Quality Testing of Shuttlecock SME Products to Improve SNI Certification in Indonesia

Andrian Listyo Kawuri
Master Program of Industrial Engineering
Faculty of Engineering
Universitas Sebelas Maret
Surakarta, Indonesia
andrianlk27@student.uns.ac.id

Eko liquiddanu, Muhammad Hisjam, Bambang Suhardi
Department of Industrial Engineering, Sebelas Maret University, Surakarta, 57126, Indonesia
ekoliquiddanu@staff.uns.ac.id, Hisjam@staff.uns.ac.id, bambangsuhardi@staff.uns.ac.id

Abstract

Badminton is a popular sport in Indonesia. Brand competition for the shuttlecock market in Indonesia is relatively high. The quality of shuttlecock products is one of the requirements to be accepted in the market. Since 2014 BSN has issued SNI Standards, but this rule has not been used to guarantee the quality of the production of small and medium shuttlecock industries. There are six requirements in the application for type 3 scheme SNI certification for product certification. This research helps one of the requirements, namely product testing. This research examines and provides information to SMEs on whether their products follow the SNI criteria or not. Product testing uses the conformity method of the SNI 0036:2014 testing method regarding shuttlecocks. This research used 6 out of 7 criteria that can be measured with tools from the SNI rules. The sample used is ten brands of SMEs that already have brands and production capacity above 1000 slop/week. The use of process capability analysis in this study estimates how consistently the process meets the specifications determined by consumers to help improve the company's internal production processes. The results show that in the SNI conformity test, one brand passes the six criteria tested. The other brands fail in the aspects of feather length and hubcap height.

Keywords
Product Quality Test, SNI, Process Capability Analysis, Shuttlecock

1. Introduction
Badminton is a popular sport in Indonesia (Hanifa 2019) and the demand for shuttlecock products is also increasing. The shuttlecock industry is growing and developing in Java Island, Indonesia. Cities that become centers of shuttlecock manufacture include Tegal, Malang, and Nganjuk. Different brands of shuttlecocks from well-known brands from abroad and domestically compete in the national market, which impacts SMEs that produce shuttlecocks.

BSN (National Standardization Agency) has issued SNI rules for shuttlecocks since 2014 but until now there are still many SMEs that have not implemented these regulations. SNI certification for shuttlecocks is included in the category of sports equipment, namely SNI Scheme type 3. There are 6 requirements in the application for SNI certification scheme type 3, one of which is product testing. This study assists SMEs in carrying out the requirements, namely for product testing. The problem with local SMEs is that they have not standardized their products because they are not sure whether their products are feasible or not. This research records 3 centers in Tegal, Malang, and Nganjuk areas. There are 60 SMEs that already have brands, from the existing 60 SMEs, only industries that produce 1000 Slops/month are taken. The data shows that only 10 SMEs are able to produce shuttlecocks with that amount, with the amount of production it is assumed that profits can be used for the process of applying SNI. If viewed from the administrative factor, SMEs already have a brand, and from an economic point of view, they are capable. In this research, samples will be taken from 10 brands measured using SNI rules. Of the 7 SNI criteria that can be measured for Shuttlecocks, only 6 criteria are used as a reference due to limited costs. This study aims to provide information to SMEs on whether their products are in accordance with SNI criteria or not.

Process capability analysis is used to estimate how consistently the process meets the specifications that have been determined by the customer. In testing the process whether it is able to produce products that meet specifications, process capability analysis is used. This study aims to determine the readiness of SMEs in implementing SNI 0036:2014, by knowing the readiness of SMEs in fulfilling the requirements for determining SNI so as to facilitate SMEs in future development efforts.

