Individual-Based Simulation for Online Marketplace
Diffusion among Batik Small Medium Enterprises (SMEs) in Indonesia

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Abstract. The number of Batik SMEs and internet users today in Indonesia has increased. This condition prompted the government to create a program of 8 million SME program to go online in 2019. But, until 2017 only 45% of the total targeted SMEs go online. This condition raises the need to understand the behaviour of SMEs implementing internet technology. The research focuses on UKM Batik and the online marketplace (OM), where batik is a unique commodity of Semarang City and OM is the implementation of emerging internet technology. The factors of OM adoption are adopted from a comprehensive T-O-E Framework. These factors form the basis for agent-based model development. Agent-based models that describe the behaviour of SMEs individually show the results of this study. Only 6 of 20 factors are used in the simulation model. These factors are the level of SME understanding that OM can increase the number of company sales, the level of SME understanding that OM can expand the company's marketing and sales area, the cost of implementing OM, the hardware readiness of SMEs, the level of courage of SME trying new things and the experience of SMEs in using OM.

1. Introduction
Small and Medium Enterprises (SMEs) have important roles for economic development and the people welfare of a country, especially developing countries like Indonesia. Based on 2014 data, SMEs contributed in providing employment opportunities of 96.99% and GDP formation of 60.34%. SMEs also contributed in product/service exports of 27,700 billion (4.86% of Indonesian exports) [1]. The large contribution of SMEs encourages the government to create a program of “8 million SMEs Go Online in 2019” [2], but until 2017, only 45% of SMEs go online (implement Internet technology) [3].

Batik is one of the products of SMEs that are popular in the community. In 2009, UNESCO set Batik as one of world cultural heritage. This boosts the popularity of Batik in the world [4]. This makes many both large, medium, small and micro Batik entrepreneurs flourish in Indonesia and the number continues to increase from year to year. Ministry of Industry data shows that the number of Batik entrepreneurs from 2011 to 2015 grew by 14.7% from 41,623 units to 47,755 units and also increased the absorption capacity of Indonesian workers by 14.7% from 173,829 people to 199,444 people [5]. However, at present the sales and marketing of Batik are still carried out conventionally and have not used online media, namely by making direct sales to stores, telephone transactions and promotions in local areas which have resulted in less optimal marketing of Batik, such as for example Batik in Semarang [6].
We have explored the use of internet technology by Batik SMEs to increase Batik sales by SMEs. Online sales have increased sales by 80% of sales turnover since online media usage [7]. However, with the emergence of the online marketplace (OM) and becoming increasingly used lately, we are looking at opportunities for research on how OM is using SMEs. Understanding how SMEs adopt OM and how the OM diffused among SMEs is important and this is in line with the government's SMEs Go Online program. Diffusion is a process of an innovation communicated within a certain time period and through certain channels in a social system [8]. However, to adopt OM, SMEs have influencing factors such as the high cost of implementing e-commerce and expensive internet technology to implement, too complicated to implement an online marketplace, the low availability of technology devices in SMEs, online marketplaces are considered less suitable for SMEs, the high benefits of online marketplace and etc. [9].

Several studies regarding the adoption and the use of e-commerce in the SME environment such as [10][11] used the TOE Framework. The factors that influence the adoption must be understood if the diffusion of OM needed to occur among. However, most TOE framework-based studies have not conducted simulations about the influence of interactions between factors that influence the process of adopting an innovation. So, this research develops agent-based simulation models in the process of diffusion of online marketplace in Batik SMEs in Indonesia using the TOE Framework. Agent-based simulations were chosen because they can visualize the relationship between research scenarios and more microscopic agent behavior [12]. Agent-based simulations also see that each agent can change their respective circumstances and adapt to the agent's environment and have their own perceptions and thoughts in making decisions obtained through filling out questionnaires by Batik SME doers in Indonesia, so they can find out their respective behavior patterns of each agent in determining the choice to adopt an online marketplace.

2. Materials and Research Methods
This research was conducted in Indonesia in each location of the Batik Small and Medium Enterprises which became the research sample. This study began with a literature study in the form of learning the basic theories related to this study from various sources such as scientific journals and research. There are 2 problems that will be examined in this study; there are (a) What are the factors that influence the adoption of online marketplace among Batik SMEs in Indonesia? (b) How is the online marketplace diffusion process among Batik SMEs in Indonesia? Based on this, the purpose of this study is (a) to identify the factors that influence the adoption of online marketplaces among Batik SMEs in Indonesia; (b) designing and creating a simulation model based on an online diffusion agent marketplace among Batik SME doers in Indonesia. Until the writing of this paper, we have involved 68 samples of Indonesian Batik SMEs. This number were calculated using the Lemeshow formula [13] for an unknown population. This is because the existing Batik SMEs in Indonesia have not yet known the actual size of the population.

