

Inventory Management System Using Economic Order Quantity And Reorder Point

Ignatius Ivan¹, Raymond Sunardi Oetama^{2✉}

^{1,2} Department of Information Systems, Faculty of Engineering and Informatics, Universitas Multimedia Nusantara, Indonesia

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ABSTRACT

The inventory management system for car workshops is still using Excel, which makes it inefficient and inaccurate for complex stock calculations. The solution is to design an inventory application that uses the Economic Order Quantity and Reorder Point methods. The application will provide timely stock replenishment information and optimize order quantities, increasing inventory management efficiency and accuracy. The Software Development Life Cycle used in this study is Rapid Application Development, a process emphasizing short development cycles. User Acceptance Test results show that users received the inventory management system very well, with an average satisfaction level of 98.44% for Admins and 97% for general users, indicating high satisfaction with the system's features and functionality.

ABSTRAK

Sistem manajemen inventori bengkel mobil saat ini masih ada yang menggunakan Excel sehingga tidak efisien dan tidak akurat untuk perhitungan stok yang kompleks. Solusinya adalah mendesain aplikasi inventaris yang menggunakan metode Economic Order Quantity dan Reorder Point. Aplikasi ini akan menyediakan informasi pengisian ulang stok yang tepat waktu dan mengoptimalkan jumlah pesanan, sehingga meningkatkan efisiensi dan akurasi manajemen inventaris. Siklus Hidup Pengembangan Perangkat Lunak yang digunakan dalam studi ini adalah Rapid Application Development, yang menekankan siklus pengembangan yang singkat. Hasil *User Acceptance Test* menunjukkan bahwa prototipe sistem manajemen inventaris diterima dengan sangat baik oleh pengguna, dengan tingkat kepuasan rata-rata 98,44% untuk Admin dan 97% untuk pengguna umum, mengindikasikan kepuasan yang tinggi terhadap fitur dan fungsionalitas sistem.

Corresponding Author :

Raymond Sunardi Oetama

Department of Information Systems, Faculty of Engineering and Informatics, Universitas Multimedia Nusantara, Indonesia

Jl. Scientia Boulevard Gading, Curug Sangereng, Serpong, Kabupaten Tangerang, Banten 15810

E-mail: raymond@umn.ac.id

INTRODUCTION

In the modern business world, Information Technology, especially computer-based systems, has become essential for effective inventory management (Beheshti et al., 2020). Technological advances have encouraged many businesses to adopt computerized inventory management systems to simplify and optimize their processes. This system allows advanced

inventory control techniques, such as optimization models, to determine optimal stock levels, reorder points, and order quantities (Wanti et al., 2020). In addition, by analyzing historical sales data and customer behavior, companies can predict demand more accurately, adjust inventory levels, and anticipate stock needs, thereby minimizing excess inventory (Taherdoost, 2023).

An Inventory Management System (IMS) is a tool or software that helps businesses manage and monitor inventory more effectively (Musa & Ibrahim, 2021). With this system, companies can ensure that the goods they need will always be available in sufficient quantities, in the right location, and at the right time (Al-Momani et al., 2020). This system makes monitoring incoming and outgoing stock easy, calculating when to reorder goods, and analyzing data to predict future needs.

A car repair workshop is a business that provides motor vehicle repair and maintenance services, including repairs to engines, electrical systems, brakes, and routine maintenance such as oil changes (Topal, 2023). To run their operations well, the shop requires various types of spare parts and materials and skilled labor to ensure optimal service quality (James & James, 2021). Effective inventory management is critical for auto repair shops for several reasons. First, spare parts should be available to repair quickly and avoid service delays due to out-of-stock (Jenvald & Hovmöller, 2020). Second, it helps reduce costs by minimizing storage costs and optimizing stock levels (Ramos et al., 2020).

However, many auto repair shops still use Microsoft Excel for inventory management. This approach can cause various problems, especially for businesses with complex inventory and high transaction volumes (Baio & Heath, 2017). Manual errors in data entry often occur, resulting in inaccurate stock data. This manual process also takes time and reduces operational efficiency. Excel is complex to rely on at scale due to the lack of necessary automation, slowing down processes such as stock reordering.

