Information system design of inventory control spare parts maintenance (valuation class 5000) (case study: plant kw)

Rina Fitriana, Parwadi Moengin, Mega Riana
Simulasi and Sistem Industry Laboratorium, Industrial Engineering Department
Fakultas Industrial Technology Faculty, Trisakti University
Email: rinauda@yahoo.com, parwadi@trisakti.ac.id, megariana12@yahoo.com

Abstract. Plat KW hadn’t using optimal inventory level planning yet and hadn’t have an information system that well computerized. The research objective is to be able to design an information system related inventory control of spare parts maintenance. The study focused on five types of spare parts with the highest application rate during February 2013- March 2015 and included in the classification of fast on FSN analysis Grinding stones Cut 4”, Cable Tie 15”, Welding RB 26-32MM, Ring Plat ½” and Ring Plate 5/8 ”. Inventory calculation used Economic Order Quantity (EOQ), Safety Stock (SS) and Reorder Point (ROP) methods. System analysis conducted using the framework PIECES with the proposed inventory control system, the performance of the plant KW relating to the supply of spare parts maintenance needs can be more efficient as well as problems at the company can be answered and can perform inventory cost savings amounting Rp.267.066. A computerized information system of inventory control spare parts maintenance provides a menu that can be accessed by each departments as the user needed.

Key Words: Inventory Control System, Information System, Economic Order Quantity (EOQ), PIECES (Performance, Information, Economics, Control, Efficiency, Information, Service).

1. Introduction
Information is very important for company management in decision making. The information system is an arrangement of people, data, processes, and information technology that interact to collect, process, store and supply as output the information necessary for an organization. (Whitten,2004). Information system created in order to simplify the management of data and information as well as help us in searching for data and information needed. Inventory information system is a system that provides information or reports required by management related to order, storage and inventory. Plant KW is a company engaged in the business of natural (agribusiness), namely natural rubber processing. The main product produced in the form of crumb rubber with the standards of quality based on SIR (Standard Indonesian Rubber). Controlling inventory control spare parts maintenance becomes an important point in supporting its success. Implementation of engine maintenance activities is important because it affects the productivity levels of production activity. The absence of planning needs spare parts for maintenance is good, can affect the occurrence of overstock and stock out. Where is the impact that will result if inventory of spare parts experienced overstock, the company will incur huge costs for the storage of spareparts. Inventory information system is one of the main requirements for operational planning activity. Therefore, it is necessary to have accuracy of the information and have a quick decision to be taken by the company in determining inventory levels and the time reservations where companies do not have a system that supports it yet. KW Plant didn’t have effective information system related issues material inventory levels of spare parts production machines. KW inventory control has not using the optimal planning of inventory levels and still lack a computerized information system well.

This research was conducted in order to determine the amount of inventory of spare parts that proper maintenance and to develop an information system that can support the maintenance of spare parts inventory control KW plant.
In this research, calculation method inventory rate is using Economic Order Quantity (EOQ) with classification FSN (Fast, Slow and Non-Moving) to limit the number of items studied, the level of safety stock, re-order point, minimum stock and maximum stock of goods spare parts maintenance. In addition, for ease in managing inventory data spareparts maintenance developed inventory information system by using Visual Basic 6.

2. Literature review

Inventory control is as an activity to determine the level and composition of inventory parts, raw materials and goods result of production or products, so companies can protect the production and sales effectively and efficiently (Assauri, 2004). Analysis method using FNS is is a useful technique to classify the types of goods into three categories Fast Moving (F), Normal Moving (N), and Slow Moving (S) based on the number and speed of consumption goods. In determining the category F, S and N is done by looking at the two parameters is a value 

\[
\text{Average Stay of the material} = \frac{\text{Cumulative No of Inventory Holding}}{\text{Total Quantity Receive + Opening Balance}}
\]  

(1)

\[
\text{Consumption Rate} = \frac{\text{Total Issue Quantity}}{\text{Total Period Duration}}
\]

(2)

Inventory is considered to have two types of costs, ordering cost/ set up cost and carrying cost/holding cost. (Heizer dan Render, 2005). Formulation Economic Order Quantity (Abayomi et.al, 2014):

Cycle Time = \( \frac{Q}{D} \)  

(3)

Ordering cost per cycle = \( S + cQ \)  

(4)

Holding cost per year = \( \frac{hQ^2}{2D} \)  

(5)

