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Design and Build a Web-Based Reverse Logistics Decision Support System for the Mobile Industry

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Abstract— *Logistics activities do not only manage the flow of goods to consumers, but also manage the return flow of materials and products from customers to suppliers, including returns, repairs, reprocessing, and disposal. This flow is known as reverse supply chain management (RSCM). Many companies have not managed the return flow of products and materials properly, because some of them consider that reverse is a burden for the company, and it is also difficult to estimate the backflow of data and information. Even though this RSCM can provide benefits to companies both economically, socially, and environmentally. RSCM management needs to be done to increase the company's competitive advantage in providing services to its customers. The research is aimed at designing a web-based decision support system that can help manage the reverse supply chain. The method used is a systems approach and systems modeling. In the design, there are two decision support systems, namely the goods redistribution DSS and the goods return status DSS. The first DSS was designed to determine the process of withdrawing goods based on sales records, this is to avoid greater losses due to depositing of goods at distributors/dealers. In the second DSS, there are several reasons why consumers carry out the process of returning goods, such as the inability of distributors/dealers to sell goods, damage during purchase, incomplete accessories, or damage after use by the end consumer. Based on these reasons, goods returns are divided into two, namely returns G (good) and returns NG (not good). Meanwhile, for NG goods there will be three decisions, namely, accept returns, refuse service assist returns, and reject returns. Besides, for end-users whose goods do not meet DOA conditions (defect on arrival), after-sales service is provided through service centers or partners. It is hoped that with the creation of this RSCM application, companies can get the convenience and benefits of the reverse product process from consumers to manufacturing companies, to achieve the effectiveness and efficiency of reverse services.*

Keywords— *Web-based decision support system, reverse supply chain, reverse logistics.*

I. INTRODUCTION

In the electronic industry, especially mobile, competitiveness is largely determined by the efficiency and performance of the company. The level of efficiency and performance is influenced by various aspects, one of which is determined by how efficient and effective management is along the supply chain and logistics in the company. Supply chain and logistics are two concepts that are both related to managing the flow of goods or services, as well as trying to optimize and increase the efficiency and effectiveness of managing goods. Supply Chain Management is a complete cycle chain management activity starting from raw materials from suppliers, then entering operational activities in the company, continuing to distribution to consumers. SCM activities involve a variety of integrated activities starting from product development, procurement, production planning and control, operation / production, delivery / distribution activities. In the process of the production system, the use of raw materials is one of the main production components, which, if not managed properly, can result in excessive, inefficient consumption of natural resources and can damage the environment. Therefore, sustainable manufacture must be the concern of all parties in the world of the mobile industry. The management of raw materials from suppliers to products is produced and distributed to customers is carried out through a supply chain management. In the theory of close loop supply chain management, logistics activities include managing the backflow of a product or material from the customer back to the original supplier. The management of the process of backflow of raw materials or products from customers is still not much discussed compared to the flow of raw materials to finished products received by customers (forward logistics). This backflow of materials and products is called reverse logistics. Rogers and Tibben-Lembke (1999) mention the notion of reverse logistics, which is a process of planning, implementing and efficiently controlling the flow of raw materials, goods in process, finished goods and related information, from point of consumption to points of origin, with the aim of to create value or to properly, cost-effectively dispose of products and goods.

There are still many companies that have not thought about and implemented reverse logistics and ignore the importance of reverse logistics, because they think that reverse logistics is a burden for the organization. In addition, companies have difficulty predicting product backflow and find it difficult to accurately determine the types of products and costs of reverse products and materials. Companies do not pay attention to products that experience returns, but rather focus on developing new products to replace products that do not meet consumer expectations. Reverse Logistics is also seen as a matter that is more complex and less structured than the usual supply chain. Also, in general, companies do not have the manpower and expertise and infrastructure to manage reverse logistics. In fact, when viewed further, reverse logistics management provides benefits to the company both economically, socially and environmentally. From an economic point of view, reverse logistics allows the return of products, both damaged products and unsold products, back to

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the factory to be separated, sorted, rearranged and recycled to minimize the overall cost of losses.

The impact is that the company's performance in the long term can also be improved. Because companies can increase the product cycle. Reverse logistics allows feedback in making improvements and analysis for various reasons for returning products. Reverse logistics can increase production speed, reduce production costs and cost of transportation, administration, maintenance and repair as well as replacement in the long run. Handling this matter can also increase customer satisfaction and loyalty. Because the company pays close attention to damaged goods and provides services ranging from repair to replacement. So that in the end the company can retain customers and achieve company goals in a sustainable manner. To manage reverse logistics, it is necessary to design a reverse logistics network to manage product returns from the point of delivery, namely from the customer to the redistribution process. Because the effectiveness of reverse logistics management can have an impact on reducing operational costs, increasing profits, reducing waste can also improve the company's image.

