Design Of Measurements For Evaluating Readiness Of Technoware Components To Meet The Required Standard Of Products

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Abstract. Although government is able to make mandatory standards that must be obeyed by the industry, the respective industries themselves often have difficulties to fulfil the requirements described in those standards. This is especially true in many small and medium sized enterprises that lack the required capital to invest in standard-compliant equipment and machineries. This study aims to develop a set of measurement tools for evaluating the level of readiness of production technology with respect to the requirements of a product standard based on the quality function deployment (QFD) method. By combining the QFD methodology, UNESCAP Technometric model [9] and Analytic Hierarchy Process (AHP), this model is used to measure a firm’s capability to fulfill government standard in the toy making industry. Expert opinions from both the governmental officers responsible for setting and implementing standards and the industry practitioners responsible for managing manufacturing processes are collected and processed to find out the technological capabilities that should be improved by the firm to fulfill the existing standard. This study showed that the proposed model can be used successfully to measure the gap between the requirements of the standard and the readiness of technoware technological component in a particular firm.

1. Introduction
To support Indonesia’s role in international trade, the government has set product standards expected to protect the national industry. This is in accordance with Government Rules (PERMEN 55/M-IND/PER/11/2013) that the goal of standards implementation is to support the productivity, production efficiency, and quality of goods, services, processes, systems, which were intended to improve the competitiveness, consumer protection, business, labor and community. However, most of the product standards designed by the governments nowadays are adopted from international standards. The requirements of those standards are relatively high, and thus it is difficult for small and medium-sized domestic businesses to meet those standards. One of the main obstacles to the implementation of product standard is the inability of domestic industry to fulfill the technological requirements of the standard, such as in terms of manufacturing technology like the equipment and machines.

Padjiastuti [6] showed that the productivity of companies that use the National Standard (SNI) as a management tool is still not good enough, and the average contribution per worker is still low when compared to industries that use other standards. Furthermore, Puspita [7] has found that there are several factors, including the competence of human resources, raw materials and technology used,
that can be the reasons why a product is unable to meet a standard [7]. This indicates that the application of product standards in Indonesia is still inefficient.

Other researchers have conducted several studies to design the method to help regulators in assessing the readiness of a company or to help a company to comply with standards. For example, Sinuhaji [8] examined in depth the readiness of humanware components (i.e., the aspect of the competence of human resources (HR)) in the industry to meet the requirements of the standard. Puspita [7] also emphasized that the technology components should also be evaluated when examining a product of a company is in compliance with product standards.

2. Literature Study
In 2007, the Body of National Standardization of Indonesia conducted research that assessed the fulfillment for standards using the method of Standard Value Assessment Tool (SVAT). This study also maintained and assessed the feasibility of standards using voting process by stakeholders. Based on the results of voting, the committee form by the stakeholders determine whether the standard should be revised or kept as existing.

Gunawan [3] extended the prior study and pointed out that the prior research had not yet thoroughly considered the aspect of technology, which might be critical in determining the capability of a company in meeting government requirements or standards. To answer that problem, he designed a model to determine the contribution of various technology components in fulfilling standards by considering Technoware and Humanware components into consideration when assessing the technology components. These components are taken from the Technoware assessment model developed by UNESCAP.

Further development of this type of research is done by Islam [4], in which QFD approach is used to design a tool for measuring the readiness of Technoware and Humanware components in laboratory to meet the standard (SNI ISO/IEC 17025). Nurcahya et al. [5] have assessed the technology level of industrial estates with respect to environment standards using a similar QFD approach to identify the gap between the existing level and the expected level of technology. The same study pointed out this assessment can be applied in the existing business processes of an industrial estate and the standard requirements. Later Akbar et al. [1] also used the same approach as a tool for identifying targets for improvement of both Humanware and Technoware components in order to impose standards in Manufacturing Polytechnic Institutions.

3. Proposed Model
House of Quality (HOQ) is the primary planning tool used in QFD. HOQ is an important tool for QFD activities, containing information on “what”, “how”, relation between “what” and “how”, and the relationship between the “how” factors themselves. HOQ describes the customer needs (as “what”), planning matrix (as “why”), product technical responses or characteristics (as “how”), relationship matrix, technical correlations, and target of technical matrix requirement (as “how much”) [2]. The structure of HOQ can be thought of as a framework of a house, as shown in Figure 1.

