Inventory Management

Project Report submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology.

in

Information Technology

under the Supervision of

Mrs. Sanjana Singh

By

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to

Jaypee University of Information and Technology

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Certificate

This is to certify that project report entitled “Inventory Management”,submitted by Satyam Sharma (111469) in partial fulfillment for the award of degree of Bachelor of Technology in Information Technology Engineering to Jaypee University of Information Technology,Waknaghat, Solan has been carried out under my supervision.

This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma.

Date: Supervisor

Designation

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Summary

Inventory control aims at keeping track of inventories. In other words , inventories of good quality and right quantities should be made available to different departments as and when they needed.

It helps to Smoothen the production process.
It helps to stabilise production and meet demand during the replenishment period.
It helps in the prevention of loss of orders and allow us to keep in pace with the changing market conditions.

Periodic review systems are commonly employed by distributors and retailers to replenish their inventories (for example, to co-ordinate in-bound transportation). It is also often the case that vendors specify minimum purchase quantities for physical (for example, packaging) or strategic reasons. When inventory systems recommend order quantities below the prescribed minimum, a decision must be made on whether or not to order**.**

The basic financial purpose of an enterprise is maximization of its value. Inventory management should also contribute to realization of this fundamental aim. The enterprise value maximization

strategy is executed with a focus on risk and uncertainty. This article presents the consequences for the recipients firm that can result from operating risk that is related to delivery risk generated by the suppliers.

The aim of this research was to develop a performance measurement tool for inventory management. As a result a unique framework is developed which enables organisations to measure their operational inventory management's performance. The final framework is shown in chapter six and (a larger version in) Appendix D. The framework consists of five business process steps and attached to each process step KPIs that are useful to measure. The framework provides a specific set of metrics, categorised along the whole process from beginning to the end.

This enables its users to see the coherence between the different aspects of inventory management. The framework also enables performance measurement of inventory management in a structured way, due to the pre-described set of metrics. The framework presents a unique approach towards performance evaluation of inventory management, because of the way the model is built up. The framework provides two main advantages over previous measures or models. First of all, contrary to existing literature the model provides a business process overview of inventory management and the relevant metrics. The structure provided by the framework gives organisations something to hold on to. With the model the inventory process can be evaluated from beginning to the end. This way issues and causes of problems can be better investigated. Uncertainties along the process, which form an important reason for keeping inventories, can be investigated for instance using the structured approach presented in the framework. Secondly, different actors are represented by the framework due to the span of the framework. This is a good thing, as it makes sure that the accent is not on a single process or output only.

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CHAPTER 1

1.Introduction

'Inventory' and 'stock' are often used to relate to the same thing (Wild, 2002); yet when inventory management is mentioned, there is however a slight difference with stock. Stock is usually an amount of goods that is being kept at a specific place (in a warehouse for example), sometimes referred to as inventory. Conversely, inventory management is primarily about specifying the size and placement of stocked goods. Inventory management is necessary at different locations within an organisation or within multiple locations of a supply chain, to protect (the production) from running out of materials or goods. The scope of inventory management is broader than stock. Basically inventory management can be defined as the "management of materials in motion and at rest" (Coyle et al., 2003). The following activities all fall within the range of inventory management (Wikipedia, 2009): control of lead times, carrying costs of inventory, asset management, inventory forecasting, inventory valuation, inventory visibility, future inventory price forecasting, physical inventory, available physical space for inventory, quality management, replenishment, returns and defective goods and demand forecasting. Inventory management basically serves two main goals (Reid & Sanders, 2007). First of all good inventory management is responsible for the availability of goods. It is important for running operations that the required materials are present in the right quantities, quality and at the right time in order to deliver a specific level of service. The second goal is to achieve this service level against optimal costs. Not all items can be held in stock against every cost for example and therefore choices have to be made.

Inventory can be defined in several ways as follows as given below:

• Inventory is the stock of physical items such as materials, components,
work-in-progress, finished goods, etc., held at a specific location at a

specific time.

• Inventory is the merchandise that is purchased and/or produced and stored for eventual sale.

• Inventory is a list of what you have. In company accounts, inventory usually refers to the value of stocks, as distinct from fixed assets. An inventory would include items which are held for sale in the ordinary course of business or which are in the process of production for the purpose of sale, or which are to be used in the production of goods or services which will be for sale.

• Inventory is a list of names, quantities and/or monitory values of all or any group of items.

• Any quantifiable item that you can handle, buy, sell, store, consume, produce, or track can be considered inventory. This covers everything from office and maintenance supplies, to raw material used for manufacturing, to semi-finished and finished goods, to fuel used to power equipment used in the business.