The solution carried out by previous research was to create an inventory management system application. ROP is one of the inventory management techniques used to determine the right time to make purchases or add stock in the warehouse (Umry & Singgih, 2019). The application of the ROP method pays attention to the waiting time for delivery of supplier purchases so that the stock value is guaranteed even though the purchase delivery process is still running. The ROP method has been proven to prevent stock accumulation in warehouses or stock shortages. At the same time, the EOQ method is a calculation that produces an economic order quantity value by paying attention to shipping costs and storage costs (Nestorenko et al., 2020). With this application, The Workshop gets information on the right purchase time based on the ROP calculation results and the most economical number of orders based on the EOQ calculation.

To this problem, this research offers a practical solution by building an inventory management software system that provides automation and real-time tracking. This research was carried out at Auto Service Jaya. This workshop still uses Excel for its inventory management, which includes analyzing problems faced by car workshops designing and implementing a new inventory management system using the ROP and EOQ methods. This research aims to develop an inventory management system to ensure optimal performance that meets the needs of this car repair shop.

LITERATURE REVIEW

Inventory Management System

Inventory means the value of physical product availability (De Giovanni, 2021). In the business world, stock availability is one of the main points to be considered because it affects business activities such as production or sales (Farooq, 2019). Every company has a strategy to maintain the availability of goods. The company's efforts to preserve the availability of goods are usually called stock management. Stock management is needed to keep the availability of goods in storage (Saeed Osman, 2022). An Inventory Management System is a software application or set of tools used to monitor, control, and manage inventory, including inventory levels (HR &

Aithal, 2020). This system helps businesses maintain optimal stock levels, prevent overstocking or understocking, and ensure accurate inventory tracking and reporting.

Economic Order Quantity

Regarding inventory management, economic understanding reduces costs arising from inventory management activities such as holding costs (Huang et al., 2020). Storage costs can arise from electricity costs for storage areas, storage security, and other costs incurred for storing goods. If the storage area is used by more than one product, the storage costs must be divided equally. The calculation of the EOQ method pays attention to the need for goods in a certain period, or it can also be from data on sales of goods, ordering costs or shipping costs for purchases from suppliers, and storage costs for each item (Vasilev & Milkova, 2022). The Formula for calculating the EOQ method is Formula (1) (Rafliana & Suteja, 2018):

$$EOQ = \sqrt{\frac{2 \times \text{Demand Rate} \times \text{Setup Cost}}{\text{Holding rate}}} \quad (1)$$

Reorder Point

The Reorder Point is a crucial strategy companies employ to determine the optimal timing for replenishing inventory and purchasing (Mittal, 2024). It helps ensure that stock is reordered or restocked at the right time to avoid stockouts and maintain adequate inventory levels. The ROP strategy considers two key factors: lead time or delivery time of goods from suppliers and the value of safety stock. Lead time refers to the duration it takes for goods to be delivered from suppliers to the company's warehouse or point of sale (Vasilev & Milkova, 2022). By considering lead time, the company can estimate the time required to receive a new order after it has been placed. This information is vital for determining when to initiate the replenishment process. Safety stock represents the inventory level held as a buffer to account for any unexpected fluctuations in demand or delays in the supply chain (Goli et al., 2020). It safeguards against uncertainties, such as unforeseen customer demand spikes or supplier delivery delays. The value of safety stock ensures that the company has sufficient inventory to meet customer demands until the new order arrives. By accurately calculating the reorder point, companies can proactively plan their inventory replenishment, minimize stockouts, and ensure that the right amount of stock is available when needed. The ROP is calculated using Formula (2) (Rafliana & Suteja, 2018):

$$ROP = \text{Average Daily Sales} \times \text{Lead Time} + \text{Safety Stock} \quad (2)$$

RESEARCH METHODS

Research Object

Auto Service Jaya is a car repair Workshop in Cimone, Tangerang, founded in 1994. Besides repair services, The Workshop sells various products, such as audio systems, bumpers, grilles, and other car accessories. Stock management is done with Excel, but calculations for diverse products become difficult. The Workshop can only set safety stock limits for products that run out quickly. Good stock planning is essential for smooth sales and storage space, while miscalculations can disrupt the supply chain and cause shortages of goods in the warehouse.

