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HIERARCHICAL CLUSTERING FOR FUNCTIONALITIES E-COMMERCE ADOPTION

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Abstract

Web functionality is one driver for e-commerce adoption. It has appeared the level of technological capabilities as well as the accentuation of the strategy put on e-commerce by the organization. Web functionality is related to the level of e-commerce relocation. A website with more functionality will give way better benefits for shoppers and trade partners. Functionalities of the web are components that support the achievement of adoption benefits. Hierarchical clustering and ranking availability of e-commerce functionality is a challenging task. Ward Linkage algorithm was used to measure distance. This study proposed to get a grouping of e-commerce functionalities that influence e-commerce adoption and to get the ranking of the groups that most influence the achievement of these benefits. The result shows that functionalities that support the achievement of every benefit of e-commerce have been clustered into two or three clusters, where each cluster also has been ranked to facilitate the achievement of these benefits. The contribution of this research is to produce recommendations on the existence of some e-commerce functionalities that must be actively accessed by users so that the benefits of using e-commerce to manage the user's business can be achieved. The novelty of this study is a grouping of e-commerce functionality that must be available and actively accessed by users. At present, there are no studies that examining this study

Key words: Functionality e-commerce, Hierarchical clustering, E-commerce adoption

INTRODUCTION

E-commerce is the process of buying, selling, transferring or exchanging goods, services and/or information through computer networks, including the internet[1]. Some of the advantages of e-commerce include the creation of a global marketing reach, cost reduction, the availability of 24/7 business, increased marketing time, improved service to consumers, increased availability of information, creation of just-in-time business decisions, elimination of geographical boundaries, expansion market penetration, operational optimization, and increased revenue[2]–[4].

E-commerce can provide benefits for all sizes of organizations, especially the small business sector [1], [5], [6]. Small and medium-sized enterprises (SMEs) are a family organization, whereas most of them are managed in a family manner, but they were able to compete in the global market [7]. SMEs in developing countries are slow to adopt e-commerce to support their business process[8], [9]. This slowness is due to the unavailability of a framework that can be used as a reference for implementing e-commerce.

Rao [10] build a model to explain how companies use e-commerce to operate their business. The e-commerce development model created by Rao is grouped based on the functionality possessed by e-commerce. The model only explains the functionality that each level of adoption has but does not explain the benefits that users will get at each level. The research that has been done by Evi et.al [11] also produces a framework that has several components, namely the level of adoption, the benefits of e-commerce adoption, and the functionality of e-commerce. Functionalities of the web are components that support the achievement of adoption benefits. However, previous research has not explained the role of these functions for each benefit that must be achieved. The last study also has not demonstrated the functionality that has the most influence on achieving benefits.

In recent years, clustering algorithm was used in commerce analysis. This method was used to help market analyst separate different customer's activities and attention from consumer database, and sum up the pattern of each kind of consumers [12]. Other researcher used hierarchical clustering method to cluster the human flow characteristic index of base station provided by the local mobile operation. The result show that different type of business district can be developed and the algorithm can achieve good clustering effect[13].

Based on the description, research is needed to classify e-commerce functionality that supports the achievements of e-commerce adoption benefits as well as ranking functionalities that most influence the achievement of these benefits. The purpose of this study is to get a grouping of e-commerce functionalities that influence e-commerce adoption and to get the ranking of the groups that most influence the achievement of these benefits by using a hierarchical clustering method.

E-commerce applications have been widely developed, but there has been no research regarding the availability of functionality in an e-commerce application. The gap in this research is that there is a need for research regarding the availability of functionality in e-commerce applications. The contribution of this research is to produce recommendations on the existence of some e-commerce functionalities that must be actively accessed by users so that the benefits of using e-commerce to manage the user's business can be achieved. The novelty of this study is a grouping of e-commerce functionality that must be available and actively accessed by users. At present, there are no studies that review this research.

