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Application of the Apriori Algorithm to Determine Public Service Patterns at the Subdistrict Office

Priska Anggraini[1]*, Akim MH Pardede[2], Zira Fatmaira[3]

[1,2,3]STMIK KAPUTAMA

priskaanggraini224@gmail.com[1], akimmhp@live.com[2], zirafatmaira0301@gmail.com[3]

Abstract

Public services at the sub-district office are a form of direct interaction between the government and the community. One of the public services is administrative services such as issuing ID cards, family cards, document legalization, domicile certificates, and SKTM certificates. At the Hamparan Perak District Office, there are several major issues that frequently arise in public services, including long waiting times, many citizens complaining about the length of service due to long queues and processes that are still conducted manually. The lack of service management due to the absence of a clear pattern in public services leads to an imbalance in the allocation of resources and manpower. By using the Apriori Algorithm, patterns of interrelated services can be identified, enabling the subdistrict office to optimize its service system. The Apriori Algorithm works by identifying frequently used service combinations (frequent itemsets) and forming association rules, thereby providing recommendations for service improvement. This method can improve service efficiency by identifying which services are frequently used together. Through testing using the RapidMiner application, this study identified age, gender, occupation, address, type of service, service time, and application status. The results show that 248 association rules were formed, with the highest Best Rule value of 5% support and 82% confidence on 3 item sets. The rule states: "If gender is male and age is between 56 and 46 years, then the application status is 'Processed.

Keywords: *Apriori Algorithm, Service, Rapid Miner*

1. Introduction

Advances in information technology have brought significant changes to various aspects of life, including public services. Information technology enables more efficient data management, faster communication, and more integrated service processes. With this technology, government agencies, including sub-district offices, have a great opportunity to improve the quality of their services to the community through the use of accurate data and automated systems. (Hasanah et al., 2024)

Public services at district offices are one form of direct interaction between the government and the public. One of the public services is the administrative field, such as making ID card referral letters, family card referral letters, document legalization, making domicile letters, and making SKTM. However, public services often face various challenges, such as long queues, long waiting times, and a lack of appropriate resource allocation, which can reduce efficiency and public satisfaction. (Juniasa, 2023)

At the Hamparan Perak Subdistrict Office, there are several main issues that frequently arise in public services, including long waiting times, many citizens complaining about the length of service due to long queues, and processes that are still conducted manually. The lack of service management due to the absence of a clear pattern in public services leads to an imbalance in resource allocation and workforce distribution. The lack of estimates for service needs means that sub-district offices do not have a system capable of identifying services that are frequently requested simultaneously, often resulting in delays in processing. In addition, the lack of utilization of service data means that existing data is not being used to its full potential to improve service quality (Juniasih et al., 2023).

To address these issues, a data-driven system capable of analyzing service patterns is required. By using the Apriori algorithm, patterns of interrelated services can be identified, enabling the district office to optimize its service system. The Apriori Algorithm works by identifying frequently used service patterns (frequent itemsets) and forming association rules, thereby providing recommendations for service improvement. This method can enhance service efficiency by identifying which services are frequently used together. Additionally, data-driven policy formulation to expedite administrative processes can be implemented, along with the utilization of technology to improve the quality of public services. The Apriori method works by analyzing historical service datasets to find relationships between services. In this way, sub-district offices can make strategic decisions, such as providing integrated services for needs that often arise simultaneously, so that people do not have to go back and forth to take care of various documents. (Fitriani et al., 2022)

Based on the background description above, the author is interested in conducting research for a thesis titled "Application Of The Apriori Algorithm To Determine Public Service Patterns At The Subdistrict Office."

