Implementation of VDI 2221 Method for Firefighter Motorcycle Design

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Abstract*: *The purpose of this study is to determine the specification of a motorcycle and other supporting equipment for firefighter motorcycle design. The criteria of a utilized motorcycle has to meet the requirement of a motorcycle that is easy to control, has model dimension that is not too big, and sufficient engine power production so that it can determine whether it is easy or not to add other equipment as a requirement for a firefighter motorcycle. External condition in the form of narrow road access in a densely populated settlement is one of the factors that is considered in choosing the criteria of motorcycle used for firefighter motorcycle.

Keywords*: *Firefighter motorcycle, VDI 2221, Centrifugal pump

I. INTRODUCTION

The development of technology becomes a new hope to improve human life. It is not only useful for fulfilling needs, but it can also be utilized for disaster prevention. A Naghsh. et. al [1]. utilizes an interaction of multi-robot as a firefighter. This system development has a purpose to collect information from a real interaction between the robot and the surrounding environment so that a disaster prevention can be implemented [2]. There is also a method which uses drone technology for mapping and fire disaster management for forest. This method has been developed by Bodnar Lazlo et al.[3].

Fire disaster does not only occur in forest, it also frequently occurs in a densely populated area especially in a city. Therefore, such disaster can cause a lot of material losses for both victim and firefighter [4]. To overcome fire disaster especially in the densely populated area, many innovations by researchers have been made, such as creating a technology-based simulation or implementing control by way of localization of fire disaster occurrence [5]. In addition, a development of firefighter infrastructure in the form of firetruck becomes one of the very interesting [6]. However, in certain cases, firetruck cannot be utilized to reach the fire disaster location. It is mainly because of the very limited access road to the location. This matter can be seen especially in densely populated settlements located in big cities.

In order to overcome the problem of limited road access in a densely populated area, a firefighter motorcycle is made so that it would make it easier to reach the fire location[7-9]. Some designs of firefighter motorcycles are only utilized as a mean of transportation that functions to carry firefighter equipment, such as Fire Extinguisher or pump complete with pump drive machine. Therefore, the capacity of Fire Extinguisher that can be carried by the motorcycle is limited.

In the development of firefighter motorcycle design that has been conducted in previous research, the material for firefighting process such as water was not included in the calculation. It was based on the assumption that when a fire disaster occurs in a densely populated settlement, water is largely available in water tanks owned by every family near the location. Meanwhile, the choosing method of a motorcycle that is utilized and installed with a centrifugal pump for firefighter motorcycle can be done using the VDI 2221 method which is based on the needs and easiness in both design and assembling process. Steps and criteria for choosing a motorcycle model are explained in the sub-chapter below.

II. RESEARCH METHOD

In regard to tool requirements, how to overcome a fire disaster that occurs in a densely populated area especially with narrow road access is one of the questions in this research. Such condition is generally found in big cities as depicted in figure 1.

Fig. 1. Narrow road access in a densely populated settlement

In determining the specification of a utilized firefighter motorcycle, the factor of narrow access road and a number of motorcycle population trending in the last 10 years becomes a dominant consideration. By applying the VDI 2221 method in the choosing process, the primary requirements and tool functions can be formulated with the following steps (figure 2).

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Meanwhile, how to determine which tool to use based on the VDI 2221 method is explained as follows:

1. Describing the main function of firefighter motorcycle. In this case, the firefighter motorcycle functions as a fast responder when a fire disaster occurs especially in a densely populated area which has limited road access.
2. Combining possible tools that will be used as the primary component of the firefighter motorcycle.
3. Describing the assembling possibility and the failure possibilities of the component required in assembling a firefighter motorcycle.
4. Defining the smallest failure or the best solution of a firefighter motorcycle design.
5. Making a note and initial design.

During the identification process of the required tools along with its alternatives, the making of initial design of the firefighter motorcycle is conducted. When a solution as suggestion for reparation is collected, the noting process and task description must always be conducted well.

The result of the VDI 2221 implementation for choosing firefighter motorcycle

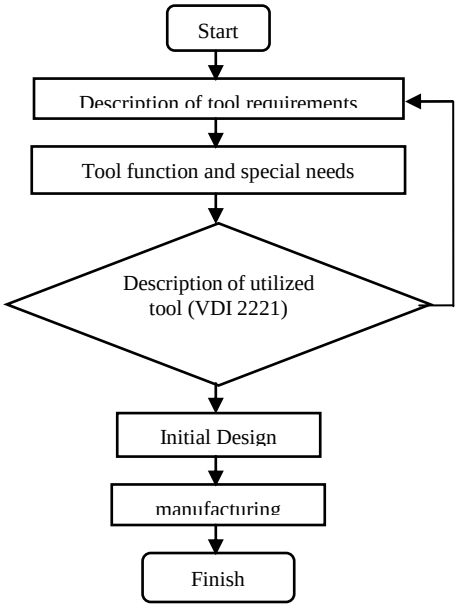

Fig. 2: flow chart of the research

III. RESULT AND DISCUSSION

When the fire disaster occurs in a densely populated area, the tool that is very least to be required by firefighter motorcycle is a centrifugal pump, inlet hose, outlet hose, nozzle as a pressure controller and personal protective equipment for facing fire disaster. From the steps that have been explained in the previous chapter, the structural function of firefighter motorcycle can be seen in figure 3, while the guideline for firefighter motorcycle manufacture is depicted in figure 4.

