Department of Digital Business
Journal of Artificial Intelligence and Digital Business (RIGGS)
Homepage: https://journal.ilmudata.co.id/index.php/RIGGS
Vol. 5 No. 2 (2026) pp: 25747-25754
P-ISSN: 2963-9298, e-ISSN: 2963-914X

Web-Based Warehouse Logistics and Inventory Management Application Using the Priority Queue Algorithm (Case Study: PT Arga Morini Indotama)

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Abstract

PT Arga Morini Indotama is a nickel mining company whose warehouse logistics and inventory management activities are still handled manually, potentially causing delays in information processing, recording errors, and difficulties in monitoring stock availability. This study aims to design and develop a web-based logistics and warehouse inventory management application to improve the effectiveness of inventory management. The system was developed using the Rational Unified Process (RUP) methodology, which consists of four phases: inception, elaboration, construction, and transition. The application implements the Rank Order Centroid (ROC) method to determine the priority weights of decision criteria and the Priority Queue algorithm to prioritize goods requests based on stock criticality, departmental urgency, and frequency of use. The application was developed using PHP, the Laravel framework, and MySQL as the database management system. System testing was conducted using Black Box Testing and User Acceptance Testing (UAT) involving 12 respondents. The results indicate that the Priority Queue algorithm successfully prioritizes goods requests accurately and consistently with manual calculations. The UAT results show an average user acceptance rate of 85.84%, consisting of 85.84% for efficiency and productivity, 85.84% for functional suitability, 84.17% for performance efficiency, and 87.50% for user interface and user experience. Therefore, the developed system is considered feasible for supporting logistics and warehouse inventory operations at PT Arga Morini Indotama more effectively, efficiently, and accurately, while also supporting inventory management decision-making. The system is also expected to improve logistics service quality, accelerate the goods request process, and minimize administrative errors in warehouse inventory management.

Keywords : *Priority Queue Algorithm, Web-Based Application, Rank Order Centroid (ROC), Warehouse Inventory, Logistics.*

1. Background

The use of information technology in an agency currently plays a very important role because it can assist the process of processing data into useful information that can be utilized by users [1]. Technology is one of the tools widely used in daily operational activities. The use of information technology helps companies in carrying out operational activities and increasing competitiveness between businesses. In addition, technology can also simplify and accelerate work processes. However, if the inventory information system is still run manually, the operational management process will be less than optimal [2]. In addition, logistics functions to plan, implement, and control effectively and efficiently the process of procurement, management, and storage of goods, services, and information from the point of origin to the point of consumption with the aim of meeting consumer needs [3]. Inventory is goods that can usually be found in closed warehouses, fields, open warehouses, or other storage places, whether in the form of raw materials, finished goods, goods for operational purposes, or goods for the purposes of a project.[4].

If the inventory information system is still run manually, operational activities become less efficient and accuracy is low. The number of transactions occurring daily, weekly, and monthly continues to increase, making manual recording less efficient, requiring more time and effort. [5] This condition can cause various problems such as recording errors, possible data manipulation, slow data input processes, and difficulties in monitoring stock availability directly (real-time). Companies that can effectively control and manage inventory will find it easier to meet customer needs, maintain stock availability, and maintain business continuity and competitiveness amidst the ever-evolving dynamics of the industry [6]. Based on the problems encountered, this study aims to To prioritize an item, this system uses the Priority Queue algorithm to determine the processing order based on the item's

importance, so that items with higher priorities can be handled first compared to other items. The Priority Queue algorithm is a data structure that sorts and processes data based on priority levels, not based on the time the data is received. In this study, this algorithm is used to sort item requests from each department so that requests with the highest priority are processed first. [7].

However, the Priority Queue algorithm requires priority values as the basis for sorting. Therefore, this study uses the Rank Order Centroid (ROC) method as an approach to determine the weight of each priority criterion. The ROC method is a simple weighting method that assigns weights based on the order of importance of each criterion, thus eliminating the need for complex pairwise comparisons. Thus, the resulting weights reflect the relative priority of each criterion used in the decision-making process. [8]. The weights generated through the ROC method are then used to calculate the priority value of each item request, which is then processed using the Priority Queue algorithm [9]. Compared to the Analytical Hierarchy Process (AHP) method, which determines weights through a pairwise comparison process using a specific assessment scale, it requires multiple assessments and consistency testing (Consistency Ratio/CR) to ensure the weighting results are valid.[10].