Software Development Method

One of the Software Development Life Cycles will be used in this study, namely Rapid Application Development (RAD). This software development method is a software development process that emphasizes a short development cycle (Subhiyakto & Astuti, 2019). This method was chosen because the research subject is relatively simple and limited in scope, enabling a fast completion without incurring significant expenses (Oetama & Armando, 2023). As depicted in Figure 1, RAD consists of several phases: Requirement Planning, User Design, Construction, and Cutover (Angellin et al., 2023).

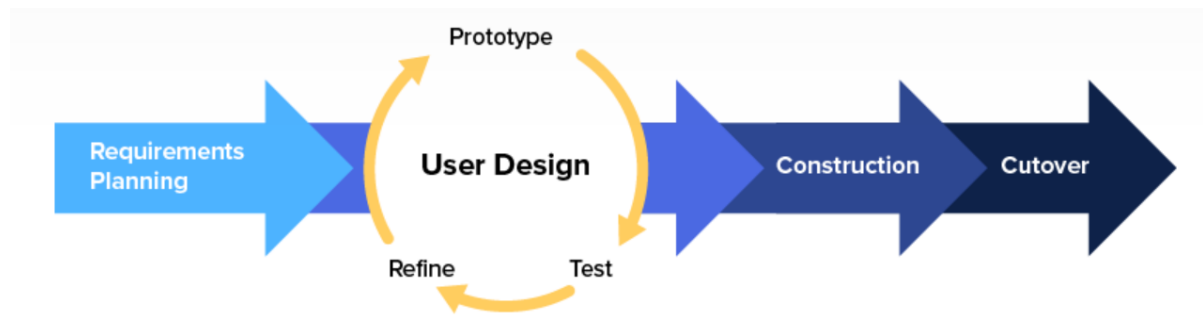


Figure 1. RAD Method Stages (Suryasari et al., 2022)

The initial phase is Requirement Planning, which involves interviews with the owner and staff of the Workshop. The content of the interview relates to the inventory management process, recording purchases of goods and goods out of goods. The subsequent phase is the User Design cycle, which encompasses prototyping, testing, and refinement. During this stage, the system is designed using UML, including Use Case Diagrams, Activity Diagrams, and Class Diagrams. Following the User Design phase is the Construction Phase. In this system design stage, HTML is utilized with the CodeIgniter framework, PHP programming language, and MySQL database running on XAMPP. Visual Studio Code serves as the text editor during this process. The final phase is Cutover, which aims to verify the proper functioning and consistency of the program, ensuring it aligns with the objectives and specifications provided by stakeholders. Testing is conducted using the Black Box Testing method, generating User Acceptance Testing as an outcome.

Evaluation Method

User Acceptance Testing (UAT) is an innovative methodology for preventing IT project failures (Afrianto et al., 2021). In the software development process, UAT serves three essential purposes. Firstly, it helps expose any undiscovered business logic or functionality that unit or system tests may not have covered. Secondly, UAT assesses how well the system fulfills user requirements. Finally, UAT limits how the system is considered complete (Gordon et al., 2022). By conducting UAT, organizations can ensure that the developed system aligns with the intended business goals and satisfies the end users' needs. It is a crucial step in the software development life cycle, enabling stakeholders to validate the system's functionality and make informed decisions regarding its acceptance and deployment.

RESULT AND DISCUSSION

Requirement Planning

This study conducted oral interviews to determine the problems the Workshop faced. The proposed system for the Workshop includes functional requirements such as viewing and inputting employee, goods, producer/supplier, and customer/buyer data management by both admins and users. It also enables the inputting of incoming and outgoing goods transactions, the performance of ROP and EOQ analysis, and access to reports on incoming, inventory, and outgoing goods.

