REVIEW OF INTERNATIONAL GEOGRAPHICAL EDUCATION
ISSN: 2146-0353 • © RIGEO • 11(3), SUMMER, 2021
www.rigeo.org
Research Article

The Dynamics of Technology Adoption Readiness of Micro, Small, and Medium Enterprises and Affecting Characteristics: The Experience from Indonesia

Rochmat Aldy Purnomo[1]
Faculty of Economics and Business, Universitas Sebelas Maret, Surakarta, Indonesia

J.J. Sarungu[2]
Faculty of Economics and Business, Universitas Sebelas Maret, Surakarta, Indonesia

Bhimo Rizky Samudro[3]
Faculty of Economics and Business, Universitas Sebelas Maret, Surakarta, Indonesia

Tri Mulyaningsih[4]
Faculty of Economics and Business, Universitas Sebelas Maret, Surakarta, Indonesia

[1]Corresponding author: Rochmat Aldy Purnomo, email: rochmataldy93@gmail.com,

Abstract
The objective of this research is analysis the level of MSMEs readiness for technology adoption and analyze the characteristics that influence technology adoption in Indonesia. The level of technology adoption for MSMEs divided into several clusters, namely the artisinal cluster (the lowest), active cluster, dynamic cluster, and advanced cluster (the highest). The type of data is based on the Likert scale which in principle is a questionnaire-based survey data collection which aims to collect opinion information from MSMEs actors related to characteristics that affect the level of readiness for technology adoption. It is found that the majority of MSMEs actors is still in the artisinal cluster in all categories, but, some of them are already in the advanced cluster. The contributions is managers/owners of MSMEs need to focus on variables that can strengthen (influence) MSMEs in order to increase their clusters.

Keywords
MSMEs, Technology Readiness Level, Indonesia, Innovation

To cite this article: Purnomo R, A, Sarungu J, Samudro B,R, and Mulyaningsih T. (2021). The Dynamics of Technology Adoption Readiness of Micro, Small, and Medium Enterprises and Affecting Characteristics: The Experience from Indonesia.Review of International Geographical Education (RIGEO), 11(3), 834-854. Doi: 10.48047/rigeo.11.3.80

Submitted: 20-01-2021 • **Revised:** 15-02-2021 • **Accepted:** 25-03-2021

Introduction

In developing countries, such as Indonesia, peoples need something are very essential part on job opportunity growth. MSMEs can play an optimal role in efforts to tackle unemployment and have a strategic role in fighting poverty (Tambunan, 2012). According to data obtained from the Central Statistics Agency (CSA), Companies in Indonesia are dominated by MSMEs (Tambunan, 2012). In 2017, the percentage of the number of companies in terms of the business field category, the majority consisted of MSMEs that is 80.07 percent. Meanwhile, the percentage of the number of large businesses was 19.93 percent. MSMEs contribute 95 percent for job opportunity in Indonesia. However, MSMEs is around 50 percent for Gross Domestic Product (GDP). In line with this, (Tambunan, 2012) stated that MSMEs in Indonesia still weak in the ability to innovate and adopt technology, including that they still focused more on low-tech production such as food, apparel, furniture and handicrafts (Tambunan, 2012).

Galindo-Rueda and Verger, (2016) described the taxonomy for industry according to the intensity level of industrial development and research in obtaining added value in an industry. These are grouped into 5 categories (high until low) on the intensity of industrial development and research. Developing countries like Indonesia are still in the middle-low and low groups. This can be seen in one of the exhibitions of MSMEs products in big cities and regional cities. For example, there are exhibition activities held by Ponorogo and its surroundings every year in order to enliven tourism activities in the city. The items on display are mainly handicrafts, culinary delights such as food and wooden products such as furniture (Purnomo & Ardiana, 2017b). Meanwhile, similar exhibitions in developed countries, MSMEs products include electronics to industrial components (high groups in development and research intensity).

MSMEs play an important role in economic development and growth Berry et al.(2001). Therefore, there needs to be an increase, one of which is in terms of readiness for technology adoption. Readiness for the adoption of information and communication technology is important for MSMEs because it can increase competitiveness. Schumpeter (Schumpeter, 1943) argued that the influence of research, technology, and development on the company has succeeded in creating a change. It is like the Schumpeterian vision of the entrepreneurial concept, to always innovate and force change for the better through technical developments.

Technology can streamline Cobb Douglas' production functions such as capital and labor, which means that when using technology there is capital that can be trimmed and also labor efficiency that can be replaced by technology such as marketing (Prasetyo, 2015; Purnomo & Ardiana, 2017a). Through increased innovation in technology and ownership of better and free computers or smartphones and software packages, technology is accessible even to micro-enterprises and ideally increases productivity (Total Factor Production). However, on the one hand, large businesses or enterprises have used computer equipment and paid software for their operations, while MSMEs tend to be slower in adopting these technological innovations (Suliyanto & Rahab, 2012).

There are three stages in the application of information and communication technology adoption, including the initiation stage, the adoption stage and the implementation stage (Pierce & Delbecq, 1977; Yap, 1990). The initiation stage contains the collection and information related to innovation. Then, when decisions are made about adopting technological innovations. After that, the stage of making decisions from the adoption results will be the implementation of the application of technological innovation in business. A study by Meyer (2010) also showed that the age of the workforce has a relationship with technology adoption, where over the age of 30 years, it is more difficult to adopt technology. Technological readiness refers to "the tendency of people to use new technology in order to achieve the goal of balancing household life and at work"(Parasuraman, 2000). Another study on technology adoption examined business scale. In their findings, technology adoption cannot be generalized to MSMEs because of the fundamental differences between large businesses and MSMEs (Hatzikian & Bampasis, 2017; Van Hemert et al.,2013).

MSMEs have a centralized structure and/or business owner as the dominant decision makers (Kossaï et al.,2020). The important role of business owners shows that the characteristics of business

owners are even more important in the decisions of Micro, Small and Medium Enterprises to adopt technology. Micro, Small and Medium Enterprises is the tendency for generalist work systems rather than specialists (Agrawal et al.,2020; Graafland & Noorderhaven, 2020). As a result, the level of awareness is lower in terms of utilizing technology adoption and the lack of technology adoption knowledge and technical skills in MSMEs (Kossaï et al., 2020). Low knowledge of technology limits the company's ability to adopt technology.