As an effort to improve the effectiveness of reverse logistics management, currently information technology can be used in handling the flow of goods back from customers to suppliers. Reverse logistics information systems can be designed and developed on a web-based basis to help companies identify the intensity and type of damage, complaints, and product problems that cause goods to return, and even the potential to recover the economic value of damaged or obsolete products can be identified. So that various plans and strategies ranging from raw material selection, activities in the production process (repair / repair, remanufacturing, packaging and redistribution, to disposal and handling of waste), can be estimated and determined earlier and more quickly.

Cellular phones (Mobile) are electronic products whose technology is very fast developing compared to other electronic products. The level of use is very high, so that the chances of it being damaged are very high. This situation causes a high reverse flow of goods from consumers to service centers, retailers, distributors to principals / manufacturers, and this certainly requires good handling. This is the background of the need conducted research to identify the Reverse Logistics process flow in the Mobile industry and to design an information system in decision making to improve the performance of Reverse Logistics.

Based on the above background, this research was conducted in the hope that it can help identify the causes of backflow and determine the action plan (repair, remanufacture, repackage, redistribute; monitor the level of sales and returns from distributors, so that companies can act to transfer products from one distributor to another more quickly, so that losses due to technological obsolescence can be reduced due to the time taken for decisions. This is the strength of this study, where research can emphasize that the reverse logistics process is very important to manage because economically the company can increase profits, also companies can still benefit from returned goods (reuse and recycle), companies can analyze the use of spare parts more efficiently; socially the company can increase customer loyalty through the retirement service process. a better sale, and environmentally the company helps deal with electronic waste, especially the mobile industry which must be handled specifically. So that with the information obtained from this application, it is hoped that the company can be faster and more careful in making policies and strategies. So that the community can benefit in achieving a level of satisfaction because repair, replacement or return services can be handled more quickly.

II. Literature Review

According to Guide, Harrison, van Wassenhove (2003), the reverse supply chain is a series of activities to retrieve products that are no longer used by consumers and whether they can be reused or wastewater. From a company perspective, implementing and controlling a reverse supply chain requires a large investment, but on the other hand, it also provides economic benefits and strategic importance for the company. Based on the European Commission (2011), product categories that always pass reverse flow include end of life vehicles, batteries, electronic and electrical goods waste, and packaging waste. The following is the reverse logistics activity hierarchy (Dyckhoff et al., 2004):

Fig. 1. Reverse Logistics Hierarchy of Activities

According to Guide & Van Wassenhove (2002), there are five main reverse supply chain processes, namely product acquisition, reverse logistics, inspection and disposition, reconditioning, redistribution and sales. The first step in designing a reverse supply chain is to choose the right take-back path from the process of collecting product returns to returning to manufacturing. There are two approaches, namely centralized reverse supply chain, decentralized reverse supply chain. In their research, Goldsby and Closs (2000) stated that the costs incurred due to product returns using an activity-based costing approach are collection costs, processing costs and administration costs. Meanwhile, Pulansari (2017), in his research said that reverse logistics costs or total reverse logistics costs (TRLC) consist of processing costs, logistics or transportation costs, replacement costs and depreciation costs for the product.

III. Research Method

The object of this research is carried out on mobile products from local mobile industrial companies that have factories in

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Semarang and have been established since 2008 with sales of one million units per month. The author chooses products in the mobile industry company because in the electronics industry, including the mobile phone industry, the return of these goods (return / reverse) is very high, because of the fast development of technology and the existence of various defects in product components. The return of goods is a common reverse activity in companies. In this study, reverse activity in mobile industrial companies is used as the object of research and case studies in designing a decision support system in the reverse logistic process in an electronics industry.

