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The Implementation of E-Commerce for Frozen Food Products in Providing Recommendations Using Item-Based Collaborative Filtering Method

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Abstract. The development of information technology, especially the internet, has significantly impacted facilitating human access to information, including the trend of society opting for frozen food as a fast food option. Meanwhile, the phenomenon of social media depicts the tendency of society to choose convenient and fast food. On the other hand, the rapid development of sales and product promotion systems through the internet is taking place, utilizing web-based technology. Recent studies also indicate that the development of web-based sales information systems for frozen food can enhance efficiency and service quality. Collaborative filtering methods in recommendation systems are also becoming increasingly popular in helping users obtain better recommendations. All of this indicates that information technology has had a positive impact on making purchasing and information management more efficient and convenient for society.

Keywords: Frozen Food, Item-Based Collaborative Filtering, Recommendation System

1 Introduction

The rapid development of information technology has facilitated human access to information significantly. One of the current advancements in information technology is the internet. With the internet, we can easily find information within seconds or by simply typing keywords, making all searched information readily available.

In this technological advancement, society tends to prefer frozen food as an alternative fast food option. Additionally, the current trend in social media shows a tendency among people to choose convenient, fast, and delicious meals without the need to prepare spices.

Currently, the sales and product promotion systems through the internet are rapidly growing. Companies utilize web-based technology to offer their products to their customers. We can observe the exchange of goods or services and money used as a medium of exchange in sales activities.

Muhammad Maulana conducted a study on the usability testing of the Zivi Frozen Food website. The aim of this research is to create a frozen food website with features or content where buyers can make purchases directly by coming to the store or through the website. The study uses usability testing methodology for evaluation. From this study, it was concluded that, based on user satisfaction measurements, only the Efficiency variable out of the five known variables significantly influences user satisfaction.

Mutia Al Masri conducted research on the development of a web-based sales information system for NSS Frozen Food using the Rapid Application Development (RAD) method. The purpose of creating this website is to reduce human errors in managing sales data. The evaluation scale table shows that a percentage of 90 percent falls into the excellent category, as a result of the creation of this website. Thus, the NSS Frozen Food sales information system meets company feasibility standards.

Terrari is the name of a household business engaged in frozen food with the goal of keeping food fresh until ready to eat and maintaining consistent food quality. Data management is still done manually where data is recorded in books.In addition to sales, Terrari Food is also involved in other operational activities, such as suppliers, inventory management, and report generation. Data processing starts from sales transactions to data storage, which could potentially lead to easy loss and damage of data. Furthermore, for the sale of frozen food products offered, customers still encounter difficulties because they have to come directly to the location, which consumes more time, energy, and additional costs.

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The aim of this research is to solve existing problems by creating a web-based frozen food sales information system. With this functionality, it is hoped that not only can products be marketed more widely in serving food, but also provide something attractive to attract customers to establish close and comfortable relationships. Therefore, this website is expected to assist business owners in promoting their products online with a wide reach and facilitating the creation of monthly transaction reports.

2 Research Methodology

2.1 Research Flow

The authors utilized various references from journals, e-books, and the internet for their research employing the Agile Software Development method to design and develop websites. In this research phase, we employed the Agile software development method to construct this frozen food sales information system. This method is considered appropriate as it allows the system to adapt to changes according to evolving business needs.The stages in Agile Software Development are as follows:

a. Data Collection
   At this point, the design for data collection and the development system plan were established. The data collected by the authors came from observations and interviews conducted with Terrari business owners and customers.
b. Design
   At this stage, the design of the website information system has been created, including use case design, activity diagrams, and database design.
c. Problem Analysis
   Based on observations conducted with Terrari business owners and customers, the authors identified constraints in the frozen food sales transaction process and information delivery, where customers must purchase or inquire about product prices and catalogs at the location directly, deemed inefficient due to time and cost wastage. Business owners also face challenges in managing sales data, making report generation difficult. Data is still managed manually, either recorded in books or using Excel.Based on the aforementioned issues, both sellers and buyers require the development of a web-based frozen food sales information system to facilitate transactions, sales administration, sales data storage, and make it easier for customers to obtain information about purchasing frozen food.
d. Implementation
   At this stage, what has been created is implemented into a program using UML and PHP as the user interface.
e. Testing
   The testing stage, also known as quality control, is conducted to ensure whether the created web information system has been adapted, to find errors on the web, and to ensure that the generated output meets expectations.
f. Deployment
   At this stage, developers inform customers of service updates. They also evaluate whether the system has achieved its goals.
g. Maintenance
   The final stage is maintenance, where maintenance and upkeep are performed. The aim is to rectify errors that occur when the device is in use.

2.2 System Design

In this design stage, application design documents have been created, including: use case diagrams, sequence diagrams, activity diagrams, and UI design layouts. The system design is created using Unified Modeling Language (UML).

a. Use Case Diagram
   The use case diagram is crucial for illustrating, defining, and recording system behavioral requirements. The use case diagram consists of several actors, use cases, and relationships. Use cases describe activities any activities being performed by users or the system. The Use Case Diagram is a diagram that depicts the interaction relationship between users and the system.
b. Activity Diagram
   The activity diagram shows the sequence of activities involved in a specific process. How each action begins, and the decisions that may be made until that action ends. The Activity Diagram represents the business process and activity flow in a system to be built.

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c. Class Diagram
One type of UML structure is the class diagram, which displays the system structure by showing classes, attributes, methods, and relationships between collaborating objects to achieve specific goals. The class diagram shows relationships between classes that have object properties and functionality.

2.3 Recommendation System

Collaborative filtering is a method in recommendation systems that uses information from a number of users or items (products or services) to make recommendations to the relevant users. This method utilizes collaboration or cooperation between users or items to produce better recommendations.There are two main types of collaborative filtering:

a. User-based Collaborative Filtering (UBCF)
This method compares similar user preferences or behaviors to find similarities among users. If two users have similar preferences in a number of items, then items liked by one user can be recommended to other users with similar preferences.
b. Item-based Collaborative Filtering (IBCF)
This method utilizes similarities between items rather than between users. If a user likes an item, then items similar to that item can be recommended to the user. Item similarity is measured based on how often the item is accessed or liked by the same user.

3 Results and Discussion

In the recommendation calculation process, it consists of two parts: calculation based on Collaborative Filtering for recommendations based on user behavior patterns. In this stage, historical sales data from Terrari is used. The following is the process of the Item-based Collaborative Filtering method:

3.1 Input Data & Data Pre-processing

Sales history data will be grouped based on Customer No. and Item Name, then the data per row will be calculated. These data will be organized according to the system's needs. The recommendation system requires 2 main components: items and users. The calculation is the sum of rated products divided by the total number of products with ratings. It is as follows:

$$R_k = \frac{a+b+c}{R}$$

Table 1. Data & Data Pre-processing

	C1	C2	C3	C4	$\bar{R}$	$\Sigma(R-\bar{R})^2$	$\sqrt{\Sigma(R-\bar{R})^2}$
Sosis	5	5	5	0	3,75	18,75	4,33
Meatball	4	0	2	5	2,75	14,75	3,83
Nugget	3	2	2	0	1,75	3,75	1,94
SpicyWings	0	3	4	4	2,75	10,75	3,28