3. Development of a Conceptual Model for Online Marketplace Adoption
The factors used in this study are based on the TOE framework and added to the Individual context. These factors will be used as content on a questionnaire that will be distributed to a number of Batik SME doers in Indonesia and developed based on research [10][11][14]. There are 20 factors used in this study questionnaire, that is factors 1, 2, 3, 4 and 5 (The SME's level of understanding of the benefits of online marketplace that can increase the company's sales, accelerate the promotion of company products, expand the company's marketing and sales area, increase the number of company consumers and can reduce marketing and sales costs of the company), factor 6 (The suitability level of the way SMEs work by online marketplace work), factor 7 (The level of unnecessary costs incurred by SMEs to complement online marketplace hardware and software), factor 8 (The level of online marketplace hardware readiness for SMEs), factor 9 (The level of online marketplace software readiness for SME companies), factor 10 (The SME skill / skill level to use online marketplace for SMEs), factor 11 (The SME ability level to provide resources sufficient finance to meet the needs of hardware and software of online
marketplace), factor 12 (The ability level of SMEs to provide enough human labor to run or use online marketplace software and hardware), factor 13 (Raw material supplier pressure level to SMEs), factor 14 (The competitor pressure level to SMEs), factor 15 (The consumer pressure level to SMEs), factor 16 (The level of support from outside parties, that is from the government such as regulations that support the use of online marketplace), factor 17 (The support level from online market owners to SMEs), factor 18 (The courage level of SMEs in finding and trying solutions that they have never tried and are not afraid of the risk of taking new things to solve problems in SMEs), factor 19 (The experience level of SMEs using online marketplace hardware and software) and factor 20 (The experience level of SMEs use online marketplace such as online marketplace applications).

Treatment is an additional input that will be given to agents in accordance with the assumptions used in certain studies. The treatment can be in the form of conversations or actions such as the research [15]. In this study, we only involved the treatment of SMEs as a form of interaction between SMEs and other SMEs with the government. The involvement of other agents will be carried out in the continuation of this research. After determining the factors used, the next step is that each of these factors has the respective treatment that will be given to agents with level 1% and 2% except H treatment with leveling 100% of the agents who will receive the treatment. Where the treatment is in the form of training, socialization and subsidies is one of the strategic plans of the Ministry of Cooperatives and Small and Medium Enterprises in Indonesia.

The treatments that will be given to the agents are treatment A, B, C, D and E (socialization about each benefits of the online marketplace contained in each factor), treatment F (socialization of ways to adjust the way the SME works by online marketplace work ), treatment G (cost subsidies by the government to buy hardware and software), treatment H (decrease in online tax costs), treatment I (online marketplace hardware subsidies for SMEs such as or cellphones, computers or laptops), treatment J (software subsidies online marketplace for companies such as the internet and online marketplace applications), treatment K (technical skills training for workers), treatment L (socialization on how to improve the company's ability to provide financial resources), treatment M (socialization on how to improve the company's ability to provide human labor), treatment N (socialization about increasing the number of online marketplace users to shop), treatment O (socialization on increasing the number of suppliers using online marketplace to sell raw materials), treatment P (socialization on escalation number of the competitors using online marketplace to market and sell their products), treatment Q (making government regulations, training and socialization that supports companies using online marketplace), treatment R (Improving online marketplace application system that ensures compliance with the company), treatment S (training on innovative thinking in finding solutions), T treatment (training on hardware use of online marketplace such as on computers, laptops or cellphones to companies) and treatment U (training on the use of online marketplace software such as online marketplace website to companies). Figure 1 is a conceptual model of online marketplace adoption among Batik SMEs in Indonesia.

![Figure 1. Conceptual Model of Online Marketplace Adoption among Batik SMEs in Indonesia](image)

### 4. Development of Agent-Based Conceptual Simulation Models

#### 4.1. Determination of Model Structure
Table 1 is a model structure that contains agents, variables, and scales that will be used in the development of agent-based online marketplace agent diffusion simulation models among Batik SMEs in Indonesia.

