

06. Design for Manufacture and Assembly for Product Development (Case study : Emergency Lamp)

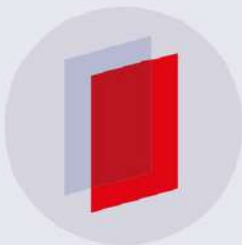
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Design for Manufacture and Assembly for Product Development (Case study : Emergency Lamp)

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Abstract. Community needs that are not primary but important in everyday life are lights for lighting. State electricity company (PLN) is experiencing limitations in supplying electricity for this puIDRose. Therefore emergency lights (emergency lights) are already marketed in the community, which limited function only illuminate a very limited space. Therefore we developed the design of energy saving lamps using "Light Emitting Diode" (LED) which can illuminate the whole house as well as functioning as mobile phone charger (HP). The method used is Design for Manufacture and Assembly (DFMA), with the result of design development The percentage increase in assembly efficiency (E) is $0.01071 - 0.00645 = 0.00426$ or = 39.76%. The decrease in material costs is IDR 234,000 - IDR 214,000 = IDR 20,000 or = 8.54% .Development design is received because of more assembly efficiency than the initial design. Power usage on previous products with series and designs of the original product can last only 4-5 hours non-stop, while the development of the design can survive 9-10 hours 2x more energy efficient.

1. Introduction

Lights are an essential requirement for the day-to-day community. Power supply lamps are supplied by the state electricity company (PLN). Lately is often faced by our society is a rotating power outage. This is due to the lack of electricity supply from PLN that is not in accordance with the needs of consumer electricity. Problem inhibiting the activity of damage power plants, especially in terms of lighting or lighting .Based on RI.NO.43th Presidential Decree 1991 on the conversion of electrical energy then public company Negara (PLN) as the provider and processing energy has made energy-saving movement. One of the research activities to realize the conversion and energy savings, especially in terms of lighting design is the development of energy-saving lamps by using "Light Emitting Diode" (LED) .Society still many who do not know and understand about the cost of energy-saving lamps (LHE). People tend to choose cheap lights and easily obtainable in the market, but the reality is not energy efficient, i.e. light type of incandescent.



Previous research has been conducted by Krist (2010) whose explain about design and manufacture of light emitting diode packages for general lighting. By exploiting the opportunities of energy-saving lamp needs, the idea came up to develop product design on emergency lamp (emergency) that already exist. Lights that will be developed are emergency lights that are still less efficient in terms of cost and assembly time and system usage is still by manual (on / off manual). The resultant lamp has a design with greater cost efficiency and assembly time than previous lights. Hopefully the resultant light development researchers are beneficial to the wider community.

2. Literature and Method.

Design for manufacture and assembly is a method that has been widely adopted in the development of new products. The term design for manufacture (design for manufacture) means design for ease of manufacture of parts collection that will form the product after assembly. The term design for assembly (design for assembly) means product design for ease of assembly (Boothroyd et al., 2014). Design for assembly (DFA) is a design paradigm where engineers use several methods such as analysis, estimation, planning, and simulation to calculate all the possibilities that occur during the assembly process and then adjust the shape of components to be easily and quickly assembled so as to minimize assembly time that can ultimately Reduce product costs (Xie, 2003). According to Xie, (2003) the term "DFMA" comes with a combination of DFA (Design for Assembly) and DFM (Manufacturing Design). The basic concept is that design engineers apply the DFMA or software paradigm to analyse manufacturing and assembly problems at the initial design stage. In other hand, Betancur-Muñoz et al., (2014) reported the benefit of application of DFA. They said, new guidelines for packaging design were applied as restrictions in a packaging optimization algorithm with DFA analogies. Hence, the DFA technique can be applied during the conceptual design phase when decisions greatly affect production costs (Favi,2016).

In this way, all considerations about the factors affecting the final result occur as early as possible in the design cycle. The extra time spent in the early stages of the design let alone the time that will be spent on redesigning repeatedly. And in the meantime, the cost will decrease. DFM is taking into account the limitations associated with manufacturing in the early stages of design; Design engineers can make selection among different materials, different technologies, and estimate the time of making products quantitatively and quickly between different schemes. They compare all 3 types of design plans and technological plans, and then the design team will make reshuffle as early as possible in the early stages of the design period in accordance with this feedback information and determine the most satisfactory design and technology plan. There are three goals in DFM: improving the quality of new products during the development period, including design, technology, manufacturing, service and so on. Hence, DFM benefit can minimize the costs, including design cost, technology, manufacturing, shipping, technical support, discharge and so on. Finally, shorten development time, including design time, preparation, and repeated calculations. DFA is considering and resolving possible problems in the assembly process in the early stages of design that can ensure that parts will be assembled at high speed, low cost and productivity. DFA is a kind of design paradigm with which engineers use all types of methods such as analysing, estimating, planning and simulating to consider all the factors that will affect the assembly process during the entire design process; Revise the assembly construction to satisfy the characteristics and functions of the final product; And in the meantime, lower the cost as much as possible.

DFA is a kind of designing method that can be used in two ways --- tools for assembly analysis and guides for assembly design. The prior use is that at the time after the initial design of the product, the engineer estimates the probability of assembly by analysing all the factors that may affect the assembly process, and provide suggestions. The second is to gather knowledge and experience from assembly experts and record it as a design guide. With the help of this guide, engineers may choose a design plan; determine the construction of such products under the guidance of such experts. 1.3

History of DFMA Development If we trace the history of DFMA, we can even find it before the Second World War. Kim (2004) said that with DFA it will be obtained: ease in component assembly process, minimize the components used and simplify and shorten the assembly process. Kim (2004) in his presentation stated that nearly 40% of the components of the selling price of a product is the cost of manufacturing. Own manufacturing costs nearly 50% is a component of components and materials. Speaking of component and material issues, the products are good and luxurious at this time relatively contains many components and subassembly.

