Designing Universal Smartphone Case with Solar Powered Chargers

H Henny1*, D Purwadi2, H Hardianto3, O Widilestariningtyas4
1,2,3,4Department of Industrial Engineering, Universitas Komputer Indonesia, Indonesia

Email. *henny@email.unikom.ac.id

Abstract. The purpose of this research is to design a product to transform solar energy to electric energy that can be used to charge the battery of phones. Method used in this study is to design chargers that can be used anywhere is ulrich method. This method consists of some steps such as planning, developing a concept stage, planning system-level, detailed design, experiment, and improvement. The results are the charging process on a smartphone with a capacity of 1810 mAh battery is fully charged within 1 hour and 23 minutes. The output generated by the tool is 0.8 ampere and 5 volts. The price is below the maximum target specification that is worth 150,000. The conclusion of this research is the concept of designing universal smartphone case with solar powered chargers requires the stages of elimination and filtering to produce a solar smartphone case that is made of brecket also using a solar powered converter and power transport mode such as USB female port. The impact of this charger is the product can be used by people that likes to go to nature.

1. Introduction

Smartphone is one of the tools that have become secondary needs of this modern era. A lot of work is generally done by using a smartphone, such as transactions, data processing, and so forth. Not in spite of it, the smartphone is a device that uses a limited resource, namely using electricity stored inside certain capacity battery. It is because of these limitations, flexibility in the use of smartphones is limited. Doing activities with easy charging is one of the breakthroughs in reducing the limited flexibility in the use of smartphones. Such convenience can be implemented by creating a tool that is used in smartphones facilitate charging activity.

Activities of charging smartphones basically can only be done if the charger is connected to the power source, among others, is the power itself. Then designed a device that could perform the activity for charging anywhere, without having to connect to a conventional electrical power source. By utilizing solar energy which can be obtained easily and inexpensively. Solar power is the power that can be used in designing the tool, considering the force with unlimited capacity, taking into account the minimal input values, and produces the optimum output. By using the concept of photovoltaic, which convert light into voltage. The task in any productive endeavour is the process and product design, which extends from the design of operations to decisions on how to accomplish task or work assignments [1]. Product Design and Development has also been implemented in a manufacturing industry [2]. Product Development with Ulrich method has also been used to design Children's Portable Bicycle Frame and Handlebar [3]. Product Development with Ulrich method has also been used to identify customer’s need to redesign feet and hands strength training equipment for the Post-Ischemic Stroke Patients [4]. Process and Product Design has also been used to identify production efficiency of Manufacturing Firms. Product Design and Development can also
implemented by using extended axiomatic design theory to reduce complexities in Global Software Development Project [5].

The purpose of this research is to make a tool which is ideally used in circumstances where conventional electrical power source is not available. As in conditions outside the room or location where access is to conventional electricity cannot meet the needs of charging. This tool also recommended in certain professions or activities such as mountain climbers, fishermen, and others. The tool is made in the concept that can be used in all types of smartphones by charging cheap resources and can be done at all places. Thus, based on these limitations, we designed product by making tool in the form of "Universal Smartphone Case with Solar Powered Charger or abbreviated CAHON PASUY". Method that is used on this research is Ulrich method.

2. Method
The design of the product is a stage in developing the concept of mature, standardized, and systematic views of the functionality of the product [6]. Designing product is inseparable from the condition where the product is a new product or the improvement of existing products, which products suit the needs of consumers. Implementation designing poured in product design shape product image, in order to meet the market pull or leverage technology innovation that is already running. Basic picture is done in the product design stage, among others, consists of 6 phases mutually continuous. The first stage is to do planning on products that will be created, viewed from the potential of the market or the level of consumer needs. The second stage is developing a concept stage. Methods and directions functionality of the product is made in either the design or some type of components used. The third stage is to perform system-level planning, associated with the level of information technology product needs to be used. The next stage is the detailed design, where the product has been designed ready to proceed to the final stage, where the assembly is in this stage. The next stage is to conduct experiments and improvements before the product is ready to be launched into the market, it is useful in ensuring that the product is good, safe and convenient when the product is being used by consumers. Previous studies mainly focus on the mapping of user needs to product and little attentions has been paid to how to acquire user needs exactly [7].

