Design and analysis of automated external defibrillator (AED) using new service development

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Abstract. Coronary heart disease has become the major health issue that causes sudden heart attacks. In Indonesia, the number of death due to heart attack has been increased significantly. The purpose of this study is to design a new service development for Automated External Defibrillator Services in the public.The method used is conjoint analysis, cluster analysis, quality function deployment, process flow diagram and quality control plan. The results provided include user preferences regarding AED services, AED user segmentation, designing technical responses, designing operational procedures and designing quality control plans. In aggregate, users choose the website as a platform to guide the direction to the AED location and AED socialization, AED placement in or near the medical room and emergency telephone is equipment that must be placed with AED.

Keywords: Conjoint Analysis; Cluster Analysis; Quality Function Deployment; Process Flow Diagram; Quality Control Plan

1. Introduction

Ischemic heart disease or commonly called coronary heart disease is the number one cause of death in Indonesia. Statistical data shows that the development of coronary heart disease has increased by 14.2% in 2016 (Institute for Health Metrics and Evaluation, 2016). Coronary heart disease is the main pathology that causes sudden heart attacks (Sudden Cardiac Arrest / SCA) (Hayashi et al., 2015). The survival of SCAs in the public environment often depends on the use of Automated External Defibrillators (AED) (Schober et al., 2011). AED is a lightweight and portable device that sends electric shocks through the chest to the heart. AEDs have the potential to stop irregular heartbeats and allow for a normal heart rhythm to return. Life-saving opportunities decrease by seven to ten percent for every minute that passes without a defibrillation device [2].

Based on Indonesia Minister of Health's Regulation number 56 of 2016, AED is required to be provided in public facilities. Some public facilities such as airports, train stations and offices especially in Jakarta have provided AEDs. Effective use of AEDs is an important factor for increasing survival.

In Indonesia many people still have limited knowledge about AEDs and their critical functions and lack of willingness to use the device. Previous research was conducted on passengers at the busiest station in Jakarta, Gambir Station. The results showed that almost 65% of participants did not know of

the existence of AEDs in public facilities, 35% of participants did not recognize the AED device and less than 35% of participants were willing to use AEDs [3].

Several studies have also been carried out in several developed countries such as the Netherlands, Germany and the United States. Research in the Netherlands shows that only less than half of participants had the willingness to use AED and more than half of participants did not recognize AED devices [4]. Research in Germany shows that less than half of participants have knowledge about AED [5]. In America, only 18.5% of participants knew the basic mechanism of using AED [6].

From the results of the previous several research, it is shown that the provision of AED devices in public facilities has not been effective, especially in Indonesia. In developing new services or New Service Development (NSD), many companies or agencies do not have systematic support. Often, the development of new services is only subjective. The subjective process will be difficult to implement the development of new services that are sustainable [7]. The way a service is delivered is as important as the results it provides to customers. Customers are participants in service delivery, therefore in designing the process a service must involve the customer so that it can be accepted by the customer [8].

In order for the provision of AED devices in public facilities to run effectively, it is necessary to develop new services or new service development that is systematic and according to user preferences. Systematic development of new services or New Service Development is carried out with several stages including opportunity identification, customer understanding, concept development, process design, refinement and implementation. In the stage of opportunity identification, a problem linkage diagram will be presented which is the basis for developing new services or new service development for AED facilities. Customer understanding is the stage to find out what is the concern of AED users before developing the AED facility. The concept development stage uses quality function deployment to determine the technical response that must be made to the development of AED facility services according to user preferences. Then, at the process design stage use the process flow diagram method and service blueprint to present the operational design of the technical response that has been designed and the service process to be provided to the user.

By designing new service development that are in accordance with the preferences of these users, it is expected that AED services in public facilities can fulfil the need of the users and maximize the benefits of the AED.

2. Materials and Methods

The new service development consists of five steps as shown in figure 1.