3.2 Similarity Calculation

$$\text{sim(Sosis,Meatball)} = \frac{(5-3{,}75)(4-2{,}75)+(5-3{,}75)(0-2{,}75)+(5-3{,}75)(2-2{,}75)+(0-3{,}75)(5-2{,}75)}{\sqrt{(5)(3{,}75)^2+(5)(3{,}75)^2+(5)(3{,}75)^2+(0)(3{,}75)^2}\sqrt{(4)(2{,}75)^2+(0)(2{,}75)^2+(2)(2{,}75)^2+(5)(2{,}75)^2}}$$

$$= -0{,}63$$

$$\text{sim(Sosis,Nugget)} = \frac{(5-3{,}75)(3-1{,}75)+(5-3{,}75)(2-1{,}75)+(5-3{,}75)(2-1{,}75)+(0-3{,}75)(0-1{,}75)}{\sqrt{(5)(3{,}75)^2+(5)(3{,}75)^2+(5)(3{,}75)^2+(0)(3{,}75)^2}\sqrt{(3)(1{,}75)^2+(2)(1{,}75)^2+(2)(1{,}75)^2+(0)(1{,}75)^2}}$$

$$= 1{,}26$$

$$\text{sim(Sosis,SpiWings)} = \frac{(5-3{,}75)(0-2{,}75)+(5-3{,}75)(3-2{,}75)+(5-3{,}75)(4-2{,}75)+(0-3{,}75)(4-2{,}75)}{\sqrt{(5)(3{,}75)^2+(5)(3{,}75)^2+(5)(3{,}75)^2+(0)(3{,}75)^2}\sqrt{(0)(2{,}75)^2+(3)(2{,}75)^2+(4)(2{,}75)^2+(4)(2{,}75)^2}}$$

$$= -0{,}68$$

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$$\text{sim(Meatb,Nugget)} = \frac{(4-2{,}75)(3-1{,}75)+(0-2{,}75)(2-1{,}75)+(2-2{,}75)(2-1{,}75)+(5-2{,}75)(0-1{,}75)}{\sqrt{(4)(2{,}75)^2+(0)(2{,}75)^2+(2)(2{,}75)^2+(5)(2{,}75)^2}\sqrt{(3)(1{,}75)^2+(2)(1{,}75)^2+(2)(1{,}75)^2+(0)(1{,}75)^2}}$$

$$= -0{,}29$$

$$\text{sim(Meat,SpiWings)} = \frac{(4-2{,}75)(0-2{,}75)+(0-2{,}75)(3-2{,}75)+(2-2{,}75)(4-2{,}75)+(5-2{,}75)(4-2{,}75)}{\sqrt{(4)(2{,}75)^2+(0)(2{,}75)^2+(2)(2{,}75)^2+(5)(2{,}75)^2}\sqrt{(0)(2{,}75)^2+(3)(2{,}75)^2+(4)(2{,}75)^2+(4)(2{,}75)^2}}$$

$$= -0{,}18$$

$$\text{sim(Nugg,SpiWings)} = \frac{(3-1{,}75)(0-2{,}75)+(2-1{,}75)(3-2{,}75)+(2-1{,}75)(4-2{,}75)+(0-1{,}75)(4-2{,}75)}{\sqrt{(3)(1{,}75)^2+(2)(1{,}75)^2+(2)(1{,}75)^2+(0)(1{,}75)^2}\sqrt{(0)(2{,}75)^2+(3)(2{,}75)^2+(4)(2{,}75)^2+(4)(2{,}75)^2}}$$

$$= -0{,}38$$

sim(Sosis,sosis)	1
sim(Sosis,Meatball)	-0,63
sim(Sosis,Nugget)	1,26
sim(Sosis,SpiWings)	-0,68
TOTAL	0,95

sim(Meatball,Sosis)	-0,63
sim(Meatb,Meatball)	1
sim(Meatb,Nugget)	-0,29
sim(Meat,SpiWings)	-0,18
TOTAL	-0,1

sim(Nugget,sosis)	1,26
sim(Nugget,Meatball)	-0,29
sim(Nugget,Nugget)	1
sim(Nugget,SpiWings)	-0,38
TOTAL	1,59

sim(SpicyWings,sosis)	-0,68
sim(SpicyWings,Meatball)	-0,18
sim(SpicyWings,Nugget)	-0,38
sim(SpicyWings,SpiWings)	1
TOTAL	-0,24

