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IMPLEMENTATION OF STRING SIMILARITY ALGORITHM IN PUBLIC COMPLAINT APPLICATIONS TO MINIMIZE SIMILAR COMPLAINTS

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Abstract — *Presently, the complaining service in Kartasura local government relies on manual recording where people must come to the government office, write their complaints and submit them to the office staff. This situation causes inefficiency since people have to travel from their places to the local government office. Moreover, the manual recording makes the complaints cannot be managed properly since the same complaints can be submitted more than one time. Additionally, it also causes some confusion to the government staff since they need to carefully check whether it has been submitted previously and approve the complaints accordingly. To solve the issue, a web-based application complaint system is developed to reduce the number of the same complaints from the citizen as well as to help staff manage the complaints data. The Jaro-Winkler String Similarity algorithm is adopted to check the similarity of newly submitted complaints with existing complaints data. The algorithm detects similarities of newly submitted complaints by determining the level of string equality to the existing complaints. Experimental results using one month period of complaints data in December 2022 show that the application is able to detect the similarity between the newly submitted complaints to the existing complaints. As the value of similarity threshold is higher, the number of rejected complaints also increases. Meanwhile, the test results of the system using the System Usability Scale Score obtained an average value of 76.5, which means the system is included in the Acceptable category and can be used for daily activity.*

Keywords*: string similarity*, *jaro winkler*, *complaint application.*

Intisari— *Saat ini pelayanan pengaduan di Kecamatan Kartasura mengandalkan pencatatan manual dimana masyarakat harus datang ke kantor kecamatan, menulis pengaduannya dan menyampaikannya ke petugas dinas. Situasi ini tidak efiesien karena masyarakat harus melakukan perjalanan dari tempat mereka ke kantor pemerintah daerah. Selain itu, pencatatan secara manual membuat pengaduan tidak dapat dikelola dengan baik karena pengaduan yang sama disampaikan lebih dari satu kali oleh orang yang berbeda. Selain itu, hal ini juga menyebabkan kebingungan bagi staf pemerintah karena mereka perlu memeriksa dengan hati-hati apakah pengaduan tersebut telah diajukan sebelumnya dan menyetujui pengaduan tersebut. Salah satu upaya untuk mengatasi masalah tersebut, dikembangkanlah sistem aplikasi pengaduan berbasis web untuk mengurangi jumlah pengaduan yang berlebihan atau aduan yang sama dari masyarakat serta membantu staf dalam mengelola data pengaduan. Algoritma Kesamaan String Jaro-Winkler diadopsi untuk memeriksa kesamaan keluhan yang baru diajukan dengan data keluhan yang ada. Algoritma mendeteksi kesamaan keluhan yang baru diajukan dengan menentukan tingkat kesamaan string dengan keluhan yang ada. Hasil percobaan dengan menggunakan data pengaduan yang diambil pada periode bulan Desember 2022 menunjukkan bahwa aplikasi mampu mendeteksi kesamaan antara pengaduan yang baru disampaikan dengan pengaduan yang sudah ada. Semakin tinggi nilai kesamaan yang ditentukan maka semakin sedikit aduan yang diterima atau semakin banyak aduan yang ditolak. Sedangkan hasil pengujian sistem dengan menggunakan System Usability Scale diperoleh nilai rata-rata 76,5 yang berarti sistem termasuk dalam kategori Acceptable dan dapat digunakan untuk aktivitas sehari-hari.*

Kata Kunci*: string similarity*, *jaro winkler*, *aplikasi pengaduan .*

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INTRODUCTION

The development of technology is currently increasing rapidly. A society that continues to develop dynamically must be followed by technology that is developing more rapidly [1]. The digital transformation leads many organizations either public or private sector implement digitalization to improve their long-term strategic policies [2]. Therefore, the computers technology allows the institution to enable the digital transformation.

One of the developments in computer technology for public sector is called E-Government [3] which aims to improve efficiency, effectivity and transparency. Public services themselves have various types in their application in the community, one of which is public complaints system such as in health service. The system is collecting reports from patients where they submit a specific health care issues and combining the staff perspectives to minimize unsafe treatments [4]. The demands that the community wants to convey must be properly responded to by the government since this is one of the duties of the local government in meeting the needs of the community in this field of public services [5].

