

Technology Transfer from Universities to Micro, Small and Medium Enterprises

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ABSTRACT

This study was conducted to identify Micro Small and Medium Enterprises (MSMEs) perspectives on technology transferred by universities and to investigate the impact of technology transfer and product innovation on MSMEs' performance. Based on the descriptive analysis of 57 MSMEs, the study found that the most needed types of technology transfer by MSMEs are the development of spin-offs, start-up companies, and research and development collaboration. It also found that the most important motivation for conducting technology transfer cooperation is to improve competitiveness, obtain funding support, and expand business networks. Limited access to research, finances, and technological and managerial capacity are the biggest inhibiting factors for MSMEs to develop collaborations with universities. Based on the data analysis using SmartPLS, the hypothesis tested the influence of technology transfer on product innovation and MSME performance was supported. Meanwhile, the hypotheses tested the influence of product innovation on MSME performance and the mediating role of product innovation in assessing the effect of technology transfer and MSME performance were insignificant.

Keywords: Technology transfer, product innovation, MSME Performance.

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1. INTRODUCTION

The role of universities as producers and transmitters of knowledge in industrial development, especially in the knowledge-driven economy, has become the most crucial aspect of innovation. The human capital is the key to sustainable economic growth. Since the 1980s, many countries around the world have implemented policies to promote and sustain the transfer of technology to MSMEs through a strategic partnership (Ibidunni *et al.*, 2021; Wuryaningrat *et al.*, 2017). Transfer of knowledge can be conducted through various mechanisms that differ between university research centers and MSMEs based on their motivation and available resources. This phenomenon increases academic interest in understanding, explaining, and justifying university-MSMEs partnership. In recent years, the discussion regarding universities' role in economic development through the transfer of knowledge and technology activities from universities to MSMEs, as well as contributions in terms of teaching and research, has received huge attention in the organizational and strategic literature.

Gopalakrishnan and Santoro (2004) suggest that the concepts of knowledge transfer and technology transfer are often considered the same since the creation of new knowledge involves understanding and absorbing certain new technologies. These two activities have different objectives, and the scope of technology transfer activities is narrower than knowledge transfer activities. Knowledge transfer includes a broader

learning process due to changes in strategic thinking, culture, and problem-solving processes adopted by the transferee. On the other hand, technology transfer places more emphasis on new equipment, methodologies, processes, and products as instruments to respond the business environment changes. This study focuses on the discussion regarding the technology transfer process conducted by universities to MSMEs to improve the MSMEs' performance (Cinar *et al.*, 2020; Abdurazzakov *et al.*, 2020; Battistella, 2023).

However, there are many barriers to transferring technology from university to MSMEs such as the character of the technology, technical skill required, and cultural differences. For instance, in the case of cultural differences, there is a significant cultural difference between universities and MSMEs, particularly in their mission. The mission of universities is to create knowledge and technology through research and development and disseminate it through education for society, while the mission of industries is to maximize economic return to shareholders. Therefore, managing technology transfer through university and MSME partnerships becomes the best strategy to improve MSMEs' performance that lead to sustainable economic growth.

Moreover, there is little systematic understanding of organizational practices in the management of university intellectual property, particularly in the developing country, such as Indonesia. There is still little attention paid to the process of technology transfer, particularly in the context of university-MSMEs technology transfer (Odriozola-Fernández *et al.*, 2019; Hilkenmeier *et al.*, 2021). Research in technology transfer through university and MSMEs partnerships is not easy to conduct in Indonesia due to the limited availability of articles published in the related field and the lack of awareness both in universities and MSMEs in Indonesia. Those obstacles will be “the additional value” of this study to provide benefits to encourage university and MSMEs partnership in Indonesia.

This study is conducted to analyze the implementation of technology transfer from university to MSME within universities and MSME partnerships, especially in the manufacturing sector. The selection of MSMEs is based on the consideration that MSMEs have a significant contribution to growth and employment in Indonesia. Data shows that in 2021, MSMEs contribute up to 60.5% and absorb 96.9% of the workforce from the total absorption of labor in Indonesia (Limanseta, 2022). Meanwhile, the selection of MSMEs that operate in the manufacturing sector is based on the consideration that MSMEs in the manufacturing sector certainly need technology since technology is the key to the growth of industries engaged in manufacturing.

Previous studies have proven that technology transfer has a significant effect not only on the overall performance of MSMEs (Cinar *et al.*, 2020; Abdurazzakov *et al.*, 2020), but also on the innovation capabilities of MSMEs (Battistella, 2023). In Indonesia, as an emerging market economy, technology transfer activities become one of many ways to improve and develop technological capabilities, especially for MSMEs that are often faced with problems of limited resources. Handoko *et al.* (2017) conducted a study involving 200 MSMEs in the metal sector in Java Island to prove that technology transfer activities can increase the technological capabilities of MSMEs. The study shows that technology transfer activities from the Government, Businesses, and Universities significantly influence in increasing MSME capabilities in Indonesia.

This research is meant to fill the gap of knowledge in this area. The broad objective of this study is to analyze the university-to-MSME technology transfer process and its outcomes, while the specific objectives are: 1) to identify the form of technology transfer required by MSMEs 2) to identify the importance of the university-to-MSME technology transfer, 3) to identify barriers to the university-to-MSME technology transfer, 4) to

identify MSME's perception toward the technology transfer joint program between universities and MSMEs, 5) to examine the impact of technology transfer on product innovation and MSMEs.

