Lean Startup Approach on Product Design and Manufacture Facility Planning in Uncertain Business Climate

W S Dewobroto¹ and I A Marie²

¹Entrepreneurship Departement, Podomoro University, Jakarta, Indonesia
²Industrial Engineering Departement, Trisakti University, Jakarta, Indonesia
¹wisnu.dewobroto@podomorouniversity.ac.id, ²iveline.annemarie@trisakti.ac.id

Abstract– Successful companies can provide the products that suit to consumer desire. There are two approaches in the product manufacturing process which are Product Development Process and Lean Startup. This study aims to demonstrate the conception of Lean Startup and its application in product design particularly in uncertain business climate. After comparing the two methods, Lean Startup approach is appropriate since the validation process in each product development process will certainly increase the possibility of products that suit to the consumer desires and reduce the time needed starting from product design to the market. In order to support Lean concept in the whole processes, there are two techniques that might be applied to support lean operational system, which are the formation of one worker multiple machine (OWMM) cells and Group Technology (GT) cells. 

Keywords: Facility Planning, Flexible Business Model, Lean Startup, Product Design

1. Introduction

A company is categorized as successful if it performs the ability to provide products in accordance with customer and consumer desire. In sustainable design process, there is a process known as Product Development Process that focuses on the needs of users or consumers. As business conditions continue to change, the Lean Startup approach adopted from the manufacturing approach has evolved and now it is applied to every process in management and business, even new products. In terms of product manufacturing, the Lean Startup approach emphasizes the process of building a business from a product, and there is no fundamental detail regarding the product technical sides.

In the development of engineering and business science, many things have evolved following consumer needs, national and global industries are adapting with current development. The development of manufacturing system (extended manufacturing system) directs the actors in the manufacturing system to move forward, make continuous improvements, adjust to the technological advancement and the needs of modern industrial societies, and see the company as part of the other companies’ supply chain.

This article will mainly discuss about the product design and manufacturing process by comparing the two approaches; Product Development Process and Lean Startup. Then, the discussion continues with the argumentation of the most suitable method, especially in uncertain business conditions, followed by an impact on the design of facility. Because it is known that product design is influenced by aesthetic, functional, and material considerations and impacts on the manufacturing process to meet the values needed by consumers. Facility planning will determine how the activities of production
facilities in an industry can be arranged in such way so that it can support the efforts to achieve the main objectives effectively and efficiently.

2. Research Methodology
This article aims to explain Lean Startup method and its application in Product Design. Then, facility planning techniques will be obtained to support the Lean Startup approach in the Product Design process. The theory references obtained become the basis and main tool in this study.

3. Result and Discussion
Product design is the whole activities of product manufacturing started from observing market potential to producing, selling, and delivering the products to customers. The good product design characteristics are as following:

1. Prioritizing the quality measured from the products that suit to the consumer needs and availability to buy the products.
2. Product manufacturing costs that meet the product value. Product manufacturing costs will affect to the selling price and product profit.
3. Calculating a product quality dimensions which include [2]: Performance, Durability, Conformance to Specification, Features, Reliability, Aesthetics, and Perceived Quality.

In the process of gaining a good product, there will be two approaches discussed; Product Development Process and Lean Startup.

3.1 Product Development Process
Product development process is generally divided into some phases:

The process begins with a planning phase related to technology advancement and advanced research activities. The output of planning phase is project mission statement, which is the input needed to start the concept development phase and a guide for each development. The completion of product development process is the product launching sent to the customers later.

Product development process consists of some significant activities, namely:

1. Identification of consumer need. This activity is designated to understand the consumer needs and communicate them effectively to the development team.
2. Target specification. Specification is the translation of consumer needs into technical requirements.
3. Concept drafting. The product concept is the illustration or estimation of technology, working principles, and product form.
4. Concept selection. Concept selection is an activity in which various concepts are analysed successively, then eliminated to identify the most promising concepts.
5. Concept testing. One or more concepts are tested to find out whether the needs of consumers have been recognized, estimate the market potential of the product, and identify some weaknesses that must be fixed during the next development process.
6. Final specification decision. The target specifications set at the beginning of the process are reviewed after the process is selected and tested.
7. Project planning. At the end of this concept development, the team formulates a detailed development schedule, sets strategies to minimize development time, and identifies resources used to finalize the project.
8. Economic analysis. Economic analysis is used to ensure the continuation of the overall development program and to solve specific bargaining, for example between manufacturing costs and development costs.