2. Research methods

2.1 Dataset

A literature review was conducted to find references from books, journals, and online sources related to logistics management, warehouse inventory, the Rank Order Centroid (ROC) method, and the Priority Queue algorithm. Interviews were conducted with PT. Arga Morini Indotama to obtain primary data regarding the business processes of inventory management, inventory recording, and the mechanism for submitting inventory requests by each department.

2.2 Development methods

The system development method used is the Rational Unified Process (RUP). The Unified Process (RUP) is a software development methodology developed by IBM Rational. This method combines a linear approach to large-scale development with an iterative process at each stage, resulting in a gradual system release. RUP can be applied to projects with both small and large teams and consists of four main phases carried out iteratively.[10], [11]

2.3 Rank Order Centroid (ROC) Method

Rank Order Centroid (ROC) Method is a simple weighting method by assigning weight to each criterion based on the order of its importance or priority [12]. The Rank Order Centroid (ROC) method is a technique used to determine the weight of criteria in a decision-making process objectively based on the order of priority of the criteria. This method is simple and effective, especially when direct comparison between criteria is difficult or impossible, such as in situations involving many criteria with different importance. ROC calculates the weight of each criterion based on its rank, where criteria with higher ranks (more important) receive greater weight than criteria with lower ranks. The weight of the criteria with ROC is calculated using the following equation [13].

$$W_j = \frac{1}{m}\sum_{i=j}^{m}\frac{1}{i} \quad (1)$$

Information :

W_j = weight of the jth criterion
m = number of criteria
i = order of criteria from j to m
j = ranking of the criteria being calculated

Where (W_j) is the weight for the (j)th criterion, (m) is the total number of criteria used, (j) is the order or ranking of the importance of a criterion, and (i) is the sum index starting from the (j)th criterion rank to the last rank (m). The weight distribution in the Rank Order Centroid (ROC) method is obtained by adding up the reciprocal values of each rank starting from the rank of the criterion being calculated to the last rank, then the sum is divided by the total number of criteria. This method produces weights that reflect the level of importance of each criterion based on a predetermined priority order.

2.4 Priority Value Calculation

The priority value is calculated by adding the product of the ROC weight and the score for each criterion. The formula used is

$$P = \sum(W_i \times C_i) \quad (2)$$

Since there are three criteria, the formula becomes:

DOI: https://doi.org/10.31004/riggs.v5i2.12797

$$P = (W_1 \times C_1) + (W_2 \times C_2) + (W_3 \times C_3) \quad (3)$$

Information:

P = Priority value of the item request
W_1 = C1 criticality weight of stock
W_2 = C2 weight of department urgency
W_3 = C3 weight frequency of use
C_1 = Stock criticality score
C_2 = Department urgency score
C_3 = Frequency of use score

2.5 Method for Determining Priority of Goods Requests

In the logistics and warehouse inventory management application developed in this study, the process of determining the priority of goods requests is carried out using a combination of the Rank Order Centroid (ROC) method and the Priority Queue algorithm. The ROC method is used to determine the weight of each criterion based on its level of importance, while the Priority Queue algorithm is used to sort goods requests based on the calculated priority value. Determining the priority of goods requests is based on three criteria, namely stock criticality (C1), department urgency (C2), and frequency of use of goods (C3). The stock criticality criterion is used to assess the condition of goods inventory in the warehouse. The department urgency criterion is used to assess the level of importance of the department submitting the goods request, while the frequency of use criterion is used to assess how often an item is used in the company's operational activities. Each criterion used in determining the priority of goods requests is assessed using a scale of 1 to 5. The use of the same scale for each criterion aims to ensure that the values between criteria can be directly compared. Because all criteria are in the same value range, this prioritization model does not require an additional normalization process. The stock criticality criteria (C1) assessment scale is used to measure the criticality of stock conditions in the warehouse. The more critical an item's stock condition, the higher the C1 score assigned. The C1 criteria assessment scale can be seen in Table 1.

