

Analysis of SMEs Readiness in the Implementation of Internet of Things to Support the Smart City Concept

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ABSTRACT

This study aims to analyze the readiness of MSMEs based on existing model artifacts related to implementing the Internet of Things (IoT) to support the concept of smart cities. In this study, the Design Science Methodology understanding model from Hevner is used in analyzing the views of SMEs actors. The results of the questionnaire processing from 147 MSME actors found that the obstacles to IoT implementation are the production process that is still manual, the production machine is still not automatic/manual, difficulties in capital, the communication media used is still email and telephone, and the production work environment is not safe and still integrated with the house. These obstacles can be used as input in implementing the Internet of Things in MSMEs. The recommendations given in the implementation of the Internet of Things for SMEs are to provide capital loans in collaboration with Regional Banks, determine regional superior products to be used as Pilot Projects in the implementation of the Internet of Things, collaborate with local governments for the development of MSMEs in funding and appropriate technology to increase the productivity and quality of SMEs production.

Keywords: *Readiness, Small and Medium Enterprise, Internet of Things, Smart City*

Introduction

As more urban areas adopt the smart city model, Small and Medium Enterprises (SMEs) play an important role in this transformation. This relationship is important because SMEs are often considered the backbone of the city's economy [1]. SMEs must change their working methods to address these factors and participate in the smart city ecosystem [2]. Digitalization of Micro, Small, and Medium Enterprises (MSMEs) is an important step in facing business challenges in the modern era [3]. By utilizing technologies such as digital applications, e-commerce, and technology-based management systems, MSMEs can improve operational efficiency, expand markets, and create more competitive products.

Information technology has been proven to affect the efficiency and effectiveness of business processes, especially in the context of SMEs as a research subject [4]. Previous research has focused heavily on social media, which affects various components of business processes. Social media that is appropriately integrated with business processes can increase productivity. However, the effectiveness of using social media can be different for each SME, as each SME has unique characteristics and business processes. Therefore, the interaction between social media features and business process needs determines the suitability of information technology adopted by SMEs. Various studies have concluded that the use of information technology, including social media, has the potential to significantly contribute to improving the performance of SMEs [5].

There is a two-way relationship between entrepreneurship and smart cities, where entrepreneurs drive the development of smart cities, and smart cities, in turn, create new opportunities for entrepreneurs [6]. Digital

transformation strengthens SMEs' ability and flexibility to face various business challenges, such as customer access, competition, financing, operational costs, external shocks, and regulations [7]. With technology adoption, SMEs can improve their efficiency and competitiveness in the market. However, this transformation also carries risks, including a shortage of skilled manpower needed to support the change and the potential loss of the typical competitiveness of SMEs that often rely on local and personal approaches to business [8].

SMEs play an important role in developing smart cities as the backbone of the economy through job creation and significant contributions to local economic activities. In a smart city ecosystem, SMEs can drive innovation and offer local solutions to urban challenges, improving people's quality of life [9]. Digital transformation is crucial for SMEs to remain competitive by utilizing AI, Blockchain, and IoT. The development of smart cities also requires a collaborative ecosystem involving the government, academia, and industry to encourage the growth of creative SMEs, especially in the food, textile, and handicraft sectors [10].

The value and challenges of an open IoT platform for small and medium enterprises (SMEs) engaged in smart cities are based on the experience of four SMEs participating in an open and research-based IoT trial [11]. IoT can improve the efficiency, accuracy, and sustainability of the SME ecosystem, which drives business growth and improves the quality of life. In smart city development, Sleman presents collaboration between the government, companies, and SMEs to create a competitive, low-cost, and sustainable business environment. This research specifically focuses on how IoT supports SMEs in Sleman, especially in development and marketing aspects [12].

Research Methods

Applying the Hevner Framework to DSM in the context of Small and Medium Enterprises can provide several benefits. This framework is commonly used in industrial research and related information systems to design, develop, and evaluate artifacts to present recommendations and innovative systems [13]. The Hevner Framework emphasizes identifying real-world problems and designing solutions to those problems. In the context of SME digitalization, this leads to the development of innovative solutions to overcome challenges faced by SMEs, such as the use of technology and innovation, operational efficiency, expanding markets, and creating competitive products.