9. Analysis of competing products. An understanding of the competing products is important for successful new product positioning and can be a rich source of ideas for product design and production processes.

10. Prototype making and modelling. Each stage in the concept development process involves many forms of models and prototypes. This includes, among others, proof of concept models that will assist the development team in demonstrating the feasibility of the model shown to the consumers to evaluate their ergonomics and style, while the worksheet model is for technical choices.

3.2. Lean Startup

In principle, the Lean Startup process trains to reduce waste by increasing the contact frequency with customers, to the extent that testing can be done, invalid market assumptions can be avoided as early as possible, and finally a valid product can be acquired. The initial validation phase begins with the hypothesis of who the prospective customers are, what they need, how many, and so on. The consumer hypothesis is then validated directly to the potential customers to determine whether the product is suitable to what is desired [1].

In a business, Lean Startup is the method that minimizes risk, especially by relying on iteration (repetitive steps) from product to market to find quality feedback as quickly as possible and as often as possible from the market [1].

Another important thing in the Lean Startup method is Validated Learning which can be defined as the process of discovering relevant facts related to the design of a product. This process is initiated by using assumptions / hypotheses which are later examined by field experiment to obtain responses from the prospective customers whether the hypothesis is correct.

The main cycle or process in Lean Startup is Build Measure and Learn. The purpose of Build-Measure-Learn is to provide the facts needed in Validate Learning. The process of Build-Measure-Learn is represented by these three repetitive phases as demonstrated below:

- **Build**: Create products based on the main hypotheses that have been examined with Validated Learning. The first product made is Minimum Viable Product ("MVP"). MVP is a minimum product that only has core features to further examine some hypotheses that have not been validated.
- **Measure**: Collect the responses, suggestions, input, and feedback from MVP users and measure the results obtained with the aim of acquiring knowledge related to the tested hypothesis.
- **Learn**: Make conclusions from the Measure process results to find the validation of tested hypothesis. The results from Learn stage are further used as the basis for product or strategy improvements or changes.

The conclusion drawn from this process also decides whether the Startup Founder must "Persevere" or "Pivot". Persevere is continuing the development process with the same strategy
or product, while Pivot is making changes or replacing some parts or the whole strategy or product.

3.3. The Comparison of Product Development and Lean Startup

From the discussion of the two methods in product design process, the main similarities and differences in the process can be found below:

- **Focus on Consumers.** In term of consumer orientation, both methods have similarities. Users or consumers are important and must be ensured that the process includes consumer need identification in which it is hidden and unspoken like the explicit ones. Later, the identification becomes the basis for compiling product specifications and developed by the development team.

- **Design Process.** When compared to the two methods, the product development process looks meticulous and is done in more static context [12]. The process is started from market analysis, resources needed, and ended with prototypes. The iteration or validation process is accomplished after System-Level Design.

![Figure 3. Product Development Process](image)

Meanwhile, Lean Startup process is executed by the time of planning and forming product Value as shown in Figure 4. The iteration is performed to the final stage quickly.

![Figure 4. Iteration Process in Lean Startup](image)

Changes (Pivot) can occur even during the planning stage to the end hence a valid product will be certainly obtained at the end of the process. In other words, Lean Startup performs the process of development and implementation in parallel, while in Product Development Process, the implementation is executed after the design process is complete. When this is applied to companies, especially in developing new products, it will certainly increase the possibility of products that suit to consumer desires and also reduce the time needed from product design to the market. But good communication is necessary in every part of the company, especially between designers and product development teams who may have different perspectives and thinking.

