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Designing Framework for Standardization and Testing Requirements of Battery Swap for Electric Motorcycle Application in Indonesia

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Abstract: The development of design framework for standard has its own challenges. Especially to identify what steps are necessary to develop a new standard. In this research, use the FACT method (Framework for Analysis, Comparison and testing Standard) and SEM (Structural Eequation Model). The purpose of this research is to make recommendation of design framework of swap battery standard in electric motorcycle applications. In addition, SEM is used for looking at models that are suitable for the commercialization of battery swap technology.

Keywords: Electric motorcycle; standard; swap battery.

1. Introduction

Motorcycles have a large sale in Indonesia [1]. Motorcycles become one of the top transportation planned to replace the petroleum-fuelled motors into electric motorcycles that do not produce emissions and environmentally friendly. With some brands of electric motors that enter in Indonesia, indicating that the education trend introduction of fossil-fuelled vehicles turns into electric motorcycles. In effort to cope with this trend, a standard and quality that ensures the quality of electric motors are required, especially in the way of charging electrical energy. Because of the way electric charging effects of the performance, safety and comfort of motor users in driving. However, due to the unavailability of Indonesian National Standard (SNI) on electric motorcycles, it is necessary to make the draft of Indonesian National Standard (RSNI) that adjust to domestic capability [2-4].

Electric Vehicle (EV), especially electric motorcycles refer to the motorcycles that use automotive electrical power as driving force. Electric motorcycles have no exhaust, high-energy efficiency, low noise and so on [5]. A major drawback of all electric vehicles is the charging time. One of the most time efficient and hassle-free charging method is the battery swapping technique [6]. In order to protect the domestic battery swap product and looking at model that is suitable for commercialization of battery swap technology, it will be developed SNI product of swap battery, which test parameters by following the conditions and the ability of Indonesia. The test parameters to be used, as standard reference need to be tested its validity by using statistical approach of the Structural Equation Model (SEM).

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2. Research method

In this research, we use the FACT (A Framework for Analysis, Comparison and Testing Standards) and make conceptual model research with the SEM (Structural Equation Model) methodology. The FACT is methodology that develop by NIST (National Institute of Standard and Technology, U.S.) which provides a framework for analysing, comparing and testing standards [7]. There are four main steps in FACT method shown on Figure 1.

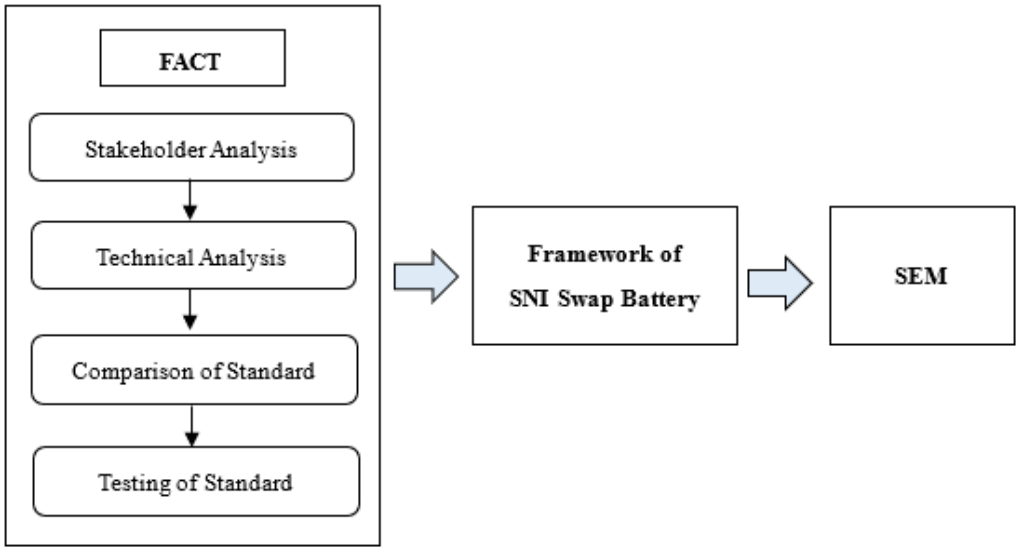

Figure 1. Stage of research.

The FACT methodology consists of four steps. The first step in this research is a study literature to collect data what the needs of swap battery specification based on international journals and interview with stakeholders of electrical motorcycle in Indonesia. The second step is technical analysis linked to the needs of swap battery specifications. The third step is to collect and identify the requirement of international standards such as International Electro Technical Commission (IEC) associated with the output from technical analysis. The fourth step is combination of output third step with IEC standard. The result can be used as a suggestion of a parameter framework to develop Indonesian national Standard (SNI) for battery swap product. The output of FACT is framework of SNI swap battery product.