(Purnomo & Ardiana, 2017a; Tambunan, 2012) stated that business owners in Indonesia tend to avoid uncertainty which can lead to a less innovative culture. Business owners tend not to undertake feasibility studies, lack standard operating procedures, and employ employees with multiple job descriptions and often exceed their working capacity. There is no division of work (specialization) or division of labor, and services are not standard. Employees in Indonesia also apply hereditary business in carrying out their business operations. In the case of micro, small and medium enterprises operating in such a culture, authority is concentrated on the business owner, reinforcing their importance in the decision to adopt technology.

Madiun Residency and its surroundings is one of the regions in Indonesia with a number of MSMEs that are evenly distributed and unique (the Central Statistics Agency of Madiun Residency and its surroundings, 2017). Madiun Residency and its surroundings consists of Madiun City, Madiun Regency, Ngawi Regency, Pacitan Regency, Ponorogo Regency and Magetan Regency. In Madiun Residency and its surroundings, the number of MSMEs still dominates. One of the characteristics of MSMEs in Madiun Residency and its surroundings is in the same industrial group (community), located close to each other in their respective regions (Purnomo & Ardiana, 2017a). For example, MSMEs in Ponorogo Regency are famous for the expertise of a workforce that specializes in making handicrafts such as reyog art equipment which includes barongan, dhadak merak, gamelan, and others with handmade and a combination of raw materials obtained both from within Ponorogo and outside Ponorogo. Then, Magetan Regency is famous for its leather industry specialties. Ngawi Regency and Madiun Regency are famous for their metal and raw material industries. Pacitan Regency is famous with the fishing industry. Madiun City is famous for its food industry and is also a center for trade in Madiun Residency and its surroundings.

The theme of innovation and technology adoption in Indonesia was started by (Parasuraman, 2000) and this study can expand the literature on the field of technological innovation because it identifies levels of technology adoption readiness that did not exist in previous studies. In addition, this study also analyzed the characteristics of MSMEs that affect the readiness of technology adoption, such as characteristics of business owners (business owner innovation and knowledge of technology adoption and e-commerce of business owners), characteristics of innovation (relative advantage, compatibility, trialability complexity), organizational characteristics (scale of business, knowledge of the workforce about technology adoption), and environmental characteristics (competition).

Economic literature (industrial organization) explains that the development of technology or innovation is related to market structures. Schumpeter and Austrian economy argued that the monopoly market structure provides an opportunity for companies to invest in technological development where they can get abnormal profits as compensation for investment in development and research (Baker & Sinkula, 2002; Jiménez-Jiménez & Sanz-Valle, 2011).

Table 1.
Technology Readiness Level

Technology Readiness Level	Each Level Explanation	Cluster	Description
TRL 1	The basic principle of quality of technology	ARTISINAL (NOT READY)	Companies are at a basic level of technological readiness (productivity and wages are still at basic levels, there is no market expansion, no accumulated

			investment. It is a local market oriented and uses simple and traditional tools and equipment. The level of cooperation between similar companies is still low and there is no specialization yet (no inter-company vertical cooperation).
TRL 2	The basic principle of quality of technology		
TRL 3	The proving of productivity and technological efficiency		
TRL 4	A validation of technology quality assurance		The company is at the middle level of technological readiness (productivity and wages are still at the medium level, it is already oriented towards market expansion, there has been accumulated investment. It is oriented to local and regional markets and uses a combination of tools and equipment (traditional and modern).
TRL 5	Technology development and innovation	ACTIVE (READY)	
TRL 6	An application of quality management and technology integration		
TRL 7	A consistency in the application of quality management and technology integration		Companies are at a high level of technological readiness (productivity and wages are still at a level of more than the average minimum wage, and have prioritized market expansion, there has been accumulated investment. It is local, regional, national and international market orientation and uses modern tools and equipment). The company is in a condition where the overseas trade network is already good. There is already internal heterogeneity within the group of each company size (for example, there are already divisions that focus on business development). Then, the technology and markets it serves are clearer. In addition, these companies played a decisive role in moving similar markets.
TRL 8	The technology application is complete and qualified in the actual environment/application	DYNAMIC (READY)	
TRL 9	The application of technology is thoroughly tested/ proven through successful operations	ADVANCED (READY)	Companies are at an advanced level of technological readiness (productivity and wages are at a level of above the average minimum wage, and have made market expansion priorities, there has been accumulated investment. It is oriented at local, regional, national and international markets and uses modern tools and equipment). The level of specialization and cooperation between companies is already high.

Source: The Level of Technology Readiness, developed.

However, there is conflicting evidence that technology adoption does not affect organizational success (Jiménez-Jiménez & Sanz-Valle, 2011). Investment for technological innovation make many companies experience the negative results of technological innovation (Simpson, Siguaw, & Enz, 2006). Wright et al.(2004) found that SME adoption of technological innovation did not affect organizational performance. However, innovation can have a positive impact on organizational performance in a hostile business environment. At the organizational level, the adoption of new services, processes, policies, products, administrative structures or systems, and new technologies (Damanpour & Schneider, 2006; Kula & Tatoglu, 2003; Levy & Powell, 2003; Locke, 2004).

MSMEs literature in developing countries generally discusses MSMEs in the manufacturing industry. The development of this literature was preceded by the appearance of an article by STALEY, (1965). Their study was based on the experiences of developed countries and developing countries. They identified three categories of conditions for the existence of MSMEs. Separate processing operations, crafts or handwork that require precision, and simple assembly, mixing and finishing processes are the most important conditions of the processing process for the existence of MSMEs.