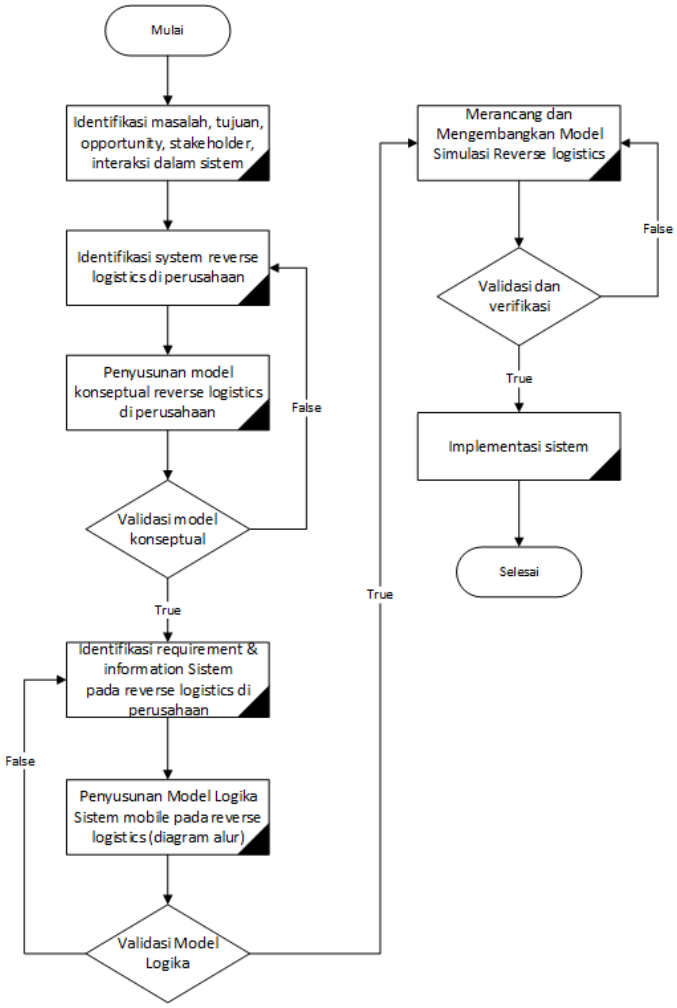

Fig. 2. Research Framework

IV. Research Result And Discussion

In general, the reason for Reverse Logistics is that it is not sold by the master distributor, defect on arrival (DOA), and after sales service. In managing the reverse / return process, mobile industrial companies divide into two processes, namely returns G (good goods) and NG (not good goods). G returns are product returns because they are not sold or the master distributor is unable to pay off the payment for the purchase of the product, while NG returns are returns due to damage, which are further classified into defect on arrival (DOA) and after sales service. In the DOA category, items returned must meet requirements such as good physical condition (99%), not more than three months from the principal's delivery, complete accessories, and not damage due to user error such as falling, burning, or being exposed to water. Meanwhile, if the period exceeds the provisions, then it is categorized as after sales service activity, with different handling and conditions. The reverse process starts from the consumer sending the product returns to the company or return division in accordance with the flow in figure by using a delivery service. Goods received by the staff of the return receipt. For products with return status G, the incoming goods will be checked by Quality Control, the finishing check will then ask for approval from the BOD to accept or not. If the return is approved, the returned product will go to the main warehouse. This return process is accompanied by an administrative process starting from the incoming goods, checking the conformity with the passport, both the quantity and type and the product identity by scanning the IMEI barcode, until it is recorded as incoming stock if returns are received. Meanwhile, for returned products with NG status, when the goods arrive, they are checked by the Quality Control functional check. There are two types of products in this NG return, namely type 1 (H1) and type 2 (H2). Type 1 is a type of product that is grouped with good sales levels and new technology, generally this type will receive returns provided that the physical condition is 99%, the completeness of accessories, and the warranty card is still there For NG products that are received, the return will then be sent to the NG return warehouse. Type 2 is a type of product whose sales are slowing down, generally this type will be refused returns. However, for some products, the company has a policy to help service. There are three types of processes in NG product recovery, namely refurbish, unit transfer (canibal), and swap. Refurbish is to repair a product so that it becomes a new product which will then be resold. Products that have been repaired are then sent to Principal's internal warehouse. The canibal process is carried out for products whose components are difficult to obtain, so the principal uses components from other units. Swap is a product that has high damage (for example damaged CPU, Ram, etc.), so a swap is required. Items that need to be swapped are then sent to the technical problem warehouse. NG products that are refused returns are returned to the master distributor after carrying out the quality control check finishing process. Meanwhile, products that are included in the "refuse service assist returns" group after checking, will be sent to the service department with the approval of the return warehouse supervisor and sales manager. There are two conditions of service status provided, namely the status of "sales", namely refusing service assistance returns and special handling is only allowed 1 IMEI number. Return process flow briefly can be seen in Figure 3.