3.4. An Uncertain Business Climate

A successful company is indicated by its ability to control all forms of uncertainty into competitive advantages. It is undeniable that many companies expect a deterministic environment, such as constant level of demand, delivery time from fixed suppliers, low price volatility of raw materials, small
variability in production processes, and so forth. However, uncertainty is inevitable and the company must live with it. Companies must have provisions to deal with uncertain conditions.

Uncertainty in the business world can occur because:

- Consumer demand rapidly changes both in volume and design variety
- Design and manufacturing capabilities of suppliers are always changing
- The use of new and various technology platform in industries
- Competitor behaviour

In this case, flexibility turns out to be important and interpreted as the company's ability to overcome the overall uncertainties precisely and quickly [3]. In this case, there are three components that must be assured to create a more-resistant-to-uncertainty company.

1. **Product Development Flexibility**. Companies must have the competence and capability in developing flexible products. In a highly competitive market characterized by increasingly shorter product life cycles, the company must be flexible in modifying product designs or even producing new products altogether. In this case, a fast and valid product development process is needed. From this, it can be said that the application of Lean Startup approach is appropriate for product development process when business conditions are full of uncertainties. With the validation in each process, it can be assured that each process has valid results or output.

   It is known before the Lean Startup process, Value Proposition needs to be made as a basis for validation of each product design process. Value Proposition is a method used in deciding how far the product or service offered has a high value according to its target customers (Osterwalder and Pigneur, 2010). In other words, it is about how a company can offer products or services that are different from its competitors. Value Proposition has two focuses, customer segments and value.

![Value Proposition Canvas](image)

**Figure 5. Value Proposition Canvas**

Value Proposition Canvas is a tool that will describe Customer Profile and Value map in detail. On the Customer profile, market segments can be specifically seen and thus the target market and the needs or expectations of target market will be more detailed. Customer Profile consists of three parts including customer gain, customer pain, and customer jobs.

Besides, Value Map illustrates in detail the value of a product from the consumer’s point of view. Value Map carries three parts, which are products and services, pain relievers, and gains creators.

The Value Proposition Canvas shows the details of the compatibility between two sides (Consumer and Value) so that the pre-launch product holds a value that meets the consumer desires and finds out solutions to the consumers’ problems. The three adjustments are Problem-Solution Fit, Product-Market Fit, and Business Model Fit.

2. **Manufacturing Flexibility**. Companies are required to be flexible in producing various products (Volume flexibility) and several types of products at once (mix flexibility). The challenge companies must face is the fact that flexibility in producing goods is not something easy. A company is said to be flexible if it has a flat average cost curve, meaning the companies can produce the products in different quantities with the same average cost. Nevertheless, not as it seems, producing a number of products per month will be cheaper than producing a number of fluctuating items. Flexibility is not unlimited. The flexibility to produce more products, to a certain extent, can be
achieved through a number of ways, such as machine flexibility, labour flexibility, routing flexibility, and material handling flexibility. The challenges faced by the manufacturing system are not merely about consumer demand change, equipment design development, and global competition, but now also increasingly need to take into account the lack of future energy resources and environmental responsibility. Manufacturing companies are demanded to have high flexibility to deal with the current phenomena. Lean Startup as an approach in product design, followed by the application of lean operating systems and lean thinking processes in every operational activity of business organizations or companies, has become a necessity to continuously excel in global competition.

3. **Supply chain flexibility.** In a strong supply chain, materials and information run smoothly without obstacles, thus all forms of waste can be eliminated. Besides the aspect of efficiency, flexibility in the supply chain is required to meet all consumer demands on time. Changes in products, services, customers, markets, and business practices potentially direct the changes in industrial supply chain network facilities. In supply chain management approach, the company tries to regulate the flow of information via supply chain to obtain synchronization level so that the company can better respond to customer needs while minimizing costs. The facility must assist business organizations to achieve supply chain excellence with the objective of increasing ROA, increasing customer satisfaction, reducing costs, and performing integrated supply chains. All facilities in the supply chain must be characterized with flexibility, modularity, upgradability, adaptability, and selective operability [11].

