Design and analysis of new box frame for online motorcycle transportation

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Abstract. With the increasing needs and human’s creativity, accompanied by the development of technological knowledge from various things, one example is the development of online-based transportation. Transportation is a tool in the form of a vehicle that is used to move an item from one place to another. In the current era of globalization, there are several companies that develop their business through online transportation, in addition to the shuttle service there is also a delivery or pick up of food/goods quickly that can provide convenience for the community. This paper describes the redesign of the box that motorcyclists could use in online transportation. The design concept is designed more innovative to design models and materials used are also more practical & efficient in terms of time in use both in terms of installation and dismantling of the box, the aim is to answer the problems of online transportation at this time, which are not only in terms of efficiency but also ergonomics. The research was conducted by observing the existing problems, then brainstorming in ergonomic box design and then making 3D modelling using the inventor's stress analysis method. to achieved a new innovative and ergonomic design for helping online transportation.

1. Introduction
In this globalization era, technology tends to develop more and more every time both from technological knowledge, tools used, communication networks and others, one of which can be seen from the ease of people doing their activities by using various technological tools such as smartphones, only by using smartphones, everyone can do various things such as shopping, looking for news, or traveling, with this ease the community can do all their activities in a short amount of time. Transportation is a tool used to move an item from one place to another, in this case using a vehicle. Basically transportation can determine the attractiveness of a city and can be used as a characteristic of the city, with the development of technology and human creativity, the use of transportation can be developed into a form of online applications, known as online transportation that can be applied and used on smartphones, but it can also be used as navigation to a place. So, this resulted in the emergence of several online transportation companies or better known as companies whose business activities are based online (e-commerce), which aims to be able to facilitate the public in traveling, shopping or shipping goods that must be done quickly [1].

The development of online transportation in Indonesia began in 2015, that year was a phenomenal time for the development of online transportation. Starting with the development of a mobile application called Go-Jek which was then followed by competitors such as Grab and especially Uber who had first
entered the country in 2014. Entering 2016, the competition was getting tougher by launching several new features from each party is like a food delivery service [2]. If it is reviewed up to now the transportation company which initially only moves from online transportation has begun to spread its businesses with features such as non-cash payment methods that start using the application, which can further facilitate its users in the transaction. Not stopping there, they began to develop their business to the express / fast shipping feature which is very influential in today's e-commerce world. Due to the increasingly widespread distribution of e-commerce, thus causing a significant increase in demand for express delivery services to consumers [3]. To overcome the high demand, the solution obtained is to enlarge the scope of the shipment so that in one route there are several goods with different shipping destinations. In this case, it takes quite a long time compared to delivery by express or fast [4].

In the case of the development of the goods delivery feature contained in the online-based transportation application such as food delivery services or goods delivery services in a fast / lightning, there are several obstacles in the delivery process based on the results of a review that has been done previously to several online motorcycle taxi drivers who work in making deliveries food or goods, there are several complaints felt by the driver. Among them is there is no limit on taking the amount or weight limit of taking the order listed so that it can be difficult for the driver himself, then coupled with unpredictable weather conditions in the process of delivery or pickup of the goods so that it can be a problem for drivers who are taking and delivery of these goods both with a short distance or with the farther distance.

The purpose of making this box is to resolve the problem of the driver, which is not only in terms of efficiency but also in terms of ergonomics. Ergonomics becomes important in design not only because it meets design standards, but the aim is to prevent mistakes in the design process that will cause the design to be incompatible with the user's body. Therefore, ergonomic calculations must be considered and applied appropriately [5].

In the current situation, there are already several choices of boxes that can be used by drivers, but the existing box design feels less practical when mounted on a motorcycle. This is because the placement of the installed box does not have a suitable design, where the placement takes up quite a large amount of space in the seat of the motorcycle, therefore when the driver gets an order other than sending goods, the driver must remove the box and when the order process occurs the driver must re-install the box so that there is a less efficient process of time. These problems will be carried out by designing a multifunctional box that aims to facilitate the driver in sending goods ordered or also facilitate the use of the box in the use of other activities such as when the driver is delivering passengers without having to remove the box that is installed.