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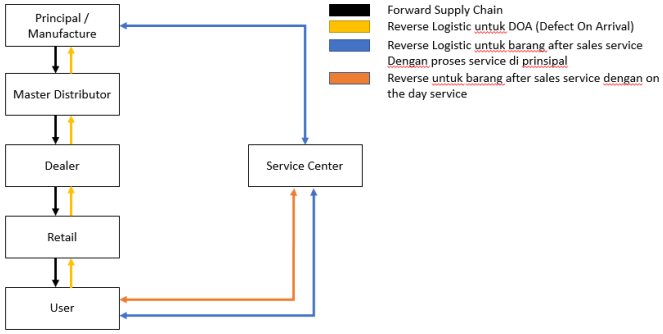

Fig. 3. Reverse Supply Chain

At the time of sale, the retailer enters data in the form of retailer and dealer code, type of item sold, date of sale, IMEI, which is done simultaneously with input / scan of the warranty card. This data will be accumulated into a dealer sales recap, and then a sales master distributor, so that the principal can monitor the level of sales for each type, and the sales data for the master distributor. The conceptual description of redistribution activities will be described as follows:

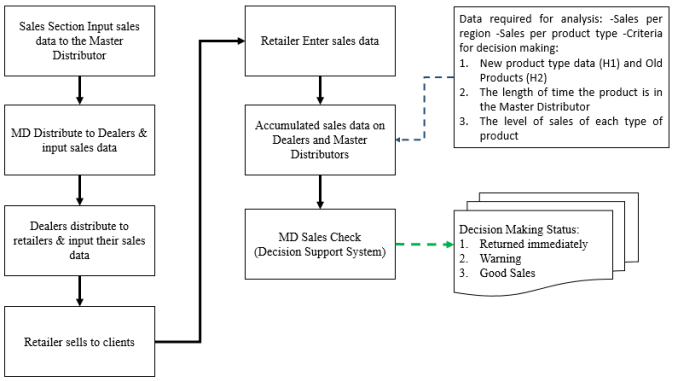

Fig. 4. The DSS Conceptual Model of Goods Redistribution

In determining the decision on the Decision Support System design, using several criteria, namely the length of time the item is in the master distributor, the level of sales of each type of item, and cellphone technology. The redistribution process flow can be done by following the following flow model.

Criteria Coding	Sub Criteria Coding
W: old stuff in MD	t: fast / high / newest
S: sales level	s: moderate
Q: technology level	r: old / low / obsolete

Decision Coding
R: Return immediately
P: Warning
F: Good sales

To determine decisions on system design, a role is compiled which consists of three decisions, namely the need to be returned immediately, give warnings and a good sale (offer additional stock). The conceptual model of designing a decision support system in the activity of determining the status of returned goods, starts from setting targets, namely to determine whether an item returned is grouped into G (good) or NG (not good) products and then determines whether the products belonging to the NG group can received returns, refused service assistance returns or refused returns. Also products that must be repaired in the service section. To make this decision, requires data and information from various parties. The data is in the form of data on the type / type of product and the number of returns obtained from the Return Road Certificate, reasons for returning, product condition data, equipment completeness, warranty card, IMEI. The parties involved (users) with this system are the principal (BOD), the return manager, the warehouse department, the QC department, the customer, the service center (for after sales service). In the DSS design, determining the status of returns, the return process is carried out in stages, where the end customer returns the damaged item during purchase (DOA) to the shop or retailer, then the retailer sends it to the dealer, then the dealer sends it to the master distributor and finally the master distributor returns to the principal. When the goods sent by MD are received by the principal, the return admin will carry out an inspection of the pass which includes the suitability of the types of goods returned and the quantity, as well as the reasons for the return. The admin needs to match the returned goods data with the sales data from the MD, by checking the IMEI number of the returned product, because the item returned by one MD must be the item purchased by the MD. If the IMEI does not match MD's sales data, it will be rejected. If the IMEI data is in accordance with the sales data of the MD concerned, it is then checked for standardization. This check will determine the decision to accept or not return an item. There are several criteria used to make decisions, namely the type of goods, reasons for returns and conditions of goods If the item received from MD is a G (good) item then what needs to be checked is what type the item belongs to. If entered in Type 1, it means that the product sales are good (running well) so that the company can receive these returns. However, if it belongs to the type 2 category, the decision to accept returns is determined by the BOD. If the BOD approves, the return product is accepted and vice versa, but the company implements a policy for goods with type H2, which will conduct negotiations regarding the return of the goods. In determining the decision on the Decision Support System to determine the status of returns, using several criteria, namely the criteria for goods returns, both groups of goods that DOA (defect on arrival), and groups that are after sales service The criteria for designing a return status decision-making system are, among others:

1. As per DOA item standards:
   - 99% physical condition of the goods
   - The end user purchase does not exceed 3 days
   - The length of purchase from MD to principal does not exceed 3 months

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- Not due to negligence in consumer use (miss-use): dropped, burned, exposed to water

Category	Score	Description
Yes	1	Conforms / meets standards
No	0	Not up to standard

2. Product Type

Product type criteria, seen from the aspects of technology, sales trends, and market demand. The company classifies its products into two groups, namely type 1 (H1) and type 2 (H2).