From the three components mentioned above, companies today must have a flexible business model. In other words, in addition to flexible product development, a flexible business model is needed to address the business climate and uncertain product demand [6]. The intended business model is those which concern on the network power pertaining products, manufacturing, and supply chain.

![Figure 6. Flexible Business Model (Network focused approach)](image)

3.5. **Facility Design Techniques to support Flexibility in Product Development, Manufacturing, and Supply Chain.**

Facing the changing and developing era, shorter cycle, rapid information technology advancement, and consumer trends disruption will affect the facility design layout on a production floor. Facilities Planning is the process of analysing, conceptualizing, designing, and actualizing a system for the manufacture of goods and services, generally represented as floor plan, or physical facility arrangement which includes: equipment, land, buildings and other means to optimize relations between implementers, the flow of
goods, the flow of information, and the procedures needed to achieve goals efficiently, economically, and safely.

Facilities Planning scholarship continues to grow with the addition of quantitative approaches and the principle optimization which are also supported by the availability of layout and simulation software packages used to acquire facility layout design results that can optimize industrial activities. The facility planning process will be strongly influenced by the strategic business plan and concepts, techniques and technology to be the factor of consideration in manufacturing strategy and assembly.

It is known that the outputs from product design stages, design process, and design schedules become the input in the design of a facility. Product design decisions, processes, schedules and facilities are made in a sequential and mutually influential manner. A clear vision is needed regarding what to do and how to do it (including concepts, techniques and technological considerations). In most cases, changes in product design, design process, and design schedule of manufacturing facilities will require modifications in layout, control, and storage facility.

Related to product design activities, a facility planner must be able to anticipate the level of uncertainty that will occur, consider the mission of planned facility, implement specific activities, and direct related activities. By considering the type of product that will be produced by the facility, the business philosophy has to consider facilities and related external factors, such as the economy, availability of labour, the level of competition, and other factors that may cause changes. If it is decided that the facilities can accommodate changes related to the use of facility and its mission, then a design with a high degree of flexibility and a very general area are needed. Conversely, if the product has high level of trust, the facility can be designed to optimize the production.

As the need for more competitive design facilities among manufacturing companies becomes stricter and borderless (global), every business organization must be able to create various strategic efforts to respond to customer value needs by reducing waste and making creative and innovative efforts to get smooth and efficient flow of material and information in the value chain. On the other hand, customer needs are increasingly varied and unique, while manufacturing equipment is increasingly automated and has integrated architectural design. It will be a significant challenge for manufacturing companies to adjust their facility design to these changes.

There are two techniques that might be applied to support lean operational systems, namely the formation of one worker multiple machine (OWMM) cells and Group Technology (GT) cells.

Figure 7. One Worker Multiple Machine (OWMM) Layout

Figure 7. illustrates five OWMM cell machines used by 1 operator in the middle (U-shape is the most common form). Operators work by moving around in a circular area. In this layout, different parts or products can be made by changing the engine setup.

Furthermore, the facility layout based on product group or product family or group technology layout is a layout based on the grouping of products or components that are made, in this case the grouping is not based on the similarity of the final product types but it is grouped based on the processing steps, shapes, machines, or equipment used. In brief, the technology layout group is a combination of fixed
and process layout. Group technology is a method for managing similar entities (components, processes, tools, etc.) to reduce manufacturing complexity by dividing manufacturing systems into sub-manufacturing cells.

4. Conclusion and Suggestion for Further Research
From the comparison results between two approaches in product design, it can be concluded that:

• Both Product Development Process approaches Lean Startup approach equally orient to consumers as product users.
• To become a successful company that is able to control all forms of uncertainty to continue having a competitive advantage, it requires a flexible, fast, and valid product development process. Hence, Lean Startup approach is appropriate for the product development process when business conditions are full of uncertainties. Involving validation in each process, valid results or output will be certainly acquired.
• Lean Startup as an approach in product design, followed by the application of lean operating systems and lean thinking processes in every operational activity of business organizations or companies has become a necessity that must be done to be able to continue to excel in competition. There are two techniques that might be applied to support lean operational systems, which are the formation of one worker multiple machine (OWMM) cells and Group Technology (GT) cells.

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