

SALES FORECASTING OF PHARMACEUTICAL PRODUCTS USING ASSOCIATION RULE MINING (ARM) METHOD

Riska Dhenabayu^[1], Ryan Ahmad Syah Putra^[2]
Faculty of Informatics Enggeenering

Email: ^[1]dhenabayu@unisbablitar.ac.id, ^[2]ryan.ahmadsyah04@gmail.com

ABSTRACT

This forecasting application can be applied to the pharmaceutical industry including the PPNI Wlingi pharmacy, which sells a variety of over-the-counter and prescription drugs and medical devices. The purchase of over-the-counter drugs is recorded daily. This, if left unchecked, will caused an accumulate sales data without any utilization of these data. Instead, the data can be used to determine the inventory turn over of goods so that it is useful in future sales strategies. One method that can be used is the Association Rule Mining (ARM) method which implement association rules. Association rule can be used to predict patterns of interrelationship between items that are often purchased by customers. The result will make it easier for companies to make the decision to increase or decrease the stock so that the inventory turn over will be shortened and reduce the risk of inefficient accumulation of goods.

Keywords : *Sales forecasting, pharmaceutical, Association Rule Mining(ARM)*

I. PRELIMINARY

When the demand increase, the required stock also need to be increased, this will make it difficult for entrepreneurs if there is no clear strategy in selling and stocking pharmaceutical products. The pharmaceutical products in question is medicine such as over the counter drugs and prescription drugs. Sales data can be used as material to predict what items will often be purchased by processing sales data in the past.

Sales data that has been processed will produce valuable information for the company. This information will later become a reference for determining future strategies in sales according to human needs.

Human needs for drugs make it often purchased as a cure when they are sick. This makes the drug stock become erratic. This is supported by the results of the author's survey, in which of the 4 pharmacies surveyed 50% had erratic stock because the need for certain

pharmaceutical products suddenly increased. Furthermore, the drug that is suitable for the customer is not fulfilled. For this reason, it is necessary to process data as a forward analysis so that the stock can be met in accordance with customer needs.

One method that can be used to process the data is using the Association Rule Mining method approach. The Association Rule Mining method is expected to be used to design and implement the application of pharmacy product sales forecasting and testing using Beta Testing.

II. THEORETICAL FRAMEWORK

A. Association Rule Mining(ARM) Method

The basic methodology of association analysis is divided into two stages, namely analysis of high frequency patterns and the process of forming associative rules(Norfiansyah, 2014:79).

1. Analysis of high frequency patterns

This stage looks for item combinations that meet the minimum requirements of the support value in the database. The support value of an item is obtained by using the following formula:

$$\text{Support (A)} = \frac{\text{Number of transactions containing A}}{\text{Total transaction}} \dots\dots\dots (2.1)$$

While the value of support for two items is obtained through the formula:

$$\text{Support (A,B)} = \frac{(A \cap B) \text{ Number of transactions containing A and B}}{\text{Total transaction}} \dots\dots\dots (2.2)$$

2. Formation of association rules

After all high frequency patterns are found next, an association rule is found that meets the minimum requirements for confidence rules if A is B. Confidence value if A then B is obtained by the formula:

$$\text{Confidence} = \frac{P(B|A) \text{ Number of transactions containing A and B}}{\text{Total transaction containing A}} \dots\dots\dots (2.3)$$

B. Forecasting

Forecasting is one way to determine things that will happen in the future through mathematical patterns. Prasetya, Hery and Lukiastuti (2009: 43), define forecasting as an attempt to forecast future conditions through testing events in the past. The essence of forecasting is the estimation of events in the future on the basis of past patterns and the use of policies towards projections with past time patterns. Furthermore, according to Subagyo, Ahmad (2007: 74), forecasting is defined as art and science predicting future events by taking historical data and projecting it with mathematical models. So, forecasting can be interpreted as a way to determine future events with past data that is mathematically projected.

C. Medicine

Medicine is one of the human needs to cure illness or reduce the pain suffered. According to Health Law No. 36 of 2009, drugs are materials or alloys of materials, including biological products that are used to influence or investigate physiological systems or pathological conditions in the framework of establishing diagnosis, prevention, healing, recovery, improvement in health and contraception for humans. According to Syamsuni, Haji (2005: 47) medicine is all single ingredients or mixtures that are used by all creatures for the inside and outside of the body to prevent, alleviate, reduce, eliminate and cure diseases.