Kartasura district is one of the government agencies located in Sukoharjo regency, central java. The institution has a schematic function as a sub-district administrator which includes general administrative services for the community such as issuing citizen identity card or Kartu Tanda Penduduk (KTP), family certificate of Kartu Keluarga (KK), administrative letters, marriage Certificates, and some other documents [6]. Currently, all the services in Kartosuro district are carried out manually. However, several services process was changed using computer technology in respond to the community's demand to obtain more convenience in satisfying their demand at the sub-district office. This is in line with the opinion in [7] which states that with the existence of technology, work in processing and receiving information will be well assisted. This means that the use of technology in fulfilling needs and developments will have a positive impact [8]. However, in reality the public service in the form of a public complaint service in Kartasura District has not been well organized.

The complaint process carried out by the community in Kartasura District is still manual, the community must come to the sub-district office and then submit their complaints to the community service officer for further data by the officer. This complaint step is certainly not effective because it requires time and money, not to mention that the complaint reports that have been received are not handled immediately because they are piled up with other reports or even the reports are lost. Additionally, some problems that previously have been reported by a community member are being resubmitted by others. Therefore, a lot of redundant and similar issues are coming to the office. The situation makes the office staffs to get confused and cannot handle the complaint report properly. In principle, efforts are made to provide public complaints services to the government to make it easier for people to submit their complaints, among others by providing services hotline, facsimile and website as a means of facilitating public complaints [9].

Based on these problems, the authors had the idea to design a website-based public complaint service application by implementing an algorithm string similarity to minimize reports of the same complaint. According to [10] string similarity can be referred to as ordinariness between two text fragments that can be used as the main task of various application such as information retrieval and document matching. It also suggests that the calculation of text similarity can be categorized into text distance and text representation.

String similarity algorithm has several variants of the algorithm such as the Brute Force algorithm, Aho-Corasick algorithm, Boyer-Moore algorithm, Knuth-Morris-Pratt algorithm, Jaro Winkler algorithm and Karp-Rabin algorithms, the algorithms are distinguished based on how they work. In terms of designing public complaint service applications, the Jaro-Winkler algorithm is adopted since it performs well in matching entities or names [11].

Several previous research that relevant to this research was carried out by [12], which examines string matching in the Indonesian language dictionary. The results of the research show that the Jaro Winkler Algorithm can effectively display the words from the database that are closest to the word that users are looking for. The similarity between these two studies lies in the use of string similarity by using Jaro Winkler algorithm to find the similarity of a particular object. The difference between the two studies lies in the object of study. The current research aims to develop a web application that implements string similarity algorithm to anticipate resubmission of the same complaints.

The public complaint application is designed with a simple view interface and the features on the application are not many. Therefore, it can make users become easier to submit complaints and reduce the effort of officers in inspecting newly incoming reports.

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MATERIALS AND METHODS

A. Jaro-Winkler Algorithm

The Jaro-Winkler algorithm is one of the variants discovered by Mathew A. Then it was developed by William E. Winkler and Thibaudeau with modify Jaro Distance to have the same weight higher, the higher the Jaro-Winkler value Distance on both strings, then string it will be more similar. Normal value on this algorithm is 0 to indicate presence the dissimilarity between the 2 strings, and has a value of 1 to indicate the similarity between the 2 strings, therefore the Jaro-Winkler algorithm is an algorithm used to measure the similarity of words between 2 sentences [13]. The Jaro-Winkler algorithm has a very effective time complexity and can work faster than other distance algorithms. The basics of the Jaro-Winkler algorithm are as follows:

1. Calculate the length of the string.
2. Find the number of characters that are equal in 2 strings.
3. Find the number of transpositions.