This study is expected to contribute to the theory and practice of strategic management, particularly in the higher education and industry sectors. In terms of theoretical significance, this study intends to improve upon existing literature by addressing the previous objective of the study. This study is also expected to develop intellectual capability and professional knowledge for researchers in the field of strategic management, through the application of theories in real sectors or business activities. The practical significance of this study lies in its attempt to provide a framework for managing partnerships between universities and MSMEs, developing practical guidelines for academia and practitioners. For practicing managers, the evidence from this study may be useful in making decisions to enhance the effectiveness of technology transfer between universities and MSMEs.

2. LITERATURE REVIEW

2.1. Technology and Technology Transfer: Conceptual Review

Technology is one source of lasting competitive advantage in the economy where the only certainty is uncertainty. When the market shifts, technologies proliferate, competitors multiply, and the products become obsolete, successful organizations are those that consistently create new knowledge and technology through knowledge management that can enhance organizational performance (Espita & Guhao, 2022). This circumstance leads to the increase of awareness of research partnerships between universities and industry, especially MSMEs, to support government policy to enhance economic growth.

Technology has been defined in many ways, in terms of the general use of knowledge in the science of industrial art. Al Ali (1995) cited in Hendrix (2018) stated that the term technology may also be interpreted as tools, machines, and intellectuals. Cunningham and O'Reilly (2018) defined technology as the ability to recognize technical problems, concepts, and tangible things developed to solve technical problems. Technology may also be defined as the ability to exploit those concepts and tangible things effectively. On the other hand, technology is hardware and software employed to solve operational problems effectively in an organization.

Literature on economics and management proved that technology is a potential source of competitive advantage. A study conducted by Wanaswa *et al.* (2021) found that technological innovation is powerful to increase competitive advantage. Technology affects manufacturing costs and other competitive drivers such as average process changeover, finished product defect rate, new product introduction lead time, delivery on time, productivity, and increased customer morale (Harisson & Samson, 1997 cited in Hidayati *et al.*, 2020). When a company uses appropriate technology to its maximum potential, a lower cost might be achieved. This cost includes the total cost, material cost, labor cost, and overhead cost. Another study conducted by Blichfeldt and Faillant (2021) found that technology adoption and innovation created competitive opportunities. Technology adoption has a positive effect on MSME's performance such as payroll size, asset size, financial rating, sales rating, and operating problem. Hottenstein and Dean (1995) found that organizations need to choose, design, and implement manufacturing technologies that are consistent with the needs of competitive advantage to develop a competitive advantage.

Technology is important not only for large companies, but also for micro, small, and medium-scale companies. However, limited resources are often the main problem

faced by MSMEs. Not only limitations in terms of budget but also limitations in terms of human resources. The skills and knowledge possessed by human resources are crucial for optimally utilizing technology. This problem might be minimized and overcome through technological transfer mechanisms. Technology transfer, from an operational point of view, is a communication process with information processing activities. According to its specific characteristics, the technology owned by an actor (individual or organization) can be transferred to another actor by information flows conveyed by appropriate media. The typology of communication and its effectiveness and efficiency will depend on the media choice.

Norman and Eisenkot (2017) define technology transfer as the process of transferring information and technology from one group to another target group which involves the licensing process and expansion of intellectual property rights from experts. In the study conducted in the biotechnology industry, the technology transfer carried out referred to initial target drugs which were the results of discoveries by the university that could then be produced and commercialized in the biotechnology industry. Through partnerships between universities and the biotechnology industry, each party has documented evidence that targeted drugs have been successfully transferred from universities to the biotechnology industry. The technology transfer process from universities to MSMEs involves several stages and collaboration to achieve success, which involves various applications and agreements between both parties, including intellectual property in the form of technology mastery.

Yahaya and Bakar (2017) define technology transfer as a process where knowledge, facilities, and capabilities are developed through research and development activities to meet both public and private needs. Apart from that, technology transfer can also be understood as a systematic activity conducted by one party to develop rational knowledge which can later be utilized by other parties. Technology transfer activities are goal-oriented and an active process between two or more parties involved in a partnership. Through technology transfer activities, it is expected that uncertainty can be reduced, and innovation capabilities can be increased, especially concerning capital resources in the research and development sector.

Mancini and Gonzalez (2021) defined technology transfer as an active process, during which technology is carried across the border of two entities. It is an essential process for the wide implementation and utilization of technology by one or more users (Kumar *et al.*, 2015). Through technology transfer, a company may permit the flow of technology from source to receiver. The source of technology is the owner or holder of knowledge which can be an individual, company, or country. Technology transfer might include activities such as processing and evaluating invention disclosures; filing for patents; technology marketing; licensing; protecting intellectual property arising from research activity; and assisting in creating new businesses and promoting the success of existing firms that may lead to the development of new products, more high-quality jobs, and an expanded economy.

2.2. Technology Transfer Issues Within University and MSME Collaboration

Based on the research objectives identified in the introduction section, several issues related to technology transfer from universities to MSMEs that will be discussed in this section include types of technology transfer from universities to MSMEs, barriers to technology transfer, the importance of technology transfer activities from universities to MSMEs, the role of universities and MSMEs in joint programs between universities and MSMEs, and the influence of technology transfer and technological infrastructure on the performance and innovation of MSMEs.

Various Forms of Technology Transfer

Basu (2023) states that technology transfer activities include the transfer of knowledge or technology from a research institution, academic institution, or private company to the market, industry, or other entity to use technology in the process of creating products, services, or solutions to problems faced. Various forms of technology transfer can include licensing, collaborative research and development (R&D), spin-offs and start-ups, and technology acquisitions.

