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Introduction

Tractors are essential vehicles that are used in agriculture, mining, or construction. This kind of vehicle is made with engineering logic so that it can serve a high tractive effort at slow speeds. In this paper, the scenario is based on a tractor company named ‘The Big Green Tractor’, which is located in Palembang, Indonesia. According to the provided case, the tractor company has faced several obstacles that hinder the industrial growth in the recent few years. Due to experiencing such circumstances, the management of ‘The Big Green Tractor’ company has decided to implement streamlining operations to recover the losses and avail effective outcomes. The company authority has hired me to help them with this job. They have also favored me to suggest some recommendations as well that will support the streamlining process in an environmentally friendly way which should cut down the pollutants from the production processes of the industrial tractor company.

Industry Knowledge and Application

A tractor is a gigantic product and requires a good manufacturing budget. In general, the process of converting raw materials into products is known as the manufacturing process that encompasses the design and manufacturing of goods using different production procedures and techniques (El Wakil, 2019).

Manufacturing in the tractor industry is extremely important as it serves certain impacts on the economy. According to research, it has been noticed that traditionally, more % contribution in manufacturing generates higher GDP. An inappropriate way to implement the manufacturing process can lead a company to decline growth in the competitive market. Several challenges can be experienced by a company such as:

- Shorter lead times
- Increased electronics
- Comprehensive varieties of sizes and designs
- Decaying unit production numbers

In the case of ‘The Big Green Tractor’, it goes the same and for that reason, the company requires to change their operation management process by implementing operational industrial streamline approaches.

Operational industrial streamline implementation is a contemporary approach in the business industry that efficiently helps to analyze or excrete unnecessary work-related tasks to enhance the effectiveness of methods in businesses. Basically, practicing streamline complex processes in business helps to produce significant cost and time savings along with increasing overall productivity as well as profitability. On the other hand, implementing this approach in business will be a long-established process, which is a time-consuming endeavor. But in reality, if the implementation process maintains the right quality programs and new technologies from the start, the company will surely improve existing processes and effectuate the immediate privileges (Frantzen, 2016).

Theoretical Application

The manufacturing process of tractors requires a huge amount of investment as it is a gigantic product and work essential jobs in the agricultural field. Minimizing the manufacturing process defects is an important way to reduce the loss rate of the tractor company and eventually it also helps to increase its growth in the marketplace.

Agricultural equipment planning alternatives can reduce the cost of manufacturing equipment. It is a significant area in which we can reduce manufacturing costs by practicing good engineering and management approach. Different factors can impact manufacturing costs. Rising costs of components are a big issue in this industry, and that can be addressed through modularity. Modularity has the potential that aids in reducing costs to obtain the product variety. On the other hand, the evolution of machines, as well as electronics to the mechatronic systems, can also lead to a notable positive impact on boosting efficiency and decreasing manufacturing costs.

Practicing standardization in the tractor industry especially for the company serves the opportunity of flexible utilization as well as reuse of components, scale economies, and interoperability (Verdouw et al., 2019). Rapid transition and the impact of electronic functions entail increased effort in the manufacturing process of the tractor industry. After studying the tractor company, I think 'The Big Green Tractor' company is growing short of competent individuals to lead this activity ahead.

Components' reusability and its practice have become a primary concern for strategies' designing. If we concern the matter to go through one component design process and form a component design that can be effective practiced in multiple product variations across the product generations, it can be possible to save huge amounts of money on development costs (Sievi-Korte, Beecham, & Richardson, 2019).

By adopting the strategy of reusing components, it is possible to bring improved products swiftly based on selectively updated components to the future market. Using reusing components

can serve another advantage i.e. economies of learning and quality improvements at the component level. It will be cheaper to use as well. It can increase the reliability of the product.

Modular design strategies are basically practiced in the branch of electrical, mechanical, electronic, and also in software systems that primarily concede architectures/modules sharing between various product lines. Implementing the approach of a proper modular design can serve reduced development time, good economies of scale, reduced-order lead-time, and most importantly more accessible product diagnostics, maintenance, and repair opportunities (Renius, 2020).