The study of the readiness of MSMEs in adopting technology can be analyzed using the Technology Readiness Level (TRL) model developed from the concept of innovation (Schumpeter, 1943) which was further developed by Parasuraman, (2000). This study used the TRL development model because the TRL development model is more appropriate to measure the level of individual readiness in adopting technology in an organizational context (Liljander et al.,2006). This study also developed a TRL development model by adding constructs adapted to the conditions of MSMEs (F. D. Davis et al.,1989), namely the perception of ease of use of technology as a measure of individual perceptions of acceptance of technology.

This study analyzed the level of readiness for adoption of MSMEs technology (Sandee & Ter Wingel, 2002). The technology readiness level model can be seen in Table 1.

Methods

The population of this research included MSMEs actors in Indonesia which were divided into several categories (Building materials, Food, Metals, Textiles, Handicrafts). The determination of the technology sector consists of five categories by looking at the basic materials used and/or the results of the production carried out by the MSMEs business unit. The first category is building materials. In this category, products are produced in the form of bricks, ceiling trim and various things related to building materials as basic materials. The second category is handicraft, in which there are products in the form of bird cages, winnowing tray, woven tenggok, tenggok, rinjing, grater, cover, hats and the like. The third category is food, which includes products in the form of onion chips, soy milk, tempeh, salted eggs, fried peanuts, chips and brown sugar. The next category is textiles and one that is included in this category is the MSMEs business unit such as convection and the last one is the metal category, which is all MSMEs business units that have production with basic materials of metal, such as gamelan and the like. Furthermore, from a population of 212,947 business units, the sample to be surveyed included 1,092 business units. The next step is where the selection of the MSMEs units will be searched by using quota sampling (Cochran, 1977). Quota sampling itself was done by way of giving proportional benchmarks and fulfilling population representation. Furthermore, it was divided into 5 categories for each total sample.

After knowing the level of readiness for technology adoption, this research provides an understanding of the characteristics of MSMEs factors consisting of business owner characteristics, technological innovation characteristics, organizational characteristics, and environmental characteristics in influencing the readiness of technology adoption with the results of clustering (Artisanal, Active, Dynamic and Advanced). The dependent variables have a scale that is polichotomous or multinomial, namely a nominal scale with more than two categories in which each individual (i) MSMEs who have filled SMERL will know and get their clusterization status. It is assumed that the SMERL cluster = 4 clusters (Artisanal, Active, Dynamic and Advanced). The

influencing factors (response variable) for the determination of clustering alternatives consist of i characteristics (business owner characteristics (business owner innovation and knowledge of technology adoption and e-commerce business owners), innovation characteristics (relative advantage, compatibility, trialability complexity), organizational characteristics (scale business, knowledge of workers about technology adoption and e-commerce), and environmental characteristics (competition) which are qualitative perception models (Qualitative Response Regression Models), measured with a Likert scale of 1-5, which are then generalized into dummy variables, namely 1 : agree (Scale 4 and 5), and 0: disagree (Scale 1 to 3) (Jeong & Lee, 2016).
The Likert scale was used in this study, because in modelling the numerical values can be reflected, one of which is the ranking (1: strongly disagree up to 5: strongly agree) (Baum, 2006; Creswell, 2016; Gujarati & Porter, 2003; Jeong & Lee, 2016; Seddighi, Lawler, et al.,2000). The type of data is based on the Likert scale which in principle is a questionnaire-based survey data collection which aims to collect opinion information from MSMEs actors related to characteristics that affect the level of readiness for technology adoption.
After that, we can describe the research model developed as follows:

$$\text{SMERL}_i: \beta_0 + \beta_1 \text{KP}_i + \beta_2 \text{KI}_i + \beta_3 \text{KO}_i + \beta_4 \text{KL}_i + e$$

Furthermore, data mining will be carried out by providing a questionnaire and question matrix. Table 2 is a matrix of the relationship between the research questions, the data needed to answer each question and how to obtain it.

Then, the aim of the multinomial logistic analysis is to provide an understanding of the characteristics of MSMEs factors consisting of business owner characteristics, technological innovation characteristics, organizational characteristics, and environmental characteristics affecting the readiness to adopt SMERL (technology and electronic commerce) with the results of clustering (Artisinal, Active, Dynamic and Advanced).
Parameters β_{12} and β_{22} are specific for alternative 2 (active), parameters β_{13} dan β_{23} for alternative 3 (dynamic) and parameters β_{14} and β_{24} for alternative 4 (advanced). The parameter for alternative 1 (artisanal) is set to be the base outcome to solve identification problems in software such as STATA and create probabilities.

Table 2.
Research Variables, Notation, Variable Status, Operational Definition, Categories and Approaches

No	Variable	Notation / Symbol	Variable Status	Operational Definition	Category	Approach
1	Technology Adoption Readiness Level	SMERL	Dependent	The level of use of production technology, computer hardware and/or tablet computers, as well as smartphone operating systems and/or software applications to support production, management,	Y = 1 for Cluster 1 (Arsanal (TRL and TKPE Level 1 to 3)), and Y = 2 if the levels of technology adoption and e-commerce for MSMEs are ready (Active (TRL and TKPE Level 4 to 6)), Y = 3 (Dynamic (TRL	(Purnomo & Ardiana, 2017a) (Parasuraman , 2000) (G. Davis & Olson, 1985)

				digital marketing and decision making in business.	and TKPE Level 7 to 8)) + Y = 4 for category 4 (advanced TKPE Level 9)).	
2	Characteristics of Business Owners	BOC	Independent	Attitudes and responses of MSME owners to innovation and knowledge of innovation Attitudes and responses of MSMEs owners to the advantages of adoption, business needs, difficulties in adoption and trials in application in business	0 : Disagree 1: Agree	(Kirton, 1976) (Attewell, Selby, & O'Donnell, 1992) (Ettlie, 1990) (Gable & Raman, 1992; Jeong & Lee, 2016)
3	Characteristics of Technological Innovation	TIC	Independent	Attitudes and responses of MSMEs owners to the advantages of adoption, business needs, difficulties in adoption and trials in application in business The attitudes and responses of MSME owners towards resources and infrastructure to facilitate the adoption of innovation (Business Scale) and the expertise of internal employees in adopting	0 : Disagree 1: Agree	(Jeong & Lee, 2016; Rogers, 1983)

