DEVELOPMENT OF SUPPLY CHAIN MANAGEMENT (SCM) IN CV. GRADIENT

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ABSTRAK

CV. Gradient is a company engaged in produce sparepart product with plastic as its basic material. Difficult to determine quantity of material has become a problem for the company to order and purchase requirement production , because all the time, the estimation was based on previous raw material purchasement, has been used to estimate procedure of procurement. The result is causing lack of raw materials. In addition the shipping has difficulty in the process delivery product to consumer, because all the time the shipment is only based on the driver desire. Based on the problem occured in CV. Gradient, a system supply chain management is needed. In order to ease procurement division to determine raw material procurement for product requirement and scheduling delivery procces to consumer is become the main purpose of development system. By this case, linear regression and pushed supply chain strategy used as the method for raw material forecasting, because the company provide stock of product before ordering process. Prediction of availability of raw material in warehouse using safety stock method and for scheduling shipment using branch and bound method. With the result of the research, it can be concluded that the system built can facilitate the procurement division in determining the amount of raw material to be ordered for production needs, and facilitate shipping division to delivery product to consumers based on schedule result.

Keywords : Supply Chain Management, Push Supply Chain, Regresi Linear, Safety Stock, Branch and Bound.

1. PRELIMINARY

CV. Gradient is a company engaged in the production and sale of products supported by experienced experts and Computer Numerical Control (CNC) facilities. This company produces motorcycle spare parts, there are two types of motorcycle spare parts that are produced, namely undercase and spring guide, other than that CV. Gradient provides maintenance services, mold maintenance, parts, injection assembling or jigs. CV. Gradient produces continuously every day to meet stock requirements in the warehouse (Make To Stock), the work chain starts from the procurement of raw materials to the delivery of products.

Procurement of raw materials carried out by the company twice a month, the process of procuring raw materials takes several days, and procurement carried out by the company is only based on the use of raw materials that have been used in the supply of raw materials in the previous period, this causes excess or repetitive shortages of raw materials with amounts that are not much different. If the shortage of raw materials the company will order raw materials to the supplier. As a result, if there is a shortage of raw materials, the company cannot meet the demand for raw materials for production needs, the delay in the production process will certainly also affect the process of delivery products to consumers.

Based on the results of the interview with Mr. Iwa as General Manager of CV. Gradient, currently the company has raw material inventory data from July 2017 to December 2017. In the period of 6 months there was a supply of raw materials with amounts not much different, the least occurred in September 2017 with a total remaining raw material of only 1700 Kg, where the remaining PP HI 10 HO raw materials reached 0 Kg and the dye reached only 250 Kg, if there is a shortage of raw material, the production process becomes late in the next period. While the highest inventory occurred in November 2017 with a total remaining raw material reaching 7775 Kg, where the remaining raw material of PP HI 10 HO reaches 5275 Kg and the remaining dye material reaches 625 kg, if there is an excess of raw material that is high enough it will cause buildup in the warehouse.

Based on an interview with Mr. Gisa as the delivery, the vehicle used in the shipping section to deliver the product is a colt diesel box car that can load 36,000 pcs of products or pack as many as 360 packs and boxes as many as 180 boxes for all types of undercase and spring guide products. CV. Gradient have ordering and shipping data from July 2017 to December 2017. The process of delivery product is carried out one day after the ordering process is completed by the consumer. In one day four times the

product delivery to consumers, delivery of product to consumers is based on the nearest location of the company. But what happened during this time was based on the driver's estimation, as in the delivery on July 25, 2017 there are 4 shipping locations, namely 2 areas of Bandung, 1 area of Bekasi, and 1 area of Jakarta. The driver instead chose to delivery the product first to Bekasi and then to Jakarta afterwards to the consumer in Bandung. So that causes delays in delivery of products to consumers and the time to return to the company due to errors in estimating the delivery destination.

Based on the problems described, the CV. Gradient needs to build an information system that is supply chain management (SCM), to help regulate raw material procurement, and scheduling product delivery to consumers. Therefore the author will conduct research with the title "Development of Supply Chain Management (SCM) in CV. Gradient.

While the objectives to be achieved from this research are:

1. Facilitate the procurement part in determining the amount of raw material that must be ordered.
2. Facilitate the shipping part in determining product delivery schedules to consumers.

