

# Determining E-commerce Adoption Level by SMEs in Indonesia Based on Customer-Oriented Benefits

*By Evi Triandini*

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Evi Triandini

Department of Informatics  
Institut Teknologi Sepuluh Nopember  
Surabaya, Indonesia  
evi.triandini11@mhs.if.its.ac.id

Daniel Siahaan

Department of Informatics  
Institut Teknologi Sepuluh Nopember  
Surabaya, Indonesia  
daniel@if.its.ac.id

Arif Djunaidy

Department of Information Systems  
Institut Teknologi Sepuluh Nopember  
Surabaya, Indonesia  
adjunaidy@is.its.ac.id

**Abstract**— Small and Medium Enterprises (SMEs) in Indonesia need to enhance their ability to face a global market. E-commerce provides potential benefits for SMEs. This study proposed a number of Indonesian SMEs' e-commerce adoption levels and their ranks based on customer-oriented benefits. The levels and ranks are determined based k-means clustering. Analysis result shows that Indonesian SMEs can be classified into four levels of e-commerce adoption based on customer-oriented benefits. The result of this study will be used as a metric in Indonesian SMEs' e-commerce adoption framework

**Keywords**—SMEs; framework; clustering; e-commerce adoption level

## I. INTRODUCTION

In global market, Small and Medium Enterprises (SMEs) need to enhance their ability to react to the market changes. E-commerce offers opportunities and potential benefits to the SMEs [1]. However, Indonesia SMEs are still protracted in adopting e-commerce. The previous study found two major problems in e-commerce adoption, i.e. difficult to develop activities with respect to e-commerce adoption in their company and lack of knowledge in managing their e-commerce [2].

In order to overcome those problems, a framework of e-commerce adoption needs to be developed. Among other things, this framework should provide a measurement that can reflect the level of e-commerce adoption of a certain SME. The weaknesses of existing measurement approach for e-commerce adoption is only developer-oriented. It fails to address other stakeholder's concern, such as system owner and system end-user. To overcome this problem, this study proposes a measurement for customer-oriented e-commerce adoption based on customer-oriented benefits. This study is part of a bigger research. The objective of this study is to determine a level of e-commerce adoption by SME in Indonesia. Whereas, the result of this study will be used for mapping each level with functionalities and non-functionalities required in an e-commerce. This mapping indicates

functionalities and non-functionalities that need to be implemented in an e-commerce in order to achieve benefits defined in each level.

The rest of this paper is organized as follows. A summary of the literature review on stage model e-commerce adoption and clustering is first presented. Then the research methodology is described. Next, result and analysis of the data processing is discussed. Finally, conclusion and further research are outlined.

## II. LITERATURE REVIEW

### A. E-commerce Adoption by Indonesian SMEs

Small and Medium enterprises (SMEs) in Indonesia reduced the rate of poverty and unemployment in Indonesia. SMEs in Indonesia are defined as independent productive enterprises, which are run by individuals or companies that are not subsidiaries that owned, run or become both directly or indirectly part of a large enterprises [3]. Indonesian's Central Bureau of Statistics (BPS) provides a definition SMEs based on the number of employees, i.e. 5-19 persons for small-sized business and 20-99 persons for medium-sized businesses.

Hafied [4] noted that SMEs in Indonesia have started to apply e-commerce to maintain their business process. The adoption among SMEs is still very low. The degree of adoption is different from on SMEs to another. Thus, these facts should be considered when designing e-commerce adoption framework for SMEs in Indonesia. It is still generally accepted that e-commerce adoption will bring positive impact towards SMEs development.

### B. Stage Model

The stage model is a common framework for describing the characteristic improvement patterns of organizational information system in general [5]. Implementation of technology in organization has a sequential phases, which usually starts from a simple to the most advances application based on the application complexity level [6]. It is believed

1 that the higher the stage an organization reaches, the greater the benefits obtained [7].