To calculate the proximity distance between 2 strings, the Jaro-Winkler algorithm uses the following formula:

$$d_j = \frac{1}{3} \mathrm{x} \left(\frac{m}{s_1} + \frac{m}{s_2} + \frac{m-t}{m} \right) \quad \text{.....(1)}$$

m = the number of characters/letters that are exactly the same
s_1 = length of string 1
s_2 = length of string 2
t = number of transpositions

B. Application Development

The method used in designing this application is System Development Life Cycle (SDLC) with approach waterfall. Method Waterfall is a method that provides a sequential or sequential software life-flow approach starting from requirements analysis, system design, code writing, testing and maintenance [14]. In general method waterfall through several stages and must be carried out sequentially [15]. Method Waterfall can be seen in Figure 1.

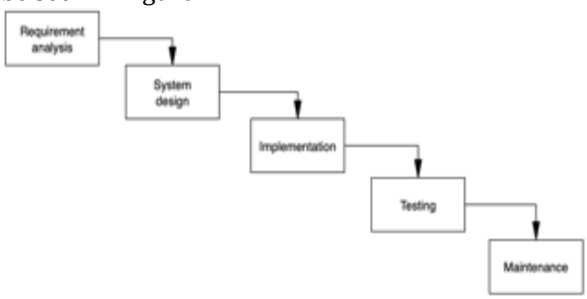

Figure 1. Stages of the method waterfall

1. Requirements analysis

Requirements analysis is the first and main stage for designing a system. Needs analysis has two main points, namely functional requirements analysis and non-functional requirements analysis [16]. At this stage the author conducted direct observations and interviews with several people in Kartasura District and community service officers regarding the needs used in the system.

a) Functional Requirements

- **Admin**
  - Login and logout
  - Manage incoming and outgoing complaint reports
- **User**
  - Write a complaint report
  - Receive notifications about report status

b) Non-Functional Requirements

- System has interface dynamic and easy to understand
- Software which is used to design applications such as Windows 10, MySql, PHP and Sublime Text
- Software which users use like web browser
- Hardware which is used like smartphone or computer connected to the internet

c) System Planning

Design is a process that considers needs such as components and system architecture [17]. The design of this application has limitations, while the limitations of this design are that the application is only intended for the people of Kartasura District and is only designed to manage reporting of public complaints. At this stage, a design will be made starting from Use Case Diagram, Activity Diagram, and Entity Relationship Diagram (ERD) with the aim of providing a more detailed reference for program design and database.

a. Use Case Diagram

Use Case Diagram describes the interaction between the user and the system through a process of how the system is used [18]. Figure 2 will explain use case diagram admin namely community service officers and user namely society. Admins can login and logout, managing incoming reports, and stating the status of complaint reports. User can write a complaint report and receive the status of the complaint report.

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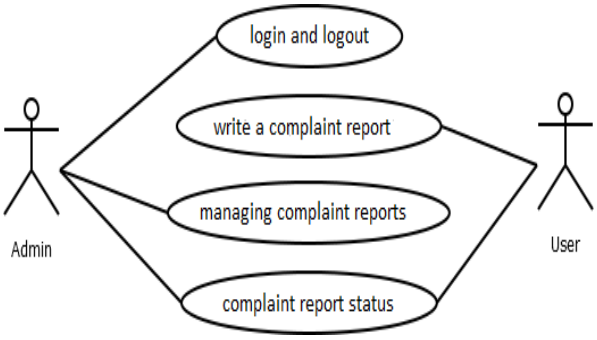

Figure 2. Use Case Diagram admin dan user

b. Activity Diagram

Activity Diagram is a plot description of use case diagram [19]. In Figure 3 is the sequence of processes carried out by the User, then in Figure 4 is the sequence of processes carried out by the Admin.

