ANALYSIS OF TECHNOLOGICAL COMPONENT CONTRIBUTIONS USING THE TECHNOMETRIC METHOD IN SMALL AND MEDIUM ENTERPRISES OF STAMPED BATIK IN PANDAK, BANTUL, D.I.YOGYAKARTA.

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Abstract. *One approach to enhancing the performance of the industrial sector is by understanding the technological performance being utilized. The analysis of technological performance can be conducted by measuring the levels of the components that constitute the technology. One commonly used measurement method is the technometric technique developed by UNESCAP. This method evaluates technology based on four primary components: technoware, humanware, infoware, and orgaware. Each of these components significantly contributes to industrial activities, making a comprehensive understanding of these elements essential for improving industrial performance. This study aims to identify the technological components utilized in five stamp batik SMEs. The sampling technique employed in this research is purposive sampling. The results of the study indicate that the TCC value of stamp batik SMEs in Pandak, Bantul, Yogyakarta ranges from 0.564 to 0.610, with an average TCC value of 0.58. Based on the range of 0.5≤TCC≤0.7, the technology utilized by these enterprises is classified as "Good."*

Keywords: Stamped batik;Small and Medium Enterprises (SMEs); Technometric.

1. INTRODUCTION

The batik industry, particularly stamped batik, is one of the key sectors in Indonesia's creative economy, with high cultural and economic value. Stamped batik is produced through a mechanical process using stamps filled with hot wax to imprint patterns onto fabric. This method allows for faster production compared to hand-drawn batik, meeting the demands of a larger and more diverse market. In the context of Small and Medium Enterprises (SMEs), this sector plays a significant role in driving the local economy, creating job opportunities, and preserving cultural heritage.

The development of the batik industry in Indonesia has experienced various dynamics in response to changing times and global market demands. Batik, as a cultural heritage recognized by UNESCO, holds a crucial role in the national economy, particularly within the SME sector. Stamped batik SMEs, as one of the subsectors within the batik industry, face complex challenges, including increasing competition with cheaper imported batik products and the lack of regeneration among batik artisans. These challenges impact the competitiveness and sustainability of stamped batik SMEs in both domestic and international markets.

One factor that can enhance the competitiveness of stamped batik SMEs is the appropriate utilization of technology. In this context, technology encompasses various components, ranging from production processes and management to product marketing. The efficient use of technology is expected to help stamped batik SMEs improve product quality, increase productivity, and reduce production costs, thereby addressing the challenges posed by cheaper imported batik products. However, the adoption of technology in stamped batik SMEs is often hindered by limited access to appropriate technology, a low understanding of the importance of technological innovation, and funding issues.

Moreover, the regeneration of batik artisans presents an equally critical issue. The aging population of batik artisans and the lack of interest among younger generations in pursuing this profession have resulted in a shortage of skilled labor in this sector. This exacerbates the challenges of ensuring the sustainability of the batik industry, particularly in meeting the increasingly diverse and dynamic market demands.

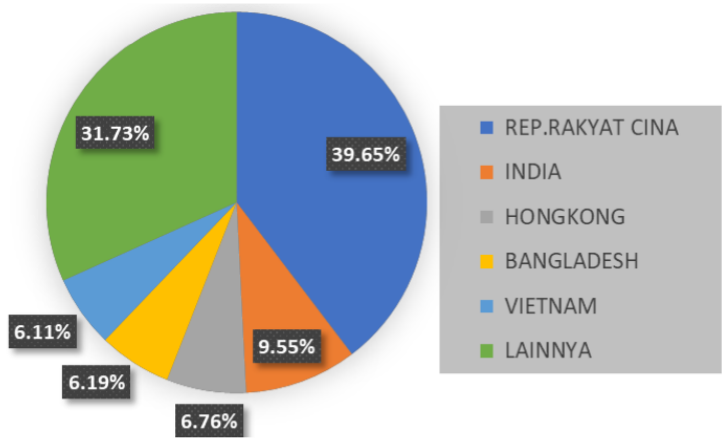

Figure 1. Country of Origin for Batik Imports, Jan-Nov 2023
(Center for Data and Information Systems, Ministry of Trade, 2023)

In the global market, imported batik from countries such as China, India, Hong Kong, Bangladesh, and Vietnam has become a major competitor for Indonesia's stamped batik products. These countries are known for their highly competitive textile production capabilities, characterized by advanced technology utilization and lower production costs. Textile products from these countries, including batik with similar patterns, are often mass-produced at lower prices. This price competition stems from their advantages in production scale and technological efficiency. Although imported batik often lacks cultural authenticity, it has managed to attract international markets, including Indonesia, due to its relatively affordable prices and faster production times.

