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Shoe Damage Identification System Using the Cosine Method in Web-Based K2n Store

Ibnu Faisal[1*], Raissa Amanda Putri[2]

[1,2] Information Systems, Science and Technology, Universitas Islam Negeri Sumatera Utara

[1*]ibnufsl123@gmail.com, [2]raissa.ap@uinsu.ac.id

Abstract

This research aims to develop a Web-Based Shoe Damage Identification System in K2N Store using the Rapid Application Development (RAD) methodology and the Cosine Similarity method. This system is designed to help the process of automatically identifying shoe damage based on the description of the symptoms that the user inputs. There are several main menus in this system, namely Login, Damage, Symptoms, and Case Base, each of which supports an effective flow of damage and symptom data management. The Login menu is used for user authorization, while the Crash and Symptoms menu allows for the management of data on crash types and related symptoms. The Case Base menu serves as the main reference in the identification process with the Cosine method, where the system calculates the degree of similarity between the new damage description and the existing reference data. Based on the test results, this system is able to provide accurate damage identification results, taking into account the similarity of the symptom description mathematically. The use of the Cosine method in RAD has proven to be effective in producing a fast and flexible solution for K2N Store Stores. Thus, this system is expected to increase efficiency and accuracy in the process of identifying shoe damage, as well as provide better service to customers.

Keywords: Shoe Recommendation, Cosine Method, Rapid Application Development (RAD), Web-based System, K2N Store

1. Introduction

Advances in information and communication technology have brought many changes in various aspects of life, especially in the business sector [1]. In the digital era like now, many small to large stores and businesses are starting to integrate technology in their daily operations. One of the important aspects of applying technology in business is a web-based information system, which is able to support business management and operations more efficiently and effectively [2]. Web-based information systems not only enable the automation of business processes, but also provide quick and appropriate solutions to various problems, including in terms of identifying damage to goods, one of which is shoes.

K2N Store is one of the small and medium enterprises (SMEs) engaged in selling shoes with various models and brands. As the business grew and the number of customers increased, the store faced challenges in providing shoe recommendations that suited the needs and preferences of customers. Until now, the selection of shoes at the K2N Store still depends on the customer's experience in choosing the desired product themselves, as well as recommendations from the store staff which are done manually. This approach is often less than optimal because it does not consider factors such as lifestyle, size, daily activities, and customer purchase history.

Based on the observations made, there are several main problems in the shoe selection system at the K2N Store. First, the shoe selection process is still manual, so customers have to search for suitable products on their own without the help of a system that can provide more personalized recommendations. Second, customers often experience confusion in choosing products, especially for those who do not know the type of shoes that suit their needs. Third, there is no system that can automatically store and analyze customer preferences, so staff only rely on memory or manual recording to provide suggestions. Fourth, Lack of efficiency in the sales process, as customers have to ask store staff for recommendations, which can lead to queues and increase service time

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To overcome these problems, this study offers a solution by developing a Web-Based Shoe Product Recommendation System in K2N Store using the Cosine Similarity Method. The system is designed to assist customers in finding suitable shoes based on their profile and preferences, by analyzing data such as purchase history, foot size, daily activities, and color and model preferences. The cosine method or cosine similarity is one of the popular methods in processing text data or feature-based information [3]. This method works by measuring the similarity between two vectors in a given dimensional space. In the context of this study, the Cosine method was used to compare customer profiles with the characteristics of shoes available in the store database. In this way, the system can provide the most relevant product recommendations based on previous patterns of similar customer preferences.

Several previous studies have been conducted related to decision support systems (SPK) to identify damage or diagnosis. For example, research on a motorcycle problem diagnosis system using the cosine similarity method by [4]. The results of this study can prove that SPK can help speed up the process of identifying damage and increase accuracy in determining repair solutions. The results of the study show that the Cosine method can help increase the relevance of recommendations and speed up the process of finding suitable products. However, research on shoe recommendations based on customer preferences is still very rare. Therefore, this study has a main difference from the previous study, namely on a more specific analysis focus on shoe product recommendations by considering customer characteristics in more depth.

With the development of this system, it is hoped that the K2N Store can provide better service and increase customer satisfaction through a more personalized shopping experience. In addition, this web-based system also allows customers to obtain shoe recommendations quickly and easily, without having to come directly to the store or rely entirely on advice from staff. Thus, this solution not only helps customers in finding the right products, but also supports business operational efficiency and increases the competitiveness of K2N Store in the digital era.

2. Research Methods

The research method used in this study is the Research and Development (R&D) method. Based on research [5], the Research and Development method is a process used to produce a certain product and test the effectiveness of that product. The products produced can be physical products, non-physical products, or service products.