The previous research was done by Rao [8] provided a stage model of e-commerce adoption based on functionality performed by e-commerce. The four stages are shown in Table I. The research by Govindaraju [9] also proposed a stage model of e-commerce adoption based on Rao stage model. This study added a non-adopter stage. The five e-commerce stages introduced by Govindaraju were non-adopter, presence, portals, transaction integration, and enterprises integration. This model was used to measure the level of e-commerce adoption by Indonesia SMEs.

The existing e-commerce adoption models have been developed based on technology perspective. Whereas this study will develop stage model of e-commerce adoption based on the benefits gaining for implemented e-commerce for running the business of SMEs.

TABLE I. STAGE MODEL E-COMMERCE ADOPTION

Stage	Description
Level 1: Presence	The web site provides information about company's products and services, with one way communication with user
Level 2: Portal	The web site provides two-way communication and services such as ordering, product feedback, and product surveys and/or quality product
Level 3: Transaction Integrator	The web site provides on-line financial transactions between partners, including the buying and selling products and services, and offers a virtual business marketplace for buyers and sellers
Level 4: Enterprise Integration	The web site provides collaboration between customers and suppliers; adds Supplier Relationship Management (SRM), Customer Relationship Management (CRM), and full integration of B2B and B2C business including value chain integration

### C. K-mean Clustering

The techniques of clustering can be grouped in two classes, that is, supervised and unsupervised clustering. The technique is used for organizing a set of data into a set of predetermined or non-predetermined groups. The grouping represents the similarities between members of each group. Clustering is best suited for statistical problems where prior knowledge about the groups is absent [10]. Three major types of clustering processes are hierarchical, partitioning and mixture model that are applied for organizing data [11]. Clustering algorithms are used in order to organize and categorize data, and also to compress and to construct model. Another reason for clustering is to discover relevant knowledge in data [12].

This paper used k-means clustering. K-means clustering is basically a partitioning method applied to analyze data and treat observations of the data as objects based on locations and distance between various data point [11]. Partitioning the objects into mutually exclusive clusters (K) is done in a way that objects within each cluster remain as close as possible to each other. Each cluster is characterized by its center point, i.e. centroid. A centroid is the point whose co-ordinate obtained by means of computing the average of each of the coordinates of the sample points assigned to the cluster. The k-

means uses euclidean distance to calculate a distance metric of each point in the data set and assign it to the cluster whose centroid is nearest to it. This technique was implemented to discover the level of e-commerce adoption by SMEs in Indonesia. The previous research also used k-mean and hierarchical cluster to found e-commerce business model [13].

## III. METHODOLOGY

In order to achieve the research objective, the following procedure is followed:

- 9 Determining criteria of e-commerce adoption benefits. Literature survey 5 is done in the previous study in order to obtain criteria benefits of e-commerce. The criteria of benefits are cost reduction, global market, market penetration, increasing revenue, increasing customer services, improving information availability, and rapid time to market [14].
- Collecting data. This research used survey method with questionnaire as an instrument to get data related with e-commerce benefits obtained by Indonesia SMEs. The questionnaire is divided into two parts. Part one is asking about respondent's information, such as business name, commodity, 11 mber of employee, total asset and sales. Part two related to the benefits of e-commerce adoption. In this part, there are 24 questions, which are derived based on seven criteria benefits of e-commerce adoption. The questionnaires were distributed to 100 respondent which has IT related or e-commerce background, however only 69 respondent replied the questionnaires.
- Conducting Reliability and Validity Testing. The measurement model was calculated for reliability and validity. Construct reliability was assessed by computing Cronbach's Alpha [15]. Whereas Correlation Pearson was used to assessed the validity of the answer of each question for instrument research [16].
- Clustering. Clustering analysis was used to determine the level of e-commerce adoption and the criteria for each level. K-means cluster analysis was used to find the optimum number of clusters based on similarities and differences, and to find out the criteria for each cluster. Infogain analysis was used to evaluate the benefit criteria 9 which were proper for classifying individual into levels of e-commerce adoption. Fitness function was used to determine the ranking of e-commerce adoption level.