Structure of the hierarchical clustering for categorization e-commerce functionality is divided into several sections.

- Section 1 discusses the description of previous research relating to the availability of e-commerce functionality, problems, and purposes of research, novelty, and contribution of research.
- Section 2 discusses the literature review related to e-commerce adoption by SMEs, the functionality of e-commerce, and hierarchical clustering.
- Section 3 discusses the research method;
- Section 4 discusses results and discussion;
- Section 5 discusses the conclusion**.**

LITERATURE REVIEW

E-Commerce Adoption By SMEs

Previous research by researchers on e-commerce adoption was used to support this research. Several previous researchers have studied the use or adoption of e-commerce for SMEs. The study results by [14] toward 128 SMEs in Italy indicated that 97% of Italy's SMEs obtained benefits from e-commerce adoption. There are increasing the number of consumers, new market penetration, increasing communication speed with the consumers, increasing flexibility in the market chain and the ability to compete, ease of access to consumer networks, and increase in profits. The results of the study by [15] also conducted a study of 158 SMEs in New Zealand. The results of his research showed that 61.4% of SMEs have and use e-commerce for their business activities. The benefits obtained include increasing the effectiveness of product promotions, increasing profits, increasing the number of consumers and sales, and reducing costs.

Research conducted by Chong [16] with 115 SMEs in Australia and 42 SMEs in Singapore showed that e-commerce adoption has succeeded in providing potential benefits. The benefits aim to increase sales, productivity, and service quality; to reduce inventory procurement and distribution costs; convincing guarantees to continue to be able to compete. The results of research conducted by [17] on 278 SMEs in China showed that e-commerce adoption could increase sales, several consumers and corporate image, and be able to reduce transaction costs. While the results of research conducted by [18] on 98 SMEs in Malaysia show that e-commerce adoption is useful to increase the ability to compete, improve company performance and reduce communication errors.

Functionality of E-commerce

The results of the research that have been conducted [19] identified one driver for e-commerce adoption, namely web functionality. A number of a variety of functionalities appeared the level of innovative competencies. And also the accentuation of the technique put on e-commerce by the organization. The functionality web is related to the level of e-commerce relocation. The website with more functionality will give way better benefits for buyers and commerce accomplices, where they ended up more willing. This study uses e-commerce functionality that has been generated from previous studies. The results also state that these functional needs support the achievement of the benefits of e-commerce adoption for SMEs in Indonesia. Mapping functional requirements on the benefits of e-commerce adoption explain the effect of the functionality on achieving the benefits of using e-commerce for SMEs in Indonesia [11], [20], [21].

Hierarchical Clustering

Clustering is one of the unsupervised learning techniques, where there is no learning phase in this method. One of the most interesting features of hierarchical clustering is that the number of clusters to be shaped is not fixed at the initial state. Therefore, any desired number of clusters can be shaped in this clustering which makes it a adaptable approach [22]. The primary purpose of this method is to group several data or objects into groups (clusters) which in each cluster will obtain data that has similarities [23]. Hierarchical clustering is one method of clustering [24][25], [26]. According to [22], the hierarchical clustering algorithm provides hierarchical clusters, and the classification of clusters depends on a bottom-up or top-down style which was formed by hierarchical decomposition.

Various levelled clustering can be categorized into two types, agglomerative and divisive. We used the agglomerative type in this study. Agglomerative Hierarchical Clustering (AHC) is considered as a bottom-up hierarchical approach where each object set in an isolated cluster at that point AHC will blend such clusters into bigger clusters [2]. Such preparation is proceeding until a particular end has achieved. The ward linkage algorithm aims to identify the similarity between two clusters. Equation 1 showed Ward's method[27]. Ward's method provides that the distance between two clusters, A dan B, is how much the sum of squares will increase when we merge them:

$$\Delta(A,B) = \sum_{i \subset A \cup B} \left\| \vec{x}_i - \vec{m}_{A \cup B} \right\|^2 - \sum_{i \subset A} \left\| \vec{x}_i - \vec{m}_A \right\|^2 - \sum_{i \subset B} \left\| \vec{x}_i - \vec{m}_B \right\|^2 = \frac{n_A n_B}{n_A + n_B} \left\| \vec{m}_A - \vec{m}_B \right\|^2 \quad (1)$$