D. Beta Testing

The forecasting of pharmacy product sales using the Association Rule Mining method can be implemented at the Wlingi PPNI pharmacy as a reference in determining the inventory. Beta testing is utilized to test the sales prediction software. Beta testing is done objectively, ie the application is tested directly by the user then answering several questions about the ease and feasibility of the application (Basjaruddin, 2014: 99).

III. DESIGN AND IMPLEMENTATION

A. Software Design

1. Data Analysis

Data analysis is used to analyze what attributes are needed to build the application. Attributes are used for the calculation process to produce useful information as a reference for the company. The required attributes is pisted in Tabel 3.1.

Tabel 3.1

Data Attributes For Calculation Methods

Numb er	Data	Attribute
1	Product	Product ID, Product Name, Unit, Volume, Price
2	Sales	Sales ID, Product ID, Amount of sales, Date of transaction

2. Flowchart

Flowchart is a diagram that can be used to describe a procedure or process. Below is the flowchart for the admin system.

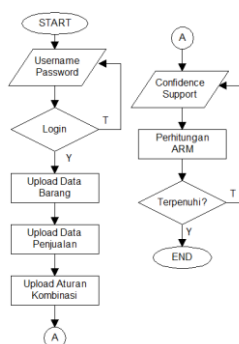


Figure 3.1. Admin System Flowchart

In accordance with Figure 3.1., the admin flowchart explains that the flow chart starts from the admin inputting the username and password to do the login process. Furthermore, the admin processes the process of adding item data, sales data and combination rules. Admin input the value of support and confidence to carry out the ARM calculation process, if it is appropriate, it is finished and if it is not finished, the input value of support and confidence will return. Next is the ARM method calculation flowchart.

3. Data Flow Diagram (DFD)

The Data Flow Diagram (DFD) explains to the user how the flow of system-functions will work. The designed grooves consist of data inputs and processes on diagrams that can be viewed from the system design. There are 2 levels of DFD namely DFD level 0 and DFD level 1.

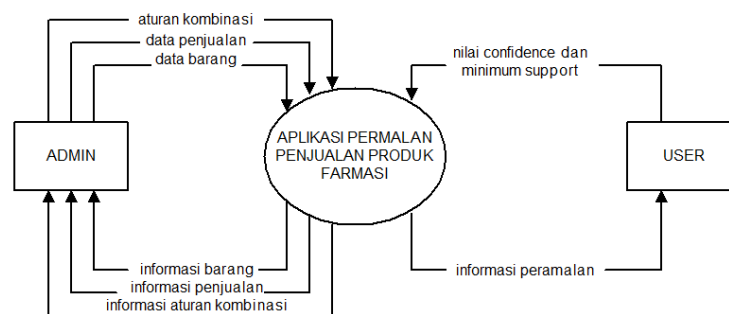
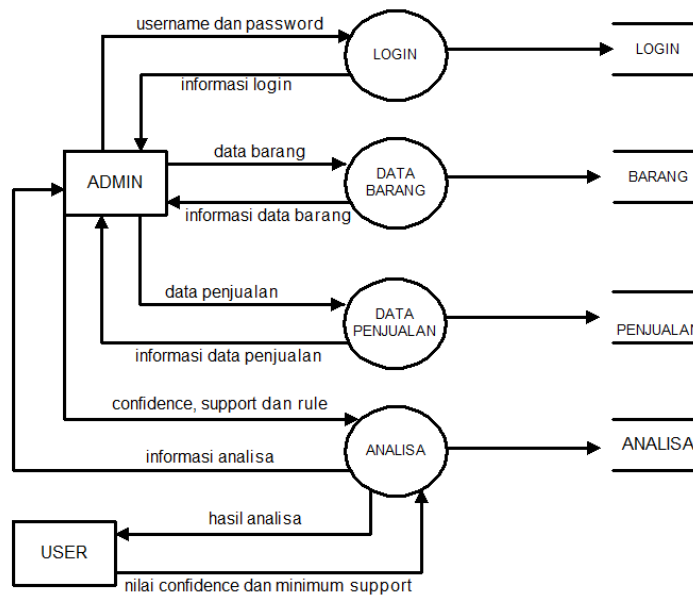