From formulation (2) and (3), the obtained formulation of the total cost per cycle:

\[
\text{Total cost per cycle} = S + cQ + \frac{hQ^2}{2D}
\]  

(6)

Based on the equation (1), (2), (3) and (4), the total cost per unit time:

\[
T = \frac{S+cQ + \frac{hQ^2}{2D}}{\frac{Q}{D}} = \frac{DS}{Q} + Dc + \frac{hQ}{2}
\]

(7)

The value of the quantity EOQ regarded as \( Q^* \), which is to minimize the value of \( T \) derived based on \( Q \):

\[
T = \frac{dT}{dQ} = \frac{DS}{Q^2} + \frac{h}{2}
\]  

(8)

EOQ or \( Q^* = \frac{2DS}{h} \)  

(9)

\( S \) = The booking fee (preparation of orders and set up the machine) per order  

\( D \) = The use or demand estimated per time period  

\( C \) = Ordering Cost per unit  

\( H \) = Storage costs per unit per year

Inventory models assume that a company will wait until the inventory level reaches zero before the company booked again and immediately submissions will be accepted (Heizer and Render, 2005). Decisions will be ordered normally disclosed in context of the reorder point, the inventory level in which to do the booking.

Database system is a system design and manage records using a computer to store or record and maintain operational and complete an organization / company so that can provide the user information necessary for optimal decision-making process (Marlinda, 2004). The database is a collection of data that contains information that correlates to each other (Yuswanto, 2005).

The life cycle of the system is an evolutionary process that is followed in implementing a system or subsystem computer-based information. This method is a classical or traditional methods that can be used to develop the information system is called SDLC (System Development Life Cycle). Stages in the
SDLC System are Planning, System Analysis, System Design, Implementation, Phase Usage. (Mcleod, 2001). Analysis and Design System used for analyzing, designing, and implementing development business functions that can be achieved through the use of computerized information systems (Kendall, 2003).

PIECES framework (Performance, Information, Economics, Control, Efficiency) refers to solve problems, exploit opportunities, and run the command (Whitten, 2004). Context diagram puts the system in an environmental context. This diagram consists of a single process symbol that symbolizes the whole system. Data Flow Diagrams is a graphical representation of a system that uses four shapes symbol to illustrate how data flows through the processes connected. Entity Relationship Diagram (ERD) is a picture on a system in which there is a relationship between the entities and their relationships. ERD is a data model that uses some notation to describe the data in the context of the entities and relationships described by the data. Physical Data Model (PDM) is a type of data model that is a portrait of the relationship between table physically. (Whitten, 2004).

There are many research about inventory information system. Pons (2010) describes a theoretical approach to examining the larger organizational factors in which inventory control systems are embedded. Mongore et al, (2013) determine the effect of material requirement planning on operational performance, establish the influence of continuous replenishment on operational performance, establish the extent to which distribution resource planning influence operational performance and the effect of vendor managed inventory on operational performance of Tea Factory. The result was significant correlation between the use of inventory control systems and operational performance of a tea processing firm. M.R. Khabbanzi et al (2013) made computerized inventory information system as system able to be integrated with other back office systems in production logistics. Singh et al. (2013) made the strategic role of JIT in inventory management. Information technology helps JIT in managing inventory effectively, it also helps in integrating the components of supply chain network and quality aspect of inventory management. Reddy et al. (2009) made management information system to provides accurate and timely information, necessary to facilitate the decision-making process and enable the organizations planning, control, and operational functions to be carried out effectively. Akindipe (2014) wrote practitioners become proactive by applying proffered solutions, efficiency will be achieved in management of raw materials and production operations. Liang (2014) build up a system to predict inventory, surveyed experts to identify key issues associated with inventory management in the food-processing and distribution industry, analyzed sequential patterns to find rules based on analytical results from the survey and proposed a model for inventory prediction. Cadavid et al. (2011) made a framework for decision support system for inventory management area with the Enterprise Resource Planning’s (ERP’s).

3. Research method
The study began with preliminary research, problem identification, literature, the purpose of research, data collection, data processing, analysis and then conclusions and suggestions are given. As for the data processing that occurs as follows.
4. RESULT AND ANALYZE  

Product Selection Based FSN (Fast, Slow dan Non-moving) Classification  

Product selection is done in a way to sort products by criteria FSN analysis which belong to the category of fast with the highest application rate. Selection of products can be seen in the table 1.