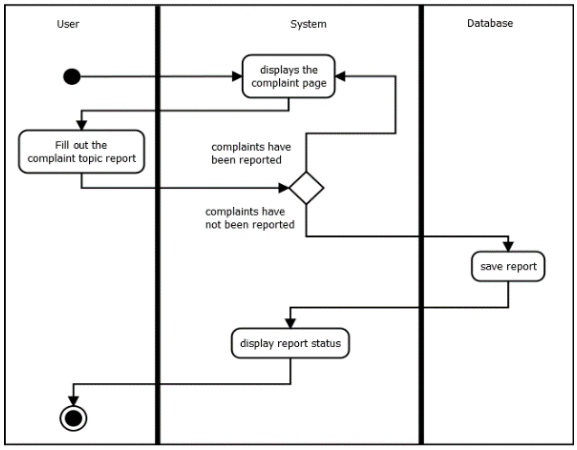

Figure 3. Activity diagram User

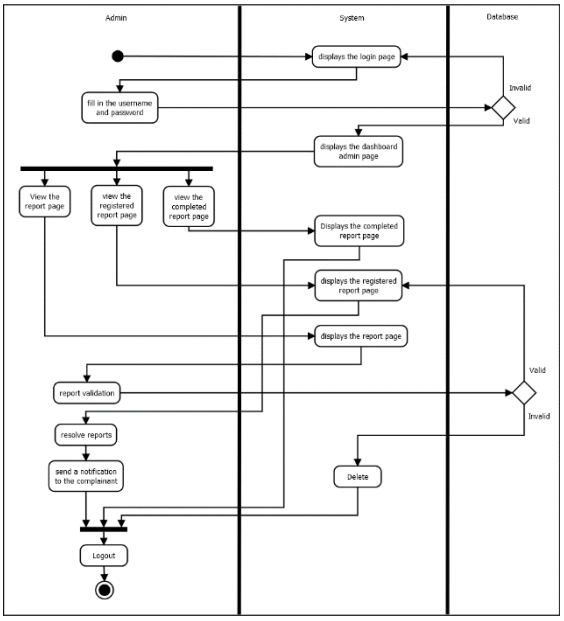

Figure 4. Activity diagram Admin

c. Entity Relationship Diagram

Entity Relationship Diagram (ERD) is a basic technique in manufacturing databases [20]. Figure 5 is the entities and relationships between tables database which aims to facilitate understanding and simplify the manufacturing process database. Database which is made consists of 2 tables namely table users and complaints.

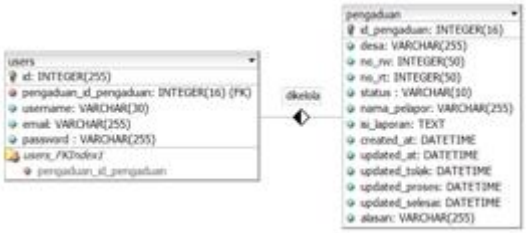

Figure 5. Entity Relationship Diagram

d) User interface design

Mockup is an initial overview of the system that aims to illustrate the interface system later so that users can interact with the developed model [21]. In Figure 6 illustrates how interface from user.

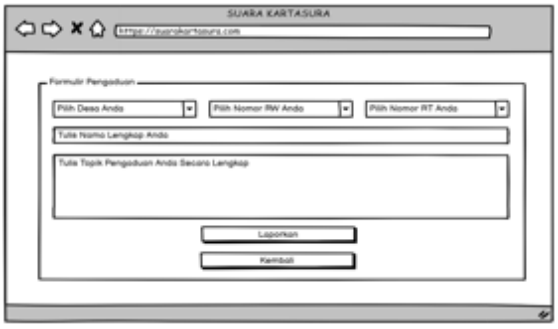

Figure 6. Interface User

The administrator page is depicted in Figure 7. It illustrates the interface from admin where the main feature of the admin page is showing the number of submitted complain, the number of complain in queue, and the number of rejected complain.

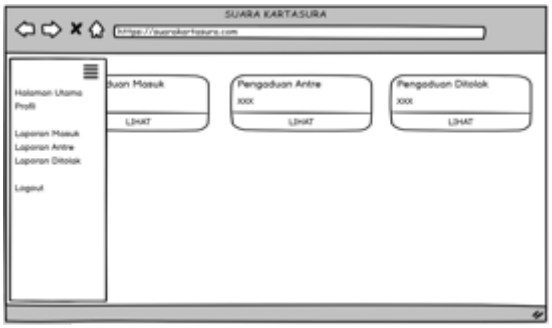

Figure 7. Interface Admin

e) Code implementation

Writing code is the process of translating programming languages where in this case we follow [22]. In this research we adopt PHP as the programming language to make the system and utilize MySQL as a database to store the data.

f) Testing and Maintenance

Testing is the stage before the software is used by the user, at this stage the system is checked whether it is functioning properly or not [23]. All functions in the system are tested to minimize errors and ensure output produced as expected. After the testing phase is complete, it continues to the last stage, namely maintenance which functions to prevent disturbances that may occur to the system.