Table 1. Stock Criticality Scale (C1)

Score	Condition
5	TOP URGENT status or very critical stock
4	URGENT status or stock is less than or equal to safety stock
3	Stock less than or equal to 1.5 times safety stock
2	Stock is less than or equal to 2 times safety stock or there is use
1	Safe stock or no use

The departmental urgency criteria (C2) rating scale is used to assess the urgency level of the department requesting the goods. Departments with more critical operational functions are given higher scores. The C2 rating scale can be seen in Table 2.

Table 2. Department Urgency Scale (C2)

Department	**C2 Score**
HSE	5
Engineering	4
HRGA	4
Logistics	3
Finance	3
Support	1

The frequency of use (C3) criteria assessment scale is used to assess how frequently an item is used. The value of this criterion is taken from the number of items issued in April 2025. The C3 criteria assessment scale can be seen in Table 3.

Table 3. Frequency of Use Scale (C3)

Score	**Frequency of Use Conditions**
5	Goods out more than or equal to 100
4	Goods out more than or equal to 50
3	Goods out more than or equal to 20
2	Items out more than 0
1	No items out

The weight of each criterion is calculated using the Rank Order Centroid (ROC) method based on a predetermined order of importance. The weighted results are then used to calculate the priority value of each item request to

DOI: https://doi.org/10.31004/riggs.v5i2.12797

obtain an objective priority order. The obtained priority values are then processed using the Priority Queue algorithm to sort all item requests based on their priority value from highest to lowest. The request with the highest priority value will be placed first in the queue and processed first by the logistics department. This approach allows the system to provide objective priority recommendations based on the condition of the item stock, the department's urgency level, and the frequency of item use. Thus, the logistics and warehouse inventory management process becomes more effective and efficient, and helps logistics staff in determining the order of processing item requests according to their priority level.

2.6 Priority Queue Algorithm

The Priority Queue algorithm is a data structure that processes each element based on its priority level, where the element with the highest priority value will be processed first. Data management in a Priority Queue is done by sorting elements according to their level of importance, so that processes with the highest priority are served first. The efficiency of this algorithm can be increased by using a heap structure, because data insertion and retrieval operations can be performed with a time complexity of O(log n) [9]. In some scheduling algorithms, such as the priority scheduling algorithm, each process has a specific priority. This priority determines the order of process execution, where processes with higher priorities will be executed before others.[14]

2.7 System Testing

User Acceptance Testing (UAT) is a software testing phase that aims to ensure that the system meets user needs and expectations before implementation. This testing focuses on several aspects, such as functionality, performance, user interface, efficiency, and system security and reliability. [15]UAT is conducted directly by users to assess whether the system is able to support the activities carried out and meet user needs, not just meet the established technical specifications [16].

3. Results and Discussion

3.1 Determination of Criteria

A higher P value indicates a more important request to be processed first. To determine the criteria that go into priority

Table 1Determination of Criteria

Code	Criteria	Information
C 1	Criticality of Stock	Assess the level of need for goods based on the condition of final stock, safety stock, and stock status.
C2	Department Urgency	Assess the level of importance of the applicant department to operational needs.
C3	Frequency of Use	Assess the level of usage of goods based on the number of goods issued during the research data period.

3.2 Determination of ROC Method and Priority Queue Algorithm

The following is an example of the Rank Order Centroid Method in the logistics and warehouse inventory management system of PT. Arga Morini Indotama.

$W1=\frac{1}{3}\left(\frac{1}{1}+\frac{1}{2}+\frac{1}{3}\right) = 0{,}611111$

$W2=\frac{1}{3}\left(\frac{1}{2}+\frac{1}{3}\right) = 0{,}277778$

$W3=\frac{1}{3}\left(\frac{1}{3}\right) = 0{,}11111$

Table 2. ROC Weight Results

Code	Criteria	Rank	Weight
C 1	Criticality of Stock	1	0.611111
C2	Department Urgency	2	0.277778
C3	Frequency of Use	3 .	0.111111

The total ROC weight is:

0.611111 + 0.277778 + 0.111111 = 1.000000

The total weight value is equal to 1. This means that the ROC weight is valid and can be used to calculate the priority value of the item request.