Development of the concept is part of the design and development phase of the product. Concept development phase begins with the identification of customer needs, alternative design concepts and elimination phases in order to choose one of the concepts that exist. Irvan said the concept is a description of a product design and specifications. The essence of the development of product design is at the stage of concept development [8]. Product design concept which is a combination of oral, literacy and prototypes are corrected so that customers have excess of designed products. Here are the stages of concept development phase. Otherwise, the design is coupled.

The design phase of the product toward the direction where the technology is used inside. It has the same direction as the statement of Lewis Mumford, that technology is divided into different kind known as a technique, in which the later statement shared from Mitcham is the technology becomes more widely that namely clothing (apparel), board (home and kitchen appliance), apparatus (container to transport the goods), utility (highway), tools (saws), machines, automata (thermostatic), and play [9]. Interactions system is composed of people, product and environments [10].

Solar power plants (PLTS) is a power plant that focuses on changing energy sun (Light) into electrical energy. Electricity generated is done using photovoltaic methods and indirectly by concentration of solar energy, Photovoltaic method converts light energy into electricity by photoelectric principle. Light is focused using lens component combined with a tracking system to focus the light energy at heat engine, Focused heat is used as a source of energy that moves the heat generator. The photovoltaic system was first developed, where the system applying the method of photoelectric. Generator photovoltaic systems apply a voltage difference principle in its application of photoelectric systems which generate electrical energy. In this system, the panel consists of three layers where in the first layer is a layer of P causes the electron apart, causing the protons to pass through the second layer to the third layer which is a layer of nerve that transfer proton currents that generate electricity in a photovoltaic system. It provides relevant information on such important questions as vital characteristics of the product, types of machines, equipment and tools, the expected
volume of output and types of labour skill required to enhance the efficiency of production [11]. Electronics is a method that applies the principles of electronics to a system or an object that is created. The principle of the electronic application with many tools seems to be applied more on household appliance (as a consumer electronic device) and electronic media (radio, television, etc.). Product is a tangible complex property, including packaging, price colors, company and retailer achievement received by purchase to satisfy needs and wants [12].

3. Results and Discussion

Design and development of the concept of product through several stages, namely the early stages of designing and developing product’s mission statements to choose from designing product concept and product development. The mission statement of the design of the product has an essence in order to design a Universal Smartphone Case with Solar Powered Charger can be seen in Table 1 below:

| Question                                                                 | Statement Respondents                                                                 | Interpretation Needs                                                                 | Customer Needs                                                                 |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| Did respondents feel constrained in the use of smartphones for power (battery) devices which is finite. | Respondents felt constrained in the use of smartphones due to power (battery) of the device is limited. | Tools that can add power limitations (battery) smartphones at the time of use. | Products that can add some capacity to the limitations of power (battery) smartphone usage. |
| Did respondents feel the activity of smartphone charging limit the activity of users in the use of smartphones. | Respondents felt smartphone charging activity limit the activity of users in the use of smartphones. | Tools that can reduce or make charging into practical activity. | Products that can reduce or make charging into practical activity. |
| Did respondents feel the level of household electricity consumption needs to be reduced. | Respondents felt the level of household electricity consumption needs to be reduced. | Tool that can perform charging activities without having to use household electricity as input. | Product that can perform charging activities without having to use household electricity as input. |

Interest requirements for products designed. The level of interest derived from the geometric based on the questionnaire product criteria of importance to be designed can be seen in table 2 below:

| No. | Criteria                                              | The level of interest |
|-----|-------------------------------------------------------|-----------------------|
| 1   | Products Ergonomic (easy to grip)                     | 4                     |
| 2   | Easy to use                                           | 4                     |
| 3   | The product price is relatively cheap                 | 4                     |
| 4   | Charging rapidly                                     | 4                     |
| 5   | safe to use                                           | 4                     |
| 6   | Does not cause damage to the device                   | 4                     |
| 7   | Can use with many types of smartphones                | 4                     |
| 8   | Durable product                                       | 4                     |
| 9   | Attractive design                                     | 4                     |
| 10  | Products that can be repaired                         | 4                     |