This DSR method encourages researchers to consider the context of using an artifact. It is important for SMEs because the solution must be tailored to their needs and constraints. DSM can facilitate that the artifacts are culturally, socially, and economically appropriate in the context of policymakers. DSM can also encourage collaboration and participation between researchers, practitioners, and community members to ensure that existing solutions are more likely to be adopted and sustainable. Hevner's work structure can support continuous improvement and adaptation based on the SME environment [14]. This repetition is important because the circumstances of SMEs can change over time. The Hevner Framework also includes an evaluation process that can help determine the effectiveness and impact of the artifacts designed to address SME problems. It is important to understand whether the solution is achieving the expected results.

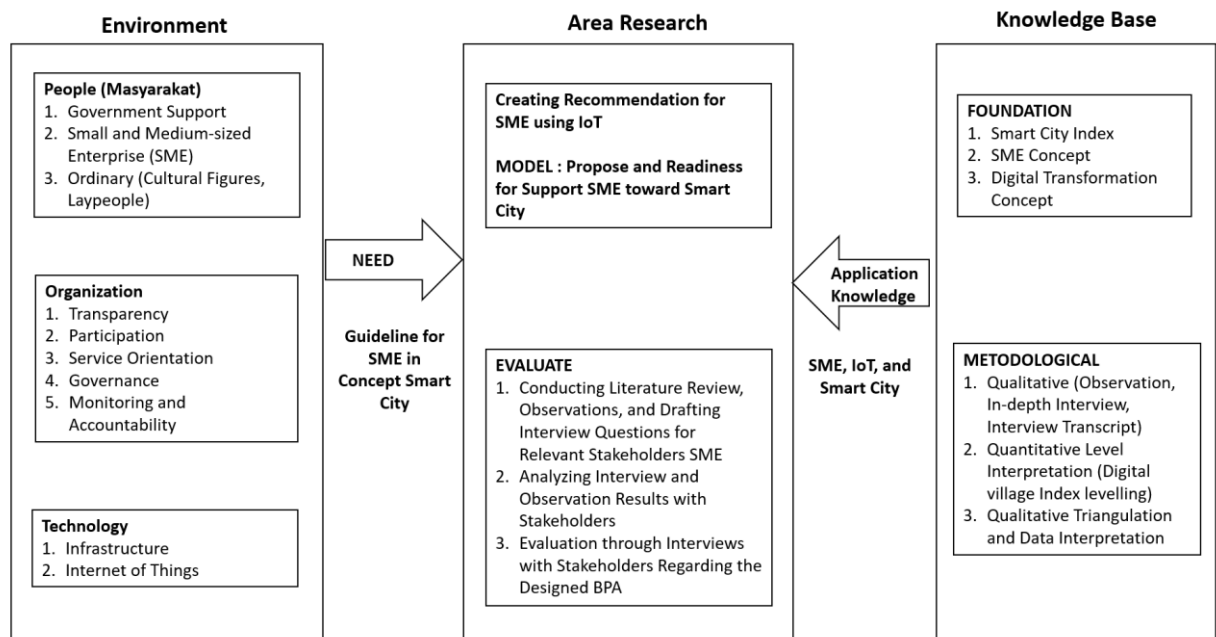


Figure 1. Design Science Research in this study

DSR can contribute to long-term sustainability in SMEs by ensuring that the solution works and is adaptable and scalable as SMEs grow. So, the Hevner Framework can be a valuable approach to overcoming challenges and opportunities in SMEs. When implementing the Hevner framework for digitalization in SMEs, it is important to consider the community's specific needs, resources, and sociocultural aspects. This approach ensures that digital solutions are not only practical but also contextually relevant and sustainable.

