. The system helps managers to understand the managerial aspects of product decision problems and to make appropriate decisions on market-based new product development.

3. Study approach

The framework of the proposed decision support system is shown in Fig. 1. The proposed system comprises of two sub-models: a customer purchasing behavior (CPB) model (sub-model 1) and a net customer lifetime value (NCLV) model (sub-model 2).

The proposed system was developed using system dynamics, which is a system modeling and simulation tool. System dynamics is an analytical method for studying feedback systems using casual loop diagrams. It is "a powerful tool to predict behavior and the relative results of a system so as to get helpful suggestions and support decision making" [49]. System dynamics has been extensively employed in strategic planning [21,34,38,53], policy design and analysis [33,52,54], and business decision-making [4,9,10,25]. It helps potential users to gain insight into the dynamic behavior of complex systems and make appropriate decisions [35,59]. The proposed system has the key features of complex systems [48]. It is a dynamic network in which customers are adaptive and their behavior depends on many factors, and its structure involves complex