From 2018 to 2023, China, India, Hong Kong, Bangladesh, and Vietnam consistently served as the primary suppliers of imported batik to the Indonesian market. China has remained the top supplier of batik to Indonesia; however, its market share has gradually declined from 60.67% in 2018 to 39.65% during the January–November 2023 period. Conversely, the role of imports from Bangladesh has shown a steady increase, rising from 2.90% in 2018 to 6.19% during the January–November 2023 period (Center for Data and Information Systems, Ministry of Trade).

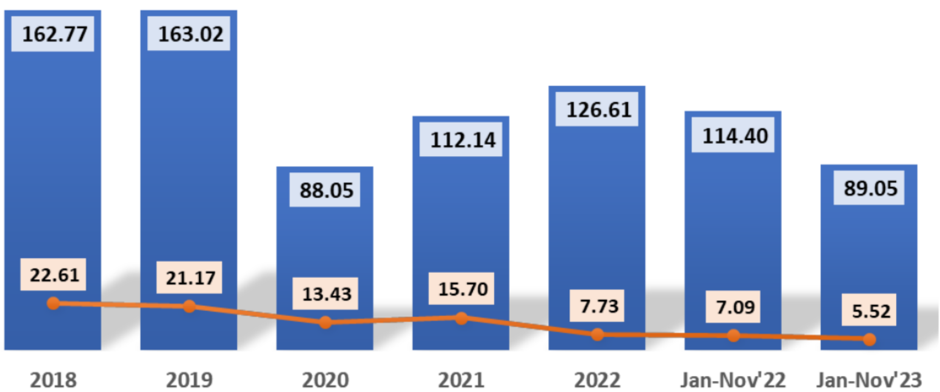

Figure 2. Realization of Batik Imports to Indonesia 2018-2023 (Jan-Nov)
(Center for Data and Information Systems, Ministry of Trade, 2023)

The challenges faced by stamped batik SMEs in Indonesia include their inability to compete on the same scale as batik products from China, India, Hong Kong, Bangladesh, and Vietnam, particularly in terms of technological efficiency and product pricing. On one hand, Indonesian stamped batik possesses unique qualities in terms of aesthetic quality, design originality, and cultural relevance. On the other hand, many SMEs still rely on limited and traditional technologies, both in terms of technoware, humanware, infoware, and orgaware. This results in limitations concerning production scale, product variety, and production speed, which are crucial in meeting the demands of the modern stamped batik market.

Technology is one of the key elements driving industry growth. In the modern business era, it is difficult to separate business activities from the application of technology. This is increasingly evident as the success of a business unit depends not only on the design of effective systems to produce quality products but also on managerial capabilities to adapt to changes in the technological environment. Industry, as one of the main drivers of the economy, significantly contributes to the enhancement of both national and regional income. The implementation of a free market also presents a unique challenge for Indonesia in competing to dominate the domestic market.

Based on these reasons, industry stakeholders must strive to enhance their competitiveness by improving performance and production quality, one of which can be achieved by maximizing the technology available to them. According to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP, 1989) in the Atlas Project, technology consists of a combination of four basic components: technoware, humanware, infoware, and orgaware.

To measure the extent of the technological contributions that have been applied, the UNESCAP technometric method can be used. The technometric method is an approach used to assess the combined contribution of the four technology components technoware, humanware, infoware, and orgaware in the process of transforming input into output. The basic concept of this method is to analyze the internal and external strengths and weaknesses of the company, and to provide recommendations for improvements that support management decision-making based on the conditions or information gathered.

2. LITERATURE REVIEW

2.1 Definition of Small and Medium Enterprises (SMEs)

The Ministry of Cooperatives and MSMEs classifies each group based on asset and revenue criteria as regulated in Law No. 20 of 2008 concerning Micro, Small, and Medium Enterprises (MSMEs), with the following definitions:

a. Micro Enterprises refer to productive businesses owned by individuals and/or sole proprietorships that meet the criteria for micro enterprises.
b. Small Enterprises are productive economic businesses that operate independently, managed by individuals or business entities that are not affiliated as subsidiaries or branches of medium or large enterprises, either directly or indirectly, and meet the criteria for small enterprises.
c. Medium Enterprises are productive economic businesses that operate independently, owned by individuals or business entities that are not affiliated as subsidiaries or branches of small or large businesses, either directly or indirectly, with net assets or annual revenue in accordance with the provisions of this law.