1.1 Function Of Inventories

Having (an amount of) stock is costly and can cause various additional risks. Waters (2003) states the following: “stocks are expensive, because of the costs of tied-up capital, warehousing, protection, deterioration, loss, insurance, packaging, administration and so on”. He therefore also wonders why inventories are being maintained by organisations at all. According to the Justin-Time principle (JIT) when all materials arrive just in time, no

stock will be needed and thus inventory management will not have to deal with the temporary storage of all these goods (Coyle et al., 2003). This is how managers often explain the JIT-principle. Unfortunately the JITprinciple cannot always be applied and JIT is just a way of control in a situation where production takes place based on an order (no mass production). JIT does not mean there are no inventories at all, but aims at elimination of unnecessary stocks during production (Dijk et al., 2007). Inventories will probably always exist due to several reasons. There are three main reasons why stocks are necessary or sometimes even inevitable: Uncertainties are the most important reason to keep inventories (DHL, 2009). If for example• a specific order is delivered exactly according to plan and on the agreed date and time, but the wrong goods are delivered or the delivery is damaged and can therefore not be used. This example illustrates two possible causes of uncertainty. Although a delivery might be perfectly on time (as being identified as the first reason for maintaining stock), there might still be something wrong with the stock as well. Uncertainties in delivery times may also form a reason to maintain a safety stock, in case a delivery arrives late. If all processes subsequent to a specific delivery are interrupted as well, it may cause major losses in the end. For this reason a stock is usually kept, to cope with unforeseen events that could otherwise prevent the production from moving on. Another important source of uncertainties is caused on the demand side; the expected orders placed by the clients are hard to predict (Wild, 2002). In order to guarantee deliveries and a certain level of service to the clients also a stock is often maintained to cope with uncertainties on the demand side. To summarize, stocks thus allow for variation and uncertainty in both supply and demand, which lets operations continue smoothly when problems arise (Waters, 2003). In relation to uncertainties, time also plays a role. Time lags which are present in the supply• chain can be intercepted by maintaining stock. A certain amount needs to be kept in stock, to use during this ‘lead time’. When something is ordered, it usually takes a while before the goods are actually delivered; during this period the production cannot stand still and therefore the stock will function as a buffer to overcome this period. Time lags in deliveries can lead to very large fluctuations and are exaggerated down the supply chain: this effect is called the

Bullwhip effect (Lee et al., 1997), (Fawcett et al., 2007), (Johnson & Pyke, 2001). Inventories are thus a means to protect oneself against this effect (Klundert, 2003). Finally it may sometimes be cheaper to keep some stock. Economies of scale for example are• a reason why inventories are kept. Buying bigger quantities is often more beneficial than ordering small amounts, due to the related discounts (Waters, 2003), (Coyle et al., 2003). Additionally ordering one unit at a time that has to be delivered to a specific place every time the user needs it, requires more logistic movements and accordingly raises high costs as well. Also fluctuating prices may form a reason to keep a stock: buying a product at a low price can provide a benefit (Waters, 2003). That is off course when the total costs of keeping additional goods in stock is cost-efficient compared to buying at a higher price, otherwise high stocking costs will immediately diminish the intended profit.

1.2 Types Of Inventories

Depending up on the type of organization the inventory can be classified into two basic types. They are as follows:

1. Manufacturing Inventory:

It is the inventory maintained by a manufacturing organization.

Manufacturing Inventory consists of following three parts:

a. Raw Materials (RM) which are processed to manufacture the final product.

b. Work In Progress (WIP) which refers to the intermediate product which is obtained by processing the raw material but is not fully converted into final product.

c. Finish Goods (FG) that are the fully processed final products that are being manufactured and are ready to be dispatched.

2. Trading Inventory:

It is the inventory maintained by a trading organization with a purchase and sale business.
Trading Inventory consists of goods that are purchased from a supplier or manufacturer and sold to customers with a certain margin of profit.
In this case, the purchased goods do not undergo any further processing and are sold directly without any change of form.
The Trading Inventory is also referred as the term ‘Stock’.

1.3 Inventory Control

The chief motive of an organization is ‘Profit Maximization’. Inventory is an essential part of an organization since it is one of the major factors that affect

the profit earned by the organization. Hence controlling or managing inventory is one of the most important tasks necessary to achieve organizational goal of earning maximum profit and reducing costs and expenses.

Inventory Control is a technique of maintaining and monitoring the size of the inventory at appropriate level, so that the production and distributions take place effectively.

The main objective of inventory control is to achieve maximum efficiency in production and sales with the minimum investment in inventory.

Inventory Control is achieved by:

- Purchasing items at proper time and price, and in right quantity.
- Provision of suitable storage locations with sufficient space.
- Maintaining proper level of stocks.
- Adequate inventory identification system.
- Up-to-date and accurate record keeping.
- Appropriate requisition procedures.

1.4 Advantages of Inventory Control

Inventory control or management has several advantages as stated below:

1. Provides protection against fluctuations in demand and supply by monitoring the trends in demand and supply.
2. Ensures a better service to the customers by avoiding the out of

stock situations by keeping a check on the minimum stock levels.

3. Helps to reduce risk of loss on account of obsolescence or deterioration of items.

4. Helps to reduce administrative work load in respect of purchasing, inspection, store-keeping, etc. thus in turn reducing manpower requirements, and consequently costs.