Table 1. Product Selection Based FSN (Fast, Slow dan Non-moving) Classification

| Material   | Usage | Period | Frequency | Percent | Result | Material | Opening | Buyer | Cumulative Stay | Average | Percent | Result | Final |
|------------|-------|--------|-----------|---------|--------|----------|---------|-------|----------------|---------|---------|--------|-------|
| KBT-0004   | 8832  | 24     | 368,00    | 100,00% | F      | KBT-0004 | 599     | 8800  | 3222           | 0,343   | 0,998   | F      | F     |
| KWL-0094   | 2015  | 24     | 83,96     | 80,98%  | F      | KWL-0094 | 25      | 1850  | 380            | 0,202   | 0,999   | F      | F     |
| RPL-0018   | 1571  | 24     | 65,46     | 76,64%  | F      | RPL-0018 | 252     | 540   | 796            | 1,005   | 0,981   | F      | F     |
| BGR-0010   | 1446  | 24     | 60,25     | 73,25%  | S      | BGR-0010 | 10      | 1485  | 302            | 0,202   | 0,999   | F      | F     |
| RPL-0005   | 1261  | 24     | 52,54     | 70,14%  | S      | RPL-0005 | 87      | 1150  | 406            | 0,328   | 0,998   | F      | F     |
Based on the classification that has been done, the materials to be used in the calculation of inventory is material that is included in the criteria of fast moving and taken five materials with the largest consumption namely spareparts KBT-0004 (cables tie 15”), KWL-0094 (Welding Wire Kawat Las RB 26-32MM), RPL-0018 (Ring Plat 5/8”), BGR-0010 (Grinding stones Cut 4”), dan RPL-0005 (Ring Plat ½”). This five materials is used as early information of inventory information system to be made.

### Requirement data in Calculation Economic Order Quantity (EOQ)
This is the requirement data in calculation:

1. Data Usage and Material Prices
   - Data usage is the amount of usage within a specific time period. The period used in of Weeks.
2. The booking fee is influenced by administrative costs include the cost of telephone, fax costs, and administrative costs as well as costs of loading and unloading of goods amounted to 5 % of the price of the material.
3. Storage costs in this study was obtained from the total percentage of the factors affecting storage costs amounting to 15 % multiplied by the unit price of spare parts

#### Table 2. Data Usage, Booking Fees and Saving Material

| Material   | Material Description       | Base Unit Measure | Average Demand (week) | Price   | Booking Fees | Saving Cost |
|------------|----------------------------|------------------|------------------------|---------|--------------|-------------|
| KBT-0004   | Cable Tie 15               | PC               | 81.6                   | Rp. 650 | Rp. 325      | Rp. 1.875   |
| KWL-0094   | Welding Wire RB 26-32 mm   | KG               | 16.88                  | Rp. 28.000 | Rp. 14.000 | Rp. 80.769  |
| RPL-0018   | Ring Plat 5/8              | PC               | 14.38                  | Rp. 450 | Rp. 225      | Rp. 72.115  |
| BGR-0010   | Gerinda Stone Pieces 4     | PC               | 13.43                  | Rp. 25.000 | Rp. 12.500 | Rp. 1.298   |
| RPL-0005   | Ring Plat 1/2              | PC               | 11.65                  | Rp. 1.000 | Rp. 500      | Rp. 2.885   |

Lead time is the time required for the supply of materials. Lead time is calculated from the time of booking until the material goes into the warehouse. Here is the data lead time based on historical data of the company.

#### Table 3. Lead Time Data Ordering Material

| Material   | Description       | Lead Time (day) | LT (week) |
|------------|-------------------|-----------------|-----------|
| BGR-0010   | Grinding stones cut 4" | 14              | 1.99      |
| KBT-0004   | Cable Tie 15"     | 9               | 1.28      |
| KWL-0094   | Welding Wire RB 26-32 mm | 9              | 1.28      |
| RPL-0005   | Ring Plat 1/2"    | 9               | 1.28      |
| RPL-0018   | Ring Plat 5/8"    | 9               | 1.28      |

1. Calculation Economic Order Quantity (EOQ), Re-Order Point and Safety Stock
EOQ calculation is used as a method which is used to determine the optimal inventory level in terms of the number of orders. Following the calculation of inventory levels for Grinding Stone Cut 4”:

\[
EOQ = \sqrt{\frac{2DS}{h}} = \sqrt{\frac{2 \times 13.43 \times 12500}{72115}} = 68.23 \sim 69 \text{ unit}
\]

\[
\text{Cycle times} = \frac{Q}{D} = \frac{69}{13.43} = 5 \text{ weeks}
\]
Frequency of booking = \( \frac{D}{Q} = \frac{1504}{69} \approx 21.79 \) ~ 22 time