				technology (Knowledge of Workers on SMERL Adoption).		
4	Characteristics of Organization	OC	Independent	The attitudes and responses of MSME owners towards resources and infrastructure to facilitate the adoption of innovation (Business Scale) and the expertise of internal employees in adopting technology (Knowledge of Workers on SMERL Adoption). Attitudes and responses of MSMEs owners in the environment where the business operates (Competition).	0 : Disagree 1 : Agree	(Dewar & Dutton, 1986) (Moch & Morse, 1977) (Utterback, 1974) (Attewell et al., 1992) (Dess & Robinson Jr, 1984) (Gable, 1991) (Jeong & Lee, 2016; Lees, 1987)
5	Characteristics of Environment	EC	Independent	Attitudes and responses of MSMEs owners in the environment where the business operates (Competition).	0 : Disagree 1: Agree	(Scott-Morton & Keen, 1978) (Link & Bozeman, 1991) (Jeong & Lee, 2016; Utterback, 1974)

Source: Primary data, processed.

The logistic regression model (Hosmer & Lemeshow, 2000) is as follows:

$$\pi(x) = \frac{e^{g(x)}}{1 + e^{g(x)}}$$

$$\text{with } g(x) = \beta_0 + \beta_1 x_1 + \cdots + \beta_p x_p$$

In general, the form of a logit function with a response variable consisting of three or more categories is as follows:

$$g_j(x) = \beta_{j0} + \beta_{j1} x_1 + \beta_{j2} x_2 + \cdots + \beta_{jp} x_p$$

Every individual of MSMEs who has filled in SMERL will know and choose their clusterization status. It is assumed j = 4 alternative clusters. Factors that influence the determination of alternative clustering consist of I characteristics (business owner characteristics, business owner innovation

and knowledge of technology adoption and e-commerce of business owners), innovation characteristics (relative advantage, compatibility, trialability complexity), organizational characteristics (business scale, knowledge of labor work on technology adoption and e-commerce), and environmental characteristics (competition) which are perception variables measured on a Likert scale of 1-5, which are then generalized into dummy variables, 0: agree (Scale 4 and 5), and 1: no agree (Scale 1 to 3) (Jeong & Lee, 2016).

A way to explain the probability for each characteristic i in influencing MSME actors to choose and find out alternatives j,

$$Pij = P \text{ (i characteristic affects alternative j)}$$

In this concept, there are j = 4 alternative clusters, denoted by j = 1 (artisanal), 2 (active), 3 (dynamic), and 4 (advanced). Then, we can describe the explanatory factors, such as the characteristics of Xi [X1 (KP), X2 (KI), X3 (KO), X4 (KL). Next, the logistic multinomial specification, in which the probability of MSMEs actors in getting alternative clusterization results is j = 1 (artistanal), 2 (active), 3 (dynamic), and 4 (advanced), namely:

$$P_{i1} = \frac{1}{1 + \exp(\beta_{12} + \beta_{22}\,Xi) + \exp(\beta_{13} + \beta_{23}\,Xi) + \exp(\beta_{14} + \beta_{24}\,Xi)}, \qquad j = 1$$

$$P_{i1} = \frac{\exp(\beta_{12} + \beta_{22}Xi)}{1 + \exp(\beta_{12} + \beta_{22}\,Xi) + \exp(\beta_{13} + \beta_{23}Xi) + \exp(\beta_{14} + \beta_{24}\,Xi)}, \qquad j = 2$$

$$P_{i1} = \frac{\exp(\beta_{13} + \beta_{23}Xi)}{1 + \exp(\beta_{12} + \beta_{22}\,Xi) + \exp(\beta_{13} + \beta_{23}Xi) + \exp(\beta_{14} + \beta_{24}\,Xi)}, \qquad j = 3$$

$$P_{i1} = \frac{\exp(\beta_{14} + \beta_{24}Xi)}{1 + \exp(\beta_{12} + \beta_{22}\,Xi) + \exp(\beta_{13} + \beta_{23}Xi) + \exp(\beta_{14} + \beta_{24}\,Xi)}, \qquad j = 4$$

Caption: exp: explanatory

Estimation is carried out with the Stata 14.0 application by using a syntax that is adjusted to the regression concept (Hill, Griffiths, & Lim, 2018). After that, perform the method of the maximum possible value (Maximum Likelihood Estimator) which is a method used to estimate the parameters of the logistic regression model by providing an estimated value of β by maximizing the Likelihood function (Agresti, 2002).

Interpretation in multinomial logistic regression uses the odds ratio which shows the ratio of the number of times the increase or decrease in the incidence of Y = j against Y = 1 as a category of comparison if the value of the predictor variable (x) changes by a certain value (Hosmer & Lemeshow, 2000). The relationship between the odds ratio to the model parameter (β) is

$$\Psi_{ab} = \exp(\beta)$$

If $\Psi < 1$ shows that between the two variables there is a negative relationship and if $\Psi > 1$ shows that between the two variables there is a positive relationship.

Hypothesis

Ho_{1a}: Owner characteristics do not have a significant positive effect on the readiness level of technology adoption in Active Clusters with the Artisinal Cluster base outcome.

Ha_{1a}: Owner characteristics have a significant positive effect on the readiness level of technology adoption in Active Clusters with the Artisanal Cluster base outcome.

Ho_{1b}: Owner characteristics do not have a significant positive effect on the readiness level of technology adoption in dynamic clusters with the Artisinal cluster base outcome.

Ha_{1b}: Owner characteristics have a significant positive effect on the level of readiness for technology adoption in Dynamic Clusters with the Artisinal Cluster base outcome.

Ho_{1c}: Owner characteristics do not have a significant positive effect on the readiness level of technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Ha_{1c}: Owner characteristics have a significant positive effect on the readiness level of technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Ho_{2a}: The characteristics of technological innovation do not have a significant positive effect on the readiness level of technology adoption in the Active Cluster with the Artisanal Cluster base outcome.