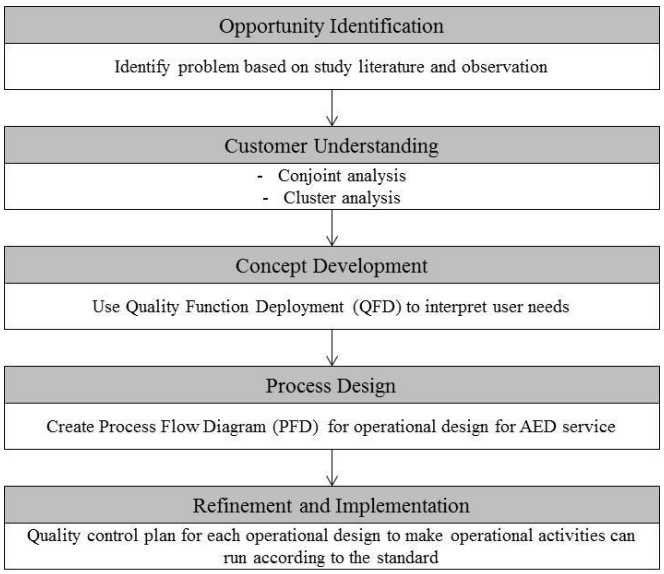

Figure 1. New Service Development Methodology

Indonesian Government has issued a regulation that AED equipment in public facilities is a mandatory, the target of the respondents is the Indonesian people who have been or are in public facilities that have provided AEDs. Some public facilities that have provided AEDs are Jakarta Soekarno-Hatta Airport and Gambir Station. The 27 attribute questionnaires were determined in Likert scale based on the combination of level and attributes using SPSS software. The questionnaires were distributed to 1000 potential participants. After distributing the questionnaires, 150 respondents were collected to proceed with further studies.

Reliability testing was determined with the value of 0.845 using Cronbach's Alpha and it was classified as consistent and valid. For the clustering analysis was presented using two stage clustering of Ward and K-means methods. In order to test the cluster validity, ANOVA testing was used, and it was found that there is a significant difference of cluster and combination of AED services.

3. Results and Discussion

New service development process consists five steps: Opportunity identification, Customer Understanding, Concept Development, Process Design, Refinement and Implementation. Based on figure 2, it appears that the Minister of Health Regulation number 56 of 2016 has issued that Automated External Defibrillator (AED) is required to be provided in public places. However, based on research conducted at one of the busiest stations in Indonesia, Gambir Station shows that 65% of participants did not know presence of AEDs in public facilities, 35% of participants did not recognize the AED device and less than 35% of participants were willing to use AED equipment. This means that in Indonesia, especially Jakarta, there are still many people who do not have knowledge about AED, its critical functions and the desire to use the AED.

Therefore, special research is needed to determine user preferences regarding AED services that are expected and serve as the basis for establishing new service development (NSD) for AED services. By forming the NSD, it will be known the user's preferences regarding the design of AED services, user segmentation, technical responses that must be done to meet user needs and control every operational activity.