2. RESEARCH CONTENT

2.1 Theoretical Basis

Theoretical basis aims to briefly explain related supporting theories to be used in the process of analysis and implementation to system development.

2.1.1 System

The system can be interpreted as a unit consisting of components or subsystems that are arranged in an orderly manner, mutual interaction, interdependence with each another, and can not be separated (integrative) to realize a goal. [1]

2.1.2 Information

According to Jogoiyanto, information is the result of managing data into a form that is more useful and more valuable for the recipient who describes the event (fact) that is actually (fact) and used as a reference for making decisions. [1]

2.1.3 Quality Of Information

Information quality will depend on 3 things as stated by jogiyanto, as follows: [1]

1. Informasi must be accurate
   Information must be free from mistakes and not biased or misleading.
2. Informasi must be on time
   Information sent or received cannot be received by the recipient too late, because the information that is used will no longer have value.
3. Informasi must be relevant
   Information must have benefits for the wearer and the relevance of information for each person will be different.

2.1.4 Value of Information

The value of information is determined by two factors, that is the benefits and costs incurred. Information is categorized as valuable if the benefits obtained are more than the costs incurred. Measurement of information value is generally associated with cost effectiveness or benefit analysis. [1]

2.1.5 Information System

Information systems according to Robert A. Leitch and K. Roscoe Davis, that is information systems is a system that exists in an organization that meets daily transaction processing needs, supports operations, is managerial and strategic activities of an organization and facilitates certain outside parties with the relevant report . [2]

2.1.6 Supply Chain Management

Supply chain is a set of activities (in the form of entities or facilities) that are related to the transformation process and the delivery of goods starting with pure raw materials until they become products and delivered to consumers. [3]

2.1.7 Pemain Utama Supply Chain Management

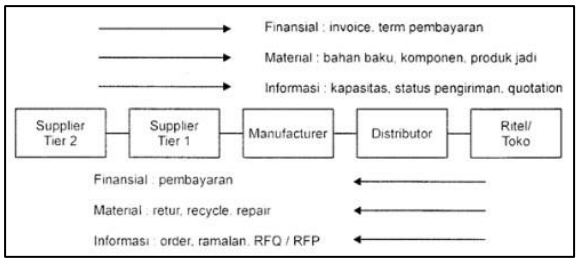
In the supply chain there are several major players who are a group of companies that have the same interests, including: [3]

1. Suppliers
2. Manufactures
3. Distribution
4. Retail Outlets
5. Customers

2.1.8 Flow of Supply Chain Management

In Supply Chain there are 3 types of flow that must be managed, including: [3]

1. Material flow, involving the movement of raw materials from suppliers to consumers or returnes from consumers (returns) of products, recycling and disposal processes.
2. Financial Flow, about payments, credit process, payment scheduling until ownership agreement.
3. Information Flow, is about demand forecasting, item position information, up to the status of goods if they have been sent or not.



Picture 1. Aliran *Supply Chain Management*

2.1.9 Component of Supply Chain Management

There are several main components that support the running of a process in Supply Chain Management, including: [3]

1. Upstream Supply Chain
   Management that takes care of the relationship between the company and the vendor or other parties in terms of transfer of goods.
2. Internal Supply Chain
   Management related to goods entry activities.
3. Downstream Supply Chain
   Management that takes care of the transfer of goods from the company directly to consumers.

2.1.10 Linear Regression Method

This method aims to calculate how an estimate or regression equation will explain the relationship between variables. Regression means that the nature or behavior of a variable will depend on other variables, because there are dependent variables and there are independent variables. The results of the regression discussion can be stated regarding the relationship between two variables that can be said to be precisely described in a straight line.. After that, in the analysis there are several results indicated by the variable relationship. A positive relationship or directly on a variable. The main purpose of using the regression equation is to estimate the value of the variable not independent of the value of certain independent variables. Like the least squares method that we already know first, the form of the regression equation is: [4]

$$Dt' = a + b.t \quad \textbf{(1)}$$

Where :

a = Y shortcut, (value Dt' if t = 0)
b = Slope of the regression line or coefficient regression
n = Number of periods
Dt = Demand (Previous Data)
t = Forecasting Period
Dt' = Forecasting Result

The example of the calculation result with linear regression method as in table 1.