Ha_{2a}: The characteristics of technological innovation have a significant positive effect on the readiness level of technology adoption in the Active Cluster with the Artisinal Cluster base outcome.

Ho_{2b}: The characteristics of technological innovation do not have a significant positive effect on the level of readiness for technology adoption in Dynamic Clusters with the Artisinal Cluster base outcome.

Ha_{2b}: The characteristics of technological innovation have a significant positive effect on the level of readiness for technology adoption) on the Dynamic Cluster with the Artisinal Cluster base outcome.

Ho_{2c}: The characteristics of technological innovation do not have a significant positive effect on the readiness level of technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Ha_{2c}: The characteristics of technological innovation have a significant positive effect on the readiness level of technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Ho_{3a}: Organizational characteristics do not have a significant positive effect on the readiness level of technology adoption in the Active Cluster with the Artisinal Cluster base outcome.

Ha_{3a}: Organizational characteristics have a significant positive effect on the level of readiness for technology adoption in the Active Cluster with the Artisinal Cluster base outcome.

Ho_{3b}: Organizational characteristics do not have a significant positive effect on the level of readiness for technology adoption in dynamic clusters with the base outcome of the Artisinal cluster.

Ha_{3b}: Organizational characteristics have a significant positive effect on the level of readiness for technology adoption in Dynamic Clusters with the Artisinal Cluster base outcome.

Ho_{3c}: Organizational characteristics do not have a significant positive effect on the readiness level of technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Ha_{3c}: Organizational characteristics have a significant positive effect on the level of readiness for technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Ho_{4a}: Environmental characteristics do not have a significant positive effect on the readiness level of technology adoption in Active Clusters with the Artisinal Cluster base outcome.

Ha_{4a}: Environmental characteristics have a significant positive effect on the readiness level of technology adoption in the Active Cluster with the Artisinal Cluster base outcome.

Ho_{4b}: Environmental characteristics do not have a significant positive effect on the readiness level of technology adoption in dynamic clusters with the Artisinal cluster base outcome.

Ha_{4b}: Environmental characteristics have a significant positive effect on the readiness level of technology adoption in dynamic clusters with the base outcome of the Artisinal cluster.

Ho_{4c}: Environmental characteristics do not have a significant positive effect on the readiness level of technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Ha_{4c}: Environmental characteristics have a significant positive effect on the readiness level of technology adoption in the Advanced Cluster with the Artisinal Cluster base outcome.

Findings

This study aimed to map and analyze the level of adoption of MSMEs actors with Small and Medium Sized Enterprises Readiness Level (SMERL) in Madiun Residency and its surroundings, as well as analyzing the relationship between the level of technology adoption of the Small and Medium Sized Enterprises Readiness Level (SMERL) and the characteristics of MSMEs which consist of: (a) characteristics of business owners, (b) innovation characteristics, (c) organizational characteristics, (d) environmental characteristics (competition) of MSMEs in Madiun Residency and its surroundings which can have an impact on the readiness of technology adoption and e-commerce in MSMEs in Madiun Residency and its surroundings. This chapter is organized into three parts. These parts are: the results of measuring the level of readiness for technology adoption, multinomial logistic analysis, and analysis of odds ratios.

The Results of Measuring the Level of Technology Adoption Readiness

The determination of the type of industry consists of five categories by looking at the basic materials used and/or the results of the production carried out by the MSMEs business unit. The five categories are building materials. In this category products are produced in the form of bricks, ceiling trim and various things related to building materials as basic materials. The second category is handicraft, in which there are products in the form of pillowcases, turtledove bird cages, reyog, ganongan, barrels and the like. The third category is food, which includes products in the form of onion chips, soy milk, tempeh, salted eggs, fried peanuts, chips and brown sugar. The next category, namely the fourth category, is textiles and which is included in this category are the MSMEs business units such as convection and the last one is the metal category, namely all MSMEs business units that have production with basic materials of metal, such as gamelan and the like.

Table 3.
Adoption of Technology Readiness by Type of Business

Type of Business	TRL									Total
	1	2	3	4	5	6	7	8	9	
Materials	64	13	20	40	19	50	5	8	4	223
	(28.7)	(5.83)	(8.97)	(17.94)	(8.52)	(22.42)	(2.24)	(3.59)	(1.79)	(100)
Handycraft	50	9	21	57	20	51	6	6	3	223
	(22.42)	(2.69)	(9.42)	(25.56)	(8.97)	(22.87)	(2.69)	(1.35)	(1.35)	(100)
Metal	42	12	16	59	22	49	4	5	5	214
	(19.63)	(5.61)	(7.48)	(27.57)	(10.28)	(22.90)	(1.87)	(2.34)	(2.34)	(100)
Food	42	16	20	55	23	47	5	4	8	220
	(19.09)	(7.27)	(9.09)	(25.00)	(10.45)	(21.36)	(2.27)	(1.82)	(3.64)	(100)
Textile	51	15	20	39	33	43	2	3	6	212
	(24.06)	(7.08)	(9.43)	(18.40)	(15.57)	(20.28)	(0.94)	(1.42)	(2.83)	(100)
Total	249	65	97	250	117	240	22	26	26	1092
	(22.8)	(5.95)	(8.88)	(22.89)	(10.71)	(21.98)	(2.01)	(2.38)	(2.38)	(100)

Source: Primary Data, processed.

In Table 3, the level 1 measurement of 1092 respondents is all met. This shows the basic level of

technological readiness where productivity and wages are still low and stagnated. In addition, it is still oriented to the local market and uses traditional or obsolete tools and equipment. Then, there is a very low level of inter-company cooperation and specialization (no vertical cooperation between companies) and no external network with support organizations. There are 411 respondents who are in the artisanal cluster. It means that the majority of MSMEs in all fields are at the lowest level of technological readiness. Then, there are 607 respondents who are already in the active cluster. Furthermore, there are national and export markets that support both supply and marketing. Conditions that are already active in marketing and the level of internal and external networks that are already good.
Then, 48 respondents out of 1,092 are in dynamic clusters. It means that the trade network abroad is good. There is already internal heterogeneity within the group of each company size (for example, there are already divisions that focus on business development). Next, the technology and markets it serves are clearer. In addition, these companies play a decisive role in moving this kind of market. 26 respondents out of 1,092 are in the advanced cluster, which means that the level of specialization and cooperation between companies is high.