Where m is the center of cluster j, and n_j is the number of points in it. Δ is called the merging cost of combining the cluster A and B. With hierarchical clustering, the sum of squares starts at zero and then grows as we merge clusters. Ward's method keeps this growth as small as possible. The sum of squares should be small.

RESEARCH METHODS

The research was conducted through the methodology showing in Figure 1. This study used access log data of functionalities provided at an e-commerce website. Data was taken from www.ind-craft.com and www.jarvicestore.com. Access log data from 48 SMEs used in the study were taken from SMEs on both webs for one year.

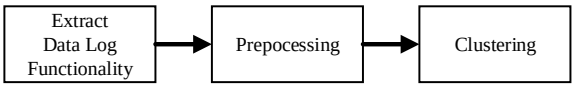

Fig1. Methodology for Clustering

The stage for the clustering functionality of e-commerce is 1) extracting data log functionality; 2) preprocessing; and 3) clustering.

The functionality of e-commerce used in this study is the result of previous studies [11]. The benefits of e-commerce adoption that can be achieved by SMEs if using e-commerce also use the results of previous research[20].

Extracted data log functionality was conducted by retrieving access log data in two web databases that store 48 SMEs data. The number of page views calculates the data according to the functional needs of each SMEs. The average data access log of the functional requirements of each SMEs is calculated. An example of log access data for SMEs showed in Table 1.

Table 1. E-commerce SMEs's URL

No.	URL	Viewed
1	/vimofunclay/	68
2	/elrahmah/	57
3	/vimofunclay/beranda/5-kalung2.html	1
4	/elrahmah/4-tas	5
…	….	…

Pre-processing is done by transposing data to get normalization data. Calculation of data transformation was done by:1) calculating the middle value with the median; 2) calculate the absolute standard deviation. An example of data transformation one benefit for SME data can be seen in Table 2. The benefits of e-commerce adoption first have several functionalities that support the achievement of the benefits of adoption by users. b1fn9 is an example of a newsletter management subscription function that supports the achievement of the first benefit, Expenses costs for an exhibition.

Table 2. Data Transformation Benefit of E-commerce

Functionalities	SME	SME (Transformation)
B1Fn9	4.933	0.086
B1Fn10	4.067	0.000
B1Fn11	4.067	0.000
B1Fn12	4.067	0.000
B1Fn13	1.270	-0.278
B1Fn15	6.731	0.265
B1Fn16	2.397	-0.166
B1Fn19	2.867	-0.119
B1Fn27	3.200	-0.086

The attribute transformation produces standard and normal data, and then it is processed using Weka 3.8.2 to group the data. In this study, data were processed using several clusters of 2,3,4, and 5. Evaluation of cluster numbers was carried out using the Sum Squared Error (SSE), showed in equation 2. SSE calculation can be seen in the equation as follows:

$$SSE = \sum_{i=1}^{k} \sum_{x \in C_i} dist^2(m_i, X) \quad (2)$$

Where X is the datapoint and cluster c_i and m_i are the centroid of cluster c_i and m_i is related to the center (mean) of the cluster.

RESULT AND DISCUSSION

The cluster results of the thirteen benefits of e-commerce adoption can be seen in Table 3. Two benefits of e-commerce adoption, namely information on how to conduct transactions (B5) and product review information (B8) have functionalities that have almost the same log access value. This results in the functionality possessed by these two benefits, not being able to be a cluster. The eleven benefits of e-commerce adoption that have different values of access log functionality can be clustered. The number cluster of each benefit is different. The determination of cluster numbers of each benefit is based on SSE. The smallest SSE value from the calculation of cluster numbers is taken to determine the final number of clusters.