Ordering cost per cycle = \( \frac{D}{Q} \times S = \frac{1504}{69} \times Rp 12.500 = Rp 272,463,768 \),-

Saving cost per year = \( \frac{Q}{2} \times h = \frac{69}{2} \times 72,115 = Rp 2,487,967 \),-

Total inventory cost = \( \frac{D}{Q} \times S + \frac{Q}{2} \times h + S \times \frac{Q}{2} = \frac{1504}{69} \times Rp 12.500 + \frac{69}{2} \times 72,115 + 12.500 \times \frac{69}{2} = Rp 706,201,735 ,-

Safety Stock = \( Z \times \sigma L \times \bar{D} = 1.65 \times 0.84 \times 13.43 = 18,613 \) \(-\) 19 unit

Re-Order Point = \( (\bar{D} \times LT) + Safety stock = (13.43 \times 1.99) + 18,613 = 45,339 \) ~ 46 unit

Minimum inventory = Safety Stock = 19 unit

Maximum inventory = Safety stock + EOQ = 19 + 69 = 88 unit

Table 4. Calculation Inventory level and Inventory Cost

| Material Description       | Safety Stock | ROP | EOQ | Total Inventory Cost | Minimum (Theory) | Maximum (Theory) |
|----------------------------|--------------|-----|-----|----------------------|------------------|-----------------|
| Cable Tie 15               | 386          | 491 | 169 | Rp. 45.196           | 386              | 556             |
| Welding Wire RB 26-3.2 mm  | 27           | 49  | 77  | Rp. 885.746          | 26               | 104             |
| Ring Plat 5/8              | 14           | 33  | 71  | Rp. 13.139           | 14               | 86              |
| Gerinda Stone Pieces 4     | 19           | 46  | 69  | Rp. 706.202          | 18               | 88              |
| Ring Plat 1/2              | 25           | 41  | 64  | Rp. 26.288           | 25               | 90              |

Table 5. Inventory Cost

| Material Description       | Total Inventory Cost | Total Inventory Cost | The Difference | Saving Cost |
|----------------------------|----------------------|----------------------|----------------|-------------|
| Cable Tie 15               | Rp. 45.196           | Rp. 163.400          | Rp. 118.204   |
| Welding Wire RB 26-3.2 mm  | Rp.885.746           | Rp. 956.861          | Rp. 71.115    |
| Ring Plat 5/8              | Rp. 13.139           | Rp. 14.211           | Rp. 1.072     |
| Grinding Stone Pieces 4    | Rp.706.202           | Rp.780.910           | Rp. 74.708    |
| Ring Plat 1/2              | Rp. 26.288           | Rp. 28.254           | Rp. 1.966     |

Total Savings Rp. 267,066

Inventory Information System Design

Information Systems Development Method

The method used in the development of information systems is SDLC (System Development Life Cycle).

Context Diagram System Proposal

Described context diagram of the proposed system to improve the quality system inventory information on the KW plant. Here is a context diagram proposals were made:
Data Flow Diagram (DFD) Inventory Information System Proposal
DFD for inventory information at KW plant consists of seven processes, namely the procurement process, requirement of goods, purchasing, receiving, calculating costs, storage and outgoing goods. DFD diagram information system proposal can be seen in figure 4:

![Data Flow Diagram](image)

Figure 4. The Proposed Data Flow Diagram Information System
Database design using the ERD (Entity Relationship Diagram)
Manufacture of ERD is intended to relationships between entities in the warehouse information system can be seen clearly. ERD Diagram can be seen in Figure 5:

![Entity Relationship Diagram Proposed system]

Physical Data Model (PDM)
Physical data model is created to facilitate the development of a database. Physical Data model is a model that uses a number of tables to describe the data and relationships between data - the data is made by ERD. Each table has a column in which each column has a unique name. PDM is a representation of the design data created in the spare parts inventory information system of KW plant.
Data Dictionary

When displaying the data of raw materials and finished goods along with related data into a display program to be made in advance to design an appropriate database. Database components such as tables integrated and formed relationships with each other. Hence the need for a data dictionary is intended as a repository for data from the database that is being designed. The data dictionary is based on PDM (Physical Data Model) made of ERD.

The Design Results

Results of the design inventory information system KW using the design database MySQL and Visual Basic 6. Views are made based on the needs of the inventory information by departments. Factory Warehouse as admin of the program can access and view all of the display, both the entry menu and edit reports. Here are the example of the inventory information system.