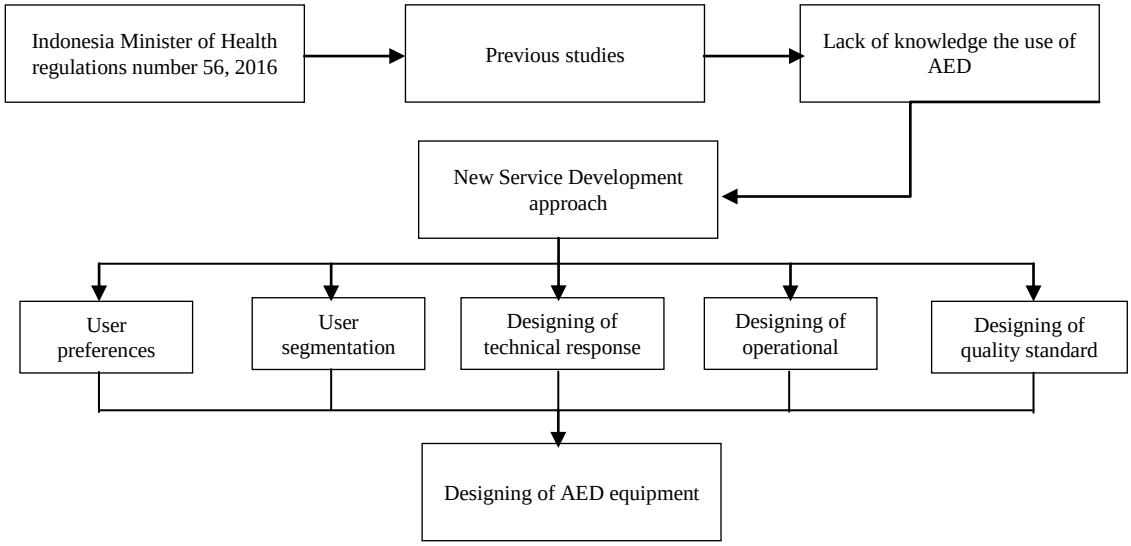

Figure 2. Interrelationship diagram

In Conjoint Analysis, the attribute determination is done by literature study. Regulations to standardize the placement of AEDs can make AEDs easier to find and optimal functionality. A

generally accessible maps or direction of AED can potentially help find an AED device in the event of a heart attack [9]. Table 1 presents the attributes and levels of service on AED.

Table 1. Attributes and levels of AED service

Attributes	Levels
Directions guide to the AED location	Website
	Direction sign on board
AED placement	Entrance
	Medical room
	Centre of the building
	Exit
	Information center
AED socialization	Website
	Billboard
	Banner
Equipment to be placed with AED	Emergency phone
	Instruction for AED use

Based on the evaluation of the goodness of fit that has been done, 150 respondents had Pearson's coefficient <0.05. This means that all the answers given by respondents when filling out the questionnaire have been accurate and consistent so that it is feasible to be analyzed further [10].

Based on table 2, it can be seen that respondents consider the attributes of "AED Placement" the most important in AED services. "Placement of AED" has a percentage level of interest that is equal to 30.17%. After that, followed by attributes that have priority 2, 3 and 4 in the AED service, namely "AED Socialization" with an interest rate of 26.38%, "Direction Guide to AED Locations" with an importance of 26.18% and "Equipment to be placed with AED "amounting to 17.27%.

Table 2. Conjoint analysis results

Attribute	Level	Utility Estimate	Std. Error	Importance Values
Directions guide to the AED location	Website	0,517	0,141	27,928
	Direction sign on board	-0,517	0,141	
AED placement	Entrance	0,080	0,277	27,027
	Medical room	0,480	0,277	
	Center of the building	-0,320	0,277	
	Exit	-0,520	0,277	
	Information center	0,280	0,277	
AED socialization	Website	0,530	0,193	21,622
	Billboard	-0,267	0,193	
	Banner	-0,267	0,23	
Equipment to be placed with AED	Emergency phone	0,433	0,141	23,423
	Instruction for AED use	-0,433	0,141	

For the "Directions Guide to AED Locations" attribute, respondents prefer "Website" with a utility level of 0.25 as a platform to guide towards the location of the AED. The choice of "Website" as a platform to guide to the location of the AED is also supported by the demographics of respondents where the majority of respondents are between the ages of 25-30 years and have the last education, namely strata 1. According to The Office of Communication (2018) [11] in their report "Adults' Media Use and Attitudes Report 2018", the age range between 25-34 years old, 84% of the population prefers to access the internet to get information

Based on the results of respondent preference, respondents preferred the "Medical Room" with a utility of 0.37 as the location in the AED placement. Given that the majority of respondents have jobs as laypersons which means people who do not have work experience or knowledge related to the medical world, the placement of AEDs in or near medical rooms is the first choice. Layperson still has the fear of helping people affected by heart attacks using AED because there is still a general lack of knowledge about AED and how to operate the AED. Layperson prefers to call medical staff to provide help rather than operating the AED itself

For the attribute "AED socialization" respondents prefer "Website" with a utility level of 0.53 as a platform to socialize AEDs to the general public. Considering the majority of respondents are between the ages of 25-30 years, according to The Office of Communication (2018) in their report Adults' Media Use and Attitudes Report 2018, the age range between 25-34 years old as 84% of the population prefers to access the internet for get information.