Business strategy also has the potential that can influence the consequence of modularity. For some important products for tractor industry products, we can expedite a proprietary architecture approach in which only we will know the critical interface stipulations that make the elements plug-and-play compatible. This kind of approach is required to upgrade swiftly in the modular architecture to maintain the benefits in the marketplace. In the short run, the use of reused components may serve good advantages by maintaining proprietary architectures in the modular design (Draft, 2017). But ultimately, in the long run, it might not be such effective in nature.

The durability of mechanical equipment used in a tractor is much longer than electronics equipment. So, it is perceived that electronics equipment could be upgraded easily while practicing the modular approach in the tractor company because it will tremendously help in extending the durability and enhancing the attractiveness of the applied equipment (Tsiropoulos et al., 2017).

We can adapt the strategy of replacing the mechanical functionality with electronic functionality because it will aid in reducing the manufacturing cost. According to recent research, it is a great concept to implement this concept where it serves as a common modular steering controller which can be used on both various tractors and combines (Gruda, Bisbis, & Tanny, 2019). Though, at the very first time, customers might create problem while they will understand the electronic equipment have content as a decrease in quantity. But this practice helps in the industry as we have seen the life span of both mechanical and electrical components. When the matter comes to serviceability, the average producer is typically accustomed to the repair and maintenance of mechanical systems. If the matter is considered deeply, it can be perceived that there is an equivalent capability in electrical systems. In comparison to early days, in the recent 21st century, agriculture is following more or less with the same trends and it is expected to have demand for agriculture in the future at the same pace.

This can be considered as the best facilitated in operations with the large-scale system of agriculture and the mighty internal infrastructure to boost agricultural manufacturing as well as production. In the manufacturing process, the prime issue is the life of the equipment. Modularity in design upon a rigorous set of product specifications can foresee the demand for modernization as well as serviceability over the product life cycle for several electronics as well as control systems.

Mechatronics is an important combination of electronic engineering, mechanical engineering, information sciences, and control engineering in the tractor industry. The use of mechatronics will tremendously help in increasing the automation of the business. The fusion of these systems in design will lead to reduced costs in design as well as manufacturing, where aids in enhancing the functionality (Kaneps & Gerina-Ancane, 2016). So, practicing

mechatronics in the tractor industry will be a great approach to avail a cost-effective manufacturing process for 'The Big Green Tractor' company.

The development of design, as well as manufacturing methods, concedes an enhanced focus on making the entire system more efficient. This must lead to design methodologies to overcome the assembly costs, including design and service. Design for Assembly is considered as the methodology for assessing product plans in a quantifiable approach to recognize unnecessary parts in an assemblage and to determine assembly times as well as costs.

The assembly time standards are partially based on comprehensive research reinforced by years of tractor industrial practice. They include wire apparatus as well as disseminated circuit board assembly, and mechanical assembly. Product engineers of the company estimate the cost contribution of every single component and after that simplify the product concept according to the part reduction strategies. It is a strategy that involves abundant features that will be economically feasible. We are required to make DFA based design for the manufacturing process so that we can able to identify more elegant products with fewer parts which functionally efficient and effortless to assemble. If we implement DFA based design, it will also reduce the equipment costs as well and improve both qualities as well as reliability. Another benefit of using DFA-based design is it supports shorter development cycles.

We can practice another approach to reduce the cost in the manufacturing process and i.e. implementing the Design for Manufacturing (DFM) methods. This approach will tremendously aid in the assortment of materials and processes and produces piece part and tooling cost evaluations at any product design stage.

DFM serves well-manufacturing insight into the cost reduction interpretation of design for Assembly. The technique divides the primary cost drivers correlated with a broad spectrum of processes for component manufacture including finishing. Usually, the approach of DFM does not rely on traditional data and for that reason, it will help us to quickly create cost assessments as the parts are being designed (Kumke et al., 2018).

Serviceability has become a fundamental merchandising point for manufacturers of all types of tractor goods. DFS i.e. Design for Service approach is another alternative approach that suitably allows architects as well as engineers to estimate the serviceability of a tractor when it is in the initial design stage, where modification can be performed to the product design at a minimum price. The advantages of implementing a DFS analysis cover reduced warranty costs and simultaneously improve customer satisfaction by serving more environmentally green alternative products due to more prolonged life through cost-effective servicing (Grześ, Kowalik, & Rybacki, 2017).