5. Helps to make effective utilization of working capital by avoiding its blockage in excess inventory.

6. Ensures to maintain a check against loss of materials through carelessness or pilferage.

7. Facilitates cost accounting activities.

1.4 ROLE OF SALES ANALYSIS IN PROFIT MAXIMIZATION

Inventory control is not all about managing stocks and ordering goods. But inventory control combined with efficient analysis tools can be truly effective as it can help us identify the trends in the demand for various products by carrying out various types of analysis. This includes comparative study of sales as well as sales analysis concentrated on a single product.

Carrying out such analysis at regular intervals can help the shop manager to decide upon the future reordering strategies and taking some major decisions regarding purchase of goods.

1.5 Business Model

In addition to the corporate strategy, an organisation chooses a business model that is aligned with their strategy. By a business model the way of operation is meant in this case, also referred to as basic structures. Make-to-stock.• In this structure, products are manufactured, regardless of any order placed by a client. It is even possible that products are produced, but there is (hopefully temporarily) no demand at all. In this structure the pressure is on the sales department when the demand drops. Paperclip manufacturers are an example of a make to stock environment. Deliver-from-stock.• The deliver from stock variant looks similar to the make-to-stock structure. However in this case the assortment is much bigger and products are not being manufactured first. This structure is usually found at a wholesaler or retailer: a builder's merchant for example has this structure. Assemble-to-order.• Some manufacturing companies only assemble. They combine different components based on the desired configuration of the client. Using a limited number of components, they are able to produce various different end-products. Dell computers for example offer various components where the clients are able to pick from; accordingly their combination of components will be assembled. Make-to-order.• A make to order structure is most common for products that have to be tailored to the consumers' desires. In this case products are only produced on (customers') demand. Building a luxuries yacht is a make-to-order example. Variations to this list exist: Hoekstra & Romme (1991) for instance also mention a fifth structure called 'purchase and make to order'. This is an even more specific case of the make-to-order structure. The order in which the above four structures are presented also represent their rank in relation to the amount of influence a customer has. In case of the make-to-stock structure, the interaction with the client takes place at the end of the production process (Hoekstra

& Romme, 1993), (Coyle et al., 2003). The client also has no influence during the production process, whereas in the make-to-order structure the client is already being involved at the beginning of the production process. The point in the process at which the client gets influence is called the decoupling point6 or Push/Pull-boundary (Simchi-Levi et al., 2003). The basic structure is very defining for the amount of stock that is kept. In case of make-to-order for example materials cannot be held in stock very easily, because the materials required depend heavily on the order that is placed by the client. If in the ideal situation the required materials are delivered precisely at the moment when they are required, no stocks will exist. This principle is called Just-In-Time (JIT) delivery. Using JIT, the make-to-order structure could in theory thus do without any inventories, if all materials and (sub) components are delivered perfectly in time. The JIT principle aims to eliminate all unnecessary materials from the production process (Klundert, 2003). This can only be achieved when all materials are handled at a specific station and it is possible to pass them on immediately after they are finished at that station. The principle of JIT is to have items when they are needed and not have those when they are not needed (Wild, 2002), (Goor & Weijers, 1998). When this theory is carried through consequently there will be no stocks at all. The basic structure may however sometimes dictate otherwise. For example the make-to-stock structure by definition always contains a stock in the end, although during and before production there does not need to be any stock. Keeping stock as small as possible is often desired, because this reduces costs and risks.

1.6 Inventory Logistics

The introduction already mentioned that the focus of this research will be on inventory management. Inventory management is part of supply chain management (SCM). Therefore first SCM will be described shortly. This is done to show how inventory management relates to this much broader field of research. Accordingly the different aspects of inventory management are described. As the previous chapter pointed out, ERP packages support a wide range of business

activities: supply chain management and inventory management are two of them. ERP and logistics are related to each other in a way that ERP supports these processes with information; in many cases IT systems even form the core of the logistic processes (Ploos van Amstel & van Goor, 2006). The relation between ERP and logistics is also addressed in the proceeding sections.

1.6.1 SUPPLY CHAIN MANAGEMENT

Supply Chain Management is a very broad term, because it incorporates a wide range of activities: transportation & logistics, inventory & forecasting, supplier management, after sales support and reverse logistics are some examples. Inventory management is just one aspect of SCM. Johnson & Pyke (2001) even distinguished up to twelve different categories within SCM. About SCM, there are various (slightly) different definitions available, for instance:

"SUPPLY CHAIN MANAGEMENT (SCM) IS THE TERM USED TO DESCRIBE THE MANAGEMENT OF THE FLOW OF MATERIALS, INFORMATION, AND FUNDS ACROSS THE ENTIRE SUPPLY CHAIN, FROM SUPPLIERS TO COMPONENTS PRODUCERS TO FINAL ASSEMBLERS TO DISTRIBUTION (WAREHOUSES AND RETAILERS), AND ULTIMATELY TO THE CONSUMER"

"SUPPLY CHAIN MANAGEMENT (SCM) IS THE MANAGEMENT OF A NETWORK OF INTERCONNECTED BUSINESSES INVOLVED IN THE ULTIMATE PROVISION OF PRODUCT AND SERVICE PACKAGES REQUIRED BY END CUSTOMERS" (HARLAND, 1996).