## IV. ANALYSIS AND RESULT

### A. Analysis

This study 3 evaluated reliability of the questionnaire and the consistency of the instrument using Cronbach's alpha. The acceptable level of reliability consistency should be higher than 0.60 [17]. This study had 24 numbers of questions that represented of research variables. The result of this study showed that the alpha value is 0.835. It was greater than recommended value of 0.60. Thus, the questionnaires used by the current study had a high level of consistency and stability.

According to Khotari, an instrument has to be validated to get the meaning of measurement [11]. The Pearson correlation matrix was used in this study to assess the validity of instrument research. Data values of each variable were summed to obtain the total value of research variable. The correlation of each variable to the total value of variable was calculated to obtain the value of significance. The result of this study showed that significant value of each variable with a total value of variable is < 0.01 at 0.01 level (2-tailed). The results show that all variable research using in this study is valid.

The k-means clustering analysis was performed to determine the optimal number of clusters and to find out which cases belong to which cluster. In order to determine the optimal number of clusters, data training and testing were used to evaluate reliability of several models with a set of attributes.

TABLE II. K-MEANS CLUSTERING

Number of Cluster	Correctly Classified Instances (CCI)	Incorrectly Classified Instances (ICI)	Kappa value (κ)	Mean absolute error (MAE)	Coverage of cases (CAC)
2	62 (89.8551%)	7 (10.1449%)	0.7971	0.1298	98.55 %
3	54 (78.2609%)	15 (21.7391 %)	0.6679	0.1452	94.20 %
4	56 (81.1594%)	13 (18.8406%)	0.7359	0.1093	89.86 %
5	46 (66.6667%)	23 (33.3333%)	0.5376	0.139	92.75 %
6	52 (75.3623%)	17 (24.6377%)	0.6728	0.0888	91.30 %
7	51 (73.913%)	18 (26.087 %)	0.665	0.0848	91.30 %

This study evaluated several alternative numbers of clusters iteratively to obtain the appropriate number of cluster. Detail evaluation is shown in Table II. CCI means the built classifier classified the instance correctly. Based on the kappa (κ) and Mean Absolute Error (MAE) values, the appropriate number of clusters in this study was four clusters. The accuracy of this cluster obtained is 81.16%, the number correctly classified instances as much as 56. Whereas the value of MAE of this cluster is 0.11%. MAE is a quantity used to measure how close the predictions are to eventual outcomes.

Infogain method was used to measure the impurity level of group of individuals with respect to a given classification feature or attribute [18]. Impurity level is measured by the weight of each attribute and calculated using a gain formulation. The result of infogain process is called gain, detail shown in Table III. Gain is a value of recommendation attribute that significantly influence the classification process.

TABLE III. GAIN VALUE ATTRIBUTES

No	Gain	Attribute Number	Attribute Name
1	0.751	17	Product Information
2	0.541	22	Review Product Information
3	0.531	18	Order Information
4	0.513	9	International Customer
5	0.49	19	Payment Information
6	0.479	24	Introduction Product Time
7	0.468	13	Amount of Income
8	0.42	8	National Customer
9	0.419	20	Order Status Information
10	0.402	4	Inventory Cost
11	0.394	7	Regional Customer
12	0.364	16	Company Information
13	0.345	2	Communication Cost
14	0.341	3	Promotion Cost
15	0.335	21	Transaction Information
16	0.334	1	Marketing Cost
17	0.299	23	Product Rating Information
18	0.263	11	Buy for sale
19	0.258	12	Amount of profit
20	0.254	15	Question Time
21	0.242	5	Distribution Cost
22	0.196	6	Local Customer
23	0.127	10	Personal Consumption
24	0.119	14	Order Time

This study used the fitness function to rank four clusters. This process was an iterative search to find a number of top attributes that produced best kappa value of each tests. Based on the process, top eight attributes were selected. Then gain of the eight attributes values were normalized to obtain constant values for each variable forming fitness function.