Category	Score	Description
Type 1 (H1)	1	Good sales, new technology
Type 2 (H2)	0	Low sales, old technology

3. Functional Check

Category	Rating Score	Information
Good	1	Works fine
Not good	0	There is a component not working

The next stage in modeling activities is to compile a logical model. The conceptual model will be a model logic model in describing the system including the modeler's thinking patterns related to problems and solutions. A logical model is a brief description that explains the logical relationships / relationships between system elements, such as inputs, activities, outputs, and outcomes as well as stakeholder needs. The uses case diagram is a concept of what the system can do, is also a technique used in the development of a software / information system to capture the functional requirements of the system in question, the use case describes the interactions that occur between 'actors' - the initiators of that system interaction itself with the existing system, a Use Case is represented by a simple sequence of steps. The following uses a case diagram for the Company's reverse logistics system.

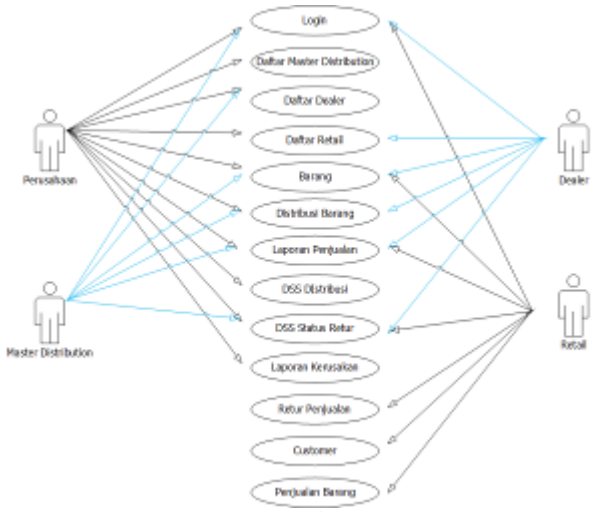

Fig. 5. Use Case Diagram of DSS Reverse Logistic

Based on the Use Case Diagram, it can be seen that the stakeholders associated with the system and the activities carried out in the system. Usecase diagram describes the functionality of the system to be developed. There are 4 actors who will use the system, namely companies, Master Distributors, Dealers, and Retail. Usecase Login is accessed by each actor.

The system interface is as follows:

1. Login

2. DSS Sales Returns

Fig. 6. User Interface DSS Sales Returns

3. DSS Distribution

V. Conclusion And Suggestions

A. *Conclusion*

Reverse logistics is generally caused by several things, including unsold products by distributors, defects on arrival, and after sales service. The flow of Reverse Logistics starts with the consumer submitting a claim to the retail where he makes a purchase, the retailer fills in the returned item data, and sends the product to the dealer for checking and approval, then the product is forwarded to the master distributor to the manufacturing company.

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Products returned are categorized into G (good) and NG (not good) categories. Category G, is further classified into type 1 (H1) which sells well (running well) and type 2 (H2) which sales are slow (slowing down). For products in the NG category, a product recovery process is carried out, namely refurbishing, unit transfer (canibal) and swap. For certain cases, the product can be rejected and the return process will be repaired and this is categorized as "refuse service assist returns". Based on these groupings, for every return product received by the company, the returns division must immediately decide what process to do for that product. Applications that have been made, facilitate product returns at the retailer, dealer, master distributor and manufacturing company / principal level. This application helps coordinate the product return process between entities involved in product distribution, so as to speed up the decision-making process in the company. The application made can shorten the reverse logistics process time, administrative costs and reverse logistics management costs, reduce the possibility of loss due to goods returns, not only at the principal, but also along the product distribution channel. This application can be developed to be applied to other types of products or industries, by adjusting the parameters, criteria and entities that are in product returns.

B. Suggestions

The research conducted on making this application still has many limitations. Developments that can be carried out in further research are:

1. Integrating applications with financial systems / applications, as well as inventory data warehouse used in the company, to determine the amount / level of spare parts inventory and cash flow in each process that occurs.
2. Perform development so that it can be developed to be applied to other types of products or industries, by adjusting the parameters, criteria and entities that are in the Reverse Logistics of a product.

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