"THE SUPPLY CHAIN CAN BE DEFINED AS A NETWORK OF RETAILERS, DISTRIBUTORS, TRANSPORTERS, STORAGE FACILITIES, AND SUPPLIERS THAT PARTICIPATE IN THE SALE, DELIVERY, AND PRODUCTION OF A PARTICULAR PRODUCT." (MURRAY, 2006).

Although these definitions differ, they do contain several similar elements. For example all definitions include consumers, products and businesses. SCM can therefore be seen as the joint

operation of several businesses to manufacture and deliver a product to the consumer. All activities that have to be performed to achieve this operation are part of SCM. Logistics is often also used to refer to SCM. A small difference can however be seen. Logistics can be seen as all activities that concern the transportation of goods in the supply chain. Logistics can be defined as "the management of business operations, including the acquisition, storage, transportation, and delivery of goods along the supply chain" (Murray, 2006). The most important distinction that can be made between logistics and SCM is the scope: SCM has a broader scope (as mentioned before SCM looks across different enterprises). Whether logistics and SCM are the same, is still heavily being discussed in literature as well (Larson et al., 2007). Due to the focus of this research, which is restricted to single organisations, logistics will be used mostly throughout this report.

CHAPTER 2

2. REVIEW OF LITERATURE

2.1 SCOPE OF THE PROJECT

Inventory management or inventory control is a very useful technique for managing the stocks and sales records of a Super-market which is our selected domain of implementation for the software.

The super-market stores and sales various products which includes packed foodstuffs and drinks, milk products, glossary, decorative items, cosmetics and many other products of day to day use. It also stores some costly items like wrist watches, small electronic goods, artificial jewelry etc. Also there are some household goods like washing powders, cleaning equipments, gaskets etc. Managing all these products, sufficient stocks, sales records, also analyzing sales and reordering from time to time is a difficult job. To do it more effectively and correctly a better inventory control or stock management is required. This is provided by our software ensuring an efficient inventory control and rigorous sales analysis facility.

Our software helps to manage the daily sales records and assist in billing process as well. It also includes reordering level and reordering quantity and gives appropriate alerts, thus maintaining a safe stock.

The software also provides authorized users to perform sales analysis of various products. By providing this facility, our software will prove to be extremely useful to adjust the purchase and sales strategies leading to an increase in profit.

2.2 PROMINENT FEATURES OF OUR SOFTWARE PROJECT

- Bill generation
- Accurate recording of daily sales
- Calculation of reordering quantity and reordering level
- ABC analysis feature for product classification
- Effective and user friendly graphical user interface

2.2.1 Bill Generation

This will be useful for carrying out daily transactions of the supermarket.
A bill of items selected by the customer will be made and available stock count will be adjusted.
A receipt of sold items will be printed and given to the customer.

2.2.2 Accurate recording of daily sales

The software records an entry for each unit of a product sold on daily basis by maintaining a separate sales table.
The table contains the information about the number of units of a particular product sold on a given date.
Maintaining such a database enables easy analysis of past sales and studying the trends in market.

2.2.3 Calculation of reorder level and reorder quantity

The inventory level R in which an order is placed is called as reorder level.

R = D.L

Where, D = demand rate in units per days/months

L = lead time in days/months

Another way calculation is,

R = (Maximum reorder period) * (Maximum usage)

The reorder quantity is the number of units of the product which must be ordered. It is denoted by Q.

Reorder quantity depends upon various factors like maximum capacity of inventory, reorder period etc.

Q = Maximum level of inventory – Reorder level –
(Minimum reorder period)*(Minimum usage)

When the inventory level of a particular item falls below the threshold R, the software will generate an alert message.

2.2.4 ABC analysis feature for product classification

ABC analysis also referred to as the Pareto analysis is a method of classifying items, events, or activities according to their relative importance. It is also know as Always Better Control analysis since it provides the most optimum way of controlling inventory.

It is frequently used in inventory management where it is used to classify stock items into groups based on the total annual expenditure, or total stockholding cost of each item. It exercises discriminating control over different items of stores classified on the basis of investment involved. Organizations can concentrate more detailed

attention on the high value/important items. Pareto analysis is used to arrive at this prioritization.

The first step in the analysis is to identify those criteria which make a significant level of control important for any item. Two possible factors are the usage rate for an item and its unit value.

The general ABC classification goes as follows:

A Class of items consist of only a small percentage about 5-15% of total number of units handled by the stores but require heavy investment about 70-80% of total inventory usage value because of their high prices or heavy requirement or both.

Paying more attention to A class items using sophisticated stock control system can give control of about 70-80% of total stock investment. Hence A Class items are controlled closely to avoid overstocking as well as shortage which may lead to a considerable loss.

B Class items are relatively less important; they may be 30% of total number of units managed by the stores. The percentage of investment required is about 15 % of the total investment in inventory.