Licensing is a general form of collaboration between universities and industry where parties who own technology or intellectual property rights permit partners to utilize technology and intellectual property for use, production, or sale so that they receive licensing fees or royalties in return. R&D collaboration can be understood as a collaborative project involving educational institutions, research centers, and companies to collaborate in efforts to develop technology and innovation for the company.

Spin-off can be understood as the separation of a company to become a new entity without eliminating the existence of the parent company and the new company can stand alone without becoming a subsidiary of the parent company. In other words, there is no dependency between the parent company and the new company, it is even possible for both parties not to work together. A startup can be understood as a start-up company that focuses on finding and developing a target market or focuses on the development stage. Meanwhile, technology acquisition is when companies or organizations collaborate to obtain technology or intellectual property rights through purchases.

The Importance of Technology Transfer

Technology transfer from universities to MSMEs is necessary to improve the performance and competitive advantage of MSMEs. Mastering technology will enable MSMEs to increase innovation capabilities and develop MSMEs so that they can survive and compete in a dynamic and competitive business environment. Basu (2023) identified several reasons why technology transfer activities are important for MSMEs including:

- a. Increasing access to innovation and competitiveness since the opportunity to access new technology by MSMEs allows them to improve products, processes, and services to consumers so that competitiveness can be increased.
- b. Reducing costs and increasing efficiency due to limited resources are the main problems that MSMEs often face, so it is expected that gaining access to new technology will assist MSMEs in producing more efficiently and optimizing the resources they have.
- c. Gaining access to specific knowledge from universities which is often rare or even not available to MSMEs, so that the opportunity to access specific knowledge, skills, research techniques, and business infrastructure development is expected to assist MSMEs in developing their business.
- d. Increase product diversification so that it supports business growth and increases MSME income.
- e. Increasing business networks through collaboration so that it can generate profits and benefits not only for MSMEs but also for collaboration partners.
- f. Developing MSMEs capacity through acquiring new knowledge and skills from partners so that overall MSMEs productivity can be increased.
- g. MSMEs can obtain funding and support, for example, funding can be obtained from the Government through grants provided by the Government for the collaborative development of universities and MSMEs.
- h. Improving the ability of MSMEs to comply with existing environmental

regulations and standards so that the reputation of MSMEs can be improved and the position of MSMEs in the market can be achieved.

- i. Increasing resilience and adaptation capabilities due to mastery of new technology obtained from technology transfer activities from universities to MSMEs will enable MSMEs to be able to adapt to the business environment and meet market demands more effectively.
- j. Acquire intellectual property that enables MSMEs to protect innovation and gain competitive advantage in the long term.

The Barrier of Technology Transfer

Burhanuddin *et al.* (2009) identified several obstacles for MSMEs in the process of transferring technology from universities to MSMEs including lack of investment funds; lack of managerial skills; and lack of talented and skilled workforce which has an impact on production quality, efficiency, and productivity; limited capacity for technology management and knowledge acquisition; limited access to finance and capital; difficulties in getting access to consultations from industrial experts; limited staff who are capable of conducting research related to new technology and innovation; takes quite a long time to find a new system; limited knowledge of current system capabilities; lack of information about potential markets and consumers; global competition.

MSME Perceptions Regarding Technology Transfer

Handoko (2019) conducted a study to identify the response of MSMEs to the respective roles of the Government, Universities, and MSMEs in technology transfer activities from universities to MSMEs. In this study, the perceptions focus of technology transfer assessment is on MSMEs, namely assessing the effectiveness of implementing technology transfer based on several aspects including; the relevance of responsibilities and control of knowledge transfer from providers with the needs of MSMEs; the relevance of the provider's technology transfer project theme with the needs of MSMEs; effectiveness of communication during the implementation of technology transfer; conference and meeting activities provided by the provider is relevant with MSMEs need; the adequacy of human resources involved by the provider to support technology transfer activities; the adequacy of the workshop program provided by the provider to support technology transfer activities; the adequacy of industrial visitation activities carried out by providers to support technology transfer activities; the adequacy of the feedback process provided by the technology provider regarding the technology transfer activities carried out.

2.3. Technology Transfer, Product Innovation, and Performance

Several studies both conceptually and empirically on technology transfer from universities to MSMEs have been conducted in Indonesia. Most of the studies focus on investigating the effect of technology transfer in facilitating the internationalization of MSMEs, increasing MSME competitiveness, improving MSME performance, and efforts to increase MSME innovation (Yahaya & Bakar, 2017; Rodrigo *et al.*, 2018; Nicodemus & Egwake, 2019; Cinar *et al.*, 2020; Hilkenmeier *et al.*, 2021; Satchawatee *et al.*, 2021; Mancini & Gonzales, 2021; Handoko *et al.*, 2019; Rahman *et al.*, 2022).

The study conducted by Yahaya and Bakar (2017) aims to analyze the role of technology transfer in increasing the competitiveness of MSMEs through Research and Development (R&D) activities. The study involved 148 MSMEs in Malaysia for 10 years from 2004-2013 including MSMEs operating in the manufacturing, service, and agricultural sectors. The study found that of the three industrial sectors, significant R&D

costs were in the service sector. The study results show that achieving competitiveness of MSMEs through technology transfer can be represented by the values of return on assets (ROA), return on equity (ROE), net income, and sales turnover. The study results also show that research and development costs have a positive impact on company performance.