Several previous studies discuss SNI and process capability analysis. Fahma, Zakaria, and Gumilang (2018) their research discusses the framework for designing a model for assessing the readiness of SMEs to adopt the Indonesian National Standard (SNI) for Batik SMEs in Surakarta. Fauziyah, Fahma, and Zakaria (2019) discussed measuring the level of readiness of UNS in meeting the requirements for determining LSPro AMDK based on SNI ISO/IEC 17065. Atmojo, Fahma, and Sutopo (2020) provides an overview of the SNI certification scheme, to help Batik SMEs understand the flow of activities and documents in business processes and increase the level of application of SNI for batik products. Another study that discusses process capability analysis Arzak et al. (2020) in his research discusses how to perform process capability analysis in filling operations, the results show that process capability analysis can assist in monitoring the quality of the filling process. Whereas the study Yang et al.(2020) discussed the case of the quality data measured by customers being cut off by the specification limit, this made it difficult to measure the process capability index, in this study a method was then proposed to estimate the process capability index based on the truncated data. Xiao et al. (2020) in his research discusses the application of statistical process control (SPC) to the IMRT/VMAT patient-specific quality assurance (PSQA) program recommended by the AAPM TG-218 report, but a comprehensive analysis of the PSQA process with non-normal distribution is still lacking. This study investigates the SPC method and process capability analysis (PCA) for non-normal PSQA IMRT/VMAT processes.

2. Literature Review

2.1 Indonesian National Standard (SNI) for Shuttlecock

The stages of the certification process carried out by the Product Certification Agency of the Center for Crafts and Batik (LSPro) have the aim of protecting consumers and producers to obtain quality products by the Indonesian National Standard (SNI) (Kemenperin, 2022). The product conformity mark with SNI is imprinted on the product, by giving the SNI mark the product is expected to increase exports through increasing products by SNI through professional services. The product certification process is carried out by LSPro using 2 types of certification schemes, namely type 3 for jewelry products, sports equipment, and textile products. The next type is type 1B for certification of children's toys and baby clothing products. In this study using a type 3 scheme, this schema includes selection, a determination which includes product testing, and field evaluation. Type 3 scheme certification must complete documents such as company profiles, business licenses (SIUP), industry registration marks (TDI), documents related to production lines, quality guidelines, and product quality test certificates. In this case, the product quality test certification used is based on SNI 0036:2014 for shuttlecocks.

2.2 Process Capability Analysis

Process capability analysis is an analysis of relative variability to requirements or specifications for product development so that the amount of variability can be reduced. Process capability is a critical performance measure that shows the process can produce products according to the specifications applied by management based on customer needs (Gasperz, 2002). According to (Breyfogle 2003) the Sigma standard index values for Cp are grouped into 3 categories (Table 1-4):

Table 1 Index Cp

Index Cp	Keterangan
$Cp = 2$	Then the process is as expected
$Cp < 2$	Then the process is out of specification
$Cp > 2$	Then the process is according to specifications

Table 2 Index Cpk

Index Cpk	Keterangan

Cpk < 0	Shows the average process outside the specification limits, then the accuracy is low.
0 < Cpk <1,5	If the Cpk value is <1.5 the accuracy and precision is low, and if the Cp value is >1.5 then the precision is high but the accuracy is low.
Cpk > 1,5	If followed by the value of Cp> 1 then the process is capable, high accuracy and precision. But if the value of Cp < 1 then the accuracy is high and the precision is low.

3. Methods

3.1 Data source

The source of data used in this research is shuttlecock size data according to SNI rules. This study uses data on weight, head height/hubcap, head center line, feather length, feather development center line, and shuttlecock flying stability. The data used consists of 40 samples of each brand, there are 10 brands of shuttlecocks. The data taken is the quality characteristics of the shuttlecock product based on the Indonesian National Standard. Data processing using Minitab software version 18.

3.2 Step of Analysis

The steps of analysis in this research are as follows:

a. Measure the SME shuttlecock with SNI standards.
b. Performing normality test of shuttlecock size data. If there is abnormal data, a probability plot search is carried out. The distribution that has the highest probability value will be used in the next stage (Wooluru, Swamy, and Nagesh 2015)
c. Make a control chart based on the size of the shuttlecock.
   If there are data that are outside the control limits (outliers), then the data is retained. This is due to the limitations of researchers to find assignable causes of the process and the provision of the amount of data used in the process of monitoring and counting.
d. Calculating shuttlecock size Process capability.

4. Results and Discussion

Quality control analysis in this study starts by measuring the size of each aspect of the Shuttlecock section, conducting a data normality test, determining the value of the center line (CL), lower control limit (LCL), and upper control limit (UCL) on the average control chart $\overline{(X)}$ and distance control map (R) to find out how many products meet specifications. Furthermore, the calculation of process capability (Cp) is carried out to determine the capability of the process.