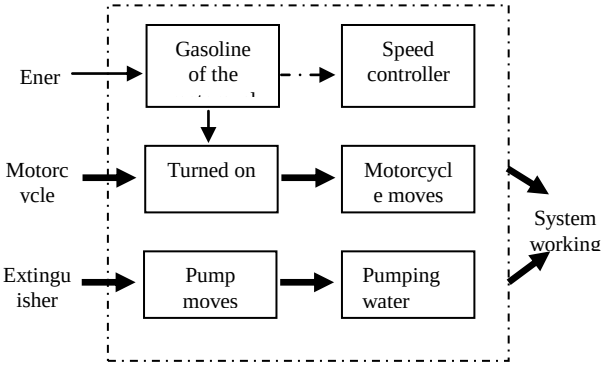

Fig. 3: Structural function of firefighter motorcycle

Generally, a firefighter motorcycle is a smaller scale of firetruck, where the component of centrifugal pump as well as other equipment are components separated from the motorcycle. When this kind of motorcycle has reached the location of fire occurrence, its engine is turned off followed by turning on the centrifugal pump and installing other equipment.

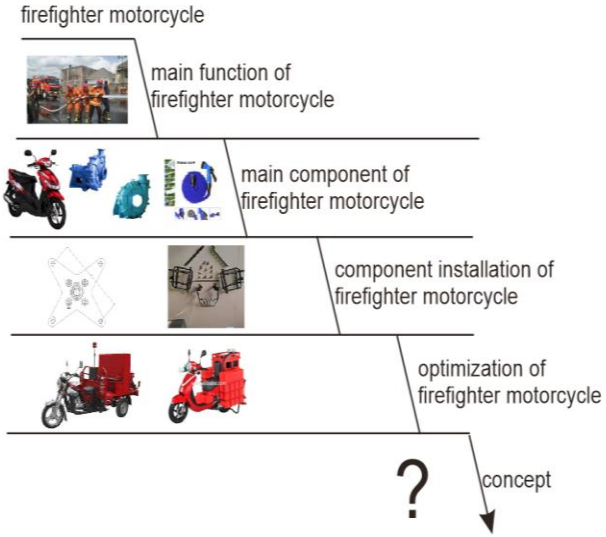

Fig. 4. Guideline for assembling firefighter motorcycle

The choosing of motorcycle used in designing the firefighter motorcycle is based on the data of motorcycle type's growth in Indonesia. As quoted from one of the automatic motorcycle manufacturers in Indonesia, the growth until the first quarter of 2018 has reached 85%. It is very different from the growth of a number of motorcycles other than the automatic type. In line with such phenomena, as it turns out, the use of automatic motorcycle provides much easiness and is simpler compared to other types of motorcycle. By only pulling the gas in order to get the acceleration of the motorcycle, even women that generally found it hard to drive a motorcycle, now can drive them since this type of motorcycle is easier to drive.

Subsequently, by utilizing the engine power as the power source of the centrifugal pump, a mechanism that connects the movement of engine as an impeller mover on the pump is required.

This model replaces the use of engine that moves the pump separately. When the motorcycle engine spins, the centrifugal pump also spins following the spin of the engine. Even though this model has a disadvantage in the stability of the spin produced, this model has an advantage as well since the motorcycle engine can be integrated with the centrifugal pump. In order to complete the design for the implementation of the VDI 2221 method, other equipment and improvement of every step are depicted in figure 5.