In case of B class items as the sum involved is moderate, the same degree of control as applied in A class items is not warranted.
The orders of the items belonging to this category can be placed after reviewing their situations periodically

C Class items do not require much investment. It may be around 5-10% of the total inventory usage value but they are nearly 50-60% of

the total number of units handled by the stores.

For C Class items there is no need of exercising constant control. Orders for C Class items can be placed after a relatively larger period of time with large quantities after ascertaining the consumption requirements.

Advantages of ABC analysis

- The investment needed is minimized.
- The maintenance cost is minimized.
- Management time is saved.
- Work connected with the purchases is systematized

2.3 TYPICAL INVENTORY BUSINESS PROCESSES

Within inventory management, several activities take place. Forecasting is the first activity that is performed. Forecasting is done based on orders: both previous amounts ordered and on (expected) upcoming orders. MRP-parameters, defined upfront, decide the levels for safety stock, review level etc. The order history for example is used to calculate the turnover rate which determines the point at which one should purchase new goods in order to prevent out of stocks. Furthermore orders that are already placed are also added to the forecast, because for those orders materials have to be purchased for certain. These parameters form the inputs for the forecast calculation. The forecast is used to decide whether goods have to be purchased in order to complement the stock to a secure level again. How high this secure level must be depends on various parameters, as the previous section pointed out. If it turns out that the current stock is too low, compared to the advice generated through forecasting, goods are purchased to replenish stocks. At a certain moment these goods are received and are stored. Upon receipt of goods, goods are sometimes first temporarily stored in quarantine to acclimatize for instance. Quarantine is optional. Finally a quality check takes place upon receipt of goods, after which the

goods are stored. In between during storage, stocks are sometimes moved to other places. Finally goods will be issued that are going to be used either for a) operations where the goods are being consumed immediately (i.e. consumables), or b) manufacturing in order to use the parts to build a greater structure, or c) direct distribution and shipment to the client. The goods issue is always triggered by an order, because the goods are necessary or required to fulfil a certain order.

2.3.1 FORECASTING

In the above model forecasting is the first process step. The previous section showed the stock level developments over time. Forecasting is necessary to anticipate on what is coming in order to maintain a continuous production or service level. Furthermore forecasting is closely related to scheduling and planning .Within the above process forecasting and planning are considered one and the same process. Forecasting is considered the most important process, because this is where the real money can be earned: if forecasts are wrong the stocks will be too high, which costs money or even worse if the stock become too low this may cause problems at the distribution. Distribution problems can eventually even cause a domino effect: production stops and clients do not get their products. This would mean major loses in income. The forecasting process is thus a very important process step in inventory management. Forecasts are almost never perfect, because there are generally too many uncertainties that need to be taken into account: it is not possible to incorporate all these uncertainties into the forecast (Ploos van Amstel, 2008). Forecasting over a shorter period is often easier however and therefore more accurate as well. For instance when daily forecasts are being done, anticipation to sudden developments in the demand can be much faster. Several steps exist within forecasting. First one has to determine what has to be forecast (which items, what level of detail and over what time scope). Secondly available data has to be gathered (e.g. historical data). Next a forecasting model has to be selected. Accordingly the forecast has to be done and finally this forecast has to be monitored and evaluated. Different forecasting methods are available to select from. First of all qualitative methods can be used: this incorporates forecasts generated subjectively by the forecaster. Some examples of these methods include: executive opinion, market research and the

Delphi method .Secondly quantitative forecasting methods such as time series model and causal models can be used .Causal models assume relations between different variables which lead to the eventual behaviour. Time series typically assume that all the needed data can be found in historical series or events. Four basic patterns can be found in time series: level, trend, seasonality, and cycles. Methods to make an estimate of the upcoming time series (based on previous time series), may make use of simple mean, simple moving average, weighted moving average or exponential smoothing methods for example. The aim of forecasting is to estimate the upcoming need as good as possible; the mean squared errormethod can be used afterwards to evaluate to what extend the forecast matched the actual demand. The forecast serves as input for the purchase process, which in this case will not be described in more detail. After purchase, the goods are delivered at a certain moment.

2.3.2 GOODS RECEIPT

When new goods are delivered to the location where the stock is kept (i.e. a warehouse mostly), several checks take place. Firstly, the price and quantity are compared to the purchase-order to see whether the delivered quantity and price match. In ERP there exists a link to information from the purchase department at this point. For some materials, the quality is also checked before adding the goods to stock. In some special cases the delivered goods even have to stay in quarantine for a while (e.g. to stabilize after transport or to acclimatize) before the quality is being checked. Because the quarantine process is optional, this block is dotted in the picture. Additionally the completeness of the order is often checked and the delivery date is registered. This information is used to keep track of the reliability of suppliers. Additionally, partial deliveries can be monitored using this information.