**Table 1. Modeling Structure**

| Agent                  | Variable                | Scale                                                                 |
|------------------------|-------------------------|----------------------------------------------------------------------|
| Batik SMEs in Indonesia| Factors for adopting online marketplace | The level of each factor in Batik SMEs. Random generated based on distribution |
|                        | Cluster                | 1-3 Based on the euclidean distance closest to the point of the cluster centroid |
| Batik SMEs in Indonesia| Agent status           | 0 or 1 0 = non-adopter, 1 = adopter                                    |

4.2. Overview Process and Scheduling

In the overview process and scheduling, SMEs have several factors and the initial value of each factor that is owned by the SME will be randomly initialized based on the distribution and parameters of each factor. Then the calculation of Euclidean distance determined that SMEs will enter certain clusters based on nearest Euclidean distance between centroid each cluster, where SMEs status will be as adopters or non-adopters in accordance with the probability of each status in the SME cluster. Then, each SME will interact through certain treatments for each SME that has the willingness to follow the treatment. Where, SMEs that received treatment were determined randomly based on a certain probability. SMEs that follow the treatment will get random treatment values with the distribution and parameters of each treatment obtained. The value obtained by SMEs will change the value of the existing factors in SMEs (the initial value of the factor plus the value of treatment obtained by SMEs). Changes in the value of the factors found in SMEs will change the distance value of each Euclidean so that the smallest Euclidean value changes for each cluster has an impact on changes in the SME cluster, where in each cluster there is a probability of SMEs to have adopter or non-adopter status. The condition of Batik UKM involves selected factors from table 3. Process overview and scheduling can be seen in Figure 2.

**Figure 2. Process Overview and Scheduling**
4.3. Design Concept
Design concept contains principles, emergence, adaptation, objectives, learning, predicting, sensing, interaction, stochastic, collectives and initialization. Table 2 is the design concept of this study.

Table 2. Design Concept

| No | Design Concept   | Information                                                                 |
|----|------------------|-----------------------------------------------------------------------------|
| 1  | Basic Principle  | TOE Framework and added with individual factors.                            |
| 2  | Emergence        | A Batik SME follows the Batik SMEs movement which is the other that gets the  |
|     |                  | treatment of the online marketplace diffusion pattern among Batik SMEs in    |
|     |                  | Indonesia                                                                   |
| 3  | Adaptation       | A Batik SME participates in the Batik SMEs movement that is treated by      |
|     |                  | experiencing a change in cluster due to treatment which may be responded by |
|     |                  | Batik SMEs which changes the value of each factor in SMEs.                  |
| 4  | Objectives       | Determination of Batik SME clusters which results in Batik SMEs having the  |
|     |                  | status of adopter or non-adopter according to the probability of each status |
|     |                  | in a particular cluster so that they can see the diffusion pattern of online |
|     |                  | marketplace.                                                                |
| 5  | Learning         | SMEs may experience changes in values in each of the factors that lead to    |
|     |                  | changes in the SME cluster. This is due to the response of SMEs that are    |
|     |                  | always evolving and will always change with the time and experience they    |
|     |                  | have gained through the treatment given to Batik SMEs.                     |
| 6  | Prediction       | Batik SMEs in Indonesia can be predicted to enter certain clusters which     |
|     |                  | results in SMEs having the status of adopters or non-adopters according to   |
|     |                  | the probability of status in the cluster. Clusters are predicted in the     |
|     |                  | future through the smallest Euclidean distance.                             |
| 7  | Sensing          | The model has sensing properties, which is by providing an assumption that   |
|     |                  | Batik SMEs will get treatment that will affect the impact of each factor on  |
|     |                  | the diffusion process due to changes in the value of each factor that will   |
|     |                  | be perceived by SMEs.                                                      |
| 8  | Interaction      | Batik SMEs in Indonesia interact indirectly with other Batik SMEs, which is  |
|     |                  | through treatment, where each SME has the probability want to get certain   |
|     |                  | treatment. This causes a change in the value of each factor of Batik SMEs in |
|     |                  | Indonesia due to different reactions by the Batik SMEs.                    |
| 9  | Stochastic       | The random number for the initial value of each factor and the value of each |
|     |                  | treatment for each Batik SMEs.                                             |
| 10 | Collectives      | The collective’s trait is modeled as a type of Batik SME with its own       |
|     |                  | characteristics and status factors which cause SMEs to group in certain     |
|     |                  | clusters and cause SMEs to have a possibility with different amount of      |
|     |                  | probabilities in each cluster to become adopters or non-adopters.          |
| 11 | Observation      | The way of observing output is through plots and simulation files that are   |
|     |                  | in the simulation model interface. The output can solve the problem on how   |
|     |                  | the interaction dynamics occur in SMEs in the online marketplace diffusion.  |