2. Method

Before doing this research, it has conducted several steps such as doing the observation on the current situation of box use, in this regard, it has formulated a problem to analyse box use in the current condition, then designing the right box model for online transportation users. Figure 1 shows a flowchart of the process a new concept of making box:

In general, the procedures of this paper are started in developing the design concept from sketching to detail design and follow the new product development concept. The detail procedures are as follow:

a) Identification of Problem: Firstly, doing the observation to online drivers for delivery order. What is the problem and inconvenience in delivery process?

b) Identification of User need: after doing the step 1, then conducted the brainstorm to start the ergonomics box design, and flexible. with purpose to facilitate online drivers in delivery order

c) Creation of Product Concept: doing the benchmarking with existing products

d) Product Specification: doing designing and determining of materials and size which will be used in the new concept of box design

e) Product Design: after doing step 4, then continues to 3D Modelling design using Inventor software
f) Product Concept Test: doing analyse stress by Inventor software to determine the maximum load which acceptable by new concept of box design

g) Product Analysis: doing the comparison between the new concept of box design and benchmarking result

h) Conclusions: the result of new concept box design which help to online drivers for delivery order

![Flow chart of the process of making a new box concept](image)

**Figure 1.** Flow chart of the process of making a new box concept

At the moment, most of delivery methods experienced by delivery company are used box as shown in Figure 2. However, this practice could lead unstable for the motor cycle driver when increase the speed and make manoeuvre during traffic jam or rush hour.

![Fibber box](image)

**Figure 2.** Fibber box

Figure 3 shows another box design that using fabric, it’s also had weakness, due to the online drivers will difficult to ride with passenger, if they have a lot of goods to delivery in the same time.

![Side box](image)

**Figure 3.** Side box
With the current condition of box design, it cannot give the easiness to online drivers due they have to unload the box when riding with passengers, and it’s not flexible. Therefore, the purpose of research is to give the easiness to online drivers in riding with passengers and delivery order without take apart the box.

3. Result and Discussion
This paper proposes a new product design that helps online motorcycle taxis or expedition services to send goods to customers easily and safely without having to take apart pairs in a long time and no need to feel worried during heavy rain. The box design that was designed also made it easy for online transportation to transport passengers without having to remove the box. This box design has a lock to make the frame strong. Here is a comparison analysis table of the new box concept with the previous design product.

Table 1. Comparison of current box vs new concept box.

| Description       | New Concept | Fibber Box | Side Box          |
|-------------------|-------------|------------|-------------------|
| Materials         | Aluminium Frame with Parachute Fabric | Fiberglass Reinforced Plastic | Fabric |
| Size              | 505 X 320 X 325 mm | 500 X 500 X 600 mm | 500 X 300 X 350 mm |
| Weight            | 3KG         | 8 – 10 KG  | 2.3 Kg            |
| Capacity          | 52 liters   | 100 liters | 50 liters/bag     |
| Utility           | - Bring a lot of goods - Flexible - No need to Disassembly assembly - High Visibility when driving - Waterproof materials - Stable when driving | - Bring a lot of goods - Permanent on Passengers seat - Waterproof Materials - Visibility when driving - Stable when driving |

Based on the comparison of Table 1. Prove that the latest box concept design has many functions and advantages compared to the previous box model. After doing a comparison of the box products, the stress analysis is carried out using the inventor software which can show an analysis of the results of the weight value of the goods carried and the speed of the motor that can affect the strength of the frame on the box.

The new box design concept is made more practical and makes it easier for drivers to fold the box when there are passengers so that passengers feel comfortable when riding a motorcycle. Figures 4, 5, 6 show the concept designed to be flexible and easy to process.