2.3.3 STORAGE

When all checks for received goods are passed, the goods are finally added to the stock. Again information is stored; at least the added number of materials or the amount of material is

registered (in ERP for example). Additionally the location where the goods are stored is registered and eventually special characteristics are also registered like value, size or best-before dates for instance. The registered information from storage is linked back to forecast and used to do new forecasts with: based on the present amount of stock it is decided how many new articles should be ordered for instance. When stock is stored, stock movements actually form the most important activity at this point. Stock movements may be required for several reasons. Goods are needed at another location for example. Each movement is registered and the location is updated in the system. Decayed or damaged goods also cause the amount of goods held in stock to mutate; this mutation also has to be registered. Usually the aim is to keep entire stock costs as low as possible. Stock mutations (movement or writing off) cost money and therefore not only the stock levels should be kept low, but also the number of movements as well. ERP can be used to real-time monitor which amount (quantity and value) of a certain material is in stock and at what location(s) it is stored. Also using the information extracted from ERP it is possible to analyse which goods have a high cycle time and which products lay ‘still’ in stock and are thus not being used but do cost money/consume space and form a risk. For cheaper items this is no problem, because they represent a smaller value, but for expensive parts this becomes very interesting. Materials that are unnecessary being kept in stock can also be traced using the information stored in ERP. Finally ERP is used to optimize the safety levels (the minimum amount of stock)

2.3.4 GOODS ISSUE

Finally goods have to be issued, usually for two reasons: depending on the environment. In a warehouse for example items may be picked to fulfil an order placed by a client. In a production environment items are retrieved from stock because they are required for production. The environment is mostly determined by the basic structure, i.e. make-to-stock vs. make-to-order for instance. When goods are retrieved from stock this is again registered (in ERP for instance) together with the date and amount that was taken from the stock. In an ERP environment

Inventory management actual stock levels are immediately updated after the goods issued are scanned, registered or written off in the system. Other departments can thereupon in real-time see the newly (changed) stock levels.

CHAPTER 3

3. Plan of Work

The software is divided into three parts:

- Database
- Administrator's User Interface
- Client Side User Interface

3.1 Database

3.1.1 Product: It stores the general information about each product in the inventory. Each entry is uniquely identified by the primary key pid. Product names and brand names are stored. Also, for better retrieval and for facilitation of analysis process the products are classified at several stages into main group, sub group and type. This table also stores valuable attributes like reorder level, reorder quantity, stock related attributes, maximum reorder period and minimum reorder period etc. which are essential for exercising inventory control.

3.1.2 Vendor : It is used to store the general information about the various

vendors that supply products to the inventory. Each entry is uniquely identified by the primary key vid. It includes attributes like Vendor name, contact person etc. along with a composite attribute address consisting of several simple attributes that can be used as criteria to search a vendor from the table.

3.1.3 Supply : This table represents the relationship between the tables Product and Vendor. Each tuple is uniquely identified by the union of foreign keys pid and vid. It stores important attributes namely, cost price, order quantity, order time and quality rating.

3.1.4 Sold: It is the data table which records daily sales for every product and serves as a basis for sales analysis. Each entry represents the number of units of a particular product sold on a particular date. Its primary key consists of pid and a date attribute named datetoday.

3.1.5 Customer : This table is used to record customer details. Primary key is custid.

3.1.6 Bill: It is used to store the basic data about a bill entity. Primary key is billID.

3.1.7 Bill Items: It is the relationship table between main tables Bill and Product. Primary key is formed by union of billID and pid. This table stores the number of units of a particular product sold within a particular bill. It also stores the custid to identify the customer.