Table 3. Priority Queue Algorithm Results

No	Request ID	Department	Goods	Priority Values	Category

DOI: https://doi.org/10.31004/riggs.v5i2.12797

1	REQ-20250430-004	HSE	Kara Coconut Milk Box	4,777777	High Priority
2	REQ-20250430-006	HSE	Trash Bag	4.666666	High Priority
3	REQ-20250430-009	HSE	Pandan Paste	4.666666	High Priority
4	REQ-20250430-014	HSE	Mayonnaise	4.666666	High Priority
5	REQ-20250430-003	Engineering	Cumin Powder	4,611111	High Priority
6	REQ-20250430-008	Engineering	Nutrijel Grass Jelly	4,388888	High Priority
7	REQ-20250430-011	Exploration	Kraft Cheese	4,388888	High Priority
8	REQ-20250430-013	Engineering	Vanilla Powder	4,388888	High Priority
9	REQ-20250430-001	HRGA	Broiler Chicken Eggs	4,333333	High Priority
10	REQ-20250430-002	HRGA	Indomie Chicken Broth	4,333333	High Priority

Based on the test results, the Priority Queue algorithm is able to accurately calculate the priority value of each purchase request using predetermined criteria weights. The manual calculation results are consistent with the system's output, effectively sorting requests from highest to lowest priority. Therefore, the Priority Queue algorithm has proven effective in helping determine procurement priorities in a more structured, objective manner, and in accordance with the needs of logistics and warehouse inventory management systems.

3.3 ROC Page Implementation

The ROC Assessment page calculates the priority value of a product request using the Rank Order Centroid (ROC) method based on criteria C1, C2, and C3. Logistics administrators can view the calculation results, perform data searches, recalculate the ROC value, and view the details of each request. The resulting priority value is used as the basis for ordering product requests using the Priority Queue algorithm .

Figure 1the ROC Page

3.4 Dashboard Page Implementation

The Admin *Dashboard* is the main page that displays a summary of warehouse logistics and inventory management information. This page displays information on total items, total assets, pending requests, critical stock, department data, users, incoming and outgoing items, and the priority queue for goods requests based on the ROC method, sorted using the *Priority Queue algorithm. The Admin Dashboard* can be seen in Figure 2.

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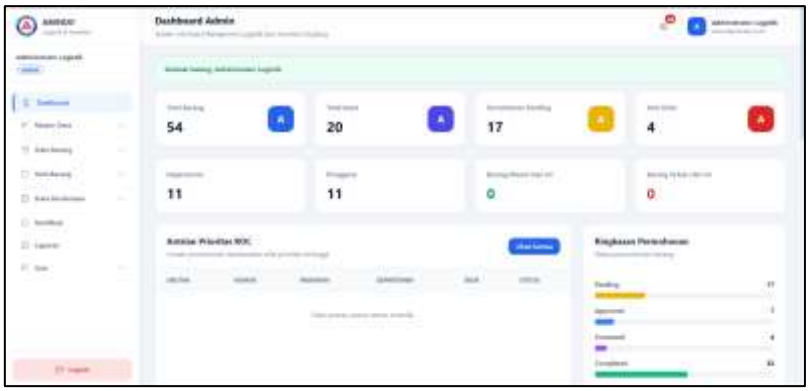

Picture 2 Dashboard Page Implementation

3.5 Stock Card Page Implementation

The Stock Card page displays the transaction history of incoming and outgoing goods. Logistics administrators can search and filter data by item, transaction type, reference, or date. This page also displays information on the number of incoming and outgoing goods, stock balance, and reference number. The Stock Card page can be seen in Figure 3.

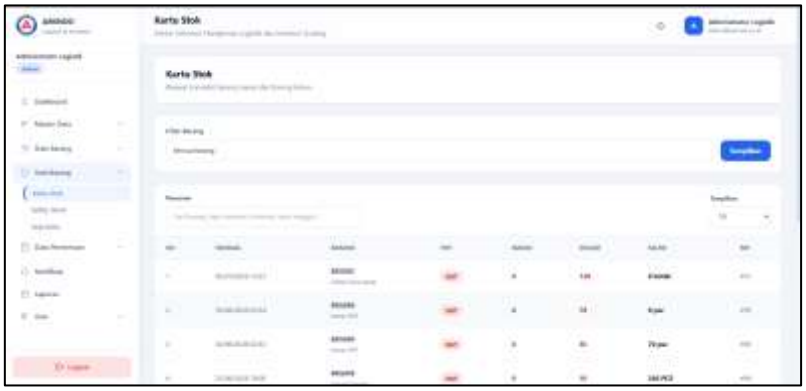

Figure 3. Implementation of the Stock Card Page

3.6 Implementation of Priority Queue Algorithm Page

The Priority Queue page displays the priority order of product requests based on the priority values calculated using the Rank Order Centroid (ROC) method. Logistics administrators can generate priority queues, search for request data, and view information on request numbers, applicants, departments, quantity requested (QTY), priority values, priority categories, request status, and queue status, as shown in Figure 4.