4.1 Analysis using the rules of the Indonesian National Standard (SNI)

The following are the results of calculations based on the Indonesian National Standard for Shuttlecocks.

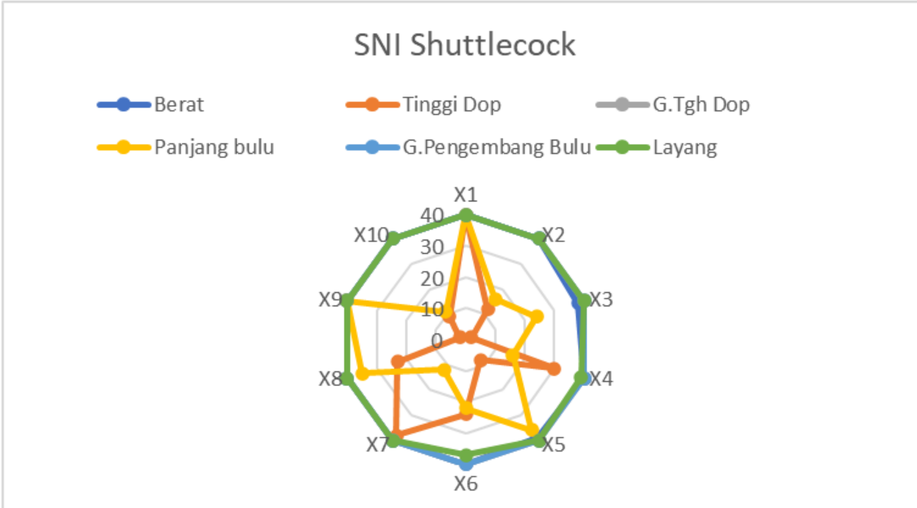


Figure 1 SNI Shuttlecock

In the analysis phase of this research, samples were taken from 10 shuttlecock brands from local SMEs, from these samples were tested whether the product was in accordance with SNI standards or not. Determination of the size of the SNI used includes 6 parameters, namely weight, the height of the head/hubcap, the center line of the head, feather length, center line/ diameter of skirt, and shuttlecock flying stability. After the measurements are made, the results are shown in Figure 1. Each parameter is measured by the SNI standard, for every 40 samples, there are a maximum of 16 samples that do not pass the standard, if more than this value, it is declared not to pass the SNI rules.

Table 3 Measurement Results using SNI rules

No	Brand	Criteria					
		Weight	**Height of the head/hubcap**	**Head Center Line**	**Feather length**	**Center line/ diameter of skirt**	**Shuttlecock flying stability**
1	X1	V	V	V	V	V	V
2	X2	V	X	V	X	V	V
3	X3	V	X	V	V	V	V
4	X4	V	V	V	X	V	V
5	X5	V	X	V	V	V	V
6	X6	V	V	V	X	V	V
7	X7	V	V	V	X	V	V
8	X8	V	X	V	V	V	V
9	X9	V	X	V	V	V	V
10	X10	V	X	V	X	V	V

*Description: "V" indicates Passed, "X" indicates Not Passed

From the results above, it shows that the X1 brand from 6 aspects tested, all six of them passed, the X2brand only aspects of the hubcap height and feather length did not pass, the X3 brand only did not pass the hubcap height aspect, the X4 brand only did not pass the feather length aspect, the X5 brand the high aspect of the hubcap that did not pass, the brand X6 aspect of the length of the feather that did not pass, the brand X7 aspect of the length of the feather that did not pass, the X8 brand of the high aspect of the hubcap that did not pass, X9 the high aspect of the hubcap that did not pass, and finally the X10 brand the high aspect of the hubcap and Long feathers that do not escape.

4.2 Process Capability Analysis

Normality test

At this stage, the test is carried out using the Kolmogorov-Smirnov method. Data processing using SPSS software. The results of the normality test obtained can be seen in Table 4.