Table 1. Calculation Of Linear Regression

Bulan	Periode (t)	Permintaan (Dt)	t^2	Dt (t)	a	b
Juli	1	210000	1	210000	217100.000	757.1428571
Agustus	2	218000	4	436000	217100.000	757.1428571
September	3	243000	9	729000	217100.000	757.1428571
Oktober	4	214500	16	858000	217100.000	757.1428571
November	5	203000	25	1015000	217100.000	757.1428571
Desember	6	213000	36	1278000	217100.000	757.1428571
Total	**21**	**1318500**	**91**	**4628000**		

What must be sought is the magnitude of the coefficients a and b, because it will determine the variable value. The magnitude of a and b can be searched by the forecasting formula is: [5]

$$\mathbf{a} = \frac{\sum \boldsymbol{Dt} \sum \boldsymbol{t^2} - \sum \boldsymbol{t} \sum \boldsymbol{Dt(t)}}{\boldsymbol{n} \sum \boldsymbol{t^2} - (\sum \boldsymbol{t})^2} \quad \textbf{(2)}$$

$$\boldsymbol{b} = \frac{\boldsymbol{n} \sum \boldsymbol{Dt(t)} - \sum \boldsymbol{Dt} \sum \boldsymbol{t}}{\boldsymbol{n} \sum \boldsymbol{t^2} - (\sum \boldsymbol{t})^2} \quad \textbf{(2)}$$

2.1.11 Safety Stock

Safety stock is used by the company to anticipate from running out of raw materials and to avoid delays in receiving raw materials purchased due to the changing demand and the irregular waiting time for orders to arrive. In determining the safety stock using static analysis which also takes into account the deviations that occur between the estimated usage and actual usage. The role of forecasting is very important to determine the amount of security supplies, if forecasting is done correctly, the company may not have a security inventory. The form of the safety stock equation is: [4]

$$Safety\ Stock = Z\ x\ Sdl \quad (3)$$

Where :

Z = Service Level
Sdl = Uncertainty of demand and uncertainty of lead time

Reorder Point merupakan titik dimana pemesanan harus kembali dilakukan karena persediaan mencapai titik terendah atau batas aman. Bentuk persamaan untuk menentukan reorder point dapat dilihat sebagai berikut:

$$Sdl = \sqrt{(d^2\ x\ sl^2 + l\ x\ sd^2)} \quad (4)$$

Where :

d = Average usage
Sl = Standar Deviation *Lead Time*
l = Lead Time
Sd = Average Usage Deviation

The example of the calculation result with safety stock method as in table 2 and 3.

Table 2. Safety Stock Of Raw Material For Under Case HKZL

Peramalan	Nama Produk	Nama Bahan Baku	Perhitungan	Jumlah Bahan Baku
6218	Under Case HKZL	PP HI 10 HO	63 x 2.3	145 Kg
		Pewarna	63 x 46	2900 Gram

Table 3. Safety Stock Of Product Under Case HKZL

Nama Produk	Stok di Gudang	Safety Stock	Status
Under Case HKZL	24800 Pcs	6218 Pcs	Aman

2.1.12 Branch And Bound Method

Solving integer programming problems can be done by the Branch And Bound method. The work process of this method by dividing the feasible area is a PL-relaxation problem by replacing it into a subproblem. This method starts from completing PL-relaxation at integer programming values. When the decision variable value of the optimal solution becomes an integer, the solution can be said to be optimal. If not, branching and addition of restrictions on the PL-relocation are then completed. [6]

The stages of problem solving by using Branch and Bound alogirtma is:[5]

1. Make solving the initial problem as a problem determination. Determination of the solution must be a complete journey. Make the upper limit (Upper Bound) on the minimum value of the objective function by looking for various possible trips. This limit is denoted by (fU).
2. After that make the initial branching by setting x1 = 1 for each city j = 2, 3, 4, ..., n (except if cij = M because it is an impossible route). Then calculate the lowest limit (fL) on the minimum value of the objective function at each point by means, in the initial data delete the 1st row and the column to j. Then set cj1 = + M, solve the result of the specified problem and add price (f) to c1j to get fL, then fL = cj1 + f. If fL> fU, measure the point and proceed to the next step.
3. If there is no active point, the best solution at this time is optimal. If not, select a point with the smallest fL value and create a new branch by setting Xjk = 1 for each city that hasn't been visited before on some trips.
4. Next make the boundary fL at each point by deleting the lines j and column k from the problem solving at the current point above the existing point, set cjk = n and add the value f to cjk and all the previous values in part of the trip. The result of scheduling shipment use the branch and bound method as follows.