5. CONCLUSION

1. Inventory information system proposals are made to provide information on the availability of goods spare parts need maintenance, capable of providing the required inventory information quickly and accurately so that facilitate the search and retrieval of information required by users. Inventory information system proposals have good security, since access is restricted by using user ID and password in every department.
2. Proposed inventory levels by using EOQ method capable of providing savings on the total cost of inventory amounted to Rp. 267,066,- per week for 5 material under study or for each material studied KBT - 0004 (Cable Tie 15") save 56.67 %, KWL - 0094 (Wire Las RB 26-32MM) saving 3.86 %, RPL - 0018 (Ring Plat 5/8") save 3.92 %, BGR - 0010 (Grinding Stone Cut 4") save 5.02 %, and the RPL - 0005 (Ring Plat ½") saving of 3.6 % per week.

Acknowledgments
Authors thank to Research Grants from Directorate General of Research of Technology and Higher Education Indonesia for funding this research.

References
[1] Abayomi, T. Onanuga and Adeyemi, A. Adekunle. 2014. *Dynamics of Inventory Cost Optimization – A Review of Theory and Evidence*. IISTE Vol.5, No.22, pp 43-52.
[2] Assauri, S. 2004. *Manajemen Produksi dan Operasi Edisi Revisi*. Fakultas Ekonomi Universitas Indonesia. Jakarta.
[3] Akindipe, Olusakin S. 2014. *The Role Of Raw Material Management In Production Operations*. International Journal of Managing Value and Supply Chains (IMVSC) Vol.5, No. 3.
[4] Cadavid, Diana Cecilia Uribe. Zuluaga, Carlos Castro. 2011. *A framework for decision support system in inventory management area*. Ninth LACCEI Latin American and Caribbean Conference (LACCEI’2011), Engineering for a Smart Planet, Innovation, Information Technology and Computational Tools for Sustainable Development, Medellin, Colombia.
[5] Heizer, Jay dan Barry Render. 2005. *Operations Management: Manajemen Operasi*. Jakarta : Salemba Empat.
[6] Pons, D. 2010. *System model of production inventory control*. International Journal of Manufacturing Technology and Management (IJMTM), 20(No.1-4), 120 - 155.
[7] Mogere, Kennedy Maeba. Oloko, Margaret. Okibo, Walter. 2013. Effect Of Inventory Control Systems On Operational Performance Of Tea Processing Firms: A Case Study Of Gianchore Tea Factory, Nyamira County, Kenya. The International Journal Of Business & Management. Vol I Issue 5.
[8] Kendall. 2003. *Analisis dan Perancangan Sistem Jilid 1*. Prenhallindo. Jakarta.
[9] Kharisma, Gema. 2013. Pengklasifikasian dan Peramalan Spare Part Di Industri Pupuk (Studi Kasus: Pt. Petrokimia Gresik). Undergraduate Thesis of Industrial Engineering. Institut Teknologi Sepuluh Nopember (ITS) Kampus ITS Sukolilo. Surabaya.
[10] Linda Marlinda. 2004. *Sistem Basis Data*.Yogyakarta: Andi Offset. pp 1- 6.
[11] Liang, Chih-Chin.2013. *Smart Inventory Management System of Food Processing-and Distribution Industry*. Information Technology and Quantitative Management (ITQM2013). Procedia Computer Science 17,pp 373 – 378.
[12] McLeod,R. 2001. Sistem Informasi Manajemen Bagian I&II edisi 7. PT Indeks. Jakarta.
[13] M.R., Khabbazi. M.K., Hasan. A., Shapi’i. R., Sulaiman. A, Taei-Zadeh. 2013. *Inventory System And Functionality Evaluation For Production Logistics*. Journal Of Theoretical And Applied Information Technology. 31st August 2013. Vol. 54 No.3.
[14] Singh, D. K. Singh Satyendra. 2013. *JIT: A Strategic Tool of Inventory Management*. International. Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 3, Issue 2, March -April 2013, pp.133-136.
[15] Whitten, Jeffrey L; Bentley, Lonnie D ; Dittman, Kevin C (terjemahan). 2004. *Metode Desain& Analisis Sistem Edisi 6*. Jogjakarta: Andi.
[16] Yuswanto. 2005. *Pemograman Client Server Microsoft Visual Basic 6.0*. Jakarta: Pustaka Raya..