2. Literatur Riview

The Apriori algorithm is a basic algorithm proposed by Agrawal & Skrikant in 1994 to determine frequent itemsets for Boolean association rules. The Apriori algorithm is a type of association rule in data mining. Rules that state associations between several attributes are often referred to as affinity analysis or market basket analysis. Association analysis or association rule data mining is a data mining technique for finding rules for a combination of items. One stage of association analysis that has attracted the attention of many researchers in order to produce efficient algorithms is high frequency pattern analysis (frequent pattern mining). The significance of an association can be determined using two metrics: support and confidence. Support (support value) is the percentage of that item combination in the database, while confidence (confidence value) is the strength of the relationship between items in the association rule. (Amna et al., 2023)
Association rules capture items or events in large data sets containing transaction data. With advances in technology, sales data can be stored in large quantities, referred to as "data baskets." Association rules defined in data baskets are used for promotional purposes, catalog design, customer segmentation, and marketing targeting.
From the above explanation, it can be concluded that the Apriori algorithm is a basic method in data mining used to find frequent itemsets and association rules in large transaction data. This algorithm focuses on analyzing high-frequency patterns (frequent pattern mining) by measuring the importance of associations using two main metrics: support, which measures how often a combination of items appears in the database, and confidence, which measures the strength of the relationship between those items. The resulting association rules are highly useful in various applications such as shopping cart analysis, promotions, catalog design, customer segmentation, and targeted marketing.
The formation of association rules that meet the minimum requirements for confidence is calculated by calculating the confidence of the associative rule A→B, where support is supporting data and confidence is certainty.

The confidence value of the rule A→B is obtained from the following formula:

$$Support\ (A) = \frac{\sum Transactions\ containing\ AdanB}{\sum Total\ transactions} \times 100\% \quad (1)$$

$$Confidence\ (A) = \frac{\sum Transactions\ containing\ AdanB}{\sum Transactions\ containing\ A} \times 100\% \quad (2)$$

Search for combinations of items that meet the minimum support value in the database. The support value of an item is obtained using the following formula:

$$Support\ (A) = \frac{Number\ of\ transactions\ containing\ A}{Total\ Transactions} \quad (3)$$

The support value of the two items was obtained using the following formula:

$$Support\ (A,B) = p\ (A \cap B)$$

$$Support\ (A,B) = \frac{\sum Number\ of\ transactions\ containing\ A\ and\ B}{\sum transaksi} \quad (4)$$

After all high-frequency patterns have been found, association rules that meet the minimum confidence requirement are sought by calculating the confidence of the associative rule A ∪ B. The confidence value of the rule A ∪ B is obtained using the following formula:

$$Confidence - P\ (B|A) = \frac{\sum transactions\ containing\ A\ and\ B}{\sum transaction} \quad (5)$$

Service is the process of fulfilling needs through the direct activities of other people. Meanwhile, the definition of service in the Indonesian Language Dictionary is helping to provide everything that other people need. Service is an activity or result that can be offered by an institution to other parties, which is often invisible, and the results cannot be possessed by those other parties. The services required by humans fundamentally fall into two categories: physical services, which are individual in nature as human beings, and administrative services, which are provided by others as members of an organization, whether that organization is a mass organization or a state. (Ferine et al., 2022)

3. Research MeMethodology

The research method used was systematic, employing scientific methods and applicable sources. This research process was designed to provide meaningful results for agencies seeking to understand patterns of public service in sub-district offices. The results of the conceptualization will be used to develop a research method using a literature study pattern, as shown in Figure II.1.

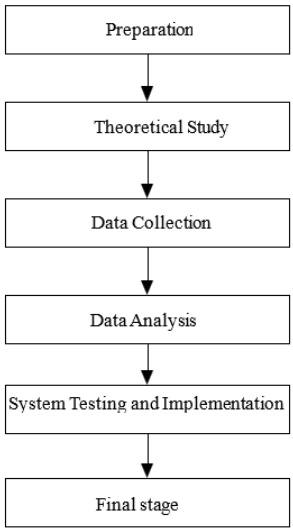

Fig. 1: Research Workflow

1. Preparation involves determining the research background, problem limitations, objectives, benefits, and other factors required in the research process using data mining.
2. Theoretical review involves reviewing the existing theory on the problem to determine the concepts to be used in the research.
3. Data collection involves gathering the supporting data required in the data mining design process. This data can be obtained from research conducted at the Hamparan Perak Subdistrict Office.
4. Data analysis involves analyzing the supporting data obtained in the previous stage.
5. System Testing and Implementation involves conducting validation tests and implementing the data that has been analyzed previously, as well as compiling the program.
6. Final Stage involves discussing the conclusions and recommendations needed for further program development.

3.1. Research Supporting Data

The entire document should be in Times New Roman. The font sizes to be used are specified in Table 1.