The study conducted by Rodrigo *et al.* (2018) aims investigate opportunities for the promotion of collaboration involving universities and industry in Sri Lanka. The collaboration between these two parties is considered to have a huge influence as a medium for overcoming technological problems faced by MSMEs in the country using research ideas and innovative capabilities that universities have as knowledge-producing institutions. The study used a mixed method approach, namely qualitative and quantitative, and data collection was conducted using questionnaires and interviews with MSME actors and industrial development councils.

Data analysis was conducted to understand the technological needs of MSMEs that can be met through collaboration with the universities. The study results show that collaboration between universities and MSMEs not only benefits one party but both parties. From the university side, they receive the benefit that the knowledge and expertise they have can be implemented in the industrial world, while from the industrial side, they receive the benefit in the form of technological support. The study also found that universities that adhere to the entrepreneurial concept, namely focusing on innovation capacity, understanding, and creating opportunities, as well as working as a team, taking risks, and being able to respond to change, will be able to strengthen relationships with MSMEs in the future. In this circumstance, universities with an entrepreneurial concept will be able to produce entrepreneurs who act as mediators in technology transfer between universities and MSMEs.

Nicodemus & Egwake (2019) conducted a study to examine the effect of technology transfer on a company's competitive advantage from a manager's perspective. Data was collected through survey techniques using questionnaires that had been tested for validity and reliability and involving 90 telecommunications company managers in Nigeria, especially Lagos State. The study results prove that there is a strong relationship between the dimensions of technology adoption, technological infrastructure, and technological innovation and the company's competitive advantage.

The study conducted by Cinar *et al.* (2020) aims to examine the relationship between technology transfer, innovation, and company performance. By involving 252 companies operating in the export sector in Turkey and the research model was tested using Structural Equation Modeling (SEM), this study found that there was a positive impact of technology transfer on innovation and company performance and innovation mediated the relationship between technology transfer and company performance in export companies. According to these findings, decision-makers are advised to carry out knowledge transfer activities appropriately so that the company's innovation capacity and performance can be improved, especially for companies operating in the export sector. An understanding of the relationship between technology transfer, innovation, and company performance is needed to assist companies in formulating the best decisions regarding technology transfer by focusing on the proper type of innovation to improve company performance.

Hilkenmeier *et al.*, (2021) conducted a study to analyze research and development collaboration programs between universities and MSMEs which focus on technology transfer-based projects. In this study, the MSMEs involved did not have experience in collaborating on research and development projects. By involving scientists from an RTO (Research and Technology Organization) in collaboration with MSMEs, the project aims

to meet MSMEs' needs. To evaluate the effectiveness in overcoming various obstacles such as selecting the right collaboration partners, limited resources, and limited absorptive capacity, in this study, the R&D Lifecycle Model was adopted (Albats *et al.*, 2018; Fernandes *et al.*, 2017).

The R&D Lifecycle Model adopted in the study includes four stages in an R&D collaboration process which includes organizational and individual "input" (first stage) required in "in-process activities" in the collaboration (second stage), which will later have an impact on "actual output" (third stage), and in the end the output can have an "impact" on all parties involved in the collaborative project (fourth stage). By involving 106 different projects and analyzing the data with Structural Equation Modeling (SEM), the study found that the majority of MSMEs involved in collaborative R&D projects were successful in overcoming the challenges of Industry 4.0, it not only provides benefits in the performance and competitive advantage of MSMEs but also strengthening technical aspects and human resource knowledge in the long term.

The study conducted by Satchawatee *et al.* (2021) aims to examine the impact of technology transfer capability measured through five dimensions (including learning capability, acceptance orientation, innovation focus, exchange competence, and concern for change) on sustainable competitive advantage. By involving 286 respondents, where top executives were the target respondents, the study found that innovation focus and exchange competencies have a significant positive impact on achieving sustainable competitive advantage for a company. This means that technology transfer capability is an important factor in increasing organizational competitiveness. Specifically, innovation focus has a significant role in the process of developing new products, operational improvements, business efficiency, and company performance.

Mancini & Gonzales (2021) conducted research to increase understanding of the influence of technology transfer and innovation strategies in increasing the growth of MSMEs. Innovation strategies defines four types of innovation: product innovation, process innovation, marketing innovation and organizational innovation (Kuo *et al.*, 2022). MSMEs have always been faced with problems of limited resources and limited participation in business networks. In conditions of dynamic changes in the business environment, MSMEs need to develop collaborative networks to be able to increase innovation capabilities and develop specific competencies, especially related to mastery of technology, which will be possible to achieve through technology transfer activities from outside the company or MSMEs themselves.

In this study, researchers develop a conceptual model of innovation and propositions related to MSME access to international markets. This model is considered easy for MSMEs to follow if they have adopted technology transfer, innovation strategies, and networking approaches. The study findings state that this conceptual framework will be easier for MSMEs to understand the driving factors and approaches to building collaboration networks and MSME performance.

A study on technology transfer from universities to MSMEs in Indonesia was conducted by Handoko *et al.* (2019) as briefly discussed in the introduction. The study involved 200 MSMEs who were requested to respond to the questionnaire survey that focused on the knowledge and technology transfer practices provided. The results of the analysis show that the level of commitment, interest, and engagement of MSMEs in terms of technology transfer is considered quite significant.