SEM is a statistical analysis tool that can explain the relationship between latent variables with manifest variables and know the effect of correlation between latent variables by taking into account the errors that will always exist at each calculation [8].

3. Result and discussion

This section consist of discussion about FACT and SEM methodology.

3.1. FACT (Framework for Analysis, Comparison and Testing standards)

As shown in Figure 1, the FACT consist of four steps, as follows: stakeholder analysis, technical analysis, comparison of standards and testing standards.

3.1.1. Stakeholder analysis

At this step, identify the stakeholder and gather requirements for specifications, which are owned by the perspective stakeholder such as: government, R&D battery, laboratory of battery, manufacturers of battery, manufacturers of electric motorcycle and users of electric motorcycle. International journals are used to determine the latest battery swap developments. Here is a summary of requirements about swap battery product in Table 1.

Table 1. Selected stakeholders of swap battery product.

Stakeholders	Requirements
Government	• Government policy has led the use of electric vehicles to be one of the alternative energy diversification for transportation facilities [9].
R & D Batteries	• It takes a focus of research, coordination research, and pre programs commercialization of electric vehicles. With these strategic steps, it is expected that electric vehicle research can be obtained good results and ready to commercialization stage [10]. • Pass the safety and performance tests starting from the battery cell level, module, and battery management system [11].
Laboratory of battery	• Pass the safety and performance tests starting from the battery cell level, module, and battery management system [11].
Manufacturers of battery	• Pass the safety and performance tests starting from the battery cell level, module, and battery management system [11].
Manufacturers of electric motorcycle	• Pass the safety and performance tests starting from the battery cell level, module, and battery management system [11].
Users of electric motorcycle	• The distance travelled long for a single charge and price of EV is cheap [12].
International journals	• Nominal battery swap capacity adjusted to the needs [13]. • Exchange battery process 3 – 5 minute [14-16]. • The existence of a heating and ventilation system installed under charging rack to avoid loss of battery efficiency when recharged [17] • Consumers can feel more comfortable using battery swaps than gasoline-powered vehicles [18]. • Charging speed with a current of 0.3 times the battery's real capacity [19]. • The existence of standardization of construction and operation swap battery [20].

3.1.2. Technical analysis

At this step, the requirements of stakeholders are converted into technical language with Zachman framework shown in Table 2. Zachman framework is a framework that use 5W+1H questions (What, How, Who, When, Why and Where). The questions used to convert requiremens from stakeholders into technical specifications language include: (i) What: What specifications are required by stakeholders to develope swap battery product?; (ii) How: How to get/measure/test the specs?; (iii) Who: Who did the measurement/test?; (iv) When: When did the measurement/test?; (v) Why: Why did the measurement/test require?; and (vi) Where: Where did the measurement/test perform?

Table 2. Technical analysis.

Requirements	Technical Analysis
• Government policy has led the use of electric vehicles to be one of the alternative energy diversification for transportation facilities [9].	• Reductions of fuel oil emissions and diversification of alternative energy can occur if fuel vehicles are replaced gradually with electric vehicles and use swap battery product as driving energy of EV, especially for electric motorcycle.
• Pass the safety and performance tests starting from the battery cell level, module, and battery management system [11]. • Consumers can feel more comfortable using battery swaps than gasoline-powered vehicles [18].	• Pass standard cell battery RSNI XXX: 2016, [18]; An Indonesian Standard of Lithium-Ion Battery [21]. • Pass standard module battery RSNI XXX: 2016 [19]; Designing framework for standardization case study: Lithium-ion battery module in electric vehicle application [22]. • Pass standard battery management system RSNI XXX: 2017 [20]; A technical review of BMS performance standard for electric vehicle applications in Indonesia [23].
• The distance travelled long for a single charge and price of EV is cheap [12].	• The price of electric motorcycle can be affordable if the swap battery product as an energy source driving can be produced by the country itself (Indonesian) • Marking and instruction
• Exchange battery process 3 – 5 minute [14-16].The existence of a heating and ventilation system	• Protection against electric shock
• Nominal battery swap capacity adjusted to the needs [13]. • Installed under charging rack to avoid loss of battery efficiency when recharged [17].	• Equipment constructional requirements
• Charging speed with a current of 0.3 times the battery's real capacity [19].	• Electromagnetic compatibility
• The existence of standardization of construction and operation swap battery [20].	• Swap batteries can be tested quality through the existence of performance and security standards

3.1.3. Comparison of standard

At this stage, gaps and overlaps between standards and technical specifications are identified using IEC 62840-2: 2016 standards. This standard is selected based on the international availability of globally applicable standards for battery swap products. IEC 62840: 2016 is the standard for battery electric vehicle battery system swap requirements [24]. Comparison between standard and technical specifications is shown in Table 3.