Table 4. Normality Test

No	Brand	Weight	Height of the head/hubcap	Head Center Line	Feather length	Center line/ diameter of skirt	Shuttlecock flying stability
1	X1	0,031	0,899	0,729	0,209	0,000	-
2	X2	0,035	0,332	0,701	0,577	0,635	-
3	X3	0,002	0,002	0,003	0,653	0,052	-
4	X4	0,225	0,666	0,715	0,086	0,000	-
5	X5	0,063	0,232	0,883	0,635	0,035	-
6	X6	0,029	0,856	0,698	0,955	0,884	-
7	X7	0,088	0,978	0,877	0,801	0,648	-
8	X8	0,090	0,765	0,526	0,621	0,820	-
9	X9	0,270	0,693	0,347	0,966	0,861	-
10	X10	0,178	0,045	0,925	0,617	0,006	-

The results of the normality test are then used to test the process capability. Some of the data that are not normally distributed must be searched for the most suitable distribution for use in process capability analysis by looking for probability plots. In the kite test, there is no normality test because the data is discrete.

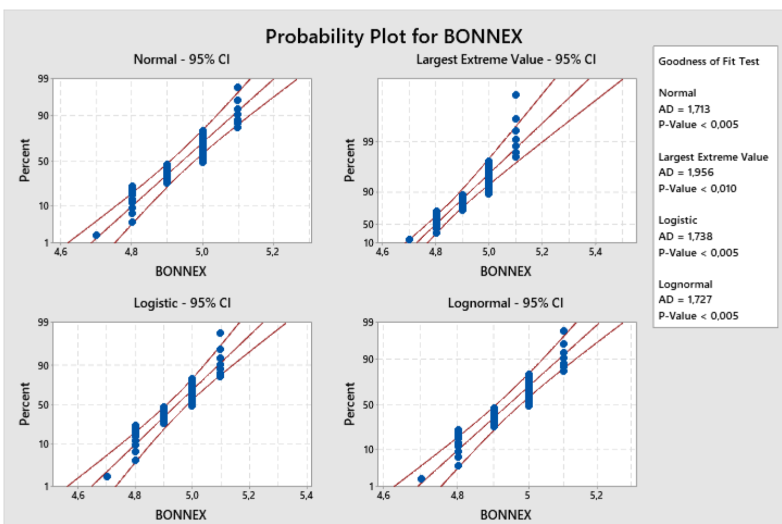


Figure 2 Probability Plot X1 Berat

At the modeling stage, the probability plot is carried out on all possible distributions, including normal, largest extreme value, lognormal, and logistic. Figure 2 shows one of the results of the probability plot, namely the distribution of the largest extreme value which was chosen to be used because it has the highest p-Value. Furthermore, this distribution will be used in the process capability analysis.

Control Chart

After the normality test was carried out, the data that were normally distributed were checked for the control chart. If there are data that are outside the control limits (outliers), then the data is maintained. This is due to the limitations of researchers to find assignable causes of the process and the provision of the amount of data used in the process of monitoring and counting. The following is one of the measurements using a control chart.