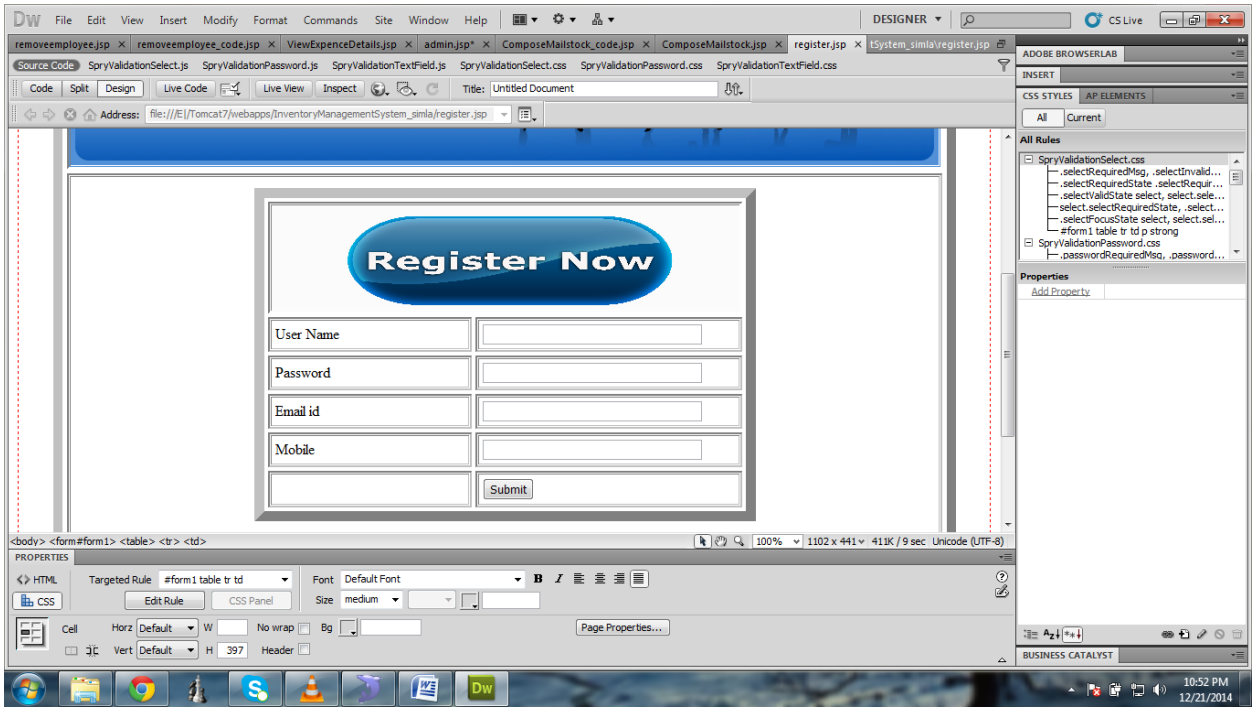
3.2 ADMINISTRATOR'S USER INTERFACE

When the administrator enters the valid username and password in the login form he will be directed to the form called 'Welcome Administrator'.
The layout of this form is as shown in the figure and consists of a toolbar having dropdown buttons, each having a menu consisting of menu items directing to the respective forms.

3.3 Login Page for Client

Client is required to put up his required details in the form of username and password. The layout of this form is as shown in the figure and consists of a toolbar having dropdown buttons, each having a menu consisting of menu items directing to the respective forms.

3.4 Register for a new Account



New users can create their account via above page . The page will request to enter a username , password, email-id and their mobile no.

The layout of this form is as shown in the figure and consists of a toolbar having dropdown buttons, each having a menu consisting of menu items directing to the respective forms.

3.5 DETERMINATION OF VARIOUS STOCK LEVELS

To avoid over-stocking and under stocking of materials, the management has to decide about the maximum level, minimum level, re-order level, danger level and average level of materials to be kept in the store.

These terms are explained below:

3.5.1 Re-ordering level

It is also known as ‘ordering level’ or ‘ordering point’ or ‘ordering limit’. It is a point at which order for supply of material should be made.

This level is fixed somewhere between the maximum level and the minimum level in such a way that the quantity of materials represented by the difference between the re-ordering level and the minimum level will be sufficient to meet the demands of production till such time as the materials are replenished. Reorder level depends mainly on the maximum rate of consumption and order lead time. When this level is reached, the store keeper will initiate the purchase requisition.

Reordering level is calculated with the following formula:
Re-order level =Maximum Rate of consumption x maximum lead time

3.5.2 Maximum Level

Maximum level is the level above which stock should never reach. It is also known as ‘maximum limit’ or ‘maximum stock’. The function of maximum level is essential to avoid unnecessary blocking up of capital in inventories, losses on account of deterioration and obsolescence of materials, extra overheads and temptation to thefts etc. This level can be determined with the following formula.

Maximum Stock level = Reordering level + Reordering quantity —(Minimum Consumption x Minimum re-ordering period)

3.5.3 Minimum Level:

It represents the lowest quantity of a particular material below which stock should not be allowed to fall. This level must be maintained at every time so that production is not held up due to shortage of any material.

It is that level of inventories of which a fresh order must be placed to replenish the stock. This level is usually determined through the following formula:

Minimum Level = Re-ordering level — (Normal rate of consumption x Normal delivery period)

3.5.4 Average Stock Level:

Average stock level is determined by averaging the minimum and maximum level of stock.

The formula for determination of the level is as follows:
Average level =1/2 (Minimum stock level + Maximum stock level)

This may also be expressed by minimum level + 1/2 of Re-ordering Quantity.

3.5.5 Danger Level:

Danger level is that level below which the stock should under no circumstances be allowed to fall. Danger level is slightly below the minimum level and therefore the purchases manager should make special efforts to acquire required materials and stores.

This level can be calculated with the help of following formula:

Danger Level =Average rate of consumption x Emergency supply time

Chapter 4

4.Working Features

4.1 Product Comparison

The form ‘Product Comparison’ allows the user to select products categorically to compare the sales within a specified period of time.
A product category such as a main group, a sub group or a type is selected using the 3 combo-boxes which provide the user with appropriate values from the database for selection.
Similar combo-boxes are used to select the span of comparison by getting the start and end date from the user.

The comparison report form basically includes a Crystal Report Viewer component and a flat toolbar to select the type of report document.
Crystal Report Viewer allows the user to view the report document that is loaded. It also provides the facilities such as search, export, zoom etc. When the form is loaded the crystal report viewer is loaded with the textual report.