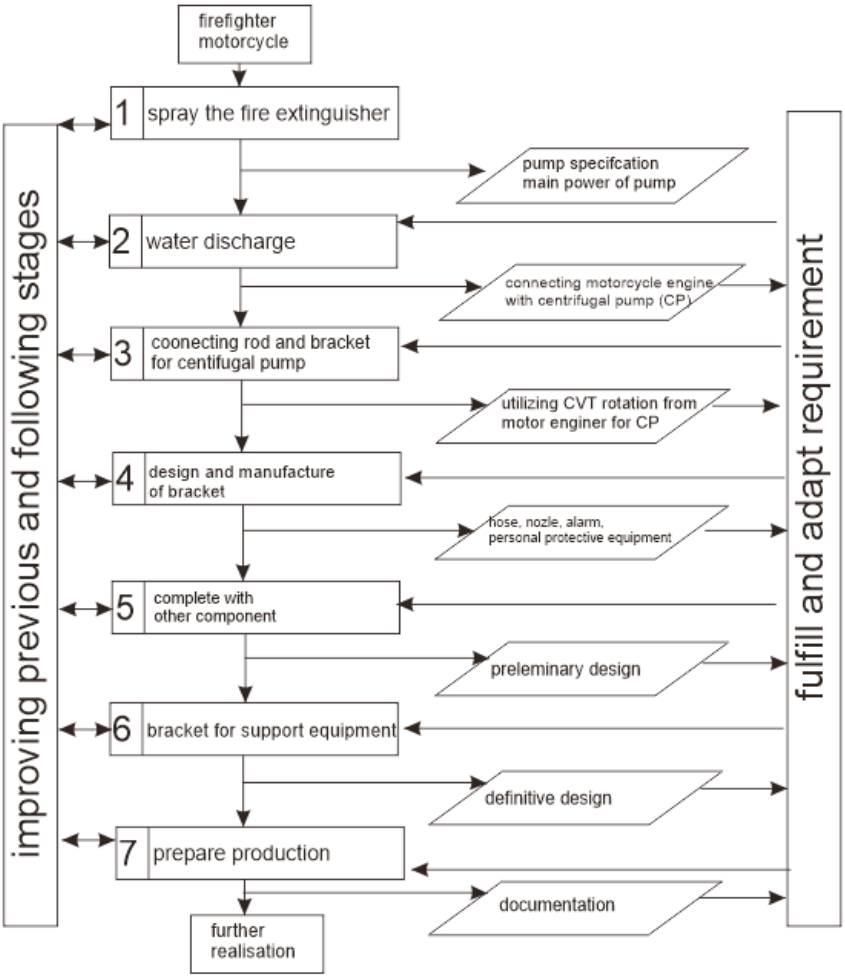

Fig. 5. Steps of VDI 2221 implementation

On every step to determine the concept of firefighter motorcycle, the reparation and fulfillment of tools specification are always considered. Similar to designing firefighter motorcycle, a narrow road access and easiness in driving motorcycle become the considered factors. For example, the main function of firefighter motorcycle is to spray the fire extinguisher media at the fire location, so, by adding a centrifugal pump equipped with engine as its primary power source for the pump impeller mover, then the load of the motorcycle increases. If the installed pump has a large dimension, the total dimension of the firefighter motorcycle will also increase since more equipment is installed to it.

In certain points, this model provides its own obstacle when the entry road access is very limited. On the other hand, when the weight of the fire extinguisher equipment installed to the motorcycle has high capacity, the load of the motorcycle also increases. In order to decrease the load of either the motorcycle or the total dimension as a result of some equipment additions, the utilization of the motorcycle engine as the main power source for the centrifugal pump becomes one of the best solutions. Meanwhile, as the consequence resulted from connecting the engine spin with the impeller spin on the centrifugal pump, an *as* dynamo connector which directly connects them is required. On the other hand, other steps can be seen on the table 1:

Table 1. Implementation of VDI in manufacturing firefighter motorcycle

NO	Steps of Design Manufacturing	Function	Initial Design	improvement
1	Centrifugal Pump	Spraying fire extinguisher media	Centrifugal pump is a separated component	Centrifugal pump is connected to the spin of firefighter motorcycle engine
2	Water discharge	Capacity of fluid output that can be sprayed	Independent, as required	Pump capacity is adjusted with the power produced by the chosen firefighter motorcycle
3	Making of pump bracket	As a place for the centrifugal pump on the firefighter motorcycle	Centrifugal pump is placed on the back of firefighter motorcycle driver	Bracket connects the pump to the firefighter motorcycle engine that spins with the help of as dynamo connector
4	Bracket form for centrifugal pump	Supporting the centrifugal pump on the firefighter motorcycle	Adjusted with the driver seat so it will not interfere when the motorcycle is driven	Adjusted with the pump stand and the stand on the firefighter motorcycle engine that spins
5	Bracket for supporting component	Sustaining supporting components besides the centrifugal pump	Adjusted with the position of centrifugal pump and places on the backside of the driver	Placed in a box behind the driver
6	Making of motorcycle model	Installation of pump bracket, installation of supporting bracket	Centrifugal pump is located behind the driver	Centrifugal pump is connected to the firefighter motorcycle engine

From the description and choosing of component in creating the firefighter motorcycle as explained on the table above the firefighter motorcycle installation process can be conducted by assembling the components as depicted in figure 6 below

Fig 6. Components of the firefighter motorcycle

Fig. 7. Installation of firefighter motorcycle

Meanwhile, the assembly result of the firefighter motorcycle is displayed in figure 7

I. CONCLUSION

By combining the requirements of the firefighter motorcycle towards the required environment condition, the implementation of VDI 2221 helps to define the needs and solutions to problem by considering the supporting components. In every study, improvement is made to provide simpler design which makes it more effective. By implementing the VD 2221 method for the firefighter motorcycle, the centrifugal pump component can be used by utilizing the engine spin as the pump spin that produces power. Meanwhile, the dimension and load of a motorcycle becomes lighter. It is very suitable if the firefighter motorcycle is used to overcome the early phase of fire disaster in a densely populated area that has a very limited road access.

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