3.3 Prediction Calculation

$$\text{Pu1,Sosis} = 3{,}75 + \frac{(5-3{,}75)(1)+(4-2{,}75)(-0{,}63)+(3-1{,}75)(1{,}26)+(0-2{,}75)(-0{,}68)}{|1|+|-0{,}63|+|1{,}26|+|(-0{,}68)|} = 4{,}843525$$

$$\text{Pu2,Sosis} = 3{,}75 + \frac{(5-3{,}75)(1)+(0-2{,}75)(-0{,}63)+(2-1{,}75)(1{,}26)+(3-2{,}75)(-0{,}68)}{|1|+|-0{,}63|+|1{,}26|+|(-0{,}68)|} = 4{,}624768$$

$$\text{Pu3,Sosis} = 3{,}75 + \frac{(5-3{,}75)(1)+(2-2{,}75)(-0{,}63)+(2-1{,}75)(1{,}26)+(4-2{,}75)(-0{,}68)}{|1|+|-0{,}63|+|1{,}26|+|(-0{,}68)|} = 3{,}817867$$

$$\text{Pu4,Sosis} = 3{,}75 + \frac{(0-3{,}75)(1)+(5-2{,}75)(-0{,}63)+(0-1{,}75)(1{,}26)+(4-2{,}75)(-0{,}68)}{|1|+|-0{,}63|+|1{,}26|+|(-0{,}68)|} = 1{,}44958$$

$$\text{Pu1,Meatball} = 2{,}75 + \frac{(5-3{,}75)(-0{,}63)+(4-2{,}75)(1)+(3-1{,}75)(-0{,}29)+(0-2{,}75)(-0{,}18)}{|(-0{,}63)|+|1|+|(-0{,}29)|+|(-0{,}18)|} = 2{,}9979167$$

$$\text{Pu2,Meatball} = 2{,}75 + \frac{(5-3{,}75)(-0{,}63)+(0-2{,}75)(1)+(2-1{,}75)(-0{,}29)+(3-2{,}75)(-0{,}18)}{|(-0{,}63)|+|1|+|(-0{,}29)|+|(-0{,}18)|} = 1{,}0119048$$

$$\text{Pu3,Meatball} = 2{,}75 + \frac{(5-3{,}75)(-0{,}63)+(2-2{,}75)(1)+(2-1{,}75)(-0{,}29)+(4-2{,}75)(-0{,}18)}{|(-0{,}63)|+|1|+|(-0{,}29)|+|(-0{,}18)|} = 1{,}0119048$$

$$\text{Pu4,Meatball} = 2{,}75 + \frac{(0-3{,}75)(-0{,}63)+(5-2{,}75)(1)+(0-1{,}75)(-0{,}29)+(4-2{,}75)(-0{,}18)}{|(-0{,}63)|+|1|+|(-0{,}29)|+|(-0{,}18)|} = 5{,}0811905$$

$$\text{Pu1,Nugget} = 1{,}75 + \frac{(5-3{,}75)(1{,}26)+(4-2{,}75)(-0{,}29)+(3-1{,}75)(1)+(0-2{,}75)(-0{,}38)}{|(1{,}26)|+|(-0{,}29)|+|(1)|+|(-0{,}38)|} = 2{,}6411392$$

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$$\text{Pu2,Nugget} = 1{,}75 + \frac{(5-3{,}75)(1{,}26)+(0-2{,}75)(-0{,}29)+(2-1{,}75)(1)+(3-2{,}75)(-0{,}38)}{|(1{,}26)|+|(-0{,}29)|+|(1)|+|(-0{,}38)|} = 2{,}3933862$$

$$\text{Pu3,Nugget} = 1{,}75 + \frac{(5-3{,}75)(1{,}26)+(2-2{,}75)(-0{,}29)+(2-1{,}75)(1)+(4-2{,}75)(-0{,}38)}{|(1{,}26)|+|(-0{,}29)|+|(1)|+|(-0{,}38)|} = 2{,}14899$$