Practical Application

To practice the cost-effective manufacturing process, formerly, we are required to focus on minimizing the concern of changing design and manufacturing modifications. We also need to take care of minimizing time and cost in considering the product from conceptual design to production as well as the introduction of the product to the marketplace.

It can be considered that the profits of a company mostly depend on the manufacturing process especially if the industry is like tractor companies. We must consider the recent advances to practice the manufacturing processes for ‘The Big Green Tractor’ company. For example, formerly, the tractors had soft steel machines, which required heat treat, and grind to accomplish

its operation. But recently, maximum tractors are controlled with EDM i.e. Electrical Discharge Machining, and the machines are made of Hard Steels. These changes help to increase the durability of the tractors by minimizing the costs and expanding their working capability. The effectiveness of new tractor models is high because of implementing proper streamlining operation i.e. cutting of tool materials including CBN and Carbides and implementing Structural Dynamics i.e. Chatter Theory in an efficient way.

For this project, after studying the case study, I have decided to apply the plasma cutting and waterjet cutting processes to implement a successful streamlining operation for 'The Big Green Tractor' company. In other developed countries, the use of Plasma cutting and waterjet cutting in this industry is wide-spread. Besides this, here I am going to suggest some other recommendations that would help to make cost-efficient manufacturing processes.

- **Adoption of local technology:** Sometimes it is helpful to import and manufacture designs locally because it may serve the advantage of securing reliable, proven equipment.
- **Use of joint manufacturing:** Joint manufacturing is also a good alternative option to accomplish cost-effective manufacturing processes. In the early days, the problems of joint manufacturing were the communications but recently in the 21st century, the advances in communications, such as the Internet, mobile, increasing universality of the English language, makes such difficulties easier to overcome.
- **Low-cost laboring:** As recently, the company's growth is downwards, the process of low-cost laboring can be implemented so that the laborers can perform labor-intensive activities effectively. The company is required to hire employees,

who can serve maximum potential in different jobs at comparatively fewer reimbursements. For example, employees must have the potential to perform design as well as manufacturing activities related to local modifications to coincide with regional requirements.

- **Avail of updated technologies from different countries:** Recently, adopting updated technology and higher manufacturing precisions are important to maintain the work in an effective way. Advanced technology-based components help to obtain better outcomes in fewer efforts. So, if it is required, the company can avail it from the more-developed countries. For example, those components can be electro-hydraulic valves, fuel injectors, etc.
- **Reduction of tractors' manufacturing costs:** Generally, to make a cost-effective manufacturing process, we need to focus on lessening the tractors' cost as a whole. The reduction of tractors' manufacturing costs can be accomplished by following three different aspects such as:
    - The reduction in acquired materials cost.
    - Reduction of cost by modular design as well as the common units.
    - Cost reduction related to entire corporate activity employing IT and CAE.

Although the practice of systems engineering was formerly developed and applied to the software as well as aerospace engineering, recently, it can be used in the tractor industry as well. As our company has faced down growth in the market place due to having several agricultural equipment complexities, we can adopt systems engineering techniques to reduce the machinery costs. With the help of this extraordinary approach, we also can mitigate the risks entailed in the design and manufacturing purpose.

By implementing systems engineering in our company's manufacturing process helps to serve effective utility. It will also enable us to obtain the best solutions through practicing effective integration of organized sets of components. Formerly, we need to plan for the development cycle so that the users' needs and required functionality can be defined and understood profoundly. This method will help to process with system validation and design synthesis by considering the complete problems as well as the product life cycle. If the matter is considered deeply, it can be perceived that adopting the system engineering method can help both in our business as well as the technical needs to serve the best quality service according to the users need.

Requirements Management is another approach that we can adopt to avail cost-effective manufacturing process. It will help to capture and allocate the requirements. This process comprises capturing and using stakeholder requirements to produce product stipulations while allocation incorporates in improving systems architecture feasibilities and systematic necessities traceability. In general, traceability is the potential to trace the specifications to the primary demands to assure that the design matches the specifications and that the goods are not designed to accommodate more than what is needed (Hinckel et al., 2016). The traceability of requirements on the overall product life cycle allows our product development team to make an impact analysis.