Table 1: Service Data

No	Age	Gender	Work	Address	Types of Services	Service Hours	Application Status
1	45	male	Fishermen	Paluh Manan	Preparation of SKTM	15:55	Finished
2	43	male	Fishermen	Lama (Desa Lama/ Kampung Lama)	Business License	16:00	Finished
3	41	female	Farmer	Kelambir Lima Kebun	Document Legalization	16:00	Rejected
4	35	male	Private Employee	Tandam Hulu Satu	Business License	11:40	Processed
5	44	male	entrepreneur	Lama (Desa Lama/ Kampung Lama)	Business License	12:14	Rejected
6	34	male	Entrepreneur	Kota Pantang (Rantang)	Document Legalization	09:27	Finished
7	25	male	Students	Tandam Hilir Satu	Making an ID card	09:48	Finished
8	64	male	Farmer	Paya Bakung	Making a Family Card	09:28	Finished
9	38	female	Civil servant	Kelambir	Making a Family Card	10:44	Finished
10	26	male	Entrepreneur	Selemak	Business License	12:57	Processed
11	27	male	Fishermen	Kelambir	Business License	08:02	Rejected
12	36	male	Fishermen	Selemak	Business License	14:50	Rejected
13	35	male	Students	Tandam Hulu Dua	Preparation of SKTM	08:18	Processed
14	61	male	Laborers	Tandam Hilir Satu	Business License	16:00	Processed
15	34	male	Farmer	Klumpang Kampung	Business License	14:09	Processed
16	39	male	Entrepreneur	Paluh Manan	Preparation of SKTM	11:33	Processed
17	50	female	Housewife	Lama (Desa Lama/ Kampung Lama)	Business License	14:36	Finished

No	Age	Gender	Work	Address	Types of Services	Service Hours	Application Status
18	53	male	Farmer	Selemak	Certificate of Domicile	10:10	Finished
19	39	female	Laborers	Tandam Hilir Satu	Making a Family Card	10:05	Rejected
20	20	female	Not yet working	Klumpang Kampung	Business License	09:55	Finished

3.2. Application of Methods

From the research conducted to apply the association rule method to identify patterns of public service at the sub-district office using a sample of service data to support the research, see Table 1. The data is a transactional database that will be represented as in Table 2, Table 3, Table 4, Table 5, Table 6, Table 7, Table 8, and Table 9.

Table 2: Data Usia

Kode	age
U1	18-25 Year
U2	26-35 Year
U3	36-45 Year
U4	46-55 Year
U5	56-65 Year

Table 3: Gender

Kode	Gender
JK1	Male
JK2	Female

Table 4: Job data

Kode	Work
P1	Not yet working
P2	Laborers
P3	Housewife
P4	Mahasiswa
P5	Fishermen
P6	Pegawai Negeri
P7	Entrepreneur
P8	Farmer
P9	Private Employee

Table 5: Address data

Kode	Address (Desa)
A1	Bulu Cina
A2	Hamparan Perak
A3	Kelambir Lima Kebun
A4	Kelambir
A5	Kelambir Lima Kampung
A6	Klumpang Kampung
A7	Klumpang Kebun
A8	Kota Datar
A9	Kota Pantang (Rantang)
A10	Lama (Desa Lama/Kampung Lama)
A11	Paluh Kurau
A12	Paluh Manan
A13	Paya Bakung
A14	Sei/Sungai Baharu
A15	Selemak
A16	Sialang Muda
A17	Tandam Hilir Dua
A18	Tandam Hilir Satu
A19	Tandam Hulu Dua
A20	Tandam Hulu Satu

Table 6: Service Type Data

Kode	Types of Services
JP1	Business License (SKU)
JP2	Preparation of SKTM
JP3	Cover letter Making an ID card
JP4	Certificate of Domicile
JP5	Document Legalization
JP6	Cover letter Making a Family Card

Table 7: Service Time Data

Kode	Service Hours
W1	08.00-11.00
W2	11.01-12.00
W3	14.01-16.00

Table 8: Application Status

Kode	Application Status
D1	Currently being processed
D2	Rejected
D3	Processing complete

And the data that has been compiled in tabular form can be found in Table 9.

