THE VALUE OF INFORMATION IN DEMAND PREDICTION FOR A NEW PRODUCT DESIGN

ABSTRACT

Manufacturing generally involves enormous uncertainties. Two major uncertainties which influence profit are product demand and process quality. The firm (or the decision maker) has the option to purchase complete demand information at either the lowest or the highest potential prices. Then the demand distribution at each price is updated using Bayesian method. We obtain the value of complete demand information at lowest and highest prices for different market characteristics. The value of information increase as demand is more sensitive to the price. Moreover, attitude toward risk plays a major role on determining the price that has more valuable demand information. In price sensitive demand, risk averse values information more at highest price while risk seeking tends to have a higher value of information at the lowest price. Moreover, we investigate the value of information for five cases where the knowledge and information about demand and price vary. In addition, the value of perfect information helps to evaluate the economical impact of improving process quality.

1. INTRODUCTION

Knowledge and information have a significant role to outline and reduce uncertainties. Updating knowledge and information is important since there is a solid interrelation between decisions in marketing and manufacturing. Quality of any decision depends on how much information and knowledge the decision maker has. Moreover, phases in manufacturing are related sequentially (i.e. decision made at an upstream stage has an impact on downstream stages). There is a concrete link between the business success and its decision making process. Hayes and Wheelwright [1] classified decisions in manufacturing into structural and infrastructural. Structural decisions such as facility, capacity, and location have a high impact on the organization. These are long term decisions and require huge investment to be changes. On the other hand, infrastructural decisions are short term and don't require high investment to be changed but they impact the overall organization profit. They include workforce, quality (defect rate), pricing. There is growing research that focuses on joint marketing and production in order to avoid decision conflict across an organization. Marketing focuses more in demand prediction while manufacturing produces good product without defects. Demand is typically forecasted based on experience or historical data. Experience and historical data help to get a *prior* demand distribution. The firm can reduce the ambiguity about demand and price by purchasing complete information at a one price level. This new information updates the firm's belief about the demand at every potential price. It is important to reduce demand uncertainty in order not to over or under estimate. Overestimated demand leads to additional cost such as inventory, however, under estimating prevents the firm from enjoying more profit. We investigate the value of complete information at three price levels: low, base and high. The firm can either buy information at low or high pricing levels. Then it uses this new information to update its knowledge about the demand at every other price. Process quality as employed in the paper is the rate of defects in the manufacturing process.

Information has a significant impact on manufacturing decisions. In supply chain, information on demand has a great attention especially in inventory theory [1, 3]. In product development information flaw and exchange has an impact on product performance and process quality [4, 5].In our analysis, we focus into four main uncertainties: demand, manufacturing cost, process quality, and finally defective cost. Demand is uncertain unless it is a contract where the firm knows how many units are needed. The manufacturer may recall all or fraction of the products due to defects especially during the warranty period. For example Dell recalled approximately 18,000 worldwide due to a defective battery (www.dell.com). Recently, Hyundai recall Sonata models 1999-2004 which operates in certain states due to a defect called (the Salt Belt) which relates to motor vehicle safety (Hyundai Motor America, 2009). A defect can be generated by either a product design or imperfect production process. Product design defect can be reduced by performing early testing during early stage of product development process (figure 1). Process defective rates can be eliminated by improving its quality level using existing quality management tool. However, improving process quality level in order to reduce the probability of having a defect may not be essential in the case when extensive inspection is performed. Sometimes, it is economical to perform extensive inspection rather that improving defective rate. Balancing detection with prevention is another purpose of this paper. Detection is defined by how many units inspected while prevention is the rate of defects. Some quality management tools like Six Sigma for example focuses solely into one objective such as minimize poor quality cost with additional appraisal cost. Obviously, the additional improving quality cost may result into a product with a higher price leads to marketing decision clashes. The model focuses into one objective across the organization which is *profit*.

During the engineering design process, engineers must decide on allocating resources, time, product or service quality level, and marketing strategy. Hatamura [6] categorized the decision made in the engineering design as (a) go or no go, (b) single selection, and (c) structured design .One important challenge in engineering design is accounting for an uncertainty. It is widely accepted that engineering design is a decision based approach [7]. Many

studies implemented various methods to incorporate uncertainty into design decision making process such as utility theory [8].Therefore, information and knowledge is crucial in order to make a good quality decision.

Decision analysis is "a logical procedure for the balancing of the factors that influence a decision. The procedure incorporates uncertainties, values, and preferences in a basic structure that models the decision. Typically, it includes technical, marketing, competitive, and environmental factors. The essence of the procedure is the construction of a structural model of the decision in a form suitable for computation and manipulation; the realization of this model is often a set of computer programs" [9]. The core bases for any decision are (i) the alternative or *what can we do?* (ii) the information or *what do we know?* and (iii) the preferences or *what do we like?* Clearly, these bases are present in any engineering design decisions which make it a solid case for decision analysis. Nowadays, economic crisis forces firms and organizations to face tough scenarios where they should act wisely. These scenarios can be external such as merging into a one big firm or internal within the firm such as production quality or hiring/firing employees. This leads us to the use of Decision Analysis to make guidelines and illustrates how DA tool lead firms to evaluate information and knowledge and thus make good decision.

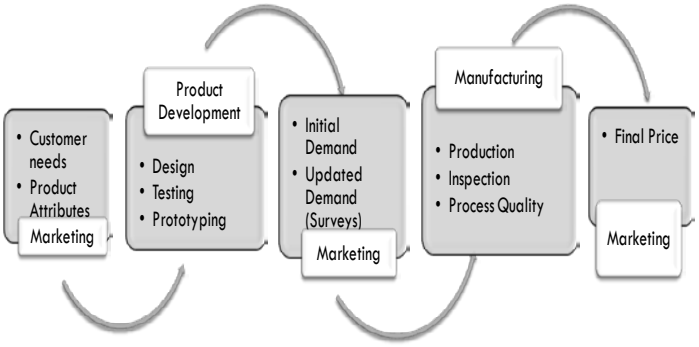

Figure 1: Marketing and manufacturing Processes.

Figure 1 illustrates the joint marketing and manufacturing model stages and tasks. These include marketing research (customer needs identification and product attributes specification), product development (which includes product architecture definition, subsystem identification, prototyping and interfaces), manufacturing (which includes process design for ramp-up and full production), and supply chain design (which may involve a large number of suppliers).

The need for a special tool that handles uncertainties, preferences, and alternatives is essential. Decision Analysis can

The rest of the paper is organized as follow section 2 explains the elements of the decision analytic model. In section 3, a numerical analysis is performed to illustrate the model. The value of complete information on demand is studied in section 4. Section 5 expands the value of information into five cases of demand variations. Value of information on process quality is investigated in section 6.