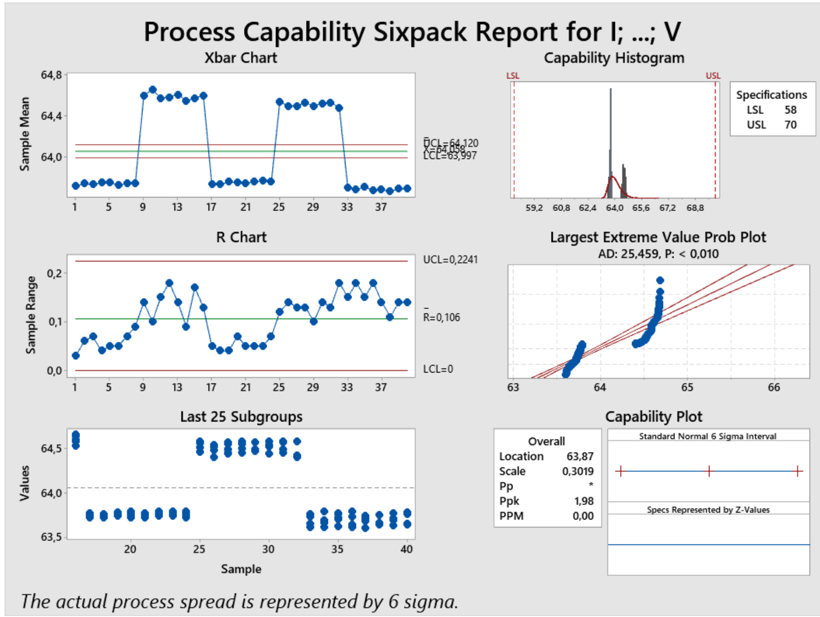
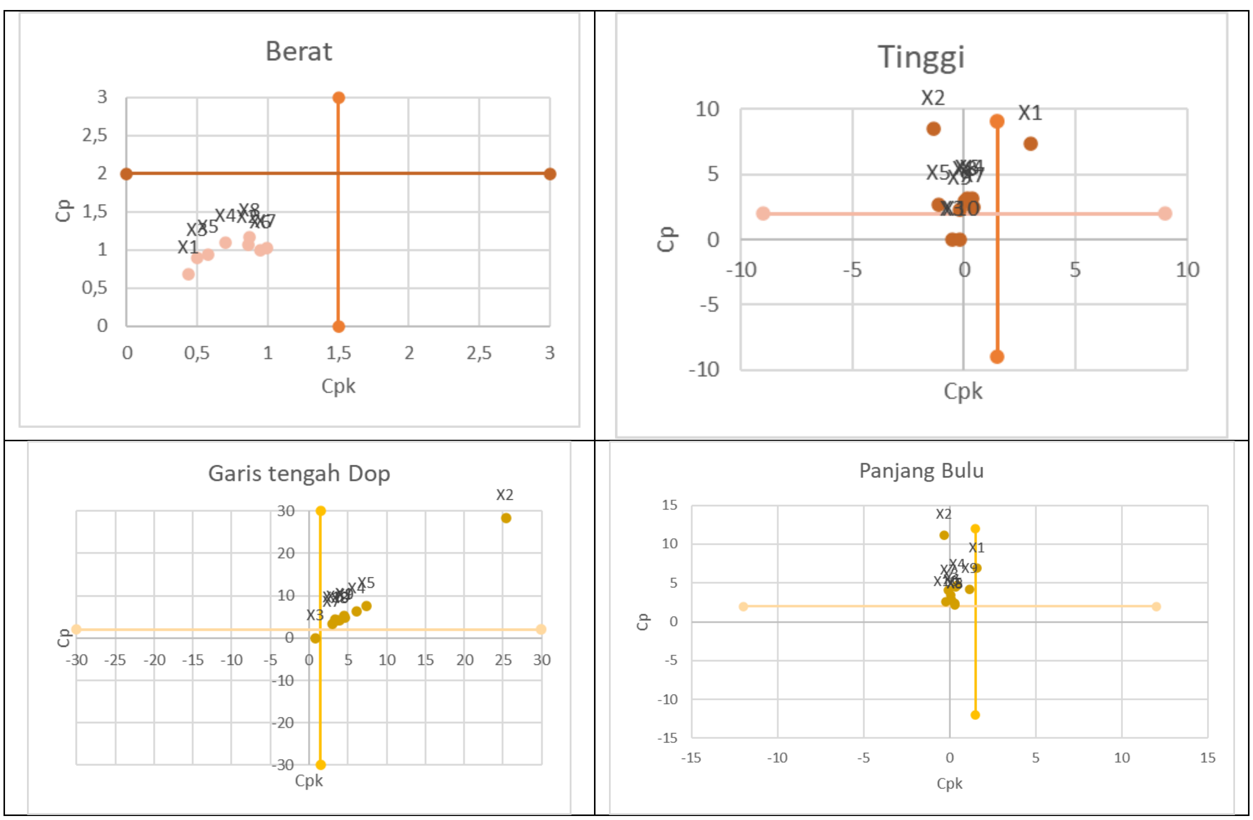


Figure 3 Process Capability Sixpack Report includes Control chart, Process Capability and Probability Plot

Process Capability Analysis

The following are the results of the process capability analysis on the aspects tested in accordance with SNI (Figure 4-5).