User Design & Construction

The use case diagram in Figure 2 outlines the Inventory Management System in the ASJ Workshop. Users can perform cases such as Maintain User, Manage Role, Organize Product, Manage Product Category, Organize Supplier, and Complete Sales. In addition, Admin has 2 more cases to perform, such as Make Analysis and Manage Purchase. The Maintain User group handles account CRUD operations, ensuring accurate user information and access control. Manage Role deals with defining user roles and permissions. Organize Product focuses on product CRUD operations and image uploads. Manage Product Category helps to put products into categories for efficient inventory navigation. Organize Supplier maintains supplier information for

effective collaboration. Complete Sales covers sales record management. Make Analysis generates analysis tables for insights into sales and inventory trends. Manage Purchases handles purchase record management for accurate procurement tracking.



Figure 2. Use Case Diagram of the Inventory Management System

ANALISIS EOQ dan ROP TAHUN 2021							
No	Kode Item	KEBUTUHAN SETAHUN (UNIT) (R)	BIAYA KIRIM TERAKHIR / UNIT (S)	BIAYA SIMPAN (C)	EOQ	PLT	ROP
1	2289 - PE1X18520TT (Suzuki Gasket Set)	257	100,000	1,098,900	7	4	14
2	2296 - PE1T18520TT (Suzuki Kabel Busi)	104	100,000	639,360	6	1	11
3	2288 - DA6K51031C (Bearing Set Dyna)	64	100,000	179,820	8	1	11
4	2290 - DA6K51041E (Toyota Belt Timing Corolla)	51	100,000	659,340	4	1	11
5	2291 - DG8L50031BB (Toyota Belt Assembly Rear Seat Corolla)	174	100,000	589,410	8	2	12
6	2293 - DA7A50221BBB (Toyota Bearing Set Crankshaft Corolla)	108	100,000	1,198,800	4	2	12
7	2297 - DA6K51041B (Toyota Bearing Radial Ball Avanza)	24	100,000	839,160	2	0	10
8	2286 - KDY35022XFBB (WIPER HONDA FREED GEN 1)	191	100,000	350,000	10	3	13
9	2287 - KE1050031BBB (WIPER HONDA GENIO GEN 4)	192	100,000	140,000	17	3	13
10	2292 - KH2451031D (Honda Engine Mounting Side)	42	100,000	2,697,300	2	1	11
11	2294 - KA3C51041P (Haima Car Mats Honda CRV)	17	100,000	1,598,400	1	0	10
12	2295 - KH2451041D (Honda Alloy Wheel CRV)	41	100,000	2,497,500	2	1	11
13	2298 - KA3C51031P (Honda Cable Speedometer)	12	100,000	419,580	2	0	10
14	2299 - KA3C51041J (Honda Disk FR Brake)	11	100,000	7,292,700	1	0	10
15	2300 - C60550031CBB (BOSCH Busi 4W Standard 14mm)	45	100,000	41,070	15	1	11
16	1222 - C27350850L (BOSCH Rear Wiper Roc Lock 2)	30	100,000	39,960	12	0	10
17	2429 - Ban Mobil Michelin	0	0	300,000	0	0	10

Figure 3. Results of the Analysis Page

In addition, Figure 3 shows the Results of the Analysis Page. This page comprises "Kode Item" (Item Code), "Kebutuhan Setahun Unit" as Demand Rate, "Biaya Kirim Terakhir / Unit" as Setup Cost, and "Biaya Simpan" as Holding Rate. For example, for Item Code 2289, Demand

rate = 257, Setup Cost = 100,000, and Holding Rate = 1,098,900. So, the EOQ can be computed using Equation (1).

$$EOQ = \sqrt{\frac{2 \times 257 \times 100,000}{1098900}} = 6.83 \approx 7.$$

As can be seen in Table 1, for this item code, the Average Daily Sales is 0.7, Lead Time = 5, and the Safety Stock is 10. Using Equation (2), the ROP is $0.7 \times 5 + 10 = 13.5 \approx 14$.

