Topic 5: Product Design

Overview

The existence of a firm is dependent on the product or service it can provide to the society. The competitive position of the firm is greatly influenced by its product strategy. The firm concentrates on a few products to remain competitive. For example, Honda is based on its outstanding engines in the vehicles it produced. Its strategy is to build particular competencies in customizing an established family of goods or services (autos, motorcycles, generators, lawn mowers). Therefore an effective product strategy must link investment ot the market and the stages of the product life-cycle.

Learning Outcomes

By the end of this topic, you will be able to:

1. explain the importance of strategy for product development for the firm’s continued existence in the market.
2. demonstrate the stages of the product life cycle as influenced by the market demands and their relationships on the development of the product to sustain in the market.
3. explain the concept of new products or services and the development of a product.
4. apply the quality function deployment (QFD) to satisfy the needs and wants of customers through designing the characteristics of the product.
5. organise for product development in four possible ways and overcoming the issues for product design.
6. consider the ethics, environmentally-friendly designs and sustainability in the product development..

Introduction

5.1 Product development strategy is fundamentally imperative for a firm to attain

 competitive advantage

5.2 The product life cycle provides the means to study the development of a product in the

 market in four phases: introduction, growth, maturity and decline. Each of these phases

 provides useful economic information about the competitive position of the product in

 the society and its strategy-environment fit.

5.3 The operations manager may carry out product-by-value analysis to determine which

 product should be enhanced to improve cash flows through market penetration or reduce

 cost to sustain competitiveness. It could also involve technology or plant improvement.

5.4 Examine the stages involved in product development and the issues in product design. A successful development of a product strategy requires the understanding of the cash flow, market dynamics, product life cycle and the organisation’s capabilities.

5.5 A operations manager needs to take into consideration the ethical factors while delivering desired goods and services.

5.6 There is a need for operations manager to take into consideration of the rapid ICT advances and the effect on the shortening of the product life-cycle. The firm needs to make appropriate responses to the “forces of change” in the environment to remain in the market. The business-level and corporate-level strategies may need to be fine-tuned or incrementally adjusted to maintain the strategy-environment fit.

**Lecture Notes**

**5. Product Design**

The existence of a firm is dependent on the product or service it can provide to the society. The competitive position of the firm is greatly influenced by its product strategy. The firm concentrates on a few products to remain competitive. E.g. Honda is based on its outstanding engines in the vehicles it produced. Its strategy is to build particular competencies in customizing an established family of goods or services (autos, motorcycles, generators, lawn mowers). Therefore an effective product strategy must link investment to the market and the stages of the product life cycle.

**Product Strategy Options Support Competitive Advantage**

There are options for the selection, definition and design of products. Product selection is the choosing the good or service to provide to customers. A firm may choose to produce household products or industrial products. A hospital may choose to provide specialization in heart treatment or maternity services or general treatment of patients.

The entire production system is designed to cater for the one product or service. This is because product or service selection affects the entire production system.

Toyota’s strategy is rapid response to changing customer demand. It has to be in the position to bring about the fastest design of automobile in the industry in order to remain competitive. It has achieved the speed to come out with a new product within two years compared to the normal standard in excess of 2 years. In other words, Toyota is capable to produce a new car before even the consumer tastes change and to do so with the latest technology and innovations. In this way Toyota has managed to achieve its competitive advantage in the automobile industry.

**Product Life Cycle**

Products are born. They live and they die. They are then cast aside by the changing society. Products therefore have their life cycles.

For purposes of academic study, it is useful to divide the product life cycle into 4 stages: introduction, growth, maturity and decline. The length of the product life cycle varies from product to product. It may be a matter of a few days, weeks, months or years. Regardless of the length of the cycle, the task for the operations manager is the same: to design a system that helps introduce new products successfully. If the operations function cannot perform effectively at this stage, then the firm may suffer losses.

*Life Cycle and Strategy*

The operations manager has to develop strategies to come out with new products or to improve the existing products when the environment makes the demand in order to enable the firm to stay in a competitive position.

The diagram below shows the 4 stages of the product life cycle and the relationship of product sales, cash flow and profit over the life cycle of a product.

 Sales Revenue

 Cost of development & production Net Revenue (Profit)

 Sales

 Cost Cash flow

 and

 Cash Negative

 Flow cash flow

 Introduction Growth Maturity Decline

*Introduction Phase*

The firm initially experiences a negative cash flow at the product development stage and at the early growth stage.