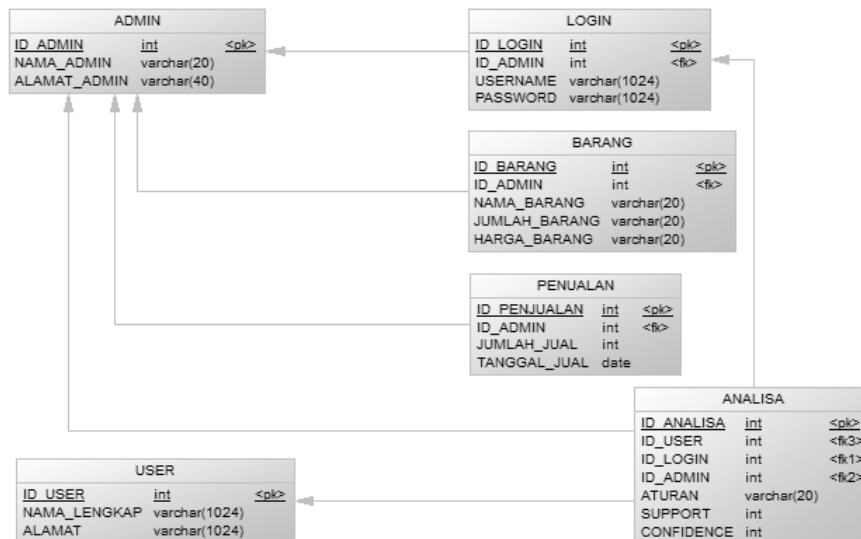
Figure 3.3. DFD Level 0

As shown in the Figure 3.3. Level 0 DFD contains 2 users and 1 process, namely admin and user and drug sales forecasting process. Admin login with the specified username and password then confirm login. Almost the same as admin, users only see data information and access it. Users only input minimum support values and minimum confidence which are then processed and produce forecasting information or analysis results.



4. Entity Relationship Diagram (ERD)

Entity Relationship Diagram shows the relationship or relationship between tables so that it forms an information that is easy to understand.



ERD (Entity Relationship Diagram) is always related to a database of a system. ER diagrams are used to determine the relationships between tables in a system database. ERD always has several attributes and uses the primary key as the identity of the table. Table item in Figure 3.5. for example, has a primary key id_barang and has the attribute name_bright, price_bright and number_bright. Furthermore, there is a foreign key as a liaison or relationship between tables.

B. Software User Interface

1. Product Data Page

NO	ID Barang	Nama Barang	Satuan	Harga	Stok	Pilihan
1	AMX100	AMOXILIN	DOOS	30500	1	✎ ✖
2	PRM001	PARAMEX	DOOS	82500	4	✎ ✖
3	PRC010	PARACETAMOL	DOOS	11300	5	✎ ✖
4	PRM002	PROMAG TABLET	DOOS	55200	3	✎ ✖
5	BDR003	BODREX	DOOS	184400	6	✎ ✖
6	LSR003	LASERYN 60 ML	BOTOL	6500	12	✎ ✖
7	MXG004	MIXAGRIP	DOOS	39500	3	✎ ✖
8	KPN0005	KALPANAX CREAM	TUBE	6200	4	✎ ✖

Figure 3.8. Product Data Page

3. Sales Data Page

NO	Nota	Tanggal	ID Barang	Nama Barang	Harga	Jumlah	Opsi
1	J180806	2018-08-06 00:00:00	PRC010	PARACETAMOL	11300	1	✖
			PRM002	PROMAG TABLET	55200	1	
2	J180807	2018-08-06 00:00:00	BDR003	BODREX	184400	1	✖
			MXG004	MIXAGRIP	39500	1	
3	J180808	2018-08-06 00:00:00	BDR003	BODREX	184400	1	✖
			LSR003	LASERYN 60 ML	6500	1	
			KPN0005	KALPANAX CREAM	6200	1	
4	J180809	2018-08-06 00:00:00	AMX100	AMOXILIN	30500	1	✖
			PRM001	PARAMEX	82500	1	
			LSR003	LASERYN 60 ML	6500	1	
5	J180810	2018-08-07 00:00:00	AMX100	AMOXILIN	30500	1	✖
			PRM001	PARAMEX	82500	1	
			MXG004	MIXAGRIP	39500	1	
6	J180811	2018-08-07 00:00:00	BDR003	BODREX	184400	1	✖
			KPN0005	KALPANAX CREAM	6200	1	
7	J180812	2018-08-07 00:00:00	BDR003	BODREX	184400	1	✖
			MXG004	MIXAGRIP	39500	1	
			KPN0005	KALPANAX CREAM	6200	1	