The study conducted by Rahman *et al.* (2022) aims to identify factors that influence the success of technology transfer between universities and MSMEs in Malaysia and develop a conceptual model of the determinants of technology transfer, government support, and MSME performance. The results of the literature review identified several

determinants of success including promotion, prior experience, protection, and activities with government support as variables that may strengthen or weaken the influence of each factor determining the success of technology transfer on MSME performance.

In the discussion of previous studies, it has been proven that technology transfer has a significant influence on innovation which will ultimately impact the performance of MSMEs, so this research will test the following hypothesis:

- H1. Technology transfer affects product innovation.
- H2. Technology transfer affects MSME performance.
- H3. Product innovation affects MSME performance.
- H4. The effect of technology transfer on MSME performance is mediated by product innovation.

3. METHODS

3.1. Sample and Data Collection

This study focuses on the manufacturing industries (specifically micro, small, and medium companies/MSMEs) in Indonesia. The unit of analysis is MSME, the sample is selected randomly from the directory in different geographical locations in Indonesia. The sample is selected based on the convenient sampling method. Data was collected through a survey. The questionnaire design includes basic respondent information, including name, gender, position in the organization, and length of work.

3.2. Measurement

The questionnaire design also required several issues and measurements: 1) the type of technology transfer needed by MSMEs consists of 4 items adopted from Basu (2023), 2) the importance of technology transfer consists of 10 items adopted from Basu (2023), 3) the barriers to technology transfer consists of 10 items adopted from Burhanuddin *et al.* (2009), 4) MSME's perception toward the technology transfer joint program between universities and MSME consists of 8 items adopted from Handoko *et al.* (2019). All the questions used a 5-point Likert scale. Some open-ended questions were designed to determine how various stakeholders defined technology transfer and its outputs as well as what they viewed as impediments to successful technology transfer and strategies for improvement.

Respondents were also asked to fill out several questions related to technology transfer, innovation capabilities, and MSME performance to test the hypotheses developed in this research. The instrument for measuring the transfer technology variable includes 12 items adopted from Sung (2009). The innovation variable consists of 5 items adopted from research by Gunday *et al.* (2011). The performance variable consists of 3 items adopted from research by Li *et al.* (2011).

3.4. Method of Data Analysis

Technique analysis to analyze data will use descriptive statistics and quantitative analysis using SMART PLS. Descriptive Analysis is used to analyze (1) the type of technology transfer from university to MSME, (2) the importance of technology transfer (3) barriers to the university-to-MSME technology transfer, (4) MSME's perception toward the technology transfer joint program between universities and MSME, 5) to examine the impact of technology transfer on product innovation and performance.

Data are analyzed using SmartPLS including testing the outer model and testing the inner model or structural model. Testing of the outer model includes validity and

reliability tests. In this study, the validity test was conducted on the factor loading value on the latent variable with its indicators. The validity value is said to be high if the loading factor value is more than 0.60 with the construct you want to measure. Reliability testing is analyzed by the Cronbach Alpha value, composite reliability, where a construct is declared reliable if the composite reliability and Cronbach Alpha value of more than 0.70 (Sihombing & Maryani, 2022).

The structural model was tested using R-square for the dependent variable and the path coefficient value for the independent variable, the significance value was measured based on the t-statistic value for each path. Sihombing and Maryani (2022) stated that the R square value of 0.67 is in the strong category, 0.33 in the moderate category, and 0.19 in the weak category. To show the magnitude of the influence of the independent variables on the dependent variable, in this study the adjusted R-value is used. Meanwhile, to determine the goodness of the model, the effect size value is used, the value of which is expected to be more than 0.15.

4. FINDINGS

4.1 Respondent Profile

The profile of respondents who participated in this research can be summarized as follows. Based on gender, 36 (63.2%) were male respondents, and 21 (36.8%) were female respondents. Based on the respondents' position at work, 82.5% were business owners, 5.3% were managers or deputy managers, another 5.3% were staff and the remaining 7.1% did not mention their status. Based on the business age, 57.9% of MSMEs have operated for 0-5 years, 1.8% have operated for more than 5 years to 10 years, 7% have operated for more than 10 years to 15 years, 5.3% have operated for more than 15 years to 20 years, and 28% operated more than 20 years.

The classification of business fields in this study refers to the classification provided by the Indonesian Banking Development Institute through the publication of Profile of Indonesian MSMEs which is the result of collaboration between the Indonesian Institute of Sciences and Bank Indonesia in 2015. The classification and results of data collection are based on the business fields or business profiles of MSMEs in the study this includes trading (3,51%), manufacturing (47,37%), agriculture (10,53%), plantation (14,03%), stockbreeding (3,51%), fishery (1,75%), and services (19,3%).

Based on the number of workers. The majority of MSMEs have a workforce of >30 workers, namely 80.7%, 8.8% have a workforce of less than 10 people, and 10.5% have a workforce of more than 10 to 30 people. Based on performance over the last 3 years, information was obtained that the majority of MSMEs experienced an increase in performance of $\leq 15\%$, namely 42.1% of MSMEs who participated in this research, 38.8% experienced an increase in performance of $\geq 15\%$ in the last three years, 14% responded that MSMEs experienced neither an increase nor a decrease. performance over the last three years. 5.3% of MSMEs responded that they experienced a decline in performance of $\geq 15\%$ over the last three years, and 1.8% experienced a decline in performance of $\leq 15\%$ over the last three years.