At this stage, there is much fine-tuning of the production technique and spending on research, product development, process modification and enhancement and supplier development. There is also consistent watching of the market reaction to the new product and the market growth and the coming out with the best manufacturing techniques.

*Growth Phase*

The product design is being accepted and the market is responding resulting in increasing sales. At this point effective forecasting of capacity requirement becomes important. Adding capacity or enhancing existing capacity to accommodate the increase in product demand may be required.

*Maturity Phase*

This stage is reached when the competitors have caught up with the market. High volume production and innovative production become necessary. Cost control needs to be improved and reduction in option and paring down of the product line may be effective or necessary for profitability and market share.

*Decline Phase*

Products that are not required in the market are withdrawn and their production stopped while new products are being produced. However certain products that are still demand in the market because of their special uniqueness or reputation are improved for the market.

*Product-by-value Analysis*

Product-by-value analysis is a process by which the products are placed in descending order of their individual dollar contribution to the firm as well as the total annual dollar contribution of the product.

The Operations manager selects items that show the greatest promise. This is known as the Pareto principle i.e. focus on the critical few but not the trivial many.

Sometimes, a product that makes low contribution on per-unit sales, may turn out to be very different when it is based on the total company sales.

A product-by-value report enables the management to evaluate the strategy for each product. It may be for increasing the cash flow, increasing market penetration or reducing cost (reach economies of scale). The report may enable the management to decide what products to be deleted, to be reinvested for coming out with a better products or for plant improvement in terms of technology or capacity. The report also enables the management to focus its attention on the strategic direction of each product.

**Generating New Products**

New products can be generated in two possible ways:

1. Come out with a new product that was never there before.

2. Come out with a modified product derived from a previously existing product.

*New Product Opportunities*

The firm must persistently scan the external environment in order to have a better understanding of the needs of the customers, the technological changes, and the competitors and other stakeholders. The firm must have a flexible structure to respond to the demands of the changing environment. It must also have a transformational leadership to bring about the necessary changes in the organisation for achieving competitive advantage.

Operations managers must be aware of the dynamic environment and are able to anticipate changes in product opportunities, the product themselves, product volume and product mix.

*Importance of New Products*

Company leaders (Gillette, Disney, Cisco Systems, and General Mills) generate a substantial portion of their sales from products less than 5 years old.

Product selection, definition and design frequently go through changes and in some cases, it involves hundreds of time for each financially successful product. Operations managers therefore must be prepared to accept changes and take risk and tolerate failure while maintaining a high volume of new product ideas and the activities in which they are already committed.

**Product Development**

***Product Development System***

A successful development of a product strategy requires the understanding of the cash flow, market dynamics, product life cycle and the organisation’s capabilities.

The product development system must determine the success of the product and the future of the firm. The development of a product goes through a process of several steps as shown in the ***diagram*** below. Each step has its own screening and evaluation criteria.

 Ideas from many sources

 Does firm have ability to carry out idea?

 Customer requirement to win orders

 Scope Functional specifications: How the product will work. Scope

 of for

 product Product specifications: How the product will be made design

 development and

 team Design review: Are these product specifications the engineering

 the best way to meet customer requirements? teams

 Test market: Does product meet customer expectations?

 Introduction to market

 Evaluation (success?)

 Diagram: Product Development Stage

***Quality Function Deployment (QFD)***

QFD is one aspect of quality function that uses a planning matrix to relate customer “wants” to “how” the firm is going to meet those “wants”. It is about how to satisfy customer needs and wants.

It refers to:

 (1) determining what will satisfy the customer; and

 (2) translating those customer desires into the target design.

Before it is possible to come out with a new product, it is absolutely to first understand what the customers want to have from the product. The wants of the customers are then incorporated into the product design. This requires the existence of a ***house of quality*** where the customer desires and product are integrated and this involves 7 steps:

1. Identify customer wants.

2. Identify specific product characteristics, features, or attributes and show how they will satisfy customer wants.

3. Relate customer wants to product how.

4. Identify relationships between the firm’s hows.

5. Develop importance ratings.

6. Evaluate competing products.

7. Determine the desirable technical attributes.

Notice that QFD is very involved with meeting the needs of customers in terms of design characteristics. The sequence of houses is a very effective way of identifying, communicating and allocating resources throughout the system. The series of houses helps operations managers determine where to deploy quality resources. In this way, it becomes possible to meet customer needs, produce quality products and win orders.