Figure 3.9. Sales Data Page

4. Data Input Page

The first screenshot shows the 'Input Data Barang' page with the following form fields: Id Barang, Nama Barang, Satuan, Harga Barang, and Jumlah. Below the fields are 'Simpan Data' and 'Reset' buttons. The second screenshot shows the 'Input Data Penjualan' page with fields for NOTA, Tanggal (pre-filled with 2018-08-20), and a table for 'JUMLAH BELI' with columns for 'ID Barang / Nama Barang / Harga / Stok' and 'JUMLAH BELI'. The table has five rows. Below the table are 'Simpan' and 'Reset' buttons.

es to enter new
3.11. sales data

Figure 3.11. Sales Data Input Page

<input type="checkbox"/>	2 Barang	0.2	0.2
<input type="checkbox"/>	3 Barang	0.05	0.05
<input type="checkbox"/>	4 Barang	0	0
<input type="checkbox"/>	5 Barang	0	0

Proses

Figure 3.12. Data Processing Page

Furthermore, after the user enters the minimum value of support and confidence, a table will appear containing the processed goods data. In addition, numbers 1 and 0 will appear which indicate a combination of two items. Figure 3.13.and 3.14. are the result page of the data processing.

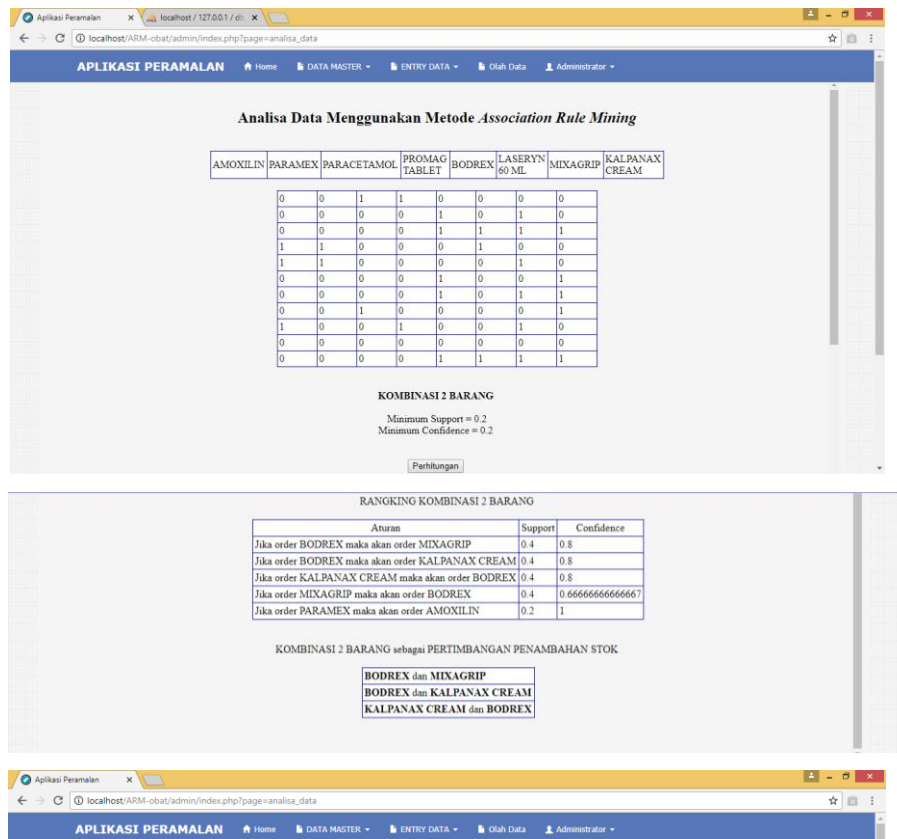


Figure 3.12. RankingResult Page

C. Data Analysis with Association Rule Mining (ARM) Method

1. Data Selection

Data selection will be used in the ARM calculation process. In addition, it determines which data you want to use in the calculation process along with the specified attributes. The data used is data taken from August 6 to 09 2018 with 28 sales data.