Based on assets, the majority of MSMEs answered that they had assets between 50 and 500 million, namely 52.6% of MSMEs, 35.1% responded that they had assets greater than 500 million, and the remaining 12.3% had assets ≤ 50 million. Based on annual turnover, the majority of MSMEs responded that they had a turnover of between 300 million and 2.5 million, namely 70.2% of MSMEs, and the remaining 5.3% answered that they had a maximum turnover of 300 million. Table 3 summarizes the characteristics of the respondents involved in this research based on gender, position in the company,

company age, number of employees, performance in the last three years, assets, and turnover owned by MSMEs.

4.2. Descriptive Statistics

Descriptive statistical testing was conducted to determine the characteristics of respondents' responses regarding the type of technology transfer needed, the importance of technology transfer, barriers to technology transfer, and perceptions of technology transfer from an MSME perspective.

Table 1. Type of Technology Transfer

No	Type of Technology Transfer	Mean	Standard of Deviation
1	Licensing	4	1.018
2	Collaborative R&D	4.12	0.908
3	Spin-off & Startup	4.19	0.833
4	Tech Acquisition	4	0.945

Source: Processed Data

Table 1 shows the types of technology transfer required by MSMEs. Based on the results of respondents' responses, it shows that spin-offs and start-up companies as well as collaborative research and development are the types of technology transfer most needed by MSMEs, as described from the highest average answers, namely 4.19 and 4.12.

Table 2. The Importance or Motivation of Technology Transfer

No	Motivation	Mean	Standard of Deviation
1	Increasing innovation capability	4.02	0.939
2	Training Collaboration	4.02	0.935
3	Cost reduction and increasing efficiency	4.09	0.916
4	Knowledge access from the university	4.09	0.786
5	Developing product diversification	3.93	0.863
6	Networking	4.12	0.758
7	Developing MSME capacity	4.11	0.724
8	Funding and support from the university	4.16	0.797
9	Improving MSME competitiveness	4.24	0.732
10	Increasing resilience and adaptability	4.11	0.838

Source: Processed Data

Table 2 summarizes the results of descriptive statistical tests regarding the MSME perspective on the importance of technology transfer from universities to MSMEs. Based on the results of the analysis, shows that most respondents responded to the need to increase competitiveness, obtain funding, and support, and develop business networks as the most important motivation with the highest average response values being 4.23; 4.16; and 4.12. Followed by the motivation to increase the resilience and adaptability of MSMEs and develop the capacity of MSMEs with an average answer value of 4.11 respectively.

Table 3 summarizes respondents' answers to questions regarding barriers to technology transfer from universities to MSMEs. The results of data analysis show that access to conduct research, financial needs, efforts to discover new systems and limited technological and managerial capacity are the main inhibiting factors with the highest mean answers being 4.05 respectively; 3.98; 3.96; and 3.96.

Table 3. Barriers of Technology Transfer

No	Barriers	Mean	Standard of Deviation
1	Investment cost	3.88	1.336
2	Managerial skill	3.95	1.007
3	Worker's skill and talent	3.93	1.005
4	Limitation of technology and managerial capacity	3.96	1.052
5	Limitation of financial	3.98	0.934
6	Lack of access to consultants	3.93	1.017
7	Lack of access to conducting research	4.05	1.033
8	Difficulties in finding and developing a new system	3.96	1.119
9	Lack of knowledge related to system capability	3.93	1.033
10	Lack of information regarding market and consumer	3.88	1.119

Source: Processed Data

Table 4. Perception of Technology Transfer Activities

No	Barriers	Mean	Standard of Deviation
1	Investment cost	3.43	0.904
2	Managerial skill	4.14	0.734
3	Worker's skill and talent	3.96	0.844
4	Limitation of technology and managerial capacity	4.11	0.724
5	Limitation of financial	3.95	0.811
6	Lack of access to consultants	4.04	0.801
7	Lack of access to conducting research	4.07	0.797
8	Difficulties in finding and developing a new system	3.98	0.744

Source: Processed Data

Table 4 summarizes respondents' answers regarding perceptions regarding technology transfer activities from universities to MSMEs. Based on the results of the responses provided by respondents, information was obtained that the relevance of technology and needs, relevance of conferences and meetings, suitability of industrial visits, and relevance of workshops, were the four main aspects that were considered the best regarding the implementation of technology transfer activities from universities to MSMEs with an average value the highest respectively is 4;14; 4.11;4.07; and 4.0

Respondents were also provided the opportunity to state the type of technology transfer needed, the motivation underlying the decision to collaborate with universities regarding technology transfer, and the obstacles they experienced in the process of transferring technology from universities to MSMEs. The results of data analysis show that most respondents responded to digital literacy or digitalization of MSMEs, marketing innovation, and product innovation as the most frequently given answers regarding the type of technology transfer needed.

Regarding the motivation underlying MSMEs to include technology transfer collaboration with universities, respond to the need for market access, expert consultation, access to university research results, development of MSME human resources, and the opportunity to obtain funding to conduct research with universities were the most frequent responses expressed by MSMEs. Regarding obstacles in conducting technology transfer

collaboration with universities, the response was that there were differences in culture, vision, and mission between universities and MSMEs, differences in the need for types of research being the main obstacle most often addressed by MSMEs.

4.3. Measurement Model Evaluation

Before the hypothesis testing process is conducted, in this study an outer model evaluation is conducted to test the validity and reliability of the measurements used. Based on the results of the outer model test, factor loading values were obtained to measure the validity of the measurements as depicted in Figure 1.