Cut Over

The User Acceptance Test was conducted with 3 Admins and 4 Users, as shown in Figure 4. The acceptance level for the Admin users was slightly below 100%, with an average of 98.44%. On the other hand, the acceptance level for the User averaged 97%. The User Acceptance Test involved assessing the system's overall performance from the perspective of both Admin and User users. The test aimed to evaluate the system's compliance with user requirements and ability to meet their needs effectively. During the test, the Admin users examined various features and functionalities specific to their administrative roles. They assessed tasks such as managing inventory, generating reports, and accessing administrative settings. The slightly lower acceptance level of 98.44% suggests a few minor issues or areas for improvement identified by the Admin users. These issues may have affected their overall satisfaction with the system but were not significant enough to impact its functionality significantly.

Features	User Requirements	expectation	Admin			Acceptance Level	Users				Acceptance Level
			Budi	Agung	Desi		Riko	Maman	Holik	Tejo	
Maintain User	Create User	user is successfully created	5	5	5	100.00%	5	5	5	5	100.00%
	Read User	user is successfully read	5	5	5	100.00%	5	5	5	5	100.00%
	Update User	user is successfully updated	5	5	5	100.00%	4	5	5	4	90.00%
	Delete User	user is successfully deleted	5	5	5	100.00%	5	5	5	5	100.00%
Manage Role	Create Role	role is successfully created	5	5	5	100.00%	5	5	5	5	100.00%
	Read Role	role is successfully read	5	5	5	100.00%	5	5	5	5	100.00%
	Update Role	role is successfully updated	5	5	5	100.00%	5	4	4	5	90.00%
	Delete Role	role is successfully deleted	5	5	5	100.00%	5	5	5	5	100.00%
Organize Product	Create Product	product is successfully created	5	5	5	100.00%	5	5	5	5	100.00%
	Read Product	product is successfully read	5	5	5	100.00%	5	5	5	5	100.00%
	Update Product	product is successfully updated	5	5	4	93.33%	4	5	5	4	90.00%
	Delete Product	product is successfully deleted	5	5	5	100.00%	5	5	5	5	100.00%
Manage Product Category	Upload Product Picture	Picture is successfully uploaded	5	5	5	100.00%	5	4	5	4	90.00%
	Create Product Category	product category is successfully created	5	5	5	100.00%	5	5	5	5	100.00%
	Read Product Category	product category is successfully read	5	5	4	93.33%	5	5	5	5	100.00%
	Update Product Category	product category is successfully updated	5	4	5	93.33%	4	4	5	4	85.00%
Organize Supplier	Delete Product Category	product category is successfully deleted	5	5	5	100.00%	5	5	5	5	100.00%
	Create Supplier	supplier is successfully created	5	5	5	100.00%	5	5	5	5	100.00%
	Read Supplier	supplier is successfully read	5	5	5	100.00%	5	5	5	5	100.00%
	Update Supplier	supplier is successfully updated	5	5	4	93.33%	5	4	4	4	85.00%
Complete Sales	Delete Supplier	supplier is successfully deleted	5	5	5	100.00%	5	5	5	5	100.00%
	Create Sales	sales is successfully created	5	5	5	100.00%	5	5	5	5	100.00%
	Read Sales	sales is successfully read	5	5	4	93.33%	5	5	5	5	100.00%
	Update Sales	sales is successfully updated	4	5	5	93.33%	5	4	5	5	95.00%
Make Analysis	Delete Sales	sales is successfully deleted	5	5	5	100.00%	5	5	5	5	100.00%
	Show Analysis Tables	tables are shown correctly	5	5	5	100.00%	5	5	5	5	100.00%
	Create Purchases	purchases is successfully created	5	5	5	100.00%	5	5	5	5	100.00%
	Read Purchases	purchases is successfully read	5	5	4	93.33%	5	5	5	5	100.00%
Manage Purchases	Update Purchases	purchases is successfully updated	5	5	5	100.00%	4	5	4	4	85.00%
	Delete Purchases	purchases is successfully deleted	5	5	5	100.00%	5	5	5	5	100.00%
			Average			98.44%	Average				97.00%

Figure 4. User Acceptance Test

Discussion

Following the aim of this study, the discussion below will discuss why EOQ and ROP can help the Workshop provide timely stock replenishment information, optimize order quantities, and increase inventory management efficiency and accuracy.