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Figure 4. Implementation of Priority Queue Algorithm Page

3.7 Report Page Implementation

The Reports page displays data summaries and provides various reports on the logistics and warehouse inventory management system. On this page, logistics administrators can view information such as total items, total stock,

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critical stock, incoming goods, outgoing goods, requests, and total assets. Additionally, a menu is available to access reports on stock, incoming goods, outgoing goods, requests, assets, and critical stock, which can be used to monitor and evaluate logistics management. The Reports page can be seen in Figure 5.

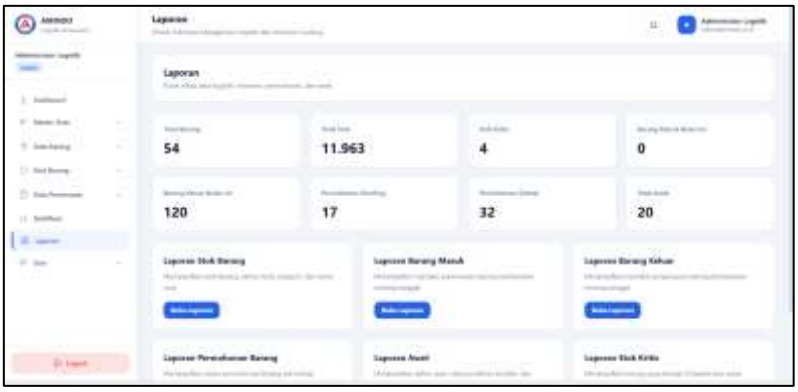

Figure 5. Implementation of the report page

3.8 User Acceptance Testing (UAT) Calculation Results

User Acceptance Testing (UAT) was conducted directly at PT. Arga Morini Indotama on 12 application users, consisting of logistics administrators and users (departments). The testing was conducted by giving each respondent the opportunity to directly try out the developed logistics and warehouse inventory management application. After the trial, respondents were asked to complete a questionnaire using Google Forms to provide an assessment of the system.

Table 4. User Acceptance Testing (UAT) Calculation Results

Aspect	SS	S	N	TS	STS	P	Average
Aspect Efficient i	5	6	1	0	0	86.67	85.85%
and Productivity	4	7	1	0	0	85	
Functional	6	4	2	0	0	86.67	85.84%
Suitability Aspect	5	5	2	0	0	85	
Performance Efficiency	5	5	2	0	0	85	84.17%
Aspects	4	4	2	0	0	83.33	
Display and User	6	6	1	0	0	88.33	87.50%
Experience Aspects	5	5	1	0	0	86.67	
Overall Aspect Average							85.84%

Based on Table 4, it can be seen that the percentage of system acceptance through User Acceptance Testing (UAT) in each aspect obtained very good results. The efficiency and productivity aspect obtained a value of 85.84%, the functional suitability aspect was 85.84%, the performance efficiency aspect was 84.17%, and the appearance and user experience aspect was 87.50%. Overall, the system obtained an average acceptance percentage of 85.84%. These results indicate that the system that has been developed can be well received by users. High percentage values in each aspect indicate that the system has met user expectations in terms of function, performance, and ease and comfort in use. Thus, the system is considered suitable for use in supporting operational activities within PT Arga Morini Indotama.

4. Conclusion

A web-based warehouse inventory and logistics management application was successfully developed to assist in recording, managing, and monitoring inventory at PT. Arga Morini Indotama, and has been proven to increase management effectiveness compared to manual processes. The Rank Order Centroid method and Priority Queue algorithm were successfully implemented to objectively determine criteria weights and prioritize goods requests, with an average UAT result of 85.84%.

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