Table 4. Delivery Scheduling Result On 5 July 2017

Urutan	Tanggal Kirim	Nama Konsumen	Alamat	Jenis Produk	Jumlah (Pcs)
1	05/07/2017	PT. ARTA UTAMA PLASINDO	Kawasan Industri MM2100, Jalan Flores Blok C/1, Cikarang, Mekarwangi, Cikarang Bar., Bekasi, Jawa Barat 17530	HKZL	3750
2	05/07/2017	PT. MITRA CMB INDONESIA	JL Gaharu, Blok F-5/11-A, Lemahabang, Jakasampurna, Bekasi Bar., Kota Bks, Jawa Barat 17550	HKZL	3750
3	05/07/2017	PT. BIGGY CEMERLANG	Jl. Kapuk Kamal Muara No.23 A - Jakarta Utara 14470	HKZL	3750
4	05/07/2017	PT. COPPAL UTAMA	Jl. Mekar Raya Kav. 36 Kawasan Industri Mekar Mulya, Gedebage, Mekar Mulya, Panyileukan, Kota Bandung, Jawa Barat 40613	HKZL	3750

2.1.13 Google Maps API

The Google Maps API is a service that provides travel time and distance of origin and destination. Google Maps is a world map that we can use to see an area. In other words, Google Maps is a digital map of the world that can be accessed through a browser. The information displayed is the recommended route from the starting point to the end point, according to the Google Maps API calculation. In the Google Maps API there are required parameters, origins, and destination, and API keys. These three parameters are required parameters, while there are also operational parameters such as mode, arrival-time, departure_time, traffic_model, and transit_routing_preference. The Google Maps feature contained in the web on blogs can be in the form of free or paid services where in the context the Google Maps API is in the form of a Library in the form of Javascript. Google Maps is clear evidence that technological progress is growing rapidly, so users can freely navigate only by using a browser. The basis for developing the Google Maps API is knowledge of HTML and JavaScript, because basically Google has provided the map itself [7]. As for the example of implementing Google Maps API for shipping on July 5, 2017 as shown in Picture 2.



Picture 2. Implementation of Delivery Scheduling Result on 5 July 2017

2.2 Problem Analysis

Problem analysis is the problems that will be described in the data processing procedures in the Supply Chain Management information system at CV. Gradient. Analysis of problems from the system that is running on CV. Gradient is:

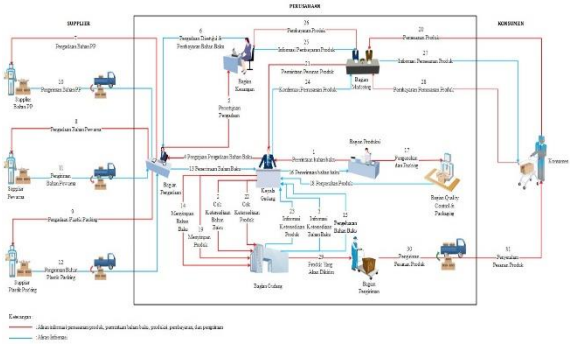
1. The procurement department has difficulty in determining the amount of raw material that must be ordered.
2. The shipping department has difficulty in schedulling product shipments

2.3 Analysis of Supply Chain Management

In the Supply Chain Management analysis phase, the problem will be faced by the company. CV. Gradient uses the Push-Based Supply Chain strategy.