Table 9: Representasi Data Usia, Gender dan Work

No	Usia					Gender		Work								
	U1	U2	U3	U4	U5	JK1	JK2	P1	P2	P3	P4	P5	P6	P7	P8	P9
1	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0
2	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0
3	0	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0
4	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1
5	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0
6	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0
7	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0
8	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0
9	0	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0
10	0	1	0	0	0	1	0	0	0	0	0	0	0	1	0	0
11	0	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0
12	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0
13	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0
14	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0
15	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0
16	0	0	1	0	0	1	0	0	0	0	0	0	0	1	0	0
17	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0
18	0	0	0	1	0	1	0	0	0	0	0	0	0	0	1	0
19	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0
20	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
∑	2	6	8	2	2	15	5	1	2	1	2	4	1	4	4	1

Table 10: Representasi Address data

No	Address											
	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
1	0	0	0	0	0	0	0	0	0	0	0	1
2	0	0	0	0	0	0	0	0	0	1	0	0
3	0	0	0	0	1	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	1	0	0
6	0	0	0	0	0	0	0	0	1	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	1	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	1	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	1	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	1
17	0	0	0	0	0	0	0	0	0	1	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	1	0	0	0	0	0	0
∑	0	0	0	2	1	2	0	0	1	3	0	2

Table 11: Representasi Address data

No	Address							
	A13	A14	A15	A16	A17	A18	A19	A20
1	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0

3	0	0	0	0	0	0	0	0
4	0	0	0	0	0	1	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0
7	0	0	0	0	0	1	0	0
8	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0
10	0	0	1	0	0	0	0	0
11	0	0	0	0	0	0	0	0
12	0	0	1	0	0	0	0	0
13	0	0	0	0	1	0	0	0
14	0	0	0	0	0	1	0	0
15	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0
18	0	0	1	0	0	0	0	0
19	0	0	0	0	0	1	0	0
20	0	0	0	0	0	0	0	0
∑	1	0	3	0	1	4	0	0

Table 12: Representasi Service Type Data, Time, dan Application Status

No	Types of Services						Time			Application Status		
	JP1	JP2	JP3	JP4	JP5	JP6	W1	W2	W3	D1	D2	D3
1	0	1	0	0	0	0	0	0	1	0	0	1
2	1	0	0	0	0	0	0	0	1	0	0	1
3	0	0	0	0	1	0	0	0	1	0	1	0
4	1	0	0	0	0	0	0	1	0	1	0	0
5	1	0	0	0	0	0	0	0	1	0	1	0
6	0	0	0	0	1	0	1	0	0	0	0	1
7	0	0	1	0	0	0	1	0	0	0	0	1
8	0	0	0	0	0	1	1	0	0	0	0	1
9	0	0	0	0	0	1	1	0	0	0	0	1
10	1	0	0	0	0	0	1	0	0	1	0	0
11	1	0	0	0	0	0	1	0	0	0	1	0
12	1	0	0	0	0	0	0	0	1	0	1	0
13	0	1	0	0	0	0	1	0	0	1	0	0
14	1	0	0	0	0	0	0	0	1	1	0	0
15	1	0	0	0	0	0	0	0	1	1	0	0
16	0	1	0	0	0	0	0	1	0	1	0	0
17	1	0	0	0	0	0	0	0	1	0	0	1
18	0	0	0	1	0	0	1	0	0	0	0	1
19	0	0	0	0	0	1	1	0	0	0	1	0
20	1	0	0	0	0	0	1	0	0	0	0	1
∑	10	3	1	1	2	3	10	2	8	6	5	9

After obtaining 6 itemsets, several data sets that meet the specified value were selected. The value itself is the numerical limit used to obtain the selected numbers, with a support value of 10%, as shown in Table 13 below:

Table 13: Support 6 Itemset

ID	*Count*	*Support*
U3, JK1, P5, JP1, W3, D2	2/20	10%
U3, JK1, P5, A10, W3, D2	2/20	10%