Table 3. Value of SSE

Benefits	Value of SEE		
	K=1	K=2	K=3
B1	5,176,244.58	279,788.32	223,620.01
B2	146,273.21	99,881.03	138,403.07
B3	65,638,828.88	65,640,200.26	105,387.28
B4	147,175,062.64	73,630,155.23	78,795,828.47
B5	-	-	-
B6	109,711.76	14,807.37	-
B7	51,376.69	2,433.67	-
B8	24.00	-	-
B9	59,688.33	52,092.18	10.13
B10	382,619.93	292,535.89	277,761.82
B11	359,667.70	317,678.93	267,559.44
B12	324,456.47	303,059.33	112,412.53
B13	186,290.34	2,525.72	1,146.19

Functionality available in e-commerce to achieve clustered benefits into three clusters for benefits B1 (expenses costs for exhibition), B3 (faster delivery of information), B9 (information of product rating), B10 (time in order product), B11 (accelerate delivery), B12 (increase market penetration), and B13 (increase revenue). While functionality available in benefits B2 (transaction without time limit), B4 (information of product), B6 (information of transaction status), and B7 (information of transaction history) clustered into two clusters.

The effect of each cluster functionality on the achievement of benefits is shown based on the average access value of each cluster. The functionality that greatly influences the achievement of B1 is the availability of the newsletter subscription management function. The functionality that greatly influences the achievement of B2 if the availability of back-office management functions that can be assessed by three levels of management, namely low, middle, and a top level management. These functions, among others, can be used to display order reports, product review reports, return reports, new consumer reports, sales reports, and dashboards. The functionality that is very influential in achieving B3 is the availability of product category functions. Visitors to the page generally choose the product category before searching for product information sought. The functionality that is very influential in achieving B4 is product stock availability, product sorting based on price/name/rating review, and address book. The functionality that is very influential in achieving B6 is the storage of shopping carts. This functionality has transaction status details for each consumer. The functionality that is very influential in achieving B7 is the availability of integrated real-time delivery. The functionality that is very influential in achieving B9 is the availability of integrated real-time delivery. The functionality that greatly influences the achievement of B10 is the availability of customer order history functions, integrated delivery time, printing invoices, COD and payment of cooperation with a local bank.

The functionality that is very influential in achieving B11 is the availability of a product review function, tax estimation, and real-time delivery cost calculation. The functionality that is very influential in achieving B12 is liked on social networks. The functionality that is very influential in achieving B13 is the availability of search engine friendly functions.

The eleven benefits that can be felt by SMEs that utilize e-commerce to support their business can be obtained by increasing access to functionality that supports these benefits. SMEs can determine one or several benefits to be achieved for e-commerce use in a certain period. SMEs can also plan to achieve the desired benefits so that e-commerce will provide convenience in the future.

The advantage of using clustering methods in research is getting a grouping of e-commerce functionality that must be available in the application and accessed by users. In contrast, the limitation of the research is that further testing of the effectiveness of the grouping of e-commerce functionalities based on the results of the clustering.

CONCLUSION

Based on the discussion, we found that there are functionalities of e-commerce that influences the benefits of e-commerce adoption. The functionalities based on user log access to SMEs e-commerce has been greeted using hierarchical clustering methods had been clustered into two or three clusters. Each cluster of e-commerce functionality that affects the achievement of the benefits of e-commerce adoption had been ranked based on the importance of its existence so that it will accelerate the achievement of e-commerce benefits. The theoretical of this study was clustering methods can be used to classify e-commerce functionality according to the needs of their use. The practical implications of this research are that if the research results are applied in the development of e-commerce, it is expected to provide benefits for its users.

Future research can be done by implementing this functionality clustering into e-commerce applications. Testing application to SMEs needs to be done to determine the performance of applications that have been met by the existence of their functionality.

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