Our system architect can probe the impact of changing particular resource confinement profoundly. The management of requirements as well as the correlated specifications set the structure for modular system architecture. The and “Bottom-Up Design and Simulation” and “Top-Down Design and Simulation” can be adopted in the design means to develop the quality of products while eliminating the prototypes, optimize machine performance, and lessen product

delivery cycle time. “Bottom-Up Simulation and Analysis” is a great practice that extraordinarily involves the simulation as well as analysis process originating from the component level and serving upward. An example of this point is the finite component analysis of engines, wheels, and three-dimensional dynamic simulation of a tractor (Zhou et al., 2017). In this process, virtual simulation, rapid prototyping, and design for manufacture as well as assembly are reasonable methods that may be adopted by the tractor company. On the other hand, the “Top-Down Synthesis and Simulation” incorporates in product development from the upper-level requirements.

Another process we can follow is virtual prototyping, which is a popular method of reducing the measure of time between the phase of designing and the introduction of a new commodity into the marketplace. In this case, a virtual environment (VE) will significantly allow our engineers to cooperate with their designs (i.e., the tractor model) in three dimensions in real-time (Wu & Zhou, 2020). These simulation models need a sufficient perception of the agricultural system and the parts that work in it. In this field, many parts of the product design may be administered concurrently. Such as:

- We can hire human operators in the simulation loop, who will significantly capture and adopt the control system parameters in x-by-wire systems. As a result, it will serve the benefit of getting reflect operator decisions and offer clean environmental impacts.
- We require to train and develop the rational, mechatronics, and control systems, in the same manner, with the application of rapid prototyping hardware-in-the-loop technologies. We also require to train as well as organize the onboard software configurations with control system parameters wisely.

In reality, our tractor industry is required to actively involved in improving and proceeding developments in virtual simulation systems and practical environments. We also need to practice complex equipment for serving service according to the virtual environments, where we can both operate and control the tractor in a safe and controlled environment.

Model

We can construct tractors in an environment-friendly manner that effortlessly supports the Go-green policy and reduce the rate of pollution in society. In reality, the primary fuel for tractors is diesel that requires ample quantity because the vehicles are gigantic in nature. When the diesel-operated tractors are working in the field, it not only pollutes the area with extreme noise but also with abundant air pollution (Ghaderi et al., 2019).

To mitigate this problem, we are thinking to obtain a Go-green approach in our industry by introducing electric tractors in the market. It will noise comparatively lower than the former diesel-based tractors and serve more powerful service as well (Gao & Xue, 2020). We only require to establish a tractor charging facility n our company to make those electric tractors charge. We are required to produce new models of tractors that will support the electric charging facilities. But the old models which are operated with diesel we need to recycle those products as well by switch hose product from diesel to gas and electricity. To mitigate the pollution factor, we also can make new models of tractors which are controlled with Hydrogen as well. Holland is the place where hydrogen-based tractors have been introduced (Farahani et al., 2019). We need to renovate the model with the intention of fully GPS coordinated large farm tractors. We should serve the fuel models as a priority. We must make a trial by running a full-size, 100+ hp tractor

off of hydrogen. We can use advanced technology to make tractors that can be operated with biofuels as well.

Conclusion

After considering the whole study, at the upshot, it has been summarized that proper practices of the manufacturing process including modern advancements in manufacturing processes, and contemporary design issues, can reduce the manufacturing cost for tractor equipment in 'The Big Green Tractor' company. Implementing this approach can make the equipment more reasonable to the customers and eventually generate more profit for the company. We also require to consider the product cycle formerly by creating a DFA-based design to mitigate the associated manufacturing risks and prolong life as well as the value of the equipment.

On the other hand, we also can use systems engineering tools for the management of the design and manufacturing process which will assure manufacturing concerns during the design method and that ultimately the final product will definitely the end-user demands without under or over elongating the product inclinations. We also can use virtual simulation and analysis significantly to lessen the demand for prototype builds, reduce the time to market and lessen software, power, as well as electronic issues in the equipment in the design cycle. Practicing and implementing these approaches in 'The Green Tractor' company will enhance the overall product quality with a notable reduction in both designing as well as manufacturing costs.

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