Table 14: *Support 7 Item Set*

No	U3	JK1	P5	A10	JP1	W3	D2	*f*
1	1	1	1	0	0	1	0	F
2	1	1	1	1	1	1	1	T

3	1	0	0	0	0	1	1	F
4	0	1	0	0	1	0	0	F
5	1	1	1	1	1	1	1	T
6	0	1	0	0	0	0	0	F
7	0	1	0	0	0	0	0	F
8	0	1	0	0	0	0	0	F
9	1	0	0	0	0	0	0	F
10	0	1	0	0	1	0	0	F
11	0	1	1	0	1	0	1	F
12	1	1	1	0	1	1	1	F
13	0	1	0	0	0	0	0	F
14	0	1	0	0	1	1	0	F
15	0	1	0	0	1	1	0	F
16	1	1	0	0	0	0	0	F
17	0	0	0	1	1	1	0	F
18	0	1	0	0	0	0	0	F
19	1	0	0	0	0	0	1	F
20	0	0	0	0	1	0	0	F
				Jumlah				2

The process of determining C7, or the minimum support amount = 10%, can be seen in Table 15 below:

Table 15: Support 7 Itemset

ID	*Count*	*Support*
Jika usia 36-45 Year *(U3)*, Gender Male *(JK1)*, Worknya adalah Fishermen *(P5)*, addressnya (Desa Lama/Kampung Lama) *(A10)*, Types of Servicesnya adalah Business License (SKU) *(JP1)*, Service Hoursnya 14.01-16.00 WIB *(W3),* maka Application Status di tolak *(D2)*	2/20	10%

After all high-frequency patterns have been found, association rules that meet the minimum confidence requirement are sought by calculating the confidence or association A→B, with a minimum confidence of 10%.

Table 16: Hasil Final Asosiasi

Aturan	*Confidence*	
If the age is 36-45 years (U3), gender is male (JK1), occupation is fisherman (P5), address is (Desa Lama/Kampung Lama) (A10), type of service is Business License (SKU) (JP1), Service Hours are 14:01-16:00 WIB (W3), then the Application Status is rejected (D2)	2/2	100%

And after multiplying Support and Confidence, the result of the multiplication is 10% for the rule that will become the Best Rule.

Table 17: Best Rule

If antecendent then consequent	*Support*	*Confidence*	*S*C*
If the age is 36-45 years (U3), gender is male (JK1), occupation is Fishermen 1 (P5), address is (Desa Lama/Kampung Lama) (A10), type of service is Business License (SKU) (JP1), Service Hours are 14:01-16:00 WIB (W3), then the Application Status is rejected (D2)	10%	100%	10%

Based on the analysis results with a minimum support of 10% and confidence of 100%, one association rule that meets the support and confidence values is obtained: if the age is 36–45 years, gender is male, occupation is fisherman, and address is in Desa Lama or Kampung Lama, the type of service is a Business License (SKU), and the service hours are from 2:01 PM to 4:00 PM WIB, then the application status is likely to result in a rejected application. In this rule, the S*C value is 10%. This number indicates how strong the relationship is between the combination of variables and the application outcome.

4. Results and Discussion

Steps taken to calculate data mining on public service data using the RapidMiner application, to identify public service patterns and obtain information quickly as a decision-making step in identifying public service patterns at the sub-district office.

4.1 Program Discussion

In the program discussion, the initial process of using the RapidMiner application in the existing program will be explained, along with an explanation of how the author will only discuss its use in data mining testing using RapidMiner.

The following is a view of the association analysis process in the RapidMiner application, which is running an association analysis process in a project called prosespelayanan. In the middle of the screen, you can see the workflow or series of operators arranged sequentially from left to right to process public service data.

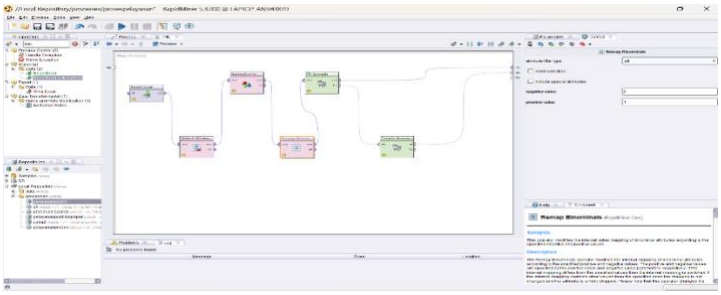

Fig. 2: Display of the Association Analysis Process in the RapidMiner Application

The following is the final result of the association rule mining analysis process using the FP-Growth algorithm in the RapidMiner 5.3 application, specifically in the AssociationRules tab (Create Association Rules). This display presents a list of association rules in a table format with columns such as Premises (initial conditions), Conclusion (results), and various evaluation metrics such as Support, Confidence, Lift, and Conviction.