$$\text{Pu4,Nugget} = 1{,}75 + \frac{(0-3{,}75)(1{,}26)+(5-2{,}75)(-0{,}29)+(0-1{,}75)(1)+(4-2{,}75)(-0{,}38)}{|(1{,}26)|+|(-0{,}29)|+|(1)|+|(-0{,}38)|} = -0{,}1875$$

$$\text{Pu1,SpicyWings} = 2{,}75 + \frac{(5-3{,}75)(-0{,}68)+(4-2{,}75)(-0{,}18)+(3-1{,}75)(-0{,}38)+(0-2{,}75)(1)}{|(-0{,}68)|+|-0{,}18)|+|(-0{,}38)|+|(1)|} = 0{,}8303571$$

$$\text{Pu2, SpicyWings} = 2{,}75 + \frac{(5-3{,}75)(-0{,}68)+(0-2{,}75)(-0{,}18)+(2-1{,}75)(-0{,}38)+(3-2{,}75)(1)}{|(-0{,}68)|+|-0{,}18)|+|(-0{,}38)|+|(1)|} = 2{,}6208$$

$$\text{Pu3,SpicyWings} = 2{,}75 + \frac{(5-3{,}75)(-0{,}68)+(2-2{,}75)(-0{,}18)+(2-1{,}75)(-0{,}38)+(4-2{,}75)(1)}{|(-0{,}68)|+|-0{,}18)|+|(-0{,}38)|+|(1)|} = 2{,}9308$$

$$\text{Pu4, SpicyWings} = 2{,}75 + \frac{(0-3{,}75)(-0{,}68)+(3-2{,}75)(-0{,}18)+(4-1{,}75)(-0{,}38)+(4-2{,}75)(1)}{|(-0{,}68)|+|-0{,}18)|+|(-0{,}38)|+|(1)|} = 4{,}046$$

3.4 Result of Prediction Calculation

4,843525	4,624768	3,817867	1,44958
2,9979167	1,0119048	1,0119048	5,0811905
2,6411392	2,3933862	2,14899	-0,1875
0,8303571	2,6208	2,9308	4,046

3.5 MAE Calculation

$$\text{MAEsosis} = \frac{|4{,}843525-5|+|4{,}624768-5|+|3{,}817867-5|+|1{,}44958-0|}{4} = 0{,}790855$$

$$\text{MAEmeatball} = \frac{|2{,}9979167-4|+|1{,}0119048-0|+|1{,}0119048-2|+|5{,}0811905-5|}{4} = 0{,}7708187$$

$$\text{MAEnugget} = \frac{|2{,}6411392-3|+|2{,}3933862-2|+2{,}14899-2|+|-0{,}1875-0|}{4} = 0{,}27218425$$

$$\text{MAEspicywings} = \frac{|0{,}8303571-0|+|2{,}6208-3|+|2{,}9308-4|+|4{,}046-4|}{4} = 0{,}581189275$$

3.6 Result of MAE before sorting

MAEsosis	0,790855
MAEmeatball	0,7708187
MAEnugget	0,27218425
MAEspicywings	0,581189275

3.7 Result of MAE after sorting

MAEnugget	0,27218425
MAEspicywings	0,581189275
MAEmeatball	0,7708187
MAEsosis	0,790855

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4 Conclusion

From the results of the item-based collaborative filtering calculation, it can be concluded that the MAE for nuggets has the lowest value at around 0.272. This indicates that the model or method used tends to be more accurate in predicting nugget sales compared to other products. The MAE for Sausages (MAEsosis) has the highest value, which is around 0.791. This suggests that the model or method may be less effective in predicting sausage sales compared to other products. Therefore, based on these MAE results, it can be concluded that nuggets have better prediction performance compared to other products, while sausages have the lowest prediction performance.

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