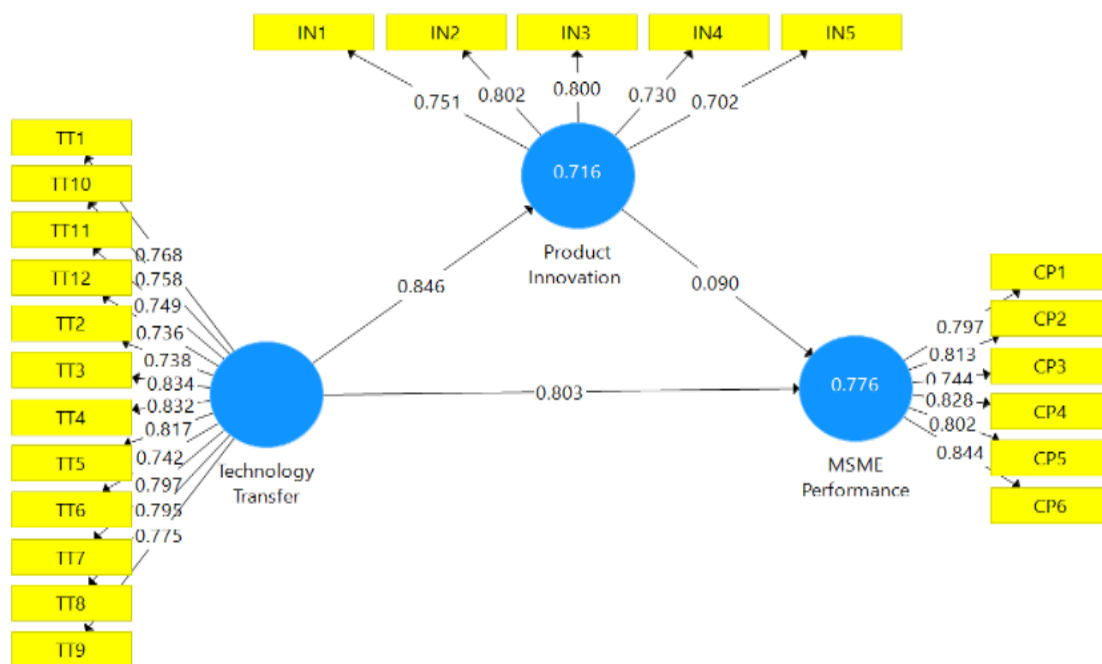


Figure 1. Loading Factors of Technology Transfer, Product Innovation, and MSME Performance Indicators

Source: Processed Data

Figure 1 shows the results of validity testing show that the factor loading value of each latent variable is above 0.6, therefore it can be concluded that the indicators measuring technology transfer (0.736-0.834), product innovation (0.751-0.802), and MSME performance (0.744-0.844) are valid (Ghozali & Latan, 2015). Based on Cronbach's Alpha [technology transfer (0.941); product innovation (0.828); MSME Performance (0.849)] and Composite Reliability [technology transfer (0.949); product innovation (0.871); MSME Performance (0.917) for all indicators that are above 0.7, so that can be concluded that all indicators are reliable (Hair *et al.*, 2019).

4.4. Structural Model Evaluation

Evaluation of the structural model is conducted by testing the effect size and coefficient of determination as summarized in Table 6 and Table 7.

Table 5. Size Effect

	MSME Performance	Product Innovation
MSME Performance		
Product innovation	0,010	
Technology Transfer	0,817	2,516

The results of the effect size describe in Table 5 that show that technology transfer in influencing MSME performance is good, therefore only technology transfer measures MSME performance with the respective f square values. 0.817 and 2.516. However, product innovation in measuring the performance of MSMEs is considered not good as indicated by the f square value 0.010 with the indicator-colored red.

Table 6. Coefficient Determination

	MSME Performance	Product Innovation
MSME Performance	0.776	0.787
Product innovation	0.716	0.710

Source: Processed Data

Table 6 summarized the results of the coefficient of determination test to assess how much an endogenous construct can be explained by an exogenous construct.

4.5. Hypothesis Testing

Table 7 summarizes the results of hypothesis testing developed in this research including testing the influence of technology transfer on product innovation, the influence of technology transfer on MSME performance, the influence of product innovation on MSME performance, and the influence of product innovation in mediating the influence of technology transfer on MSME performance.

Table 7. Hypothesis Testing Result

Hypotheses	Causal Association	Original Sample	Standard Deviation	T statistic	P Values
H1	TT -> PI	0.846	0.037	22.584	0.000
H2	TT -> Perf	0.803	0.112	7.184	0.000
H3	PI -> Perf	0.090	0.125	0.726	0.468
H4	TT -> PI Perf	0.076	0.101	0.756	0.447

Source: Processed Data

As summarized in Table 7, the results of hypothesis testing show that the hypothesis which states that technology transfer influences product innovation is supported by a t statistic value of 21.885 and a P value of 0.000. The hypothesis which states that technology transfer affects MSME performance is supported by a t statistical value of 7.461, P value 0.000.

The results of hypothesis testing regarding the influence of product innovation on MSME performance show that the hypothesis is not supported based on the t statistical value of 0.726 and the p-value of 0.468. This means that product innovation does not affect MSME performance. The results of testing the mediating role of product innovation in mediating the influence of technology transfer on MSME performance are also not

supported. The results of testing the role of mediation based on specific indirect effects show a t-statistic value of 0.756 with a p-value of 0.447. This means that product innovation does not mediate the effect of technology transfer on MSME performance.