RESULTS AND DISCUSSION

This study results a website-based information system for managing public complaint services for the Kartasura District Office. This information system can help office staffs to manage public complaint reports in Kartasura District. The following are the results of the research.

1. Home page

Figure 8 shows the home page of the system. The page is the initial display of the system when accessed. This page contains several menus, namely the Reporting menu, the Report Viewing menu and the Special Admin menu.

Figure 8. Page Display Home

2. Report Page

The Report Page as depicted in Figure 9 is the page used by the user, in this case the community write and send reports by using this page. To avoid confusion for users, the system does not provide login feature for users and it makes it easier for users to write and submit their report.

Figure 9. View of the Reporting Page

3. Report Viewing Page

The Figure 10 shows report viewing page. The page is displayed after a user successfully sent a report. This page can also be accessed from the page home to see the progress of the reports that have been sent by the user by pressing the status button.

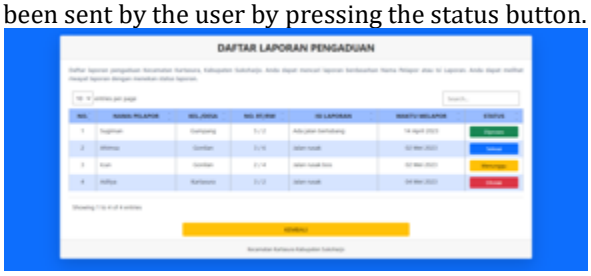

Figure 10. Page Display View Report

4. Login Page for Admins

Page Login for Admin is the page used to log in to dashboard admin as well as a deterrent or barrier so that not just any user enters dashboard admin. The detail feature of admin login page is depicted in Figure 11.

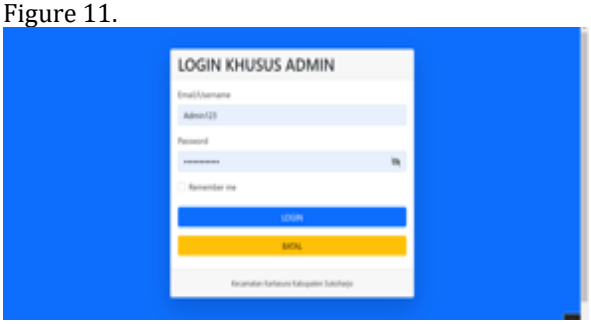

Figure 11. Page Display Login Admin

5. Admin Dashboard Page

Figure 12 represents dashboard admin page. The page appears when the admin successfully performs login in accordance with username or email and password. On the dashboard page there are several menus namely Incoming Reports, Processed Reports, Rejected Reports, Completed Reports, All Reports and Print Reports.

Figure 12. Page Display Dashboard Admin

6. Report Management Page

The Report Management Page as represented in Figure 13 is the page used by the admin to manage reports, such as incoming reports, processed reports, completed reports and rejected reports. On the incoming report page there is a Process and Reject feature which functions to determine whether the incoming report is valid or not the next time the report is valid then the report will be processed further. On the other hand, when the report is not valid the report will be rejected.

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Figure 13. Display of the Report Management Page

7. All Report Page

The all reports page is used by the admin to view all reports and their data, such as reports that have just arrived, reports that are being processed, reports that have been completed or reports that have been rejected. The reports shown in Figure 14 are generated for testing purpose thus some reports do not have completion date.

Figure 14. Display of the All Report Page

8. Black-Box Testing

Black-Box Testing is a test step carried out to observe the input and output results of the system that has been made with the aim that everything runs smoothly as expected.