Normalized values of eight attributes are shown in Table IV. Normalized attribute values are used as constant values in fitness function of individual data collected from respondents. The formula of fitness function has variable C and X which identify a constant value and gain value. Equation fitness function:

$$Fit Value = C_{17}X_{17} + C_{22}X_{22} + C_{18}X_{18} + C_9X_9 + C_{19}X_{19} + C_{24}X_{24} + C_{13}X_{13} + C_8X_8 \quad (1)$$

The next process was to calculate the average value of the fitness function of all individuals of each cluster. The equation of average fitness value is as follow

$$Average Fit Value = \frac{\sum_{i=1}^n Fit Value_i}{n} \quad (2)$$

Average Fitness Value (AFV) indicates the fitness value of each cluster. The fitness value represents the level of e-commerce adoption by SMEs. The higher the average fitness function value of a cluster, the higher the e-commerce adoption level of SMEs within the cluster. If a and b are two different clusters,  $AVG_a$  higher than  $AVG_b$ , then the e-

commerce adoption level of cluster *a* should be higher than cluster *b*. The average fitness value of each cluster **5** shown in table V. This value showed the ranking of **e-commerce adoption** level.

TABLE IV. NORMALIZATION

No.	Attribute Name	Normalization
<b>1</b>	Product Information	0.179108037
<b>2</b>	Review Product Information	0.129024565
<b>3</b>	Order Information	0.126639637
<b>4</b>	International Customer	0.122346768
<b>5</b>	Payment Information	0.116861436
6	Introduction Product Time	0.114238016
7	Amount of Income	0.111614596
8	National Customer	0.100166945

TABLE V. FITNESS VALUE

Cluster	Average Fitness Value
0	4.1300719
1	3.8884891
2	3.7002848
3	2.8537245

The benefits of e-commerce adoption by SMES are received in various levels. Based on the analysis using **k-11** clustering and infogain methods, this study identified the benefits of e-commerce adoption in four clusters, as shown in Table VI.

TABLE VI. CLUSTER OF BENEFITS CRITERIA

No	Cluster Ranking	Criteria
1	Cluster 3	Product Information not satisfying; Rating Product Information not satisfying; Order Information not satisfying; Payment Information not satisfying; Order Status Information not satisfying; Company information not satisfying; Transaction information not providing; Product rating not satisfying; a small Income; a number of revenue constant; Introduction product not satisfying; exist Regional Customer; exist National Customer; International customer not providing
2	Cluster 2	Product Information satisfying; Rating Product Information satisfying; Order Information satisfying; Payment Information satisfying; Order Status Information satisfying; Company information satisfying; Transaction information providing; Product rating satisfying; increasing Income; increasing revenue; Introduction product satisfying; a small of International customer;
3	Cluster 1	Increasing International customer; increasing buy for sale
4	Cluster 0	Order Information satisfying; Payment information satisfying

## V. CONCLUSION

This study proposed the four-level of Indonesian SMEs' e-commerce adoption based on customer-oriented benefits. K-means clustering technique has been used to find the optimum number of clusters for classifying Indonesia SMEs based on customer-oriented benefits.

The number of cluster found in this study similar with the result of Rao's stage model. However, the level of e-commerce adoption generated in this study is based on customer-oriented benefits of using e-commerce, whereas e-commerce adoption level developed by Rao is based on the functionalities that are exist in e-commerce.

Since this study **5** is part of a bigger project, that is the development of **e-commerce adoption** framework, the **e-commerce adoption** levels that **have been** identified will be used to model the e-commerce adoption level of SMEs in Indonesia. The selected attributes will also be used to map benefits, as the business viewpoint of SMEs, to e-commerce functionalities and non-functionalities, as the system requirements that need to be developed by e-commerce developers.

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