 Design Specific Production Quality

 characteristics components process plan

Customer Design Specific Production

requirements House characteristics House components House process House

 1 2 3 4

 Diagram: House of Quality Sequence Indicates How to D4ploy Resources to Achieve

*Organising for Product Development*

Four ways to organise product development are:

1. A traditional approach is to have distinct departments: a research and development department to do the necessary research; an engineering department to design the product; a manufacturing engineering department to design a product that can be produced, and a production department that produces the product. Disadvantage: rigid structure and lacking of forward thinking.
2. Get a product manager to champion the product through the product development system and related organisations.
3. Use teams to engage in product development, designing, manufacturing and value creating.
4. Do not subdivide organisation into departments/teams all the various team efforts are in one organisation. This is the Japanese approach (not the Western approaches as seen in the first three cases). Therefore there is better communication and coordination among the members.

*Product Development Team*

Teams charged with moving form market requirements for a product to achieving product success. Team members come from other departments and the team is set up for a specific purpose or project. When the purpose or project is completed, the members of the team return to their respective previous positions in the organisation. The use of such teams is also known as ***concurrent engineering***.

*Manufacturing and Value Engineering Activities*

These activities are helping to improve a product’s design, production, maintainability and use. They also produce other benefits such as:

1. Reduced complexity of the product.
2. Reduction of environmental impact.
3. Additional standardization of components.
4. Improvement of functional aspects of the product.
5. Improved job design and job safety.
6. Improved maintainability (serviceability) of the product.
7. Robust design.

The activities may be the best cost-avoidance technique available to operations management. They bring about value improvement to meet customer requirements in an optimal way. They can reduce cost by 15% to 70% without reducing quality.

Issues for Product Design

Besides an effective system and organisation structure for product development, techniques to design a product are just as important. There six possible techniques for designing products:

1. Robust design - the product is designed so that small variations in production or assembly

 do not adversely affect the product.

2. Modular design - a design in which parts or components of a product are subdivided into

 modules that are easily interchanged or replaced.

3. Computer-aided design - computer is used to design the product with the proper software

 programme. It saves time and cost to come out with a new design. The CAD is even

 extended to design for manufacture and assembly (DFMA) and also for 3-D object

 modelling - a small prototype development of a model of a product.

 The latest development of the CAD is the Standard for the exchange of product data

 (STEP) - a standard that provides a format allowing the electronic transmittal of three-

 dimensional data and enabling geographically dispersed manufacturers to integrate design

 manufacture and support processes.

4. Computer-aided manufacturing (CAM) - special programme to direct and control

 manufacturing equipment. When CAD information is translated into instruction for CAM

 the result of these two technologies is CAD/CAM. The benefits are:

1. Product quality is improved.
2. Shorter design time.
3. Production cost reduced.
4. Database availability - dramatic cost reductions in manufacturing.
5. New range of capabilities for manufacturing is developed.

5. Production cost reduction.

*Virtual Reality Technology*

With the development of the CAD, a virtual form of communication becomes possible. A virtual reality technology has emerged. 3-D layouts of everything from restaurants to amusement parts become possible. Changes to mechanical design, restaurant layouts, or amusement park rides are much less expensive at the design stage than later.

*Value Analysis*

Value analysis refers to the technique that is used during the production process. It enables improvements to be made on the quality of the product at the production stage. (Cf: value engineering).

**Ethics, Environmentally-Friendly Designs and Sustainability**

An operations manager’s task is to enhance productivity while delivering desired goods and services in an ethical environmentally sound and sustainable way.

In an OM context, sustainability means ecological stability. This means operating a production system in a way that supports conservation and renewal of resources. The entire production life cycle from design, to production, to final destruction or recycling - provides an opportunity to preserve resources. Plant Earth is finite; managers who squeeze more out of its resources are its heroes. The good news is that operations managers have tools that can drive down costs or improve margins while preserving resources, e.g. at the design stage, production stage and destruction (recycle) stage.