In Table 1, the ROP for item code KDY35022XFBB is 13 units, meaning that when the remaining stock reaches 13 units, it is the right time to place a reorder. If the Workshop reorders when the remaining stock is less than 13 units, it could result in a risk of stock shortages. Businesses

will likely run out of inventory before new orders arrive. It can lead to customer disappointment, lost sales, and a compromised business reputation. It may be too early to reorder if the Workshop reorders when the remaining stock is more than 13 units. Ordering too early can lead to excessive inventory accumulation, increasing carrying costs, and eroding profitability.

The optimal number of items that must be reordered (EOQ) for item code KDY35022XFBB is ten units. If the Workshop orders items below the recommended optimal quantity, this may occur due to considerations of ordering costs or immediate needs. In this case, although stock will increase, there is a risk that more frequent ordering costs could increase total inventory costs. If the Workshop orders more than the recommended optimal quantity, this could result in unwanted excess stock. Excess stock can increase carrying costs and reduce profitability due to too much inventory.

The use of Economic EOQ and ROP can also help The Workshop increase the efficiency and accuracy of inventory management for several reasons. As explained above, if EOQ is ignored, orders can occur too early, leading to excessive inventory accumulation, which, in the end, can increase carrying costs and erode profitability. Then, using the correct data, EOQ and ROP increase accuracy in inventory planning, reduce human error in estimating stock requirements, and ensure that order decisions are based on reliable data.

Table 1. EOQ Calculation Results

Item Code	Demand Rate	Setup Cost	Holding Rate	EOQ	Average Daily Sales	Lead Times	Safety Stock	ROP
KDY35022XFBB	191	100.000	350.000	10	0.53	5	10	13
KE1050031BBB	192	100.000	140.000	17	0.53	5	10	13
DA6K51031C	64	100.000	179.820	8	0.17	5	10	11
PE1X18520TT	257	100.000	1.098.900	7	0.7	5	10	13
DA6K51041E	51	100.000	659.340	4	0.14	5	10	11
DG8L50031BB	174	100.000	589.410	8	0.48	5	10	12
KH2451031D	42	100.000	2.697.300	2	0.11	5	10	11
DA7A50221BBB	108	100.000	1.198.800	4	0.29	5	10	11
KA3C51041P	17	100.000	1.598.400	1	0.05	5	10	10
KH2451041D	41	100.000	2.497.500	2	0.11	5	10	10
PE1T18520TT	104	100.000	179.820	11	0.29	5	10	11
DA6K51041B	24	100.000	839.160	2	0.06	5	10	10
KA3C51031P	12	100.000	419.580	2	0.03	5	10	10
C60550031CBB	45	100.000	41.070	15	0.125	5	10	11
C27350850L	26	100.000	39.360	11	0.07	5	10	10

CONCLUSION

The inventory management system we created using Economic Order Quantity and Reorder Points has proven helpful for the Workshop. Using EOQ helps calculate optimal order quantities to minimize inventory costs. In addition, ROP helps ensure stock replenishment is done on time to avoid stock shortages that can disrupt daily operations. It contributes significantly to the efficiency and accuracy of their inventory management.

The Rapid Application Development development method that we apply in system development also helps accelerate the process of developing solutions that suit the needs of the

Workshop. The results of the User Acceptance Test that we conducted with Admin and User also provide a positive picture of the system's success. With an average acceptance rate of 97%, we saw that users expressed general satisfaction with the system's functionality for their daily use tasks, confirming that the system we developed met their needs and expectations.

Based on the analysis and findings, it is suggested that the system be improved further by developing advanced reporting and analytics. Expand the reporting capabilities to include comprehensive analysis reports, such as inventory turnover and supplier performance. Incorporating advanced analytics will provide deeper insights for decision-making and strategic planning.

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