2.2 Batik

According to the dictionary definition, batik refers to a design or decoration on fabric created through a process of wax-resist dyeing, where parts of the fabric are covered with wax or resin before being dyed or colored. Batik fabric itself is fabric adorned with patterns made through a specific process using wax or resin, which is subsequently processed through certain methods (Setiawati, 2008).

According to the Indonesian National Standard (BSN, 2019), batik is a handcrafted art produced using a dyeing technique with hot wax as a resist, applied using a canting tool for hand-drawn designs or stamps to create meaningful motifs. Based on its production techniques, batik is categorized into three types: hand-drawn batik (*batik tulis*), stamped batik (*batik cap*), and a combination of both techniques. Generally, the batik production process consists of four main stages: patterning the fabric, applying wax using canting, dyeing, and removing the wax (*pelorodan*) (Besar Kerajinan Dan Batik Badan Standardisasi Dan Kebijakan Jasa Industri, 2021).

In addition to being a cultural heritage product recognized globally through UNESCO's designation in 2009, the batik industry in Indonesia is one of the nation's key industries. It plays a strategic role in national economic development due to its contributions to employment, meeting domestic clothing needs, and generating export revenue. Today, batik has become a prominent trend in Indonesia's fashion industry. The demand for batik products has increased in terms of both consumer interest and production by batik manufacturers (Masiswo et al., 2017). According to Mandegani et al. (2018), batik has experienced rapid development in design variations, influenced by consumer preferences for specific patterns and colors.

2.3 Technology

Etymologically, the term "technology" originates from the Greek word *technología*, which refers to a set of principles or rational methods related to the creation of objects, specific skills, or knowledge of methods and arts. The *Oxford English Dictionary* defines technology as the systematic application of scientific knowledge in industry. Several experts have also provided definitions related to the concept of technology.

Meanwhile, the Organisation for Economic Co-Operation and Development (OECD) (as cited in Hany, 2000) states that technology consists of four main components: techniques, knowledge, organization, and products. Techniques involve the machinery and equipment used in production processes (*hardware*), while knowledge and organization are referred to as *software*. Products, in turn, represent the outcomes of these three components combined.

Furthermore, according to the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), as cited by Nazarudin (2008), technology comprises four fundamental components that interact in the transformation process. These components are technoware, humanware, infoware, and orgaware.

2.4 Basic Components of Technology

The transformation of natural resources as production inputs into final or intermediate products is achieved through the application of technology. Technology functions as a "transformer" that supports economic growth through two primary mechanisms. First, technology drives economic growth by facilitating the optimal utilization of resources for practical application. Second, technology enhances resource output through more efficient and productive transformation processes, utilizing the same amount of resources.According to the report by the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) in the *Technology Atlas Project*, technology in the context of production can be understood as a combination of four fundamental components that dynamically interact within the transformation process, as illustrated in Figure 3.

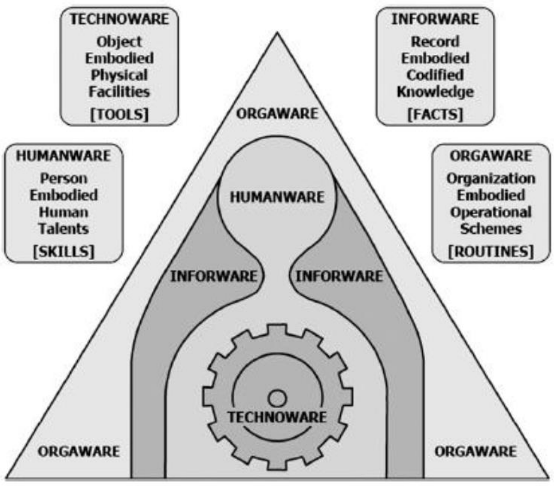

Figure 3. Components of Technology (Smith and Sharif, 2007)

2.5 Technometric

The technometric method evaluates four main components that constitute technology, with these components collectively contributing to the transformation process of inputs into outputs (Hanny, 2000). This method aims to measure the combined contribution of the four components to the level of technological sophistication. The theoretical foundation of this approach lies in analyzing the internal and external strengths and weaknesses of a company, as well as in formulating and providing recommendations for improvements to facilitate managerial decision-making aligned with the obtained conditions or information. The final outcome of applying this model is the value of the Technology Contribution Coefficient (TCC).