2.3.1 Model *Supply Chain Management* CV.Gradient

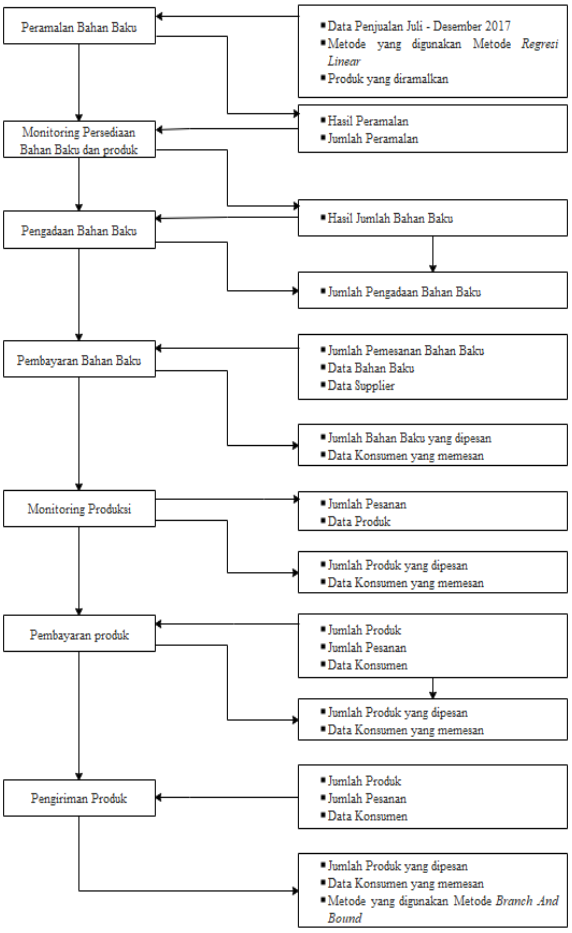
Based on the problems that occur, the CV. Gradients can be proposed to use the Supply Chain Management approach in system development. The supply chain management model contained in the CV. Gradient as in Picture 3.



Picture 3. Model Supply Chain Management di CV. Gradient

2.3.2 Stage of Approach Supply Chain Management

The stage in the information system strategy of the SCM approach to be built can be seen in Picture 4.

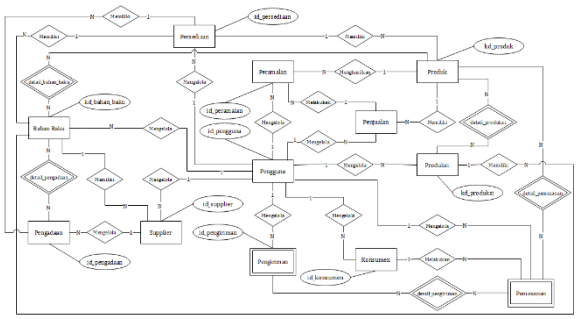


Picture 4. Stage of Approach SCM in CV. Gradient

1. **Stage of Forecasting**
   At this stage CV. Gradient manages product demand data by consumers to predict the procurement of raw materials in the following month based on the previous 6 months demind data using the Linear Regression equation.
2. **Stage of Monitoring Inventories of Raw Materials and Products**
   At this stage the company monitors the availabiliity of raw materials and warehouse products carried out by the warehouse head and determines the safe limits that must be available using Safety Stock and also the company controls the inventory of products to avoid the occurrence of shortages / stock losses in the warehouse.
3. **Stage of Procurement of Raw Materials**
   At this stage the procurement department procures raw materials so that production needs can be met. Because the company has a stock of raw materials in the warehouse, so the amount of raw material procurement is based on the amount of raw material that must be available minus the remaining material in the warehouse.
4. **Stage of Payment Of Raw Materials**
   At this stage the finance department will determine the amount of costs that must be spent for each raw material to be ordered to the supplier.
5. **Stage of Monitoring Production**
   At this stage is the activity of calculating the number of products produced on a daily basis to meet product demand needs so that there will be no product deficiencies or vacancies. The number of products to be produced is calculated based on the results of forecasting minus the product stock and divided by the number of working days in one bull
6. **Stage of Shipping**
   At this stage the company sends products based on the results of scheduling forecasting with the Branch and Bound method based on ordering data. This aims to find out the delivery schedule, how many products are sent, whether or not the product goes to the consumers place and find out the shipping status.

2.4 Analysis Database

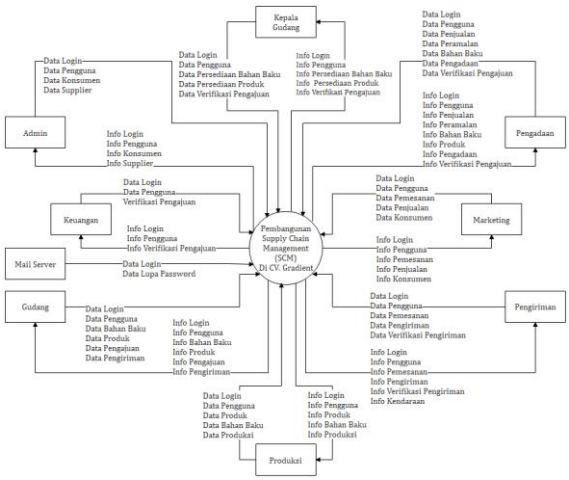
This stage is an activity of analyzing interrelated data sets where the data will be used in making software. In database design using Entity Relationship Management (ERD) data model. The ERD can be seen as follows:



Picture 5. Entitiy Relationship Diagram

2.5 Context Diagram

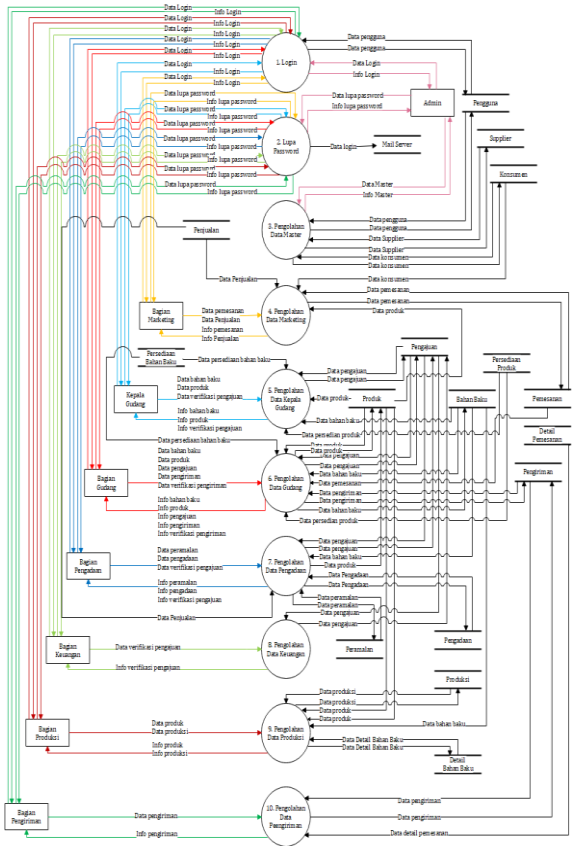
Context diagram is a model to explain overall how the input and output data flow runs on the system to be built. Context diagram on CV. The gradient can be seen in Picture 6.



Picture 6. Context Diagram

2.6 Data Flow Diagram (DFD)

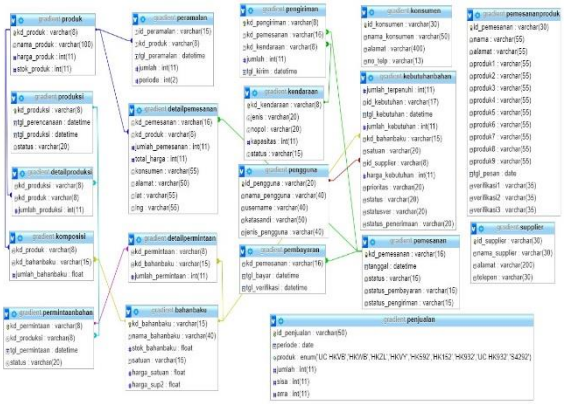
Data flow diagrams can show the flow of data running on the system and the processes that occur in the system until the process is more detailed. Until the discovery of levels that cannot be lowered. Level 1 DFD can be seen in Picture 7.



Picture 7. DFD Level 1

2.7 Scheme Relation

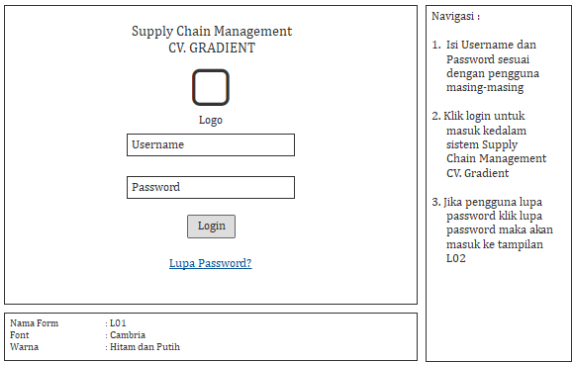
The scheme relation is a description of the connection of tables in the system in detail or clearly. The scheme relation can be seen in Picture 8.