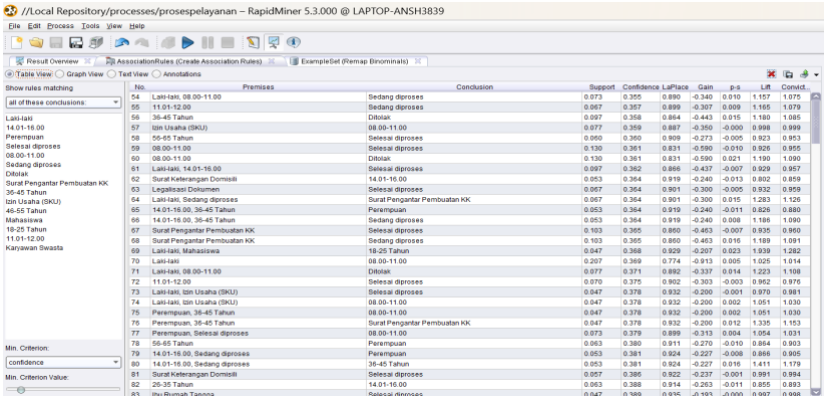

Fig. 3: Associate Table Display

The image below shows the results of association rule analysis in text view in the RapidMiner 5.3 application. Each row in this view represents an association rule formed from public service data, in the format "premise → conclusion" along with a confidence value indicating the level of confidence in the rule. For example, the rule "[56–65 Year] → [08.00–11.00]" with a confidence of 0.300 means that 30% of applicants aged 56–65 Year arrive between 08.00–11.00. Additionally, there are rules such as "[Female, 08.00–11.00] → [36–45 Year]" that show patterns of association between several applicant characteristics. The confidence values listed indicate how strong the relationship between the items is in the data. This display helps users understand patterns of behavior or trends in society regarding access to services, making it highly useful for decision-making or improving public service strategies. The results of the association rule formation from the testing in the RapidMiner Studio application can be seen in the following figure:

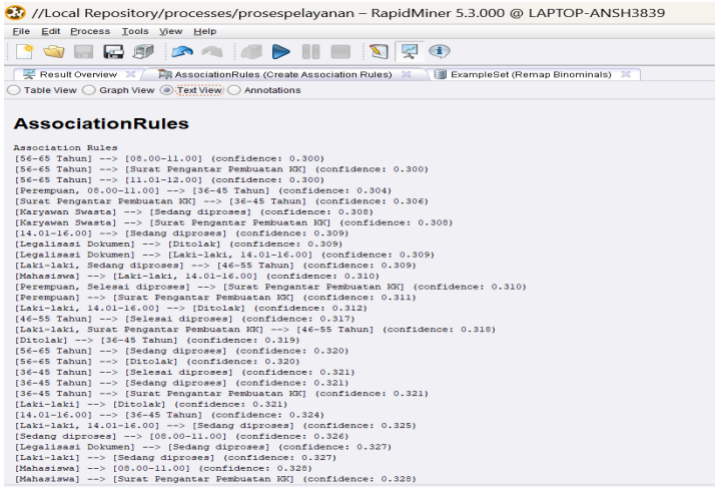

Fig. 4: Associate Rules Display

4.2 Implementation

Application of the Apriori Algorithm in identifying patterns of public service at the Sub-District Office. Data processing was carried out using RapidMiner to identify correlations between items and generate the best rules, and to input the results of the rules from the processing carried out on RapidMiner.

If anttendance then consequent	*Support*	*Confidence*	*lift*
If the applicant is male and aged between 56 and 46 years old, then the application status is "Processed."	5%	82%	1.47

5. Conclusion

From testing using the RapidMiner application, this study identified age, gender, work, address, types of services, service hours, and application status. The results show that there are 248 association rules formed with the highest Best Rule value of 5% support and 82% confidence on 3 item sets. The rule is "If Gender is Male and age is 56-46 years, then Application Status is Processing Complete.

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