3. RESEARCH METHODS

The technometric model is a framework used as a tool to measure the level of technology within each constituent component as well as the overall classification of technology. Through a series of calculations performed on each component, these values are subsequently combined to produce a final value referred to as the Technology Contribution Coefficient (TCC). This final value is then matched against a qualitative classification table, which provides an indication of the technology level of the unit under study. The steps involved in a technometric study include the following phases:

1. Degree of Sophistication

In this stage, the sophistication of a technological component is assessed based on the facilities or equipment available. The degree of sophistication is determined using a scoring system that establishes upper and lower limits for each activity level of the component. This evaluation is based on generic criteria defined by UNESCAP (Utomo and Setiastuti, 2019).

2. State of the Art (SOTA)

This stage evaluates the sophistication of each technological component based on the overall operational process. The degree of sophistication is determined using a rating system with a score range from 0 (lowest) to 10 (highest), following the generic criteria also established by UNESCAP.

3. Contribution of Technological Components

Once the degree of sophistication scores and the state of the art ratings are obtained, the contribution of each technological component is calculated using relevant equations.

$$Ti = 1/9 [Lti + Sti (UTi - LTi)]$$
$$Hj = 1/9 [Lhj + SHj (UHj - LHj)]$$
$$I = 1/9 [Li + SI (UI - LI)]$$
$$O = 1/9 [LO + So (UO - LO)]$$

Where:
LT = Lower limit of technoware
UT = Upper limit of technoware
ST = State of the art of technoware component
LH = Lower limit of humanware
UH = Upper limit of humanware
SH = State of the art of humanware component
LI = Lower limit of infoware
UI = Upper limit of infoware
SI = State of the art of infoware component
LO = Lower limit of orgaware
SO = Upper limit of orgaware
UH = State of the art of orgaware component

4. Intensity of Technological Component Contributions

The next step involves calculating the intensity of each component's contribution using the Analytic Hierarchy Process (AHP) through a pairwise comparison matrix.

The determination of values is conducted using a scale of relative importance levels to calculate the intensity of the technology component contributions. The consistency ratio (CR) is a parameter used to assess whether the assessments of the importance levels by industry actors are made consistently. The criteria are as follows:

$$CR \leq 0.1\text{: consistent}$$
$$0.1 < CR \leq 0.15\text{: somewhat consistent}$$
$$CR > 0.15\text{: inconsistent}$$

5. Technology Contribution Coefficient (TCC)

The final stage of the technometric study is calculating the Technology Contribution Coefficient (TCC). This final value is then interpreted based on qualitative assessments provided in the classification table. Based on the known values of T, H, I, O, and β, the technology contribution coefficient (TCC) can be calculated using the following equation:

$$TCC = T^{\beta t} \times H^{\beta h} \times I^{\beta i} \times O^{\beta o}$$

The contribution values of the technology components T, H, I, and O obtained must fall within the range of 0 to 1. After normalization, the total value of β in the assessment of the intensity of the technology component contributions must sum to 1, making the maximum value of the Technology Contribution Coefficient (TCC) equal to 1. The TCC value obtained is then interpreted into the qualitative TCC assessment table as shown in Table 3.8 below (Anggariawan, Syamsuri, and Prabowo, 2019).

Table 1. Qualitative Assessment of the Technology Contribution Coefficient / TCC (Anggariawan, Syamsuri, and Prabowo, 2019)

TCC Value	**Clasification**
$0 < TCC \leq 0.1$	Very Low
$0.1 < TCC \leq 0.3$	Low
$0.3 < TCC \leq 0.5$	Fair
$0.5 < TCC \leq 0.7$	Good
$0.7 < TCC \leq 0.9$	Very Good
$0.9 < TCC \leq 1.0$	State of The Art

4. RESULTS AND DISCUSSION

1. Degree of Sophistication

The results of measuring the degree of sophistication of technological components are based on the generic criteria proposed by UNESCAP. From the data on the degree of sophistication of technological components obtained, the following can be explained for stamped batik SMEs in Pandak, Bantul, Special Region of Yogyakarta:

A. Technoware

The sophistication score for the technoware component ranges from a lower limit of 1 to an upper limit of 4. This indicates that the production facilities used are at the levels of manual facilities, powered facilities, and general facilities. This suggests that most activities are still performed manually, although some powered machinery has been introduced.