Figure 4. Folded view
After designing the box, the maximum stress test was conducted on the Inventor yield strength software, from the data obtained as shown in Figure 7 which shows the value of 275 MPa which is the maximum stress that can be received by aluminum material used in the frame box and the ultimate tensile strength is achieved at 310 MPa. It is shown that the maximum force allowed to be applied in the box design is 275 MPa to avoid the aluminum material on the frame is damaged.

Table 2. Summary of product performance parameters

| Name        | Minimum | Maximum        |
|-------------|---------|----------------|
| Volume      | 21518700 mm$^3$ |                |
| Mass        | 3 kg    |                |
| Von Mises Stress | 0.00000273086 MPa | 128.943 MPa |
| 1st Principal Stress | -40.4874 MPa | 175.485 MPa |
| 3rd Principal Stress | -138.124 MPa | 39.9602 MPa |
| Displacement | 0 mm    | 3.21379 mm     |
| Safety Factor | 2.13272 ul | 15 ul         |
| Stress XX   | -50.0011 MPa | 73.0341 MPa    |
| Stress XY   | -12.4238 MPa | 35.8472 MPa    |
| Stress XZ   | -34.516 MPa | 41.5779 MPa    |
| Stress YY   | -64.4678 MPa | 81.6965 MPa    |
| Stress YZ   | -46.2858 MPa | 58.6439 MPa    |
| Stress ZZ   | -124.101 MPa | 135.958 MPa    |
Section stress of XX, XY, and XZ are shown on Figure 7, with a maximum stress value of 73.0341 MPa for section XX, 35.8472 MPa for part XY, and 41.5779 MPa for part XZ. It is found that all the figures are significantly safe to be applied in box frame design.

The section of YY, YZ, and ZZ parts are shown in Figure 8, with a maximum stress value of 81.6965 MPa for YY, 58.6439 MPa for YZ, and 135.958 MPa for ZZ. The figure indicates the ability of the design to withstand several loads and to ensure to be safe when the design to be implemented in the motorcycle.

Figure 7 shows the stress that given to part XX, XY, XZ, and figure 8 on the part YY, YZ, and ZZ still accepted by the product made by aluminum. Color that is shown in figure 7 and figure 8 shows that the product has not damaged when received stress on several sides. The blue color on the product is indicated the product in good condition, if the color turns into the red it means the stress that given to the product is over so that it can cause damage to the product. Figure 7 shows the stress that received on the side of the product, figure 8 shows the stress that received by-product on the backward.

4. Conclusion
From the results of the analysis carried out for design, 3D modeling, and stress analysis, using stress analysis inventor yield strength software, it can be concluded that by making designs that can be folded could make it easier for motorists in the assembly and disassembly process of the box, and for the maximum stress analysis performed shows a value of 275 MPa which is the maximum stress that can be accepted by aluminum material used in the frame box and for ultimate tensile strength of 310 MPa to be able to show the maximum force before the aluminum material in the frame is damaged, in this case, the maximum load conditions that can be placed in the box are 50 kg for a speed of 72 km/h. As a result, a new design of the box frame is the potential to be applied for motorcycle online transportation.

References
[1] Nürnberg, Mariusz 2019 Analysis of using cargo bikes in urban logistics on the example of stargard. Transportation Research Prodia, 39 360-369
[2] Aditya Hadi Pratama 2016 Kilas balik perkembangan transportasi online sepanjang tahun 2016 https://id.techinasia.com (accessed on December 12, 2019)
[3] Morganti, Elenora, Saskia Seidel, Corinne Blanquart, Laetitia Dablanc, Barbara Lenz 2014 The impact of e-commerce on final deliverie alternative parcel delivery services in France and Germany. *Transportation Research Prodia*. 4 178-190

[4] Punakivi, Mikko, Hannu Yrjola, Jan Holmstrom 2001 Solving the last mile issue reception box or delivery box. *International Journal of Physical Distribution & Logistics Management*. 31 427-437

[5] Broberg, Ole 1997 Integrating ergonomics into the product development process. *International Journal of Industrial Ergonomics*. 19 317-327