The majority of respondents chose "Emergency Telephone" as equipment that needed to be placed together with AED. As mentioned earlier, the layperson still has the fear of helping people with heart attacks using AEDs because there is still a general lack of knowledge about AED and how to operate the AED. Layperson prefers to call medical staff to provide help rather than operating the AED itself

To classify 150 respondents based on perceptual similarities, several stages were carried out. The stage is to do two stage clustering using the Ward method and K-means. The first stage in clustering will use the Ward method. The Ward method is used to determine the optimal number of groups [10]. The results of clustering use Ward's method in the form of an agglomeration schedule coefficient. The coefficient agglomeration schedule is interpreted in graphical form as in figure 3. As shown in figure 3, coefficient agglomeration of 150 respondents cause elbow on graph. Thus, the number of the clustering can be found by the total number of respondents was reduced by the number of respondents who experienced elbow, namely (150-144) = 6 clusters.

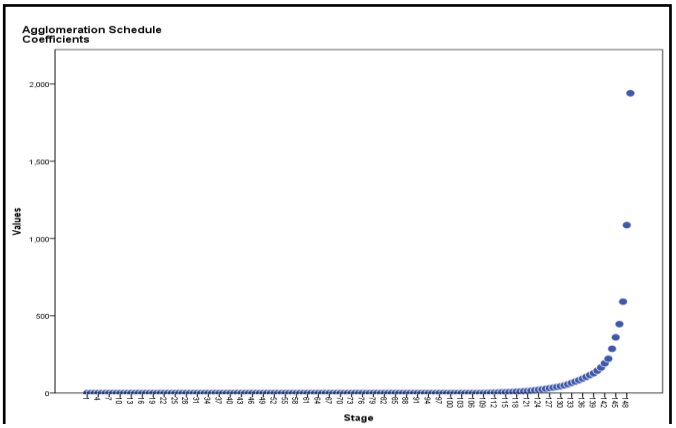

Figure 3. Coefficients from agglomeration schedule

The second stage in clustering will use the K-Means method. The results of this method will show the number of members in each group and show the average value of AED service combinations for each group.Testing the validity of grouping prospective AED users is done by the Analysis of Variance (ANOVA) method. Based on the one-way ANOVA, it is known that for all preferences the

value obtained is p-value <0.05. This means that there are significant differences from the six clusters regarding the combination of AED services [10].

After conducting literature studies and direct surveys of users about what is needed in this AED service, four attributes have been obtained, including guidance to the location of the AED, placement of AEDs, socialization of AEDs and equipment placed with AEDs. Based on processing data using SPSS 22, the value of relative importance in aggregate and cluster is obtained.

Based on the results of identifying the needs of prospective AED service users, it is necessary to establish a technical response. Technical response is the things that need to be done to be able to develop and improve the quality of AED services. Some technical responses that need to be carried out include the following:

1. Adding new features "Public AED Services" at the Ministry of Health Republic of Indonesia Website
2. Introducing the new "public AED Service" feature that already exists in the Website Ministry of Health to the general public
3. Placement of the AED device is placed in or near the medical room
4. Provide emergency telephones together with AED devices in the public
5. Information about the obligation to place AEDs in the public
6. Check the quality of the AED device before it is released