Table 1. Test results with Black-Box Testing

No	Tested function	Input	Output	Status
1	User Properly prepare and send reports	User fill out the report form correctly	The system saves the report and displays the report view page	Valid
2	User Create and send reports incorrectly	User fill out the report form incorrectly	The system failed to save the report and display the report page	Valid
3	User access the menu to view reports and report status	User open the view report page	The system displays the view report page	Valid
4	Admin does login correctly	Admin entered email/username and password correctly	The system displays the page dashboard admin	Valid
5	Admin does login wrongly	Admin entered incorrectly email/username and password	The system continues to display the page login admin	Valid
6	Admin accesses the incoming report menu	Admin opens the login report page	The system displays the incoming report page	Valid
7	Admin approves report	Admin presses "Process" button	The system updates the status and time of the report	Valid
8	Admin rejected the report	Admin presses "Reject" button	The system updates the status and time of the report	Valid
9	Admin accesses the processed report menu	Admin opens the report page is processed	The system displays a processed report page	Valid
10	Admin completes the report	Admin presses "Done" button	The system updates the status and time of the report	Valid
11	Admin accesses the completed report menu	Admin opens the completed report page	The system displays the completed report page	Valid
12	Admin access menu report rejected	Admin opens the rejected report page	The system displays a rejected report page	Valid
13	Admin deletes report	Admin presses "Delete" button	The system updates the status and time of the report	Valid
14	Admin accesses the print report menu	Admin opens the report print page	The system displays a print report page	Valid
15	Reports are filtered by status and period	Admin fills out the form filter based on status and period	The system displays the results filter based on status and period	Valid
16	Admin prints reports	Admin prints the report by pressing the "Print Report List" button	The system prints reports based on status and period	Valid
17	Admin does logout system	Admin presses a button logout	The system kicks out the admin and displays the page login	Valid

9. System Usability Scale (SUS) testing

Testing System Usability Scale (SUS) is a measure used to assess the usability of a product [24] based on the subjective assessment of system users. Testing this information system aims to evaluate the suitability of users, in this case, the admin and the public for the information system. SUS includes a questionnaire consisting of 10 statements with answers ranging from 1 to 5 in the order "Disagree", "Disagree", "Neutral", "Agree", "Strongly Agree". Figure 17, is a classification of SUS criteria.

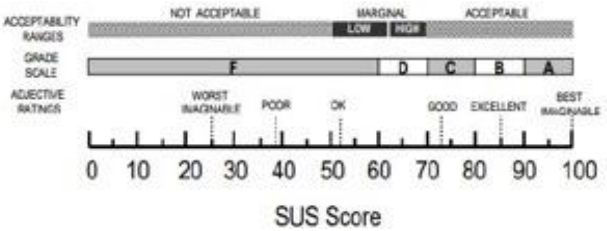

Figure 15. System Usability Scale

The questionnaire consists of 10 statements shown in Table 2.

Table 2. Test statement with System Usability Scale

Code	Statement
P1	I am thinking of using this system
P2	I find this system cumbersome to use
P3	I find this system easy to use
P4	I need help from other people or technicians in using this system
P5	I feel the features of this system work as they should
P6	I feel there are a lot of things that are not consistent or not compatible with this system
P7	I have a feeling that others will understand how to use the system quickly
P8	I find this system confusing
P9	I feel there are no obstacles in using this system
P10	I need to familiarize myself first before using this system