In this study, we use the same approach to describe a relationship between implemented standards and the production process technology of a particular manufacturing firm. First, we define the standard requirements to take the place of customer needs & benefits in the HOQ matrix (“what”). Then we define the production processes to take the place of technical responses in the HOQ matrix (“how”). We can then define the relationship between the standards and production process using the classifications detailed in the HOQ approach.

The planning matrix (“why”) in the traditional HOQ approach is then combined with the UNESCAP technometric model to assess the level of Technoware components needed to fulfill the prescribed standards and the level of Technoware components currently being used in the particular firm. Other information in this matrix includes the target value, improvement ratio, absolute weight and normalized absolute weight. These numbers are calculated to describe the gap between the current capability of the firm and the effort that they should concentrate to fulfill the required standards.
To fill in the planning matrix described before, data will be collected from experts to determine the level of Technoware components based on standard requirements (denoted as $TS$), the level of technoware of production processes in industry (denoted as $TI$) and the importance weight of standard requirements (denoted as $WS$) and production processes (denoted as $WP$). We can then proceed to calculate the Aggregate Technoware of Standards Requirements ($ATS$), Aggregate Technoware of Production Processes in industry ($ATI$), Improvement Ratio and Absolute Weight ($AW$) using the following equations:

\begin{align*}
ATS &= \sum WP \times TS \quad (1) \\
ATI &= \sum WP \times TI \quad (2) \\
\text{Improvement Ratio} &= \frac{ATS}{ATI} \quad (3) \\
AW &= WS \times \text{Improvement Ratio} \quad (4)
\end{align*}

4. Data Collection
We use the proposed model to measure a manufacturing firm’s Technoware component capability to meet the required standards in the toy industry (SNI ISO 8124-1:2010). To help in determining the variables $TS$, $TI$, $WP$ and $WS$, 8 experts have been asked to provide their judgment. These experts are people with knowledge and experience in government standards (of the toy product) or people active in the industry for more than 10 years, including head officers of the testing laboratory, head officers of the body of certification and standardization, head of the toys laboratory, analysts of the laboratory, head officers of production department, head of R & D department, staff of production department, and staff of R & D department. Responses from the experts are collected using the Analytical Hierarchy Process (AHP) to produce one consistent value for the variables mentioned.

The standard mentioned before consists of 29 requirements of toy products in general and will be defined as customer needs and benefits in the House of Quality with the assumption that customers will want products that meet the standard. The experts then converted them into 20 requirements because not all requirements in the clauses stated in the original standards are related to the toy products analysed in this study (ride-on toys). On the other hand, discussion with the experts generated 9 main processes required to manufacture the toys. Figure 2 shows the clauses of the standard included in this research.

Figure 1. House of Quality (HOQ)
Correlation between the standards and the technical processes can then be filled using the usual HOQ procedure. By using the weights and measurements of Technoware components, the planning matrix section of the modified HOQ matrix is then filled. The partial modified HOQ matrix is shown in Figure 3.
5. Results and Discussion
The modified HOQ of Figure 3 shows that the planning matrix allows us to prioritize customer needs indicated from the Normalized Absolute Weight value. The highest value is in the standard terms “toys with functional sharp edges” and “toys with functional sharp points” with a value of 0.074. Second order is on the standard of “Accessible edges, corners, mold parting area of molded toys” with a value of 0.066, while the lowest priority is in the “accessible clearance for moveable segment” with a value of 0.019.
The goal value is set equal to the value of ATS because the fulfillment of the standard requirements of the toy product is the goal aimed by the industry. The effort required in achieving the goals is represented by Improvement Ratio, where a higher the number means that more effort is needed to improve that particular aspect. The highest value of the improvement ratio is in the clause of “hole and clearances” (standard clause regarding accessible circular hole in any rigid material and accessible clearance for moveable segment) which has a value of improvement ratio of 1.111. While the lowest value is found for the clause sub criteria of “edges” (standard clause regarding accessible edges, corners or mold parting areas of molded toys and accessible metal edges), which is equal to 0.900.

Filling in the modified HOQ matrix will also show which standard requirements are met by the technical response and which are not yet met. This is indicated by evaluating whether the ATS value is lower or higher than the ATI value. If ATS is lower than ATI, that means the process meets the standard requirements and vice versa. In this case the matrix shows that there are three standards that have not yet been met by the industry and these are as follows:

- All material shall be visually clean and free from infestation
- Accessible circular hole in any rigid material
- Accessible clearance for moveable segment

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