Focus is to design a production system that can fulfil all the demand orders within due dates at a reasonable cost [13]. Here is a list of metrics universal smartphone case with solar powered charger can be seen in Table 3 below:

| No. | Needs | Metric          | interest | Unit     | marginal value |
|-----|-------|-----------------|----------|----------|----------------|
| 1   | 1.2   | dimensions of the product | 4        | cm       | $<10 \times 15 \times 6$ |
Stages combination table is used to find a solution concept of the design of products or alternative concepts of universal smartphone case with solar powered charger. Described in Table 4 below:

| No. | Needs     | Metric          | interest | Unit | marginal value |
|-----|-----------|-----------------|----------|------|----------------|
| 2   | 4,5,6     | output power    | 4        | ampere | 0.5 <A <2.1     |
| 3   | 1,2,7     | flexibility     | 4        | list  | -              |
| 4   | 8.10      | Durability      | 4        | list  | -              |
| 5   | 9         | design          | 4        | list  | -              |
| 6   | 3         | Production cost | 4        | rp    | <150.000       |

Filtering concept is intended to assess the most concepts to choose from, it is used to carry out the elimination of the concepts that are not potential. Here can be seen in Table 5 below:

| Selection | Concept | References | 1 | 2 | 3 | 4 | 5 | 6 |
|-----------|---------|------------|---|---|---|---|---|---|
| Design    |         | 0          | - | - | 0 | 0 | + | + |
| Transform |         | 0          | 0 | 0 | 0 | 0 | 0 | 0 |
| Transport |         | 0          | - | + | - | + | - | + |
| Many (+)  |         | 0          | 0 | 1 | 0 | 1 | 1 | 2 |
| Many (0)  |         | 0          | 1 | 1 | 2 | 2 | 1 | 1 |
| Many (-)  |         | 0          | 2 | 1 | 1 | 0 | 1 | 0 |
| Ranking   | -       | 5          | 3 | 4 | 2 | 3 | 1 |   |
| Continue? | -       | No         | No| No| Yes| No| Yes|   |

After filtration concept, there are 2 alternative concepts selected by rank 1 and 2, namely: 4 and 6 draft concept because the concept of ranking criteria is superior than other concepts. Ratings concept is intended to narrow down the concept that has been filtered. Here are two concepts that have been chosen through the screening of six concepts, further assessment of selected two concepts can be seen in Table 6 below:

| Selection | Weight | 4 | 5 | 6 | 
|-----------|--------|---|---|---|
| Design    | 50%    | 2 | 1 | 3 | 1.5 |
| Transform | 20%    | 1 | 0.2 | 1 | 0.2 |
After going through the assessment phase concept, the sixth concept is chosen as the best concept of all the concept of universal smartphone case with solar powered charger. Here is a picture of the selected design can be seen in Figure 1 below:

![Concept Design Selected]

Figure 1. Concept Design Selected

Product testing is done in some indicators such as the dimensions, the process of charging, the power output and voltage produced can be seen in Table 7 below:

| No. | Indicator        | Test results         | Marginal value | Object Test             |
|-----|------------------|----------------------|----------------|-------------------------|
| 1   | Dimension        | 10 cm × 13 cm × 5.5 cm | 10 cm × 15 cm × 6 cm | -                       |
| 2   | Process charger  | 1 Hour 23 Minutes    | -              | Iphone 6 (1810 mAh)    |
| 3   | Power output     | 0.8 A                | 0.5 A <P <2.1 A | -                       |
| 4   | Voltage generated| 5 V                  | -              | -                       |

A research carried out by Dinesh Keiloth Kaithari by making solar power operated table for charging electronic gadgets [14]. Research has also been carried out by Mohammad Asif to design a small solar panel in charger to absorb solar power and transform it to electrical energy [15]. Research has also been carried out by Gaurav Chamate to make a coin based mobile charger using solar tracking system [16]. Besides that, quality is also an aspect that is important in the making of this solar charger product [17].