B. Humanware

The sophistication score for the humanware component ranges from a lower limit of 1 to an upper limit of 8, which indicates that human resource capabilities are at the levels of operating abilities and improving abilities, with a few SMEs reaching the level of innovating abilities. In terms of education, most workers/artisans are elementary or junior high school graduates.

C. Infoware

The sophistication score for the infoware component ranges from a lower limit of 2 to an upper limit of 5. This means that the level of information mastery is at the stages of describing facts and utilizing facts. This is because workers typically possess prior batik-making skills passed down through generations. During the batik production process, additional information is usually limited to how to fill in the designs being worked on. For product marketing, some companies have started creating brochures, participating in exhibitions, and using e-commerce.

D. Orgaware

The sophistication score for the orgaware component ranges from a lower limit of 1 to an upper limit of 4. This indicates that the organizational capabilities are at the levels of striving framework and venturing framework. At the striving framework level, companies have low management capabilities, with a small workforce and irregular production schedules. At the venturing framework level, companies are self-managed by the owner, employ more formal management practices, have predictable production schedules, rely on self-sourced capital, and receive support from financial institutions. Additionally, some SMEs have reached the stabilizing framework level, characterized by efforts to build success through continuous improvements in output quality and variety.

2. State of the Art (SOTA)

The assessment of the State of the Art (SOTA) level for each technological component was conducted using the technometric method developed by UNESCAP. The evaluation measured each technological component (THIO), with a score of 0 representing the lowest value and 10 representing the highest.

A. Technoware

The technology utilized in stamped batik SMEs in Pandak, Bantul, Special Region of Yogyakarta, including techniques, equipment, and raw materials, is generally still very traditional.

B. Humanware

The skills and expertise of workers are generally passed down through generations from batik experts to their descendants. However, workers also participate in training programs organized by the Department of Industry and Trade (Disperindag) and batik training centers. These training sessions typically focus on dyeing techniques using natural dyes.

C. Infoware

In general, the mastery of information is limited to the internal scope of the company. However, some businesses have started utilizing technology to engage directly with customers or intermediary companies that market their products, such as by creating websites or using email on the internet.

D. Orgaware

The utilization of organizational tools in stamped batik SMEs in Pandak, Bantul, Special Region of Yogyakarta, remains suboptimal. In general, these businesses lack effective management and forward-looking strategic planning. Most batik enterprises operate under a family-based management system, where information flow occurs directly between the owner and workers.

3. Contribution of Technological Components

The contribution values of technological components are obtained after determining the degree of sophistication and the state of the art of each technological component. Based on the data analysis, the following results were obtained:

A. Technoware

The contribution of technoware in stamped batik SMEs in Pandak, Bantul, Special Region of Yogyakarta ranges between 0.38 and 0.42, indicating that the technoware component contributes 38% to 42% to the Technology Contribution Coefficient (TCC).

B. Humanware

The contribution of humanware in stamped batik SMEs in Pandak, Bantul, Special Region of Yogyakarta ranges between 0.64 and 0.7, indicating that the humanware component contributes 60.4% to 77% to the TCC.

C. Infoware

The contribution of infoware in stamped batik SMEs in Pandak, Bantul, Special Region of Yogyakarta ranges between 0.57 and 0.68, indicating that the infoware component contributes 57% to 68% to the TCC.

D. Orgaware

The contribution of orgaware in stamped batik SMEs in Pandak, Bantul, Special Region of Yogyakarta ranges between 0.72 and 0.77, indicating that the orgaware component contributes 72% to 77% to the TCC.

The technoware component, which includes production facilities, predominantly utilizes semi-manual machines, requiring a relatively high level of operator skill for operation. This implies that the humanware, or workforce capability, plays a crucial role in transforming inputs into outputs. The skill and expertise of operators are critical in determining the production process. However, access to infoware or information within the batik craft industry in Yogyakarta remains highly limited, restricting the mastery of information related to strategy improvement and system optimization. Similarly, the orgaware, or organizational capability, within the craft industry is still confined to the partial capabilities of individual enterprises.