In Small SMEs, IoT, and Smart Cities, DSR can be used to design technologies or systems that support IoT integration in SME business operations. These artifacts, such as IoT-based data management platforms or innovative e-commerce solutions, enable SMEs to contribute to the development of Smart Cities by leveraging real-time data to improve efficiency, productivity, and customer experience.

Through DSR, SMEs can become agents of innovation in the Smart City ecosystem by adopting IoT to address specific challenges, such as logistics management or energy consumption reduction. The iterative process of DSR involving requirements gathering, design, testing, and evaluation allows for the creation of solutions that suit the needs of SMEs while supporting the sustainability of Smart Cities. By focusing on collaboration between various stakeholders, DSR not only enhances the capabilities of SMEs in the IoT ecosystem but also strengthens their role in constructing efficient, inclusive, and technology-based smart cities.

Results and Discussion

This study aims to identify the dominant factors business actors need to implement *the Internet of Things system*. This research was conducted using the *Design Science Research method*, which conducts interviews based on the Root Cause Analysis criteria: *Man, Machine, Method, Material, and Environment* in Micro, Small, and Medium Enterprises. *The Internet of Things* relates to digital technology used in production processes such as machines, data management, and the readiness of other supporting technologies, such as communication tools and internet networks. The following is a list of interviews submitted to each Micro, Small, and Medium Industry Business Actor. Interview questions conducted with *the Man* criterion are about the readiness of the workforce to use *the Internet of Things*, the *Machine criteria* is a question about the production machines used in increasing productivity and product quality, the *Material* Criterion is questions related to supporting facilities in the application of *the Internet of Things*, These facilities such as internet networks, communication tools in working such as email and telephone, in addition to data management facilities such as databases using SAP and Oracle technology. Another support is related to the amount of capital available if the application of *the Internet of Things* is carried out in Micro, Small, and Medium Industries. Method criteria are questions related to automatic and manual work methods used in Micro, Small, and Medium Industries in Micro, Small, and Medium Industries—*environmental* Criteria regarding the safety and security of the work area during the production process. The following are the results of the disseminated interviews and questionnaires on MSME Readiness in implementing *the Internet of Things*. The results of the Questionnaire Distribution and interviews conducted from *the Man* criteria were as many as 94% of 147 SMEs and their workforce can use computers well. If the implementation of *the Internet of Things* is carried out, the workforce will be ready to operate every technology and database very well, but it is necessary to carry out socialization and training related to its operation.

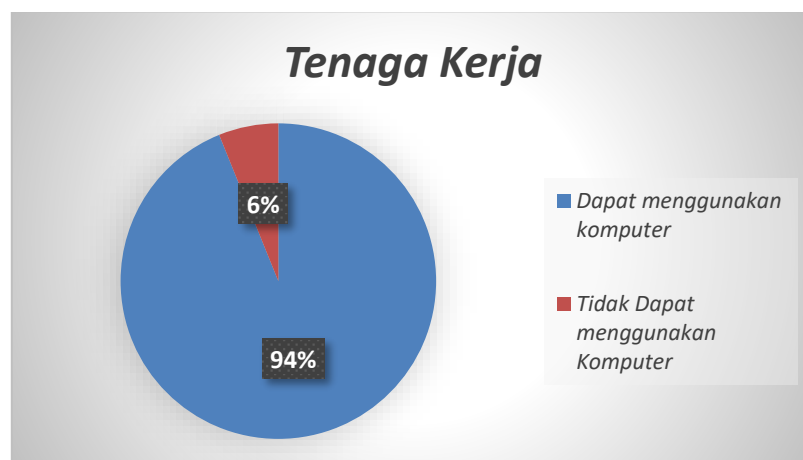


Figure 2. Workforce Data Distribution.

Based on the data above, most workers can use computers, so the workforce can efficiently operate the Internet of Things. The technology training provided will also make it easier to practice supporting product quality and productivity improvement. The problem of readiness based on the labor criteria is that workers in MSMEs need training to improve their skills. Therefore, SMEs need help to implement *the Internet of Things*.