2. Data Pre-processing

The data used in this process is data that is clean in the sense that there is no data duplication. So that the data used is consistent data for sampling sales data in accordance with the data that has been obtained. The following Tabel 3.2. is the data used as sample data.

Tabel 3.2.

Sales Sample Data

	Nota	Id Barang	Nama Barang	Harga	Jumlah	Tanggal
1	J180806	PRC010	Paracetamol	11300	1	06/08/2018
2	J180806	PRM002	Promag Tablet	55200	1	06/08/2018
3	J180807	BDR003	Bodrex	184400	1	06/08/2018
4	J180807	MXG004	Mixagrip	39500	1	06/08/2018
5	J180808	MXG004	Mixagrip	39500	1	06/08/2018
6	J180808	BDR003	Bodrex	184400	1	06/08/2018
7	J180808	LSR003	Laseryn 60ml	6500	1	06/08/2018
8	J180808	KPN005	Kalpanax	6200	1	06/08/2018
9	J180809	AMX100	Amoxilin	30500	1	06/08/2018
10	J180809	PRM001	Paramex	82500	1	06/08/2018
11	J180809	LSR003	Laseryn 60ml	6500	1	06/08/2018
12	J180810	AMX100	Amoxilin	30500	1	07/08/2018
13	J180810	PRM001	Paramex	82500	1	07/08/2018
14	J180810	MXG004	Mixagrip	39500	1	07/08/2018
15	J180811	BDR003	Bodrex	184400	1	07/08/2018
16	J180811	KPN005	Kalpanax	6200	1	07/08/2018

17	J180812	BDR003	Bodrex	184400	1	07/08/2018
18	J180812	MXG004	Mixagrip	39500	1	07/08/2018
19	J180812	KPN005	Kalpanax	6200	1	07/08/2018
20	J180813	PRC010	Paracetamol	11300	1	07/08/2018
21	J180813	KPN005	Kalpanax	6200	1	07/08/2018
22	J180814	AMX100	Amoxilin	30500	1	08/08/2018
23	J180814	MXG004	Mixagrip	39500	1	08/08/2018
24	J180814	PRM002	Promag Tablet	55200	1	08/08/2018
25	J180816	MXG004	Mixagrip	39500	1	08/08/2018
26	J180816	BDR003	Bodrex	184400	1	08/08/2018
27	J180816	LSR003	Laseyn 60ml	6500	1	08/08/2018
28	J180816	KPN005	Kalpanax	6200	1	08/08/2018

There are 28 samples of sales data, before entering the transformation process the data is simplified into clean data without data duplication. To simplify grouping, the following Tabel 3.3. is data on drugs that have been filtered.

Tabel 3.3.

Product Sample Data

No	Id Barang	Nama Barang	Satuan	Harga	Stok
1	AMX100	Amoxilin	Doos	30.500	1
2	PRM001	Paramex	Doos	82.500	4
3	PRC010	Paracetamol	Doos	11.300	5
4	PRM002	Promag Tablet	Doos	55.200	3
5	BDR003	Bodrex	Doos	184.400	6
6	LSR003	Laseryn 60 ml	Botol	65.00	12
7	MXG004	Mixagrip	Doos	39.500	3
8	KPN005	Kalpanax Cream	Tube	6.200	4

3. Data Transformation

Next in Tabel 3.4. is the transformation stage or combining the data into tables so as to form a combination of items according to the data of the drug that has been purchased.

Tabel 3.4.
Data Transformation

Nota	Nama Obat							
	Amoxilin	Bodrex	Paramex	Paracetamol	Promag	Laseryn	Mixagri p	Kalpax
J180806				✓	✓			
J180807		✓					✓	
J180808		✓				✓	✓	✓
J180809	✓		✓			✓		
J180810	✓		✓				✓	
J180811		✓						✓
J180812		✓					✓	✓
J180813				✓				✓
J180814	✓				✓		✓	
J180816		✓				✓	✓	✓
Jumlah	3	5	2	2	2	3	6	5