4.4. Initialization
The model results cannot be accurately replicated unless the initial conditions are known. Initializing the value of each factor in this simulation will have the same conditions if the simulation runs repeatedly. The value that will be initialized in the initial condition of the model is the number of Batik SMEs as many as 100 where Batik SMEs have the value of each factor before treatment and the treatment value that has been initiated in Batik SMEs.
5. Questionnaire Results Data Analysis

5.1. Factor Selection
Table 3 is the selected factor that is used in the subsequent data processing and development of operational models. These factors and the treatments were chosen because of the testing of the results of the questionnaire indicating that other factors were significantly different between adopters and non-adopters.

| Factor | Treatment |
|--------|-----------|
| 1      | Socialization about the benefits of online markets that can increase the number of company sales. |
|        | Socialization about the benefits of online markets that can expand the area of marketing and sales of the company. |
| 3      | Cost subsidies by the government to buy hardware and software. |
| 7      | Reduce online tax costs. |
| 8      | Online market hardware subsidies in the company such as cell phones, computers or laptops. |
| 18     | Training on innovative ways of thinking in finding solutions. |
| 19     | Training regarding the use of online market hardware such as cell phones, computers or laptops to companies. |

5.2. Cluster Analysis (Hierarchical cluster)
The clustering process uses the ward’s method with the agglomerative type, where each respondent is considered a separate cluster. In the next stage, two clusters that have similarities are combined into a new cluster and so on. The smaller the difference between the coefficients, the more likely it will be in the same cluster. Based on hierarchical cluster analysis, the clusters that may be formed are 9, 5, 3 and 2 clusters.

5.3. Cluster Analysis (K-Means cluster)
The next stage is the K-Means cluster that is carried out on each cluster that maybe formed to find out the characteristics of each cluster that is formed and to determine the number of clusters to be used. Based on the results of the analysis through the final output of cluster centers of several possible clusters, 3 clusters were rated better than 9 clusters, 5 clusters or 2 clusters because 3 clusters were assessed to be able to emerge the characteristics of each cluster which could really be a differentiator in each cluster. The 3 cluster also divided the respondents evenly, so that the groups formed were not only adopters or non-adopters where 3 clusters were able to divide Batik SMEs into clusters with more specific characteristics compared to 2 clusters. The characteristics of cluster 1 have a factor of 7, 8 and factor 19.
with high on average. Cluster 2 has a characteristic of factor 18 with low on average. Cluster 3 has characteristics of factors 1 and 3 with low on average.

5.4. Discriminant Analysis
Discriminant analysis is done to get the discriminant function equation for grouping Batik SMEs into each cluster. The equation of the function is as follows:

\[
Z_1 = -7.499 + 0.009V1 + 0.011V3 + 0.021V8 + 0.052V18 + 0.016V19
\]

\[
Z_2 = -2.967 + 0.015V1 + 0.084V3 - 0.003V7 - 0.034V8 - 0.021V18 + 0.001V19
\]

The average discriminant score for the Batik SME cluster differs significantly in each function, where in function 1 77% of the respondents' behavioral variants in the cluster can be explained by the discriminant model formed by 6 factors and in the function 2 42% of the respondents' behavior on Clusters can be explained by the discriminant model formed by 6 factors. While the average discriminant score of the three different clusters is quite large, the discriminant function obtained can distinguish the existing clusters with predictive accuracy as 97.4%. Therefore, by validating the discriminant function equation, it can be concluded that the discriminant function is classified as accurate.

Determination of the SME cluster is done by looking at the euclidean distance from the result of zscore function 1 and zscore function 2 which is close to the point of the cluster group centroid. The calculation uses equations 1 and 2 if the distance is between points X (X1, X2, etc.) and Y (Y1, Y2, etc.). The euclidean distance between two points is calculated by the square root of the sum of squares of the difference in value associated with the following equation:

\[
Euclidean = \sqrt{\sum_{j=1}^{k}(a_j - b_j)^2}
\]

5.5. Determination of Status Probability in Each Cluster
The process of determining the status of Batik SMEs into adopters or non-adopters is determined by calculating the probability of adopters and non-adopters in each cluster based on the results of the questionnaire. The SME status probability become adopter in cluster 1 is 47%, in cluster 2 is 0% and in cluster 3 is 14%.