The following criterion determining the readiness for implementing the Internet of Things in Small and Medium Industries is machinery. Machines used by Small and Medium Industries contribute to increasing the productivity and quality of MSMEs. The following is the result of the distribution of data related to the use of machinery in the production process.

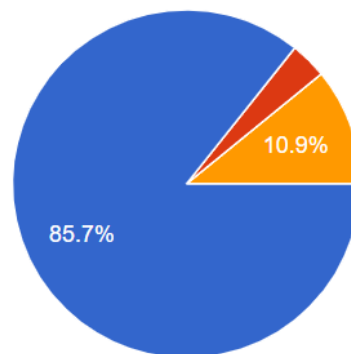


Figure 3. Machine Data Distribution SMEs.

Based on the data above, 85.7% of 147 MSMEs stated that the cause of their unpreparedness in implementing *the Internet of Things* is that the production equipment (machines) they use still needs to be updated and modern. Hence, equipment facilities need to be improved to support the productivity and quality of the production process. The machines used by SMEs in Balikpapan City are still unable to display real-time data such as temperature, process time, and process automation. Based on the distribution data above, only about 10.9% of the 147 SMEs use computer-based machines, and 3.4% use automatic special machines.

The next cause is from the criteria material, which consists of supporting facilities *for the Internet of Things*, namely the availability of the Internet, communication tools used, and capital/investment support that can support the implementation of the *Internet Of Things*. The following are the results of interviews with 147 MSMEs for the criteria *Material*.

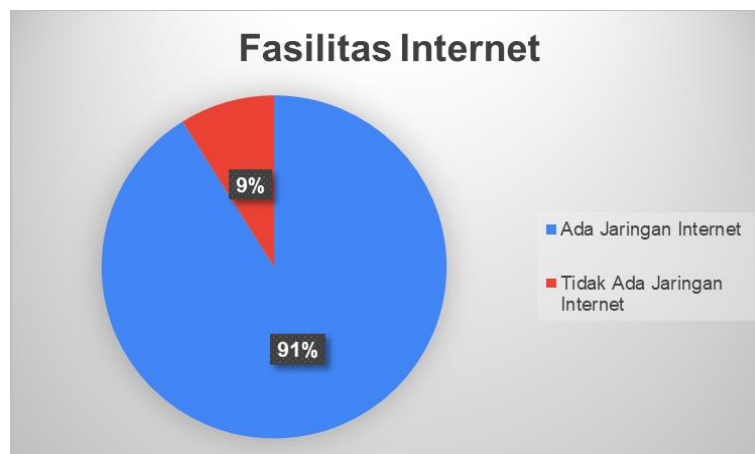


Figure 4. Internet Facilities Distribution SMEs.

The availability of internet networks in each MSME already exists at 91% of the total 147 MSMEs, while 9% do not have an internet network. If the Internet of Things application is carried out, MSMEs do not

experience difficulties because they already have an Internet network. Furthermore, the cause of material criteria to support the Internet of Things is a communication media network. MSME Communication Media still uses phones in data collection and business activities; only some use email and no one even uses database programs to support the implementation of the Internet Of Things.

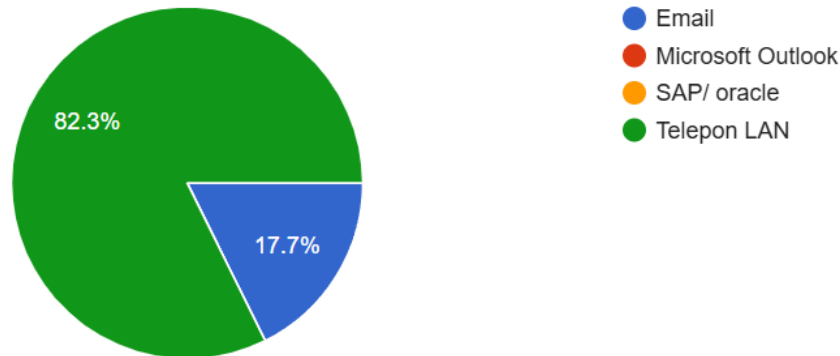


Figure 5. Communication Tools Distribution SMEs.