4. Conclusion
Conclusion on designing tool in the form of universal smartphone case with solar powered charger is the importance of the concept design of products which the function of product concept has been selected through phases of elimination and filtering to produce the case of universal smartphone case with solar powered charger which is made of brecket using solar powered power converters and...
transport power mode, which is female USB port. Resulting in the dimensions of the product is 10 centimeters long, 13 cm wide and 5.5 cm thick as well as the output of 0.8 A and a voltage of 5 volts. Cost needed to design this product is 110.000 rupiahs. The products are designed to meet consumers’ needs which can be seen from the user target specifications matrix. The product prototype is made based on the function that is used as a further reference of product production. In other words, it is still categorized as a prototype to be used as a reference for mass production.

Acknowledgement
Thank you to PDDIKTI Kementrian Riset Teknologi dan Pendidikan Tinggi for supporting this research and also the support from the Rocket Division B in the idea of product design.

References
[1] Bagshaw, K. B. 2017. Process and product design: production efficiency of manufacturing firms in Rivers State, Nigeria. Engineering Management Research, 6(1), pp. 49-55.
[2] Chan, S. W., Zaman, I., Ahmad, M. F., & Liew, C. Y. 2018. Identification of the concept selection method for product design and development in the manufacturing industry. International Journal of Engineering & Technology, 7(29), pp. 352-355.
[3] Sianturi, G., & Fuad, L. A. 2018. Conceptual design of children’s portable bicycle frame and handlebar. In IOP Conference Series: Materials Science and Engineering, 407(1), pp. 012084. IOP Publishing.
[4] Mariawati, A. S., Fatin, S. D., Umyati, A., Fawaid, M., & Nurtanto, M. Identification Customer Need for Redesign Feet and Hands Strength Training Equipment for the Post-Ischemic Stroke Patients.
[5] Kandjani, H., Tavana, M., Bernus, P., Wen, L., & Mohtarami, A. 2015. Using extended Axiomatic Design theory to reduce complexities in Global Software Development projects. Computers in Industry, 67, pp. 86-96.
[6] Kart. T. Ulrich and Steven. D. Epinger. 2001. "Design and Product Development” Salemba Tekika, pp.6-150.
[7] Lu, R. J., Feng, Y. X., Zheng, H., & Tan, J. R. 2016. A product design based on interaction design and axiomatic design theory. Procedia CIRP, 53, pp. 125-129.
[8] M. Irvan. 2011. "Product Concept Development phase In Event Design and Product Development" J. Ilm. Fakt. Exacta, 4(3), pp.263.
[9] UNIKOM, T. D. T. I. 2014. Pengenalan Teknik Industri (Untuk Wirausahaan Muda). Bandung: Rekayasa Sains.
[10] L. Shiguo. 2008. “Experience and Challenges-Product Interactions Design” Nanjing, Jiangsu Fine Arts Publishing House, pp.25.
[11] Bagshaw, K. B. (2017). Process and product design: production efficiency of manufacturing firms in Rivers State, Nigeria. Engineering Management Research, 6(1), pp. 49-55.
[12] G. Tengor, L. Kawet and S. Loidong, 2016. “Influenced of Brand, Design and Quality of Product to Purchasing Decision of STIE Eben Haeyzar Manado” Universitas Sam Ratulangi, pp. 368-374.
[13] Koste, L. L., & Malhotra, M. K. 1999. A theoretical framework for analyzing the dimensions of manufacturing flexibility. Journal of operations management, 18(1), pp. 75-93.
[14] D. K. Kaithari, A. K. S. A. Ismaili and M. Achuthan, 2017. “Solar Power Operated Table for Charging Electronic Gadgets”, International Journal of Students’ Research In Technology & Management, 5(3), pp. 11-15.
[15] M. Asif, S. A. Mir, S. Kh. Baba. 2018. “Wireless Solar Mobile Phone Charger”, International Journal of Advance Engineering and Research Development, 5(1), pp. 1-6.
[16] G. Chamate, J. Wankhade, V. Kommulwar, 2017. “Implementation of Solar Panel Based Multi Mobile Charger with Auto Cut Off of Power”, 3(3), pp. 63-67.
[17] Henny, H., Agnia, N., & Hardianto, H. 2019. Analysis Quality Control of Carded and Combed Yarns Using Six Sigma Method. In IOP Conference Series: Materials Science and Engineering, 662(6), pp. 062008.