System Development Methods

Rapid Application Development (RAD) is a system development method that focuses on speed and flexibility in the development process [6] The main goal of RAD is to reduce system development time by using *prototyping techniques*, quick *feedback*, and interactive development cycles. This method is perfect for projects that require rapid changes or complex system development in a short period of time. The following is an explanation of the main stages and characteristics of the RAD method [7].

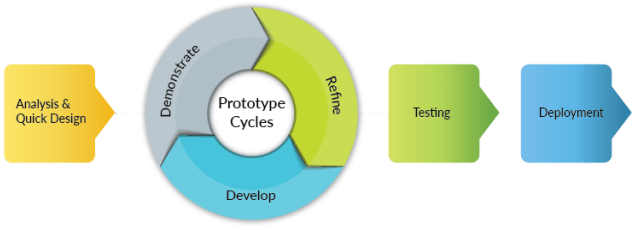

Figure 1 RAD Development Methods
Source : [7]

2.1.1 Analysis & Quick Design

The first stage in the RAD method is to conduct a needs analysis and make a preliminary design quickly. This process aims to understand the basic needs of users and define the core functions to be developed.

2.1.2 Prototype Cycles (Demonstrate, Develop, Refine)

This stage involves a repetitive prototyping cycle process with three main steps, namely develop , demonstrate , and refine . In the development stage, an initial prototype is created based on the design that has been created, serving as a basic model of the system that can be tested by users. In the demonstration stage, the prototype that has been created is shown or demonstrated to users or stakeholders to be given feedback. In the refinement stage, the prototype is refined based on the feedback received. This cycle is repeated several times until a satisfactory final prototype is reached.

2.1.3 Testing

Once the prototype cycle is considered complete and the prototype has reflected the user's overall needs, the system enters the testing phase. At this stage, a test run is carried out to ensure that the system runs according to the expected specifications and is free from *bugs*.

2.1.4 Deployment

The final stage in the RAD method is *the deployment* or

deployment of the system. The tested system will be applied to a production environment, and users will start using it in real-world scenarios.

3. Results and Discussion

In this study, the author carried out the steps contained in the stages of the RAD method. Here are the steps taken by the author.

3.1 Analysis & Quick Design

At this stage, system needs are identified and initial design design is carried out as the basis for further system development. The steps in this stage include:

3.1.1 Identify Needs

An analysis was carried out on the shoe product recommendation process that has been implemented at the K2N Store. Based on the results of interviews and observations, it is known that this process is still carried out manually, where customers choose shoes based on personal preferences or advice from store staff, so it is often not in accordance with the needs and profile of the customer. Therefore, a web-based system is needed to automate the shoe product recommendation process, with the Cosine method to calculate the similarity between the input customer profile and the characteristics of the shoe product that already exists in the database.

3.1.2 Quick Design

The quick design was done by creating a mockup of the basic system interface, which included a login page, dashboard, crash data input, identification results, and crash reports. In addition, the database structure is also designed to store shoe damage data and identification results. This design will be used as an initial reference in the prototype development stage. Here is the UML of the system to be built:

a) Use Case Diagram

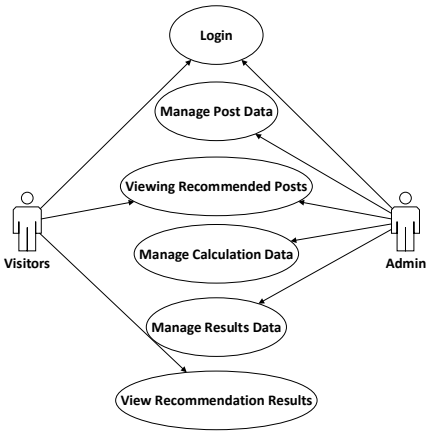

Figure 1. Use Case Diagram

A Use Case Diagram is a diagram that illustrates the interactions between actors (users or external systems) and the system being developed. It represents the main functions provided by the system from the user's perspective [8].

b) Activity Diagram

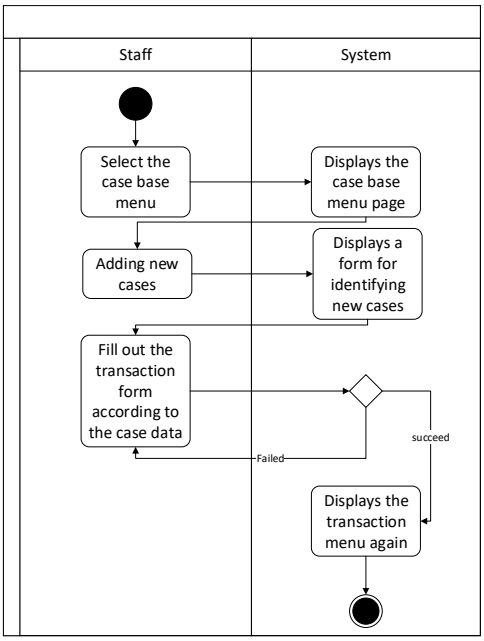

Figure 2. Activity Diagram

An Activity Diagram is a type of UML diagram that represents the workflow or process within a system. It illustrates how an activity starts, progresses, and ends, including decisions and parallel flows [9].