4.2 Timeline Analysis

This feature is provided to study the trends in the sales of a particular product over a period of time.
Secondly, the user is also asked to select the time period to be considered. A group of radio buttons is used to get a choice among daily, monthly and yearly sales comparison. When ‘OK’ button is clicked the queries are fired at the sales database and the reports are generated using their results.
The reports are displayed in the next form named ‘Time line report’. It has a Crystal Report Viewer in which the report document is loaded.

4.3 Check Alerts

Administrator can check for the alerts regarding Class ‘A’ and Class ‘B’ products whose current stock has gone below their currently assigned reorder level. These alerts are fired by a trigger at the back-end which continuously monitors the current stock of all the products. Alerts for Class ‘C’ products are not given since these products can be dealt with automatically by the software and do not need intervention of the administrator.
Administrator can modify reorder strategy for such products, if desired. When administrator selects a product from the alert grid, he/she is redirected to the supply information form where he/she can modify the reorder strategy of that particular product with respect to various vendors.

1.

4.4 Edit User Detail

Administrator has authority to edit client login details. Administrator can permanently delete a particular client user account, so that, henceforth, a sales person cannot logon at the client side using that username and

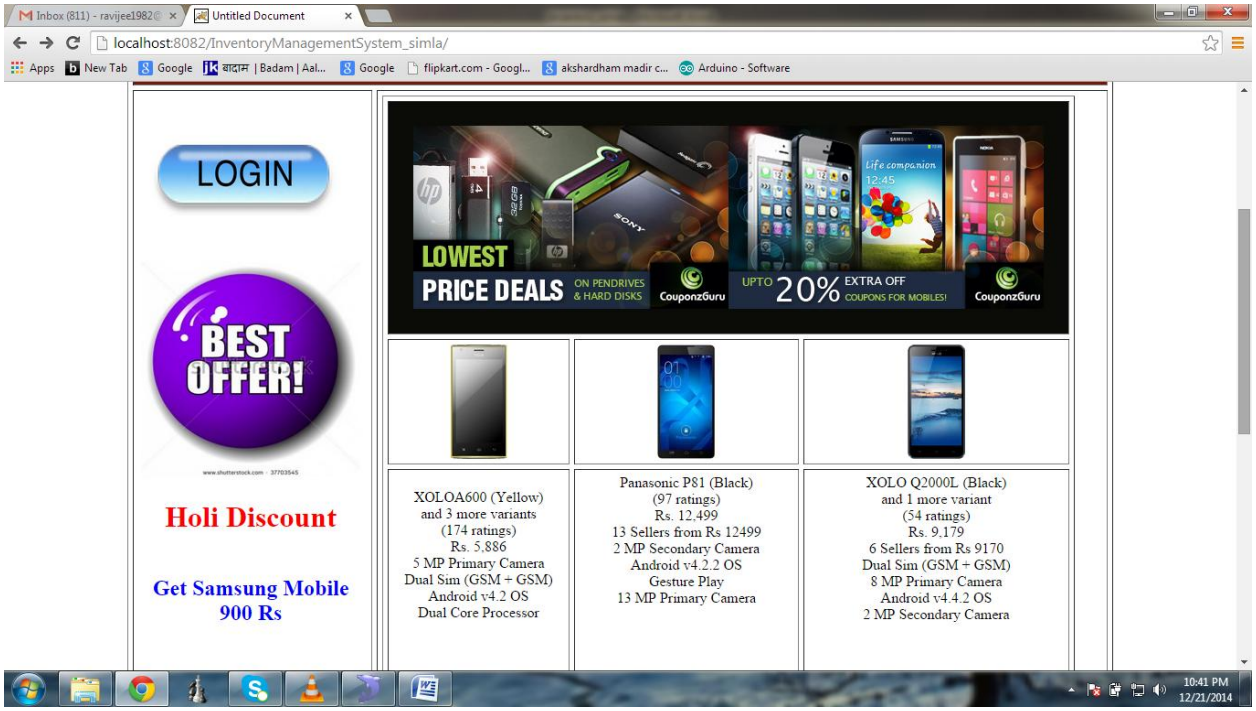
corresponding password.

Administrator can also change password for a particular client user account, without deleting that account. This may be the case when the sales person requests administrator to change his password if he/she has lost or forgotten his/her current password.

4.5 Product Information

The New Product Information Form contains many textboxes which are used to enter the information of the product in the database. The first textbox is of Product-ID which is unique for every product. A textbox for Barcode Number is also kept which can be used if there is a Barcode reader. r. The product is classified under Main group, Sub-group, type, and brand name. There are fields for Current Stock, Minimum Stock, Maximum Stock, Reorder level, and Selling Price.

The Product can be searched in many different ways. The Product can be searched using its Product ID, Main Group, Sub Group, Type or Product Name in a hierarchical manner. The user has to press ‘OK’ button to see the results of the Search.



4.5.1 Product Update:

When the user has updated a data field of a product and then he presses the ‘Update’ button to save the changes. An alert message is shown to the user to confirm the update. If the user does not want to save the changes then he can select the ‘No’ button or else press ‘Yes’.

After pressing the ‘Yes’ button, the software makes the changes for the respective Product in the database. After that a message box is shown which says that the Update was successful