*Systems and Life Cycle Perspectives*

Two possible ways to add an ethical and environmental friendly approach to the job of operations managers and their teams:

1. Need to view products from a ‘system’ approach i.e. view it from the inputs to the firm,

 the processes and the outputs and their effects/impacts on the environment such as

 pollution and contamination and destruction of lives of other living things.

2. The impact of the life cycle of the product (the 4 stages) on the environment. This can be

 done through the application of the life cycle assessment (LCA) - part of ISO 14000

 assesses that environmental impact of a product from material and energy inputs to

 disposal and environmental releases.

Goals for the two issues:

1. Develop safe and more environmentally sound products.
2. Minimize waste of raw materials and energy.
3. Reduce environmental liabilities.
4. Increase cost-effectiveness of complying with environmental regulations.
5. Be recognised as a good corporate citizen.

Six Guidelines to achieve ethical and environmentally-friendly designs:

1. Make products recyclable.
2. Use recycled materials.
3. Use less components.
4. Use lighter components.
5. Use less energy.
6. Use less material.

Law and Industry Standards - they can help operations managers make ethical and socially responsible decisions.

**Time-Based Competition**

The rapid ICT (Information Communication technology) advances, rapid technological change and short product life cycles have push product development. Firms that do not make appropriate responses to these developments in the external environment will lose their competitive advantage. This concept is known as “time-based competition”.

As a consequence firms are becoming more concern in term of their business-level and corporate-level strategies. In turn the product development strategies become the important integrating and coordinating factors of the firm’s success. At the same time, the firm has to pay attention to the external strategies in terms of the acquisition of new technology, establishment of joint ventures and development of alliances.

Defining a Product

Before anything can be produced, a product’s functions and attributes must be defined. Once this is done, the product is designed and the firm has to decide how those functions are to be achieved (i.e. the functional purpose).

It is followed by vigorous specifications of a product to assure efficient production. The product is then defined, designed and documented i.e. the engineering drawing. Equipment layout and human resources requirement can then be defined.

From the engineering drawing the dimensions, tolerances, materials and finishes are indicated. It also enables a bill of material (BOM) to be made i.e. list the components, their description and the quantity of each required to make one unit of a product.

*Make-or-Buy Decisions*

The firm may decide to buy some of the components for the product from other sources. This depends on whether there is saving of costs, improved quality aspects, delivery time and flexibility and long term reliability.

*Group technology* - it refers to a product and component coding system that specifies the type of processing and the parameters of the processing. It allows similar products to be grouped.

*Documents for Production*

An assembly drawing, assembly chart, route sheet, work order and engineering change notices (ECNs).

ECN - a correction or modification of an engineering drawing or bill of material.

Configuration management - a system by which a product’s planned and changing components are accurately identified.

*Product Life-Cycle Management (PLM)* - software programmes that tie together many phases of product design and manufacture.

**Service Design**

Service industries include banking, finance, insurance, transportation and communication. The products offered by them range from a medical procedure to shampoo and a hair cut in a saloon and to a great movie.

Designing services are more challenging because of their unique characteristics. Usually any attempt to change a productivity improvement involves customer interaction. The customer may involve in the design of the service and in the delivery of the service too (e.g. in counselling, education, financial management of personal affairs or interior decorating).

However, the cost and quality of the service are defined at the design stage. There are techniques to reduce cost of service e.g.

(1) *customization is delayed* such as tint and styling are done at the later stage or

(2) *modularize the product* so that customers can select the modules they like (e.g. college

 curricula, meal, cloths and insurance).

(3) is to divide the service into small parts and identify those parts that lend themselves ***to***

 ***automation or reduced customer interaction*** (ATM machines, airline automatic

 ticketing).

(4) focus design on the so-called moment of truth - the moment that exemplifies, enhances or

 detracts from the customer’s expectations. That moment may be a simple smile or having

 the check-out clerk focuses on you or when you placed your order at the McDonald’s or

 registered for a college course.

Documents for Services

They are in the form of job instructions that specify what is to happen at the moment of truth.

For example to draw money from the saving account.

Application of Decision Trees to Product Design

They are helpful when there are a series of decisions and various outcomes that lead to subsequent decisions followed by other outcomes.

Transition to Production

A product is the result of an idea. It started with an idea - that can bring about a useful purpose and an innovation. It has to be a creative idea. It is then subjected to a design and to production. This move is known as *transition to production*.