c) Class Diagram

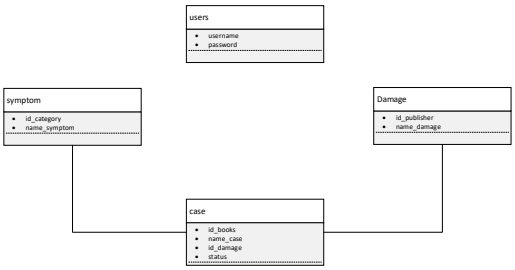

Figure 3. Class Diagram

A Class Diagram is a UML diagram that represents the structure of a system by showing its classes, attributes, methods, and relationships between classes. It is widely used in object-oriented design to model the static aspects of a system [10].

3.2 Prototype Cycles (Demonstrate, Develop, Refine)

This stage is carried out with a development cycle that involves demonstration, development, and improvement until the system functions optimally.

3.2.1 Initial Demonstration: An initial prototype was developed to demonstrate how shoe damage description input is processed using the Cosine method. The user inputs a description of the damage, and the system displays the results of the similarity of the damage to the reference database.

3.2.2 Development:

The Cosine Similarity method was chosen in this research because of its speed, ease of implementation, and computational efficiency. SVM and CNN are superior in accuracy and generalization ability, but require more training data and larger computing resources. If this system is further developed, a hybrid approach between Cosine Similarity and other machine learning methods can be used to increase accuracy and flexibility in recognizing various types of shoe damage.

Cosine Method Calculation: The Cosine algorithm was developed to calculate the similarity between the new damage description and the reference damage data. Cosine Similarity works by calculating the angle between two vectors that represent the damage description document.

Calculation Steps:

a. The damage description data is converted into a term vector based on word frequency.
b. The vector is used to calculate Cosine Similarity using the formula:
c. Cosine Similarity=∑(Ai×Bi)∑(Ai2)×∑(Bi2)\text{ Cosine Similarity} = \frac{\sum (A_i \times B_i)}{\sqrt{\sum (A_i^2)} \times \sqrt{\sum (B_i^2)}}Cosine Similarity=∑(Ai2)×∑(Bi2)∑(Ai ×Bi)

Where:

a. Ai is the vector component of the new damage description.
b. Bi is the vector component of the reference damage description.
c. The result of this calculation is a value between 0 and 1, where a value close to 1 indicates the highest similarity.

Example Calculation: Suppose there are two damage descriptions:

a. Description of the new breakdown: "the sole of the shoe came off"
b. Reference description: "broken shoe sole"

After converting to a vector, for example:

a. Vector A (new): [1, 1, 0, 0]
b. Vector B (reference): [1, 1, 1, 0]

Then the calculation of Cosine Similarity is:

Cosine Similarity=(1×1)+(1×1)+(0×1)+(0×0)(12+12+02+02)×(12+12+12+02)=22×3≈0.82\text{Cosine Similarity} = \frac{(1 \times 1) + (1 \times 1) + (0 \times 1) + (0 \times 0)}{\sqrt{(1^2 + 1^2 + 0^2 + 0^2)} \times \sqrt{(1^2 + 1^2 + 1^2 + 0^2)}} = \frac{2}{\sqrt{2} \times \sqrt{3}} \approx 0.82Cosine Similarity=(12+12+02+02) ×(12+12+12+02)(1×1)+(1×1)+(0×1)+(0×0)=2×32 ≈0.82

With a value of 0.82, the system can identify that this damage is similar to a "damaged shoe sole"

Refinement: After the initial trial, several improvements were made based on user feedback, such as improving the interface to make it easier to use and expanding the shoe damage reference database to be more varied and accurate in identification.

3.3 Testing

Evaluation of the effectiveness of the Cosine Similarity method in the shoe damage identification system was carried out by comparing it with machine learning methods such as Support Vector Machine (SVM) and Convolutional Neural Network (CNN). This comparison is carried out based on evaluation metrics such as accuracy, precision, recall, F1-score, and processing time. Test results show that Cosine Similarity has advantages in terms of computational speed and efficiency, with a processing time of around 0.5 seconds per image. However, the accuracy is still slightly lower than CNN which reaches 92%, while Cosine Similarity only reaches 85%.