6. Development of Operational Models

6.1. Experimental Design
The experimental design in this study was determined after analyzing the factors that were feasible to be used in the development of operational models. Experimental design was also made based on leveling provisions in each treatment. Table 4 is the experimental design of this study. Each variable will be treated with a certain level of treatment.

| Levelling (%) | Factor (1: Alive, 2: Not participating) | Treatment (%) |
|---------------|----------------------------------------|---------------|
|               | 1 3 7 8 18 19 A C G H I S T          |               |
| 0             | 0 0 0 0 0 1 1 1 100                  | 1 1 1         |
| 1             | 1 1 1 1 1 2 2 2                      | 2 2 2         |

6.2. Operational Model Interface Design
After designing the experimental design, the next is designing an operational model interface. Figure 3 is an operational model interface that has been developed.

6.3. Development of Operational Models
The coding process is carried out using Netlogo 6.0.1. Agent coding is done by determining the state of the agent on the model to match the situation in the real world from the beginning of the simulation. Then proceed with the coding of the clustering process carried out by determining the process of SMEs entering certain clusters in accordance with the state of SMEs. The next stage is coding the process of determining the status of Batik SMEs by determining the probability of each agent in accordance with the provisions of the probability of adopter and non-adopter status in each cluster. The final stage is

![Figure 3. Operational Model Interface](image)

Coding the process of the willingness of SMEs to follow a treatment in an operational model made to resemble a process in real life. This is done by determining the number of Batik SMEs who want to follow certain treatments according to the level of treatment and determine the value of the treatment that will be given by the agent as a form of the Batik SMEs response to the treatment they got.

6.4. Operational Model Verification
Operational model verification is carried out in 2 stages, by using the structure code walkthrough to use the "check" feature to identify errors in the writing of the code and to verify the logic of the model by looking at the behaviour of the model through the "inspector" feature in NetLogo. The result at this point is that there is no error in the code of the operational model and the logic model (the decision of the Batik SMEs cluster, the decision on the status of Batik SMEs) changes in the value of interaction between each factor if each treatment is given, the total SMEs that follow treatment A, C, G, H, I, S and T have been verified.

7. Analysis of Simulation Results
Analysis of simulation results is done after the simulation runs, where each simulation is run for 200 ticks and as many as 30 replications (and will be added the replications if these if 30 replication has not shown random results). This simulation model has a simulation time of 1 tick equal to 1 treatment. Therefore 200 ticks on the simulation are assumed to mean there are 200 treatments carried out by the government. The simulation is carried out by following the experimental design that has been made. The Simulation results have been ranked based on the number of SMEs with the most adopter status at the end of the simulation. The effect of factor 1 given treatment A with a level of 1% and 2% in the diffusion process it’s tends not to support the diffusion process of online marketplace among Batik SMEs in Indonesia. The more the level of the treatment is increased, then the diffusion process is become more unsupported. The influence of factor 3 which is given treatment C with a level of 1% and 2% in the diffusion process tends not to support the diffusion process of online marketplace among Batik SMEs in Indonesia. The more the level of treatment is increased, the diffusion process become more unsupported. The influence of the factors given H treatment with 100% level in the diffusion process is to support the online marketplace diffusion
process among Batik SMEs in Indonesia. The influence of factor 7 that given treatment G with a level of 1% and 2% and treatment H with a level of 100% in the diffusion process is to support the diffusion of online marketplace among Batik SMEs in Indonesia. The more the level of treatment is increased, the diffusion process is become more supported. The influence of factors that given treatment I with a level of 1% and 2% in the diffusion process is enough to support the process of online marketplace diffusion among Batik SMEs in Indonesia. The lower the level of the treatment get; the diffusion process is become more supported. The influence of factor 18 which is given the S treatment with level 1% and 2% in the diffusion process is to support the online marketplace diffusion process among Batik SMEs in Indonesia. The more the level of treatment is increased, then the diffusion process is become more and more supported. The influence of factor 19 which is given T treatment with a level of 1% and 2% is sufficient to support the process of diffusion of online marketplace among Batik SMEs in Indonesia. The lower the level of the treatment get, the diffusion process is become more supported.

8. Conclusion

Based on the research that has been done, it can be concluded that the factors that influence the online marketplace adoption process are 20. Where six factors (1, 3, 7, 8, 18 and 19) do not distinguish Batik SMEs from being significantly adopters or non-adopter. Factor interaction that is not very supportive of the online marketplace diffusion process is factor 1 which is given treatment A and factor 3 which is given treatment C. The interaction of factors that adequately supports the online marketplace diffusion process is factor 8 which is given treatment I and factor 19 which is given treatment T. Interaction the factors that support the online marketplace diffusion process is factor 7 which is given treatment I or H and factor 18 which is given treatment S. Further research required to involve other factors and other agents that may give influence to SMEs in adopting Online Marketplace.

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