Picture 8. Scheme Relation

2.8 Interface Design

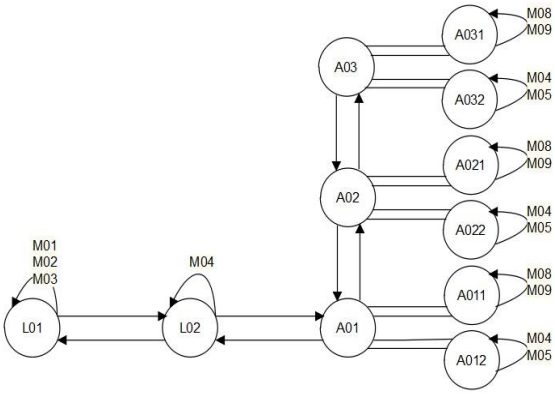
Interface design aims to describe the appearance of the SCM information system that will be used by users to interact with the system being built. The design of the login interface is one example like Picture 9.



Picture 9. Design of Login Interface

2.9 Semantic Network

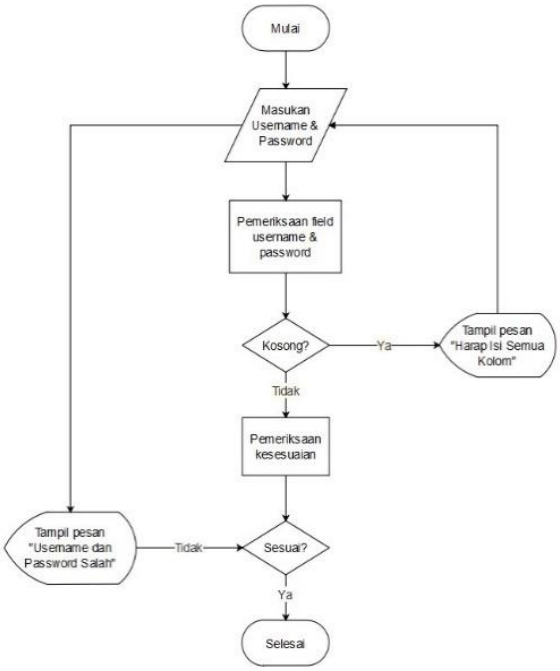
Semantic network is the stages of network design that connect menus that will be accessed by users on the system being built. Examples of semantic networks such as Picture 10.



Picture 10. Semantic Network Admin

2.10 Procedural Design

Procedural design changes the elements of the program architecture into the procedures of the software component. The example of procedural design is logging in the SCM information system that will be built like Picture 11.



Picture 11. Procedural Design Login

2.11 System Implementation

System implementation is a stage based on the results of system analysis and design. With the aim to ensure the suitability of the design system, so that users can provide input to the system. As for the implementation discussion regarding the implementation of software, hardware, databases, and interfaces.

2.12 System Testing

System testing is done to find errors or deficiencies that might occur in the program being tested. It aims to know the suitability of the results of system development and meet the needs with the aim of building the system.

System testing plan is done by black box testing. Because this test focuses on the functional specifications of the software in sequence on the system being built.

1. Function Testing

Tests carried out using black box testing. Because this test is carried out based on the test results on each process in the system.

2. Beta Testing

This test is done by going to the company directly and doing the test with the interview method to each part or user who will use the system at CV. Gradient.

3. CLOSING

This section explains the conclusions that contain the results of the research obtained through the analysis, design, implementation, and design of information systems built on CV. Gradient. As well as suggestions that will allow for improvements that

need to be made in software development that is better than before.

3.1 Conclusion

Based on the results of the thesis research, conclusions can be drawn as follows:

1. Supply Chain Management in CV. Gradient can facilitate the procurement department in determining the amount of raw material to be ordered.
2. Supply Chain Management in CV. Gradient can facilitate the shipping department in determining the delivery of products to consumers based on the results of delivery scheduling

3.2 Suggestion

Supply Chain Management information system for CV. This gradient can still be developed to be better in the future.

As for suggestions for developing the Supply Chain Management information system at CV. The gradient is as follows:

1. There needs to be a development of the appearance and interconnection between parts, because in some parts there is still information that is submitted manually.
2. There needs to be a menu that connects directly between suppliers and companies so that companies can find out information related to raw materials faster.
3. There needs to be a menu that connects directly between consumers and companies, so consumers can make their own transactions with a faster time.

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