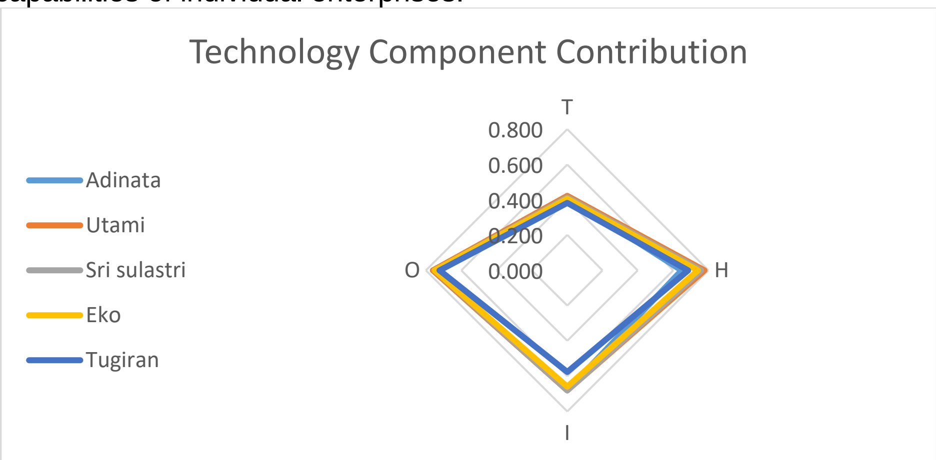

Figure 4. Graph of Technology Component Contribution Analysis

4. Intensity of Technological Component Contributions

The data on the intensity of technology component contribution refers to the level of importance of the components technoware, humanware, infoware, and orgaware.

Table 2. Technology Component Intensity Data

No	SMEs Name	Component Contribution Intensity Value				
		βt	βh	βi	βo	CR
1	Adinata	0,282	0,425	0,213	0,080	0,04
2	Utami	0,360	0,399	0,159	0,081	0,04
3	Sri Sulastri	0,360	0,481	0,086	0,074	0,03
4	Eko	0,360	0,399	0,159	0,081	0,04
5	Tugiran	0,277	0,446	0,205	0,072	0,05

5. Technology Contribution Coefficient (TCC)

The TCC value cannot be zero because there is no transformation activity without the involvement of all technology components. This means that the function of TCC does not allow T, H, I, O to be zero. The maximum value of TCC is one. The TCC of a company indicates the technological contribution of the total transformation operations to the output. The results of the TCC analysis in the batik craft industry in Yogyakarta are shown in Figure 5.

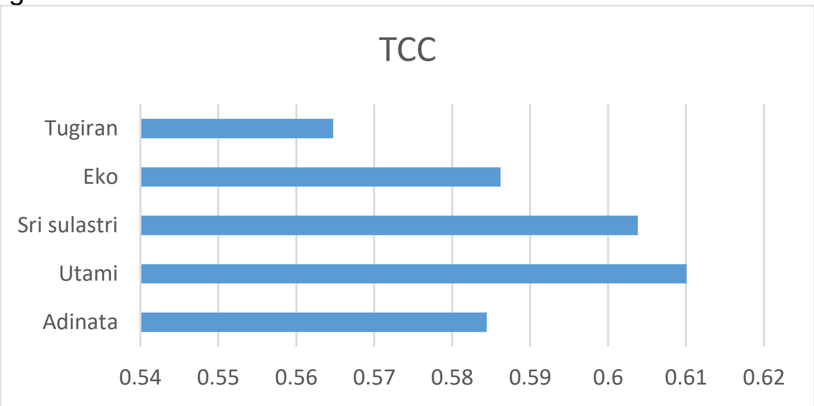

Figure 5. TCC graphic

From the diagram above, it is obtained that the TCC value ranges from 0.564 to 0.61, with an average TCC value of 0.58. indicating that the company has good performance.

CONCLUSION

The data analysis results reveal that the contribution of technoware in stamp batik SMEs in Pandak, Bantul, D.I. Yogyakarta falls within the range of 0.38–0.42, indicating that the contribution of the technoware component to the TCC is 38–42%. The contribution of humanware in these SMEs ranges from 0.64–0.77, meaning that the humanware component contributes 64–77% to the TCC.

Furthermore, the contribution of infoware in stamp batik SMEs in Pandak, Bantul, D.I. Yogyakarta is within the range of 0.57–0.68, signifying a contribution of 57–68% to the TCC. Lastly, the contribution of orgaware in these SMEs is in the range of 0.72–0.77, indicating that the orgaware component contributes 72–77% to the TCC.

The level of technological content, as reflected by the Technology Contribution Coefficient (TCC) values, indicates the technological contributions of each enterprise as follows: Batik Adinata (0.584), Batik Utami (0.610), Batik Sri Sulastri (0.603), Eko Batik (0.586), and Batik Tugiran (0.564), with an average TCC value of 0.58. Since the TCC values fall within the range of $0.5 \leq TCC \leq 0.7$, these enterprises are categorized as having technology classified as "Good."

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