Level					*Customer needs*	*Technical Response*								*The Relative Importance*						
						1	2	3	4	5	6	7	8	*Agg.*	*Cl. 1*	*Cl. 2*	*Cl. 3*	*Cl. 4*	*Cl. 5*	*Cl. 6*
L,11			L,12		Website	9	9	3		9			9	26,2	25,3	29,4	25,9	47,7	23	25,3
L,21	L,22	L,23	L,24	L,25	Ruangan Medis	3	3	9		9				30,17	27,74	30,8	27,01	21,43	37,79	29,1
L,31	L,32		L,33		Website	9	9	3		9			9	26,392	50,48	45,94	53,3	44,03	44,03	44,03
L,41		L,42			Telepon Darurat				9		3	3		17,27	22,44	17,59	26,01	12,2	10,36	18,58
Importance Absolute					1	765,33	765,33	477,02	201,97	931,76	67,32	67,32	682,11							
					2	770,05	770,05	503,08	158,29	954,85	52,76	52,76	677,65							
					3	793,64	793,64	480,64	234,08	955,71	78,03	78,03	712,61							
					4	889,64	889,64	467,99	109,79	1018,22	36,60	36,60	825,35							
					5	716,27	716,27	541,06	93,26	942,99	31,09	31,09	602,90							
					6	711,35	711,35	469,92	167,26	885,95	55,75	55,75	624,04							
Importance Relative					1	16,47	16,47	16,23	20,94	16,38	20,94	20,94	16,54							
					2	16,57	16,57	17,11	16,41	16,78	16,41	16,41	16,43							
					3	17,08	17,08	16,35	24,27	16,80	24,27	24,27	17,28							
					4	19,15	19,15	15,92	11,38	17,90	11,38	11,38	20,01							
					5	15,42	15,42	18,41	9,67	16,57	9,67	9,67	14,62							
					6	15,31	15,31	15,99	17,34	15,57	17,34	17,34	15,13							
Cluster 1 ranks						4	4	6	2	5	1	1	3							
Cluster 2 ranks						3	3	1	5	2	5	5	4							
Cluster 3 ranks						3	3	5	1	4	1	1	2							
Cluster 4 ranks						2	2	4	6	3	5	5	1							
Cluster 5 ranks						3	3	1	5	2	4	4	5							
Cluster 6 ranks						4	4	2	1	3	1	1	5							
Importance Absolute Aggregate						563,65	563,65	429,24	155,42	744,67	51,81	51,81	473,14							
Importance Absolute Aggregate (%)						18,58	18,58	14,15	5,12	24,55	1,71	1,71	15,60							

7. Maintenance regular against AED
8. Conduct training on how to use AEDs in the public to lay groups (Laypersons)

The concept of AED design and development as shown in figure 4 using quality function deployment.

Figure 4. Quality function deployment of AED design

In the process design, the operational design of the AED service was explained to be installed in public or public places. This operational design was presented in the form of a process flow diagram so that all operational activities can be carried out in a structured manner.

Operational design of check the quality of the AED device before it is released, operational design of AED Equipment Installation Registration to the Ministry of Health of the Republic of Indonesia and operational design of Maintenance regular against AED.

In refinery and implementation stage, a quality control plan should be designed for each operational design that has been formed to avoid failures in its operational execution. Quality control

plan of check the quality of the AED device before it is released. The testing team has an important role in checking before the installation. This stage must be ensured that all parts of the AED device have been checked by the testing team so that the AED can function according to the standard after being installed.

Quality control plan of AED Equipment Installation Registration to the Ministry of Health of the Republic of Indonesia. The first process is the validation of the registration file. In this process, staff in charge at the Ministry of Health who have an important role to be able to avoid any incompatibility between the conditions set and the files entered by the registrant. Therefore, the in charge staff has a high level of accuracy and correctly understands all conditions. The second process is input registration data to the database. The in charge staff must double check the compatibility between the data entered in the database and the original file. The third process is to publish the location of the related AED on the Ministry of Health website. Possibility of failure is that publish location does not match the address that should be. Therefore, in charge staff need to request confirmation from the registrant regarding the actual location point before publication.

4. Conclusion

It is concluded that the design of the AED service that matches the preferences of prospective users is to use the website as a platform to guide the direction of the AED and socialize the AED, place the AED device in or close to the medical room and put emergency phones together with public AED device.

The technical response that needs to be taken in order to meet the needs of prospective AED users is to add a new feature "Public AED Service" at the Ministry of Health Republic of Indonesia website, introducing a new "public AED Service" feature that has been available in Website Ministry of Health to the general public, AED device placement is placed in or near the medical room, providing emergency telephones along with AED devices in the public, socializing the obligation to place AEDs in public, checking the quality of AED devices before circulating, conducting routine checks on AED devices, conducting training on using AEDs in public to lay groups (Laypersons).

The operational designs were formed, including the Operational Check of the quality of the AED device before it was installed, the Operational Design Registration Kit for the AED Device to the Ministry of Health of the Republic of Indonesia, Operational Design Conducting routine checks on AED devices. From the operational design that has been formed, a quality control plan for each operational design that has been formed has been prepared so as to avoid failures in its operational execution.

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