Multinomial Logistics Analysis and Odds Ratio

The variable that is influenced in this study was the adoption readiness level clustering divided into 4 clusters, namely the artisanal, active, dynamic and advanced clusters. Meanwhile, the predictor variables used were response variables, namely Owner Characteristics consisting of Innovation (Business Owner Innovation); Adoption Knowledge (Business Owner Adoption Knowledge), Characteristics of Technological Innovation which consists of Relative Advantage (Relative Advantage of SMERL Adoption); Compatibility (SMERL Adoption Compatibility); Complex (SMERL Adoption Complexity); Trial (SMERL Adoption Trialability), Organizational Characteristics consisting of Scale (Business Scale); Workforce Knowledge (Workforce Knowledge of SMERL Adoption), and Environmental Characteristics consisting of Competition (Competition). Partial testing was used to determine predictor variables that have a significant effect on the level of readiness for adoption. The following is an individual parameter test using the Wald test to determine the significance of the predictor variable parameters on the level of readiness for adoption individually.
Hypothesis:

$H_0 : \beta_k = 0$ (The predictor variable does not have a significant effect on the model),
$H_1 : \beta_k \neq 0, k = X1, X2, X3, X4$(The predictor variable has a significant effect on the model)
Significance level: $\alpha = 0.05$
Rejection Region: Reject H_0 if $W_k > Z_{\frac{\alpha}{2}}$ or P-Value < 0.05

Table 4.
The Estimate of Parameters and Odds Ratio of Concurrent Testing TRL Characteristics of MSMEs

Cluster	Predictor Variable	Coefficient	Std. Err.	Wald (Z)	P-Value	Odds Ratio
Artisanal			Base Outcome			
	Constant	0.04	0.41	0.1	0.922	-
	BOC	0.27	0.12	2.2	0.028	1.253
Active	TIC	0.16	0.09	1.75	0.05	1.198
	OC	-0.09	0.09	-1.09	0.275	0.58
	EC	0.26	0.1	2.53	0.011	1.046
Dynamic	Constant	-1.8	0.55	-3.25	0.001	-
	BOC	0.17	0.15	1.11	0.266	1.583

	TIC	0.15	0.11	1.36	0.175	1.043
	OC	0.22	0.12	1.86	0.043	0.646
	EC	0.23	0.13	1.71	0.038	1
	Constant	-0.01	0.58	-1.81	0.973	-
	BOC	0.06	0.17	0.49	0.050	1.132
Advanced	TIC	0.32	0.13	-2.54	0.623	1.132
	OC	0.25	0.12	1.76	0.011	0.569
	EC	0.01	0.14	0.03	0.048	1.092

Source: Primary data primer, processed

Notes: Variable Level of Technology Readiness (TRL)
as the dependent variable.

Legend: BOC (Characteristics of Business Owners); TIC (Characteristics of Technological Innovation); OC (Organizational Characteristics); EC (Environmental Characteristics)
After calculating the technology readiness level variable on the characteristics of MSMEs. Next, the results of the Estimate of Parameter and Odds Ratio of Concurrent Testing of TRL for the sub-characteristics variables of MSMEs are described in Table 5.

Table 5.
The Estimate of TRL Concurrent Testing Parameters and Odds Ratio
Sub Characteristics of MSMEs

Cluster	Predictor Variable	Coefficient	Std. Err	Wald (Z)	P-Value	Odds Ratio
Artisanal			Base Outcome			
Active	Constant	-0.35	0.44	0.08	0.937	-
	Innovation	-0.27	0.13	-1.96	0.05	0.441
	Adoption Knowledge	0.48	0.11	0.42	0.677	0.436
	Relative Advantage	-0.17	0.14	-0.12	0.903	0.441
	Compatibility	-0.05	0.13	-0.4	0.69	1.324
	Complex	0.1	0.13	0.75	0.454	1.324
	Trial	0.06	0.14	0.48	0.631	0.436
	Scale	0.09	0.12	0.71	0.48	0.441
	Workforce Knowledge	-0.11	0.09	-1.21	0.225	0.441
	Competition	-0.03	0.11	1.96	0.05	0.436
Dynamic	Constant	-2.55	0.6	-0.02	0	-
	Innovation	-0.03	0.17	-0.02	0.983	0.273
	Adoption Knowledge	0.44	0.15	2.79	0.005	0.282
	Relative Advantage	-0.07	0.19	-0.39	0.694	0.273
	Compatibility	0.35	0.18	1.96	0.05	1.021
	Complex	0.08	0.18	0.45	0.655	1.021

	Trial	0.05	0.18	0.3	0.761	0.273
	Scale	-0.07	0.16	-0.44	0.66	0.273
	Workforce Knowledge	0.2	0.12	1.6	0.109	0.273
	Competition	-0.45	0.15	-2.89	0.004	0.273
	Constant	-0.1	0.62	-0.17	0.865	-
	Innovation	-0.21	0.2	-1.06	0.29	0.228
	Adoption Knowledge	0.24	0.16	1.47	0.142	0.215
	Relative Advantage	-0.19	0.21	-0.95	0.344	0.215
Advanced	Compatibility	-0.08	0.18	-0.46	0.644	1.017
	Complex	0.12	0.19	0.63	0.53	1.017
	Trial	-0.17	0.21	-0.82	0.412	0.215
	Scale	0.13	0.18	0.75	0.455	0.228
	Workforce Knowledge	-0.3	0.13	-2.26	0.024	0.228
	Competition	-0.1	0.16	-0.17	0.865	0.215

Source: Primary Data, processed (TRL as dependent variable)

Legend: Innovation (Business Owner Innovation); Adoption Knowledge (Business Owner Adoption Knowledge); Relative Advantage (Relative Advantage of SMERL Adoption); Compatibility (SMERL Adoption Compatibility); Complex (SMERL Adoption Complexity); Trial (SMERL Adoption Trialability); Scale (Business Scale); Workforce Knowledge (Workforce Knowledge of SMERL Adoption); Competition (Competition).

From Table 4, three multinomial logistic regression functions can be obtained, as follows:

$$g_2(x) = 0.04 - 0.27_{X1} + 0.16_{X2} - \mathbf{0.09_{X3}} + 0.26_{X4}$$

$$g_3(x) = -1.80 + \mathbf{0.17_{X1}} + \mathbf{0.15_{X2}} + 0.22_{X3} + 0.23_{X4}$$

$$g_4(\mathrm{x}) = -0.01 - 0.06_{\mathrm{X1}} - \mathbf{0.151_{X2}} + 0.32_{\mathrm{X3}} - 0.01_{\mathrm{X4}}$$

∗ Writing in bold for insignificant variables

The three multinomial logistics functions can be used to form a probability function for each clustering of technology adoption readiness to the response variable, namely Owner Characteristics consisting of Innovation (Business Owner Innovation); Adoption Knowledge (Business Owner Adoption Knowledge), Characteristics of Technological Innovation which consists of Relative Advantage (Relative Advantage of SMERL Adoption); Compatibility (SMERL Adoption Compatibility); Complex (SMERL Adoption Complexity); Trial (SMERL Adoption Trialability), Organizational Characteristics consisting of Scale (Business Scale); Workforce Knowledge (Workforce Knowledge of SMERL Adoption), and Environmental Characteristics consisting of Competition (Competition).

In the results of Table 4, the characteristics of MSMEs consisting of ownership characteristics (X1), innovation characteristics (X2) and environmental characteristics (X4) have a significant effect on the readiness level of adopting active cluster technology, with the base outcome of the artistic cluster. Then, the characteristics of MSMEs consisting of organization (X3) and environmental characteristics (X4) have a significant effect on the readiness level of dynamic cluster technology adoption, with the base outcome of the artistic cluster. Owner characteristics (X1), organizational

characteristics (X3) and environmental characteristics (X4) have a significant effect on the readiness level of adoption of advanced cluster technology, with the base outcome of the artisanal cluster.
Table 4 also shows the odds ratio values for each category of predictor variables.

Discussion

It can be analyzed that the odds ratio value in the active cluster is 1.182 for the owner characteristic variable, which means that MSMEs owners who have characteristics such as innovation and knowledge of adoption have the ability to increase the cluster from artisanal by 1.182 times greater than MSMEs owners who do not have characteristics such as innovation and adoption knowledge. Furthermore, the odds ratio value in the active cluster is 1.170 for the characteristic variable of technological innovation, which means that MSMEs owners who have characteristics and implement things such as relative advantages in adoption, adoption compatibility, adoption complexity and trialability have the ability to increase the cluster from artisanal to 1.170 times greater compared to MSMEs owners who do not have characteristics and apply things such as relative advantage in adoption.
Furthermore, the odds ratio value in the active cluster is 0.549 for the organizational characteristics variable, which means that MSMEs owners who have characteristics and implement things such as business scale development and increased workforce knowledge on adoption have the ability to increase the cluster from artistic to 0.549 times greater than MSMEs owners who do not have characteristics and apply things such as developing business scale and increasing workforce knowledge of adoption. Furthermore, the odds ratio value in the active cluster is 1.046 for the environmental characteristics variable, which means that MSMEs owners who have characteristics and apply things such as competition have the ability to increase the cluster from artisanal by 1.046 times greater than MSMEs owners who do not have characteristics and apply this like a competition.
In the dynamic cluster, it can be analyzed that the odds ratio value in the dynamic cluster is 1.583 for the owner characteristic variable, which means that MSMEs owners who have characteristics such as innovation and knowledge of adoption have the ability to increase the cluster from artisanal by 1.853 times greater compared to MSMEs owners who do not have characteristics such as innovation and adoption knowledge. Furthermore, the value of the odds ratio in the dynamic cluster is 1.043 for the variable characteristics of technological innovation, which means that MSMEs owners who have characteristics and apply things such as relative advantages in adoption, compatibility of adoption, complexity of adoption and trialability have the ability to increase the cluster from artisanal by 1.043 times greater compared to MSMEs owners who do not have characteristics and apply things such as relative advantage in adoption, adoption compatibility, adoption complexity and trialability.
Furthermore, the value of the odds ratio in the dynamic cluster is 0.646 for the organizational characteristics variable, which means that MSMEs owners who have characteristics and apply things such as business scale development and increased workforce knowledge on adoption have the ability to increase the cluster from artisanal to 0.646 times greater than the MSMEs owners who do not have characteristics and apply things such as developing business scale and increasing workforce knowledge of adoption. Next, the odds ratio value in the dynamic cluster is 1.000 for environmental characteristic variables, which means that MSMEs owners who have characteristics and apply things such as competition have the ability to increase the cluster from artisanal by 1.000 times greater than MSMEs owners who do not have characteristics and apply this like a competition.
In the advanced cluster, it can be analyzed that the odds ratio value in the advanced cluster is 1.132 for the owner characteristic variable, which means that MSMEs owners who have characteristics such as innovation and knowledge of adoption have the ability to increase the cluster from artisanal by 1.132 times greater compared to MSMEs owners who do not have characteristics such as innovation and adoption knowledge. Next, the odds ratio value in the advanced cluster is 1.132 for the variable characteristics of technological innovation, which means that MSMEs owners who have characteristics and apply things such as relative advantages

in adoption, adoption compatibility, adoption complexity and trialability have the ability to increase the cluster from artisanal by 1.132 times larger compared to MSMEs owners who do not have characteristics and apply things such as relative advantage in adoption, adoption compatibility, adoption complexity and trialability.

Next, the odds ratio value in the advanced cluster is 0.569 for the organizational characteristics variable, which means that MSMEs owners who have characteristics and implement things such as business scale development and increased workforce knowledge on adoption have the ability to increase the cluster from artisanal by 0.569 times greater than the MSMEs owners who do not have characteristics and apply things such as developing business scale and increasing workforce knowledge of adoption. Furthermore, the odds ratio value in the advanced cluster is 1.092 for environmental characteristics variables, which means that MSMEs owners who have characteristics and apply things such as competition have the ability to increase the cluster from artisanal like a competition. After the description of the results and discussion of the multinomial logistic regression parameters and the results of the odds ratio, we can see a summary of the results of the research hypothesis in Table 6.

Conclusion

In the analysis of the level of technological readiness, the majority of MSMEs business actors are in the artisanal cluster, although there are MSMEs that are active in the adoption of technology, which means that MSMEs have used more skilled workers and better technology. Then, there are national and export markets that support both supply and marketing. Conditions that are already active in marketing and the level of internal and external networks that are already good.

In the analysis of the characteristics of MSMEs that affect the results of technology adoption readiness. Managers or MSMEs actors in the artisanal cluster need to focus on ownership characteristics, innovation characteristics, and environmental characteristics to increase the cluster to be active. It is necessary to increase knowledge related to technology adoption and focus on product focus, product excellence, and compatibility, dare to do trialability, increase complexity in products, and dare to compete. This is because it is shown in the results and analysis discussion, that the characteristics of MSMEs such as ownership characteristics have an influence on the level of readiness for technology adoption to active clusters. Therefore, by focusing on these characteristics, it is certain that there will be an increase in the readiness adoption clustering of MSMEs. This is in accordance with (Levy & Powell, 2003) who argued that technology adoption, followed by technology system integration and business process reengineering, can significantly improve firm performance.

MSMEs in active clusters, in order to increase to dynamic clusters of technology adoption readiness levels, need to focus on organizational and environmental characteristics. This has an influence on the level of readiness for adoption. Managers or MSMEs actors in dynamic clusters need to encourage owner characteristics, organizational characteristics, and environmental characteristics in order to advance to advanced clusters. This is by increasing their ability to increase knowledge related to technology adoption and focusing on product focus, product advantages, and compatibility, daring to do trialability, increasing complexity in products, and daring to compete.

Table 6.

Summary of Research Hypothesis Results

Hypothesis	TRL
$\mathbf{Ho_{1a}}$: Owner characteristics do not have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) in the Active Cluster with the Artisanal Cluster base outcome.	Rejected

Ha_{1a}: Owner characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Active Cluster with the Artisanal Cluster base outcome.	Accepted
Ho_{1b}: Owner characteristics do not have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) on Dynamic Clusters with the Artisanal Cluster base outcome.	Accepted
Ha_{1b}: Owner characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) on Dynamic Clusters with the Artisanal Cluster base outcome.	Rejected
Ho_{1c}: Owner characteristics do not have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Advanced Cluster with the Artisanal Cluster base outcome.	Rejected
Ha_{1c}: Owner characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Advanced Cluster with the Artisanal Cluster base outcome.	Accepted
Ho_{2a}: The characteristics of technological innovation do not have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) in the Active Cluster with the Artisanal Cluster base outcome.	Rejected
Ha_{2a}: The characteristics of technological innovation have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Active Cluster with the Artisanal Cluster base outcome.	Accepted
Ho_{2b}: The characteristics of technological innovation do not have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) on Dynamic Clusters with the base outcome of the Artisanal Cluster.	Rejected
Ha_{2b}: The characteristics of technological innovation have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) on Dynamic Clusters with the Artisanal Cluster base outcome.	Accepted
Ho_{2c}: The characteristics of technological innovation do not have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Advanced Cluster with the Artisanal Cluster base outcome.	Accepted
Ha_{2c}: The characteristics of technological innovation have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Advanced Cluster with the Artisanal Cluster base outcome.	Rejected

Ho_{3a}: Organizational characteristics do not have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) in the Active Cluster with the Artisanal Cluster base outcome.	Accepted
Ha_{3a}: Organizational characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) on the Active Cluster with the Artisanal Cluster base outcome.	Rejected
Ho_{3b}: Organizational characteristics do not have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) on dynamic clusters with the base outcome of the Artisanal Cluster.	Rejected
Ha_{3b}: Organizational characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) on dynamic clusters with the base outcome of the Artisanal Cluster.	Accepted
Ho_{3c}: Organizational characteristics do not have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Advanced Cluster with the Artisanal Cluster base outcome.	Rejected
Ha_{3c}: Organizational characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) on the Advanced Cluster with the Artisanal Cluster base outcome.	Accepted
Ho_{4a}: Environmental characteristics do not have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Active Cluster with the Artisanal Cluster base outcome.	Rejected
Ha_{4a}: Environmental characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Active Cluster with the Artisanal Cluster base outcome.	Accepted
Ho_{4b}: Environmental characteristics do not have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) on Dynamic Clusters with the base outcome of the Artisanal Cluster.	Rejected
Ha_{4b}: Environmental characteristics have a significant positive effect on the level of readiness for technology adoption and electronic commerce (SMERL) on Dynamic Clusters with the Artisanal Cluster base outcome.	Accepted
Ho_{4c}: Environmental characteristics do not have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Advanced Cluster with the Artisanal Cluster base outcome.	Rejected
Ha_{4c}: Environmental characteristics have a significant positive effect on the readiness level of technology adoption and electronic commerce (SMERL) in the Advanced Cluster with the Artisanal Cluster base outcome.	Accepted

Biography

Rochmat Aldy Purnomo. Aldy is researcher in Universitas Muhammadiyah Ponorogo and Rumah Harapan who extremely concern about applied economy. Aldy has co-authored a number of research papers and have articles published in various journals. Aldy is part of International Project in ACES (A- Community-Centered Educational Model for Developing Social Resilience through Play), which investigating the impact of transformative education through playful approaches and experiences towards developing social resilience, targeting young people in Malaysia, Vietnam, and Indonesia. Also, he is an economist which support global programme that imagines and activates new forms of cultural and economic agency, by placing creativity, experimentation, co-design, social purpose, action research, and international connection at the heart of its work, with his overseas partnership, such as Malaysia, Vietnam, United Kingdom, and Australia.

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