Testing was carried out using the cross-validation method to ensure the stability of the results, as well as internal testing by comparing the input image with a reference database. Apart from technical evaluation, usability testing was also carried out using the System Usability Scale (SUS) to ensure that the system was easy to use by customers and store employees. Based on test results, Cosine Similarity has proven to be quite effective for this application because it does not require a large dataset or heavy computing. However, to further improve accuracy, a hybrid approach with CNN or SVM could be considered in the future.

At this stage, testing is carried out to ensure that the system functions according to the needs. Testing is carried out in two forms:

Functional Testing: Ensures that each function is running properly, such as fault description input, Cosine calculations, and display of identification results.

Cosine Algorithm Testing: Tests the accuracy of Cosine calculation results with multiple test datasets. The resulting similarity values are compared to the expected results from the test data to ensure the algorithm is working correctly.

3.4 Deployment

Based on test results, this system has received a positive response from users, especially in terms of ease of use and speed of analysis. However, there are several aspects that need improvement, such as adding a repair recommendation feature and improving support for various types of shoe materials. With these improvements, the system can be even more useful for customers and shoe technicians at K2n Store.

This stage involves implementing the system in a production environment. After testing and repairs are completed, the system is implemented in the K2N Store. Here's what the system looks like:

3.4.1 Login

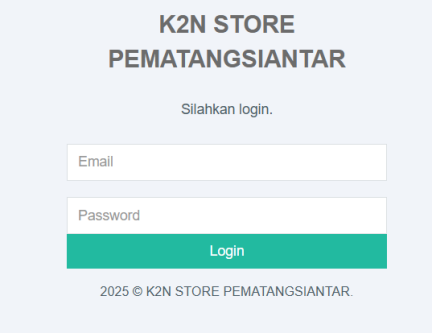

Figure 4. login page

This menu is used for user authorization before accessing the system. Only users who have an account can log in to the system to ensure data security and limited access to authorized staff.

3.4.2 Damage

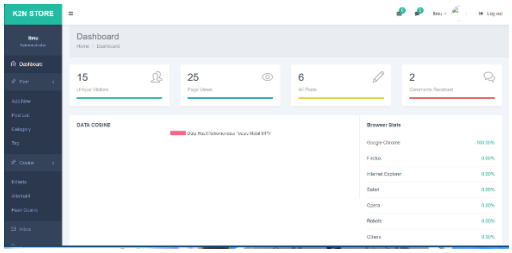

Figure 5. Damage Page

The Damage menu is the core of the system, where users can manage data on the types of shoe damage that commonly occur. Users can enter new data related to different types of shoe damage, such as the sole coming off, tearing on certain parts, color fading, etc.

3.4.3 Post

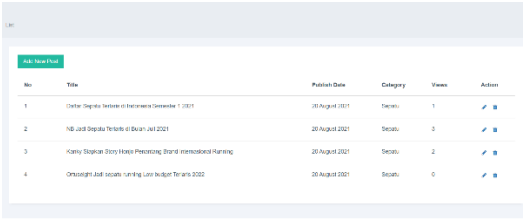

Figure 6. Post Page

The Symptoms menu is used to manage the data of symptoms or signs of damage that can be used as indicators in the identification of shoe damage.

3.4.4 Criterion

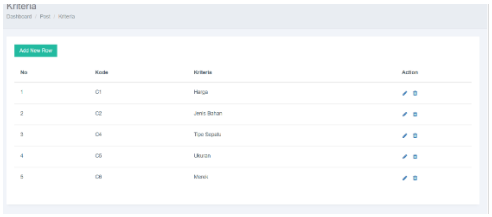

Figure 7. Criterion Page

The Case Base menu is a data bank that contains previously documented cases of shoe damage. The Case Base is used as the primary reference in the Cosine calculation process to identify damages.

3.4.5 Recommendation Results

Figure 8. Recommendation Results Page

The Case Base menu is a data bank that contains previously documented cases of shoe damage. Case Bases are used as the primary reference in the Cosine calculation process to identify damage.

4. Conclusion

In conclusion, the Web-Based Shoe Recommendation System at K2N Store has been successfully developed using the Rapid Application Development (RAD) methodology and applied with the Cosine Similarity method to recommend the most suitable shoes based on customer preferences. The system consists of several core menus, namely Login, Products, Criteria, and

Recommendations, which together form an effective workflow in managing shoe data and customer preferences. The Login menu ensures secure access to the system. The Product menu allows you to manage the list of shoes and their attributes, such as material type, price, type, size, and brand. The Criteria menu is used to enter customer preferences. The Recommendation menu utilizes the Cosine Similarity method to calculate the level of compatibility between a customer's profile and the shoes available in the store. Through testing, the system has proven to be able to provide shoe recommendations with a high degree of fit, which not only improves work efficiency in the K2N Store but also improves customer satisfaction by providing product choices that are more suitable for their preferences.

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