Table 3. Test results with System Usability Scale Score

Respondent	Calculated Result Value										Amount	Amount x 2.5
	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		
R1	4	1	5	2	5	1	3	1	4	2	28	70
R2	3	2	4	3	5	5	2	4	4	4	36	90
R3	5	1	5	1	5	1	5	1	5	2	31	77.5
R4	5	1	4	1	5	1	5	1	5	2	30	75
R5	4	2	5	4	4	3	5	2	3	1	33	82.5
R6	5	1	5	4	4	2	5	2	4	1	33	82.5
R7	5	2	5	1	5	3	5	1	5	3	35	87.5
R8	5	1	5	1	5	1	5	1	5	1	30	75
R9	5	5	4	3	4	3	4	3	2	2	35	87.5
R10	5	3	5	4	4	3	4	3	4	4	39	97.5
R11	4	2	4	4	2	5	2	5	3	2	33	82.5
R12	4	3	4	1	4	2	3	2	5	2	30	75
R13	4	1	2	1	5	3	4	2	3	2	27	67.5
R14	5	1	3	5	5	5	5	5	5	5	44	110
R15	3	3	5	3	3	3	3	3	3	3	32	80
R16	5	2	5	1	4	2	5	1	5	4	34	85
R17	3	1	3	1	5	1	5	2	4	2	27	67.5
R18	5	1	4	1	5	1	5	1	5	3	31	77.5
R19	4	2	4	3	4	2	4	2	4	4	33	82.5
R20	4	2	5	2	4	1	5	2	4	2	31	77.5
R21	5	1	4	2	4	1	4	2	4	2	29	72.5
R22	3	3	4	4	4	3	4	3	2	5	35	87.5
R23	4	1	4	1	4	2	4	1	1	4	26	65
R24	4	1	3	2	4	1	4	3	1	4	27	67.5
R25	4	1	3	1	5	1	4	1	1	3	24	60
R26	4	1	2	2	3	1	5	1	1	3	23	57.5
R27	3	2	5	2	3	1	3	3	2	4	28	70
R28	4	1	3	1	2	2	3	1	2	4	23	57.5
R29	3	1	4	1	4	2	4	3	1	4	27	67.5
R30	4	1	2	1	5	1	4	1	1	4	24	60
					Total score						918	2295
					Average							76.5
					Classification							C

Based on the testing results using System Usability Scale (SUS) in Table 3, an average value of 76.5 is obtained, which means that the system is included in the category Acceptable which means it can be accepted by users of the information system both from the public who send reports and the admin who will manage the report system.

10. Similarity Testing

Similarity Testing is a test performed to determine the limit similarity or the best similarity limit for these information systems. There are 10 sample reports used to define limits similarity as shown in Table 4.

Table 4. Test report with bar chart

No	Report
1	There is a broken road there
2	Many roads are damaged
3	There are many broken roads
4	There are potholes
5	Many potholed roads
6	The roads are broken and potholes
7	The roads are potholed and badly damaged
8	The roads are broken and there are lots of potholes

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No	Report
9	The road is full of potholes and very badly damaged
10	There are lots of potholes, please fix them as soon as possible

To test whether the system can effectively reject the newly added complains we insert ten complaints to the system.

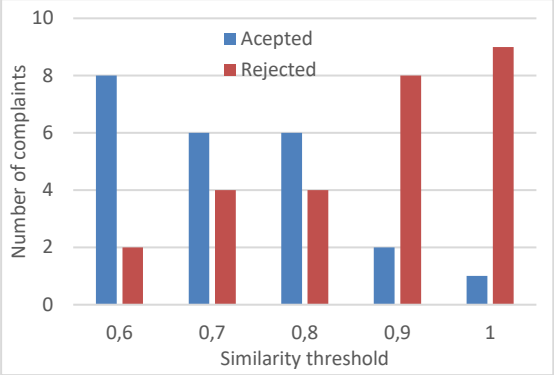

Figure 16. Result similarity testing

According to the result in Figure 16, as the value of similarity threshold is higher, the number of accepted complain is lower. For example, when the similarity threshold is 0.6 the number of accepted complaints is 8 and the number of rejected complaints is 2. However, when the similarity threshold is set to 1, there is only one complaint is accepted and 9 complaints are rejected.

CONCLUSION

This research produces a system that is able to manage the level of similarity of public complaint reports in Kartasura District with string similarity using an algorithm Jaro Winkler. This system is capable of matching string based on his writing by comparing string which goes in with string stored in the specified database with different levels of writing string the. As the value of similarity threshold increases the number of accepted complaints decreases while at the same time, the number of rejected complaints increases. Test results with System Usability Scale Score obtain an average value of 76.5, which means the system is included in the category Acceptable. Therefore, the system is able to reject the submitted complaints that have high similarity to the existing complaints and thus it can reduce the number of newly submitted complaints. In the next research a new scheduling algorithm can also be included. The scheduling algorithm such as priority scheduling algorithm can help the users to determine which complaint that should be prioritized. Thus, the local government can manage to solve the complaint more effectively and efficiently.

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