3.1.4. Testing of standard

At this stage, the output of standard comparison is used as a questionnaire material distributed to stakeholders of electric motorcycle in Indonesia in order to obtain a standard framework design of battery swap products in Indonesia and verify the national capabilities. The results of questionnaire distribution are shown in Table 4.

Table 3. Comparison of standard.

Measurement/Test	IEC 62840-2: 2016
Protection against electric shock	Section 7
Equipment constructional requirements	Section 8
Electromagnetic compability	Section 9
Marking and instruction	Selection 10

Table 4. Crosstab between fulfilment of stakeholder requirement and national capabilities.

Measurement or Test	A	B	C	D	E	F
Protection against electric shock	*	Yes	*	*	Yes	*
Equipment constructional requirements	*	Yes	*	*	Yes	*
Electromagnetic compability	*	Yes	*	*	Yes	*
Marking and instruction	*	Yes	*	*	Yes	*

Note:
A : Government
B : R&D institution of Battery
C : Testing Laboratory of Battery
D : Manufacturers of Battery
E : Manufacturers of Electric Motorcycle
F : Users Electric Motorcycle
* : Still under discussion

3.2. SEM (Structural Equation Model)

SEM is a statistical analysis tool that can explain the relationship between latent variables with manifest variables and know the effect of correlation between latent variables by taking into account the errors that will always exist at each calculation [8]. The latent variable is a variable that is not directly measurable and requires the existence of a number of manifest variables or indicators for the latent variables to be measured. The manifest variable can be called a measurable variable. Error is drawn with a little circle shape whereas manifest variable is depicted with box shape. Latent variables in this research are illustrated in the form of large circle, among others: implementation of standard, national characteristic, protect consumer and protect stakeholder. Manifest variables in this research are illustrated in the form of box, among others: protection against electric shock, equipment constructional requirements, electromagnetic compability, and marking & instruction. In Figure 2 given a conceptual SEM model used to identify the national differences of the standard to measure impact of the commercialization energy.

4. Conclusion

Based on the results of data processing, it can be concluded that the swap battery needs about 4 types of measurements/testing, among others: protection against electric shock, equipment constructional requirements, electromagnetic compability and marking & instruction. It is expected that from these results we can reinforce on development of National Standards of Indonesian (SNI) for swap battery product in electric motorcycle in Indonesia. In addition, the conceptual SEM model is used to perform national characteristic of the standard that can protect consumer and stakeholder. For further research, will be examined about the validity of the SEM model with questionare and use a software SmartPLS. The software SmartPLS is use to test the

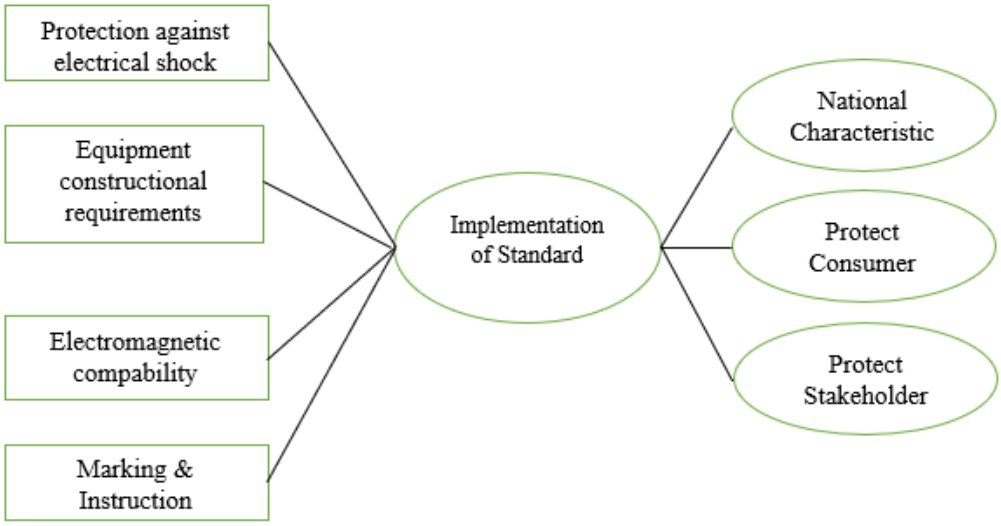

Figure 2. Conceptual model SEM of successful commercial technology.

SEM model whether the existing indicators can really explain the constructs and test the structural model whether there is a significant relationship between the variables or how strong the relationship is.

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