The number of components that need to be assembled will result in 80% of manufacturing costs depending on the initial phase of the design, because the initial design will determine the material, the machine used and the required labour. Errors in the initial design phase will result in swelling of manufacturing costs (Kim, 2003). Because of the magnitude of the assembly cost components, the percentage of assembly tendencies in manufacturing companies and the importance of the initial phase of the design of a product, the concept of Design for Manufacture and Assembly (DFMA). In addition, the design for manufacture and assembly (DFMA) principle is widely used in assembly system design (Li and Lockett, 2017).

Assembly Efficiency

To know the extent to which the efficiency level of the assembly of a product can be used the following formula:

$$DE = 3 \times NM / TM$$

Where :

DE = Design efficiency

NM = Minimum number of parts theoretically

TM = Total assembly time of all parts

Source: Otto (2017)

3. Result and Discussion

Table 1. The number of initial design components

No	Constituent components	Amount
1	Box (unit)	1
2	Cover(unit)	1
3	Screw (unit)	14
4	Pcb(unit)	1
5	Component circuit(unit)	1
6	Transformer et (unit)	1
7	Cable (meter)	2
8	Lamp output(unit)	1
9	Clinch(unit)	1
10	Accu 12 v(unit)	1
11	LED Indicator (unit)	2
12	Saklar(unit)	1
	Total	27

Table 2. Assembly time of one product

No	Assembly of each part	Time (minute)	Time (seconds)
1.	Install componentsbox	10	600
2.	Installation of pitingan	10	600
3.	Assemble components to the pcb board	20	1200
4.	Installing pcb to box	5	300
5.	Installation of transformer to box	5	300
6.	Install the battery / battery to the box	6	360
7.	Installation of the switch	7	420
8.	Connecting cables to all components on the box	15	900
9.	Installation of indicator light to box	5	300
10.	Installation of neon output to the box	5	300
11.	Pair bolts and nuts in each component	3	180
12.	Installation of lamp cover	2	120
Total		93	5580

3.1 Production assembly efficiency analysis:

From the assembly efficiency calculation, the starting product has an assembly efficiency of 0.00645. This means that the initial product manufacturing process with a total of 12 parts and totals assembly time of 5580 seconds, resulting in assembly efficiency of 0.00645

3.2 Cost analysis of product:

Material costs in the original design Have total cost has total component price IDR. 234.000

3.3 Assessment of Product Development assembly:**Table 3.** Assembly time of one product

No	Assembly of each part	Time (minute)	Time (seconds)
1.	Lamp Box Assembly	5	300
2.	Installation of transformer CT	4	240
3.	Installation of MP2PI relay	7	420
4.	Installation of condenser	5	300
5.	Installation of led indicator	3	180
6.	Installation of resistors to USB sockets	3	180
7.	Installing ic7805 to USB socket	5	300
8.	Installation of diodes into USB sockets	3	180
9.	Installation of USB sockets to the box	10	600
10.	Installing all components in the box	15	900
11.	Installation of the fuse	3	180
12.	Installing 12v / 5a battery	5	300
13.	Install Plavon led panel output	2	120
Total		70	4200

Table 4. Number of Components of Product Development

No.	Constituent components	Total
1.	Analog switch(unit)	1
2.	Led indicator (unit)	2
3.	Cable (meter)	1
4.	Relay mp 2pi (unit)	1
5.	Switch (unit)	1
6.	Condenser 470uf / 50v(unit)	2
7.	Ic 7805 (unit)	1
8.	Resistor 1k (unit)	2
9.	Sockets usb (unit)	1
10.	Accu 12v/5a (unit)	1
11.	Travo ct (unit)	1
12.	LED Ceiling panel(unit)	1
13.	Diodes (unit)	1
14.	Paint (tin)	1
15.	Box power supply (unit)	1
16.	Fuse (unit)	1
	Total	19

3.4 Development efficiency of assembly:

From the assembly efficiency calculation, the Development product has an assembly efficiency of 0.01071, meaning that the development process of the Development product with the number of components 15 and the total assembly time is 4200 seconds, resulting in assembly efficiency of 0.01071.

3.5 Analyse the cost of development design:

The material costs of the overall innovation design are required for innovative products that have a price of IDR.214.000

Based on the calculation Percentage increase in assembly efficiency (E) is $0.01071 - 0.00645 = 0.00426$ or = 39.76%. The percentage decrease in material costs is $IDR\ 234,000 - IDR\ 214,000 = IDR\ 20,000$. Or = 8.54% And the innovation design is received due to greater assembly efficiency than the old design



Figure 1. Product Lamp Early Figure 2. Product Assembly Lamp Early

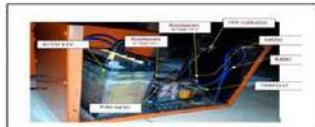


Figure 3. Product Assembly Design Lamp Figure 4. View of design Lamp

4. Conclusion

Design Development can work automatically when the current source is disconnected (die) and Design Development can also be used for all rooms without having to move the products other than as

a source of lighting at the time of the blackout design Development also has the function of mobile phone charge with universal output (USB).

Product design the development that has greater assembly efficiency and the cost incurred is also low in comparison with the initial design i.e. Percentage Improved assembly efficiency (E) is $0.01071 - 0.00645 = 0.00426$ or = 39.76%. The decrease in material costs is IDR 234,000 - IDR 214,000 = IDR 20,000 or = 8.54% .Development design is received because of more assembly efficiency than the initial design.

Power usage on the previous product with series and design of the original product only last 4-5 hours non-stop while the product owned by Product Development with series and design of product development can survive 9-10 hours 2x more energy efficient.

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