4. Algorithms Calculation Process

a. Support values for one item

Tabel 3.5.
Support Values For One Item

No	Nama Obat	Support	Support (A)
1	Amoxilin	3	$3/10=0.3$
2	Bodrex	5	$5/10=0.5$
	Paramex	2	$2/10=0.2$
4	Paracetamol	2	$2/10=0.2$
5	Promag	2	$2/10=0.2$
6	Laseryn	3	$3/10=0.3$
7	Mixagrip	6	$6/10=0.6$
8	Kalpanax	5	$5/10=0.5$

b. Support values for two items

Tabel 3.6.
Support Values For Two Items

No	Kombinasi 2 Barang	Support	Support (A,B)
1	Amoxilin, Paramex	2	$2/10=0.2$
2	Amoxilin, Mixagrip	2	$2/10=0.2$
3	Bodrex, Laseryn	2	$2/10=0.2$
4	Bodrex, Mixagrip	4	$4/10=0.4$
5	Bodrex, Kalpanax	4	$4/10=0.4$
6	Laseryn, Mixagrip	2	$2/10=0.2$
7	Laseryn, Kalpanax	2	$2/10=0.2$
8	Mixagrip, Kalpanax	3	$3/10=0.3$

c. Confidence values

Tabel 3.7.
Nilai Confidence

No	Kombinasi 2 Barang	Nilai Confidence
1	IF buy Amoxilin THEN buy Paramex	$2/3=0.667$
2	IF buy Amoxilin THEN buy Promag	$1/3=0.334$
3	IF buy Amoxilin THEN buy Laseryn	$1/3=0.334$
4	IF buy Amoxilin THEN buy Mixagrip	$2/3=0.667$
5	IF buy Bodrex THEN buy Laseryn	$2/5=0.4$
6	IF buy Bodrex THEN buy Mixagrip	$4/5=0.8$
7	IF buy Bodrex THEN buy Kalpanax	$4/5=0.8$
8	IF buy Paramex THEN buy Laseryn	$1/2=0.5$
9	IF buy Paramex THEN buy Mixagrip	$1/2=0.5$

10	IF buy Paracetamol THEN buy Promag	$\frac{1}{2}=0.5$
11	IF buy Paracetamol THEN buy Kalpanax	$\frac{1}{2}=0.5$
12	IF buy Promag THEN buy Mixagrip	$\frac{1}{2}=0.5$
13	IF buy Laseryn THEN buy Mixagrip	$\frac{2}{3}=0.667$
14	IF buy Laseryn THEN buy Kalpanax	$\frac{2}{3}=0.667$
15	IF buy Mixagrip THEN buy Kalpanax	$\frac{3}{5}=0.6$

Tabel 3.7. shown the results of the calculation of confidence values. After determining the minimum support value of 0.2 and confidence of 0.2, it is found that the value meets the criteria with the highest results.

Tabel 3.8.

Kriteria Hasil

Aturan Kombinasi 2 Barang	Support	Confidence
IF buy Bodrex THEN buy Mixagrip	0.4	0.8
IF buy Bodrex THEN buy Kalpanax	0.4	0.8

In accordance with Table 3.8., the conclusion is the addition of inventory items must be purchased in these combinations:

- 1) Bodrex and Mixagrip
- 2) Bodrex and Kalpanax

D. Beta Testing Result

Tabel 3.9. Earned Beta Test Value

No	Aspek	SB	B	C	K
1	Kesesuaian Aplikasi	30,7 %	56,1 %	13,2 %	0
2	Kemudahan Aplikasi	40%	54%	6%	0

Based on the table of beta testing, it can be seen from the appropriateness aspect that the appraisal of good valuation gets a percentage of 56.1%. Furthermore, the ease of application aspects get good value with a percentage of 54%.

IV. CONCLUSION

The initial stage of this research was to determine the problems that existed in the Wlingi PPNI pharmacy, namely the accumulation of data that was not utilized. The results of these problems researchers get the application requirements, namely data items and sales data input. In accordance with these data, the researchers designed the flowchart, DFD and ERD as the basis for making the application.

Implementation of the pharmaceutical product forecasting application is made using the PHP programming language based on the website and MySQL database so that it is easily understood and used. Based on the sales data input for three days this application produces a combination of bodrex and mixagrip drugs and bodrex and kalpanax as the final results of predictions of additional drug stock that must be added.

The application of forecasting the sale of pharmaceutical products using the Association Rule Mining (ARM) method has good results. The two aspects tested were the appropriateness aspects of the application which got a percentage of 56.1% and the ease of application aspects of 54%

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