4.6. Discussion

The results of hypothesis testing state that technology transfer has a significant positive effect on product innovation and MSME performance support and confirm the findings of previous studies which state that technology transfer affects product innovation (Cinar *et al.*, 2020) and MSME performance (Cinar *et al.*, 2020; Hilkenmeier *et al.*, 2021; Rahman *et al.*, 2022). These findings prove that technology transfer activities and practices from universities to MSMEs will have a significant positive influence on product innovation policies carried out by MSMEs. Likewise, the expected influence on improving the performance of MSMEs.

Activities and supporting factors for technology transfer activities from universities to MSMEs include the existence of communication channels between universities and MSMEs, managerial support, incentives provided to support the implementation of technology transfer activities, understanding the general objectives of technology transfer cooperation, understanding of the business being carried out, concern for technology transfer activities, collaboration between the two collaborating parties, government support, attitudes and values of each party, concrete technology, technology transfer based on demand needs from MSMEs, and product excellence.

Hypotheses related to the influence of product innovation on MSME performance and testing the mediating role of product innovation on the influence of technology transfer on MSME performance show results that conflict with the findings of previous studies conducted by Cinar *et al.* (2020). It can be explained concerning product innovation measurement items and the problems faced by MSMEs in Indonesia in general. The product innovation measurement instrument in this study was adopted from the research instrument developed by Gunday *et al.* (2011).

The questions measuring product innovation in this study include five items, namely First, product development with technical specifications and functions that are different from the products currently produced by MSMEs. Second, developing new products currently produced by MSMEs to provide ease of use and improve consumer satisfaction. Third, developing current products with new components and materials that are completely different from current products. Fourth, reduce costs in components and materials from current products. Fifth, improving the quality of current product components and materials.

The product innovation stated previously is considered to require significant financial and human resources. On the other hand, it cannot be denied that many MSMEs in Indonesia are still struggling to overcome classic MSME problems, including limited access to funding and limited knowledge and skills of human resources, which result in MSMEs in Indonesia still having difficulty developing, especially in terms of product innovation that requires capital resources. financial and human resources are quite large, including in terms of mastery of technology to support product innovation that will be carried out (Soehandoko, 2023). It is hoped that this logical argument regarding conditions in the field can explain the findings of the third and fourth hypotheses which contradict the findings of previous studies.

5. CONCLUSION

This study was conducted to investigate MSMEs' perceptions of the type of technology transfer required, motivations for engaging in technology transfer cooperation, barriers, and MSMEs' perceptions regarding implementing technology transfer cooperation. In addition, this study examines the influence of technology transfer and product innovation variables on MSME performance. The study results show that the development of spin-offs and start-up companies as well as research and development collaboration are the types of technology transfer needed by MSMEs. Improving competitiveness, obtaining funding support, and expanding business networks are the three main motivations considered most important by MSMEs when deciding to collaborate on technology transfer from universities.

Regarding barriers to collaboration, according to the perception of MSMEs, limited access to conduct research, financial limitations, limited technological and managerial capacity, as well as limitations in finding new systems are the biggest inhibiting factors for MSMEs to build collaborations with universities. Regarding perceptions regarding the relevance of technology transfer to the needs of MSMEs, technology provider factors and the needs of MSMEs, the relevance of conducting conferences and meetings, the relevance of industry visits, and the relevance of providing workshops are the factors considered to be the most relevant in implementing technology transfer cooperation from universities to MSMEs.

The results of hypothesis testing show that technology transfer influences product innovation and MSME performance. However, from the results of testing the effect of product innovation on MSME performance and the mediating role of product innovation in assessing the effect of technology transfer and MSME performance, the results were not significant. The logical explanation for these two insignificant results has been explained in the previous discussion section.

The managerial implications that can be identified based on the study results include: First, there is a need to improve communication and collaboration between universities and MSMEs to overcome gaps and differences in vision, mission, and work culture so that collaboration can be carried out more effectively and efficiently. Second, as a knowledge-producing institution, the focus of university research, especially in the social sector, is more on basic research for publication and dissemination of research results. In the future, universities need to open themselves to applied research which is born out of motivation to solve existing problems that occur with partners and formulate appropriate policies and strategies for partners. Third, MSMEs need to open themselves to the transfer of knowledge and technology from external parties, one of which is from universities so that the main problems of MSMEs related to limited resources can be overcome and the performance and competitiveness of MSMEs can be improved.

The limitations of the research and suggestions for future research in this study can be described as follows: First, the sample used in this study is still quite limited, with only 57 respondents, so that the research results may not be representative of the MSME population in Indonesia so that in future research the sample will be sufficient. It is necessary to pay attention to increasing the number of samples and using more varied data collection considering that there are still many MSMEs who are not familiar with digital technology and therefore refuse to participate as respondents in this research.

Second, measuring the performance of MSMEs in this study uses perceptions of MSME satisfaction with sales results, profits, return on investment, return on assets, sales growth, and market share growth. Considering that performance measurement in this case is based on the respondent's perception of satisfaction with these six measures, bias can occur in assessing the performance of MSMEs so it is necessary to consider using objective performance measurements in future research.

Third, this study does not test the role of control variables in explaining the influence of the dependent variables (technology transfer and product innovation) on MSME performance. Future research could test the role of control variables such as MSME business sector or firm size (measured by the number of employee or total assets) in explaining the influence of technology transfer or product innovation on MSME performance.

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