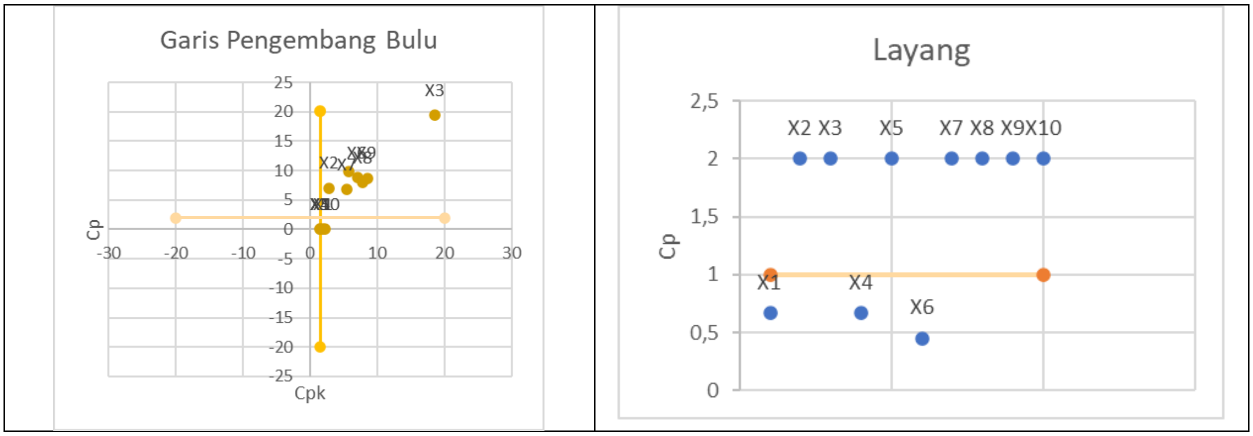


Figure 4. Capability Analysis Results

Table 5 shows the interpretation of the results of the process capability analysis of each brand of the shuttlecock.

Table 5. Interpretation of Process Capability Analysis Results

Brand	**Weight**	**Height of the head/hubcap**	**Head Center Line**	**Feather length**	**Center line/ diameter of skirt**	**Shuttlecock flying stability**
X1	Low precision and accuracy	High Precision and Accuracy	High Precision and Accuracy	High Precision and Accuracy	High Precision and Accuracy	Low precision and accuracy
X2	Low precision, high accuracy	Low precision and accuracy	High Precision and Accuracy	Low precision and accuracy	High Precision and Accuracy	High Precision and Accuracy
X3	Low precision and accuracy	Low precision and accuracy	Low precision, high accuracy	Low precision, high accuracy	High Precision and Accuracy	High Precision and Accuracy
X4	Low precision and accuracy	Low precision, high accuracy	High Precision and Accuracy	Low precision, high accuracy	High Precision and Accuracy	Low precision and accuracy
X5	Low precision and accuracy	Low precision and accuracy	High Precision and Accuracy	Low precision, high accuracy	High Precision and Accuracy	High Precision and Accuracy
X6	Low precision and accuracy	Low precision, high accuracy	High Precision and Accuracy	Low precision, high accuracy	High Precision and Accuracy	Low precision and accuracy
X7	Low precision and accuracy	Low precision, high accuracy	High Precision and Accuracy	Low precision and accuracy	High Precision and Accuracy	High Precision and Accuracy

Brand	Weight	Height of the head/hubcap	Head Center Line	Feather length	Center line/ diameter of skirt	Shuttlecock flying stability
X8	Low precision and accuracy	Low precision, high accuracy	High Precision and Accuracy	Low precision, high accuracy	High Precision and Accuracy	High Precision and Accuracy
X9	Low precision and accuracy	Low precision and accuracy	High Precision and Accuracy	Low precision, high accuracy	High Precision and Accuracy	High Precision and Accuracy
X10	Low precision and accuracy	Low precision and accuracy	High Precision and Accuracy	Low precision and accuracy	High Precision and Accuracy	High Precision and Accuracy

Comparative Analysis of CP with SNI certification for each Brand

Based on the calculations that have been carried out, a comparative analysis of the results of the CP value with product pass is made according to the SNI rules for each brand, the following are the results:

1. For Brand X1 shows the results of CP products that are capable of five aspects, while the aspect of Shuttlecock flying stability is not yet capable. For the results of SNI, all six aspects passed.
2. Brand X2 shows capable product CP results for the six aspects. For the SNI results, the height of the hubcap and feather length aspects did not pass.
3. Brand X3 shows capable product CP results for the six aspects. For the SNI results, the height of the hubcap aspect did not pass.
4. Brand X4 shows the results of CP products that are capable of 4 aspects, only aspects of Weight and Shuttlecock flying stability are not capable. For the results of SNI for feather length aspects that have not passed.
5. Brand X5 shows the results of CP products that are capable of 5 aspects, only the Weight aspect is not capable. For the results of the SNI for the height of the hubcap aspect that has not passed.
6. Brand X6 shows the results of CP products that are capable of 5 aspects, only the aspect of Shuttlecock flying stability is not capable. For the results of SNI for feather length aspects that have not passed.
7. Brand X7 shows the results of CP products that are capable of 5 aspects, only the Weight aspect is not capable. For the results of SNI for feather length aspects that have not passed.
8. Brand X8 shows the results of CP products that are capable of 5 aspects, only the Weight aspect is not capable. For the results of the SNI for the height of the hubcap aspect that has not passed.
9. Brand X9 shows the results of CP products that are capable of 5 aspects, only the Weight aspect is not capable. For the results of the SNI for the height of the hubcap aspect that has not passed.
10. Brand X10 shows the results of CP products that are capable of 5 aspects, only the Weight aspect is not capable. For the results of SNI aspects of the height of hubcap and feather length that have not passed.

From the results of the analysis, most SMEs are not capable of the weight shuttlecock aspect, namely 6 SMEs. As for the SNI certification of SMEs, many did not pass the aspects of the height of hubcap and feather length, respectively 6 and 5 SMEs.

5. Conclusion

The following are conclusions that can be drawn from the research that has been done, as follows:

1. From the results above, it shows that the X1 brand out of 6 aspects tested, all six of them passed, the X2 brand only the aspect of the height of the hubcap and the length of the feathers that did not pass, the X3 brand only the aspect of the height of the hubcap that did not pass, the X4 brand was only the aspect of the length of the feathers that did not pass, brand X5 with a high aspect of hubcap that didn't pass, brand X6 with an aspect of the length of a feather that didn't pass, brand X7 with aspect on length of a feather that didn't pass, brand X8 with high aspect on hubcap that didn't pass, X9 with high aspect on hubcap that didn't pass, and finally brand X10 with high aspect hubcaps and the length of the feathers that do not escape.
2. The results of the process capability analysis show the test results of 6 aspects from 10 SMEs only the X8 brand has a high precision and accuracy value in all five aspects, only the heavy aspect needs improvement, while other

brands do not yet have a high level of precision and accuracy in the 6 aspects tested. These results will then be used as input to the company for proposals for internal process improvements.

3. From the results of this study, it is hoped that it can help and facilitate SMEs to be able to understand the shortcomings or obstacles of their companies in completing the requirements for SNI certification, such as quality requirements that are still difficult to fulfill. Recommendations that can be given are that SMEs can improve product quality according to SNI 0036:2014 certification to improve product quality management.

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Biographies

Andrian Listyo Kawuri is a student at Master Program of Industrial Engineering Department, Universitas Sebelas Maret, Surakarta, Indonesia. His research interests are logistics and supply chain management, e-business design, and business strategic management.

Eko Liquiddanu has been a lecturer at the Department of industrial engineering faculty of engineering "Universitas Sebelas Maret" since 1998. His research interest are SME competitiveness, Indonesian national and Halal standards. He currently serves as a head department of industrial engineering "Universitas Sebelas Maret."

Muhammad Hisjam is a lecturer at the Department of Industrial Engineering, Faculty of Engineering, Universitas Sebelas Maret since 1998. He earned Bachelor in Agroindustrial Technology from Universitas Gadjah Mada, a Master in Industrial Engineering & Management from Institut Teknologi Bandung, and Ph. D in Environmental Science from Universitas Gadjah Mada. His research interests are supply chain, logistics, business, and sustainable development. He published some papers in journals and proceeding his research area. He holds an Accredited Supply Chain Analyst from the American Academy of Project Management. He is the Head of Logistics System and Business Laboratory, Faculty of Engineering, Universitas Sebelas Maret. He is a member of IISE, AAPM and IEOM.

Bambang suhardi is a lecturer in Master Program of Industrial Engineering at University Sebelas Maret, Surakarta. His research interests include ergonomic, environmental ergonomic, lean manufacturing, plant layout, and improving work methods in small and medium enterprises. He currently serves as the head a Laboratory Work System Design and Ergonomics, Department Industrial Engineering, Faculty of Engineering, University Sebelas Maret.