Based on the figure above, it can be concluded that 82.3% of MSMEs still use LAN phones, email only 17.7%, Microsoft Outlook related to company email does not exist, and SAP/oracle also does not exist. It is an obstacle to implementing the Internet of Things because SAP and Microsoft Outlook are needed for data connectivity and real-time data capture. Obstacles from MSMEs in communication media can be used as input for implementation strategies for the Internet of Things. On the other hand, capital is difficult for MSMEs in the Internet of Things; very little capital hinders the provision of automated machines. The following are the results of capital interviews as an obstacle in the implementation of Internet of Things MSMEs.

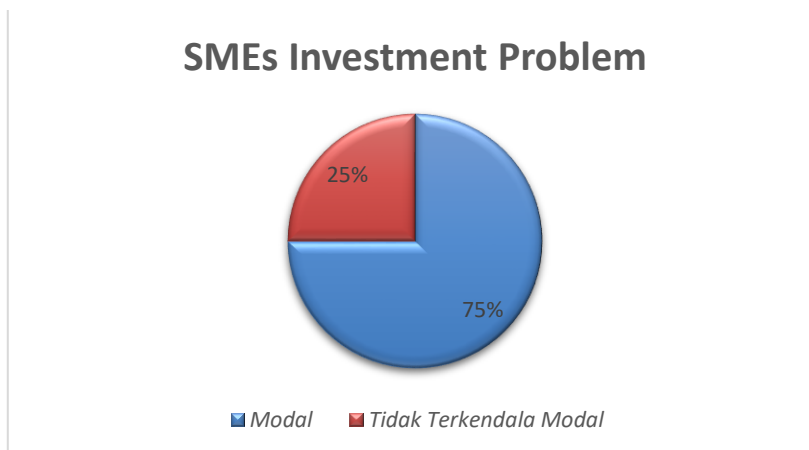


Figure 6. SMEs Investment Problem.

Based on the data above, around 111 (75%) MSMEs said that capital is one of the obstacles in implementing the Internet of Things, and only 36 MSMEs said capital constraints. Capital is one of the causes of the unpreparedness of MSMEs to improve automatic machines and implement the Internet of Things. Implementing the Internet of Things in MSMEs needs to be a concern. Furthermore, the cause of MSMEs' unpreparedness to implement the Internet of Things is the criteria method, namely the production process carried out by MSMEs. The production process that still involves much labor and is carried out manually by human hands is an obstacle to implementing the Internet of Things. The following are the results of interviews with MSME actors related to the types and conditions of the production process in MSMEs.



Figure 6. Production Process Criteria SMEs.

Based on the figure above, it is an obstacle to the readiness to implement the Internet of Things in MSMEs. The production process in each MSME is still manual, so it is not easy to get real-time data on the production process and machine specifications. Real-time data on production processes and machine and product specifications are the main criteria for implementing the Internet of Things. Another causative factor is from the criteria environment; the leading cause of the environment is that 137 MSMEs still use housing to carry out production process activities, so these production activities are not environmentally friendly, vulnerable to heat, and have a high risk of accidents and occupational safety. One of the causes of implementation readiness for the Internet of Things is a work environment that unites the production process with residential houses; this is a concern in the implementation of the Internet of Things. Because if it is done, it requires a large area for cables and places server MSMEs.

Conclusion

- The analysis of SMEs' readiness in the implementation of *the Internet of Things* is that there are several obstacles, namely the production process is still manual, the production machine is still not automatic/manual, there are difficulties in capital, the communication media used is still email and telephone, and the production work environment is not safe and still integrated with the house. These obstacles can be used as an input in implementing *the Internet of Things* in SMEs.
- Alternative Strategy Recommendations for implementing *the Internet of Things* for MSMEs are to provide capital loans in collaboration with Regional Banks, look for regional superior products to be used as *Pilot Projects*, and collaborate with local governments to develop MSMEs in funding and appropriate technology to increase the productivity and quality of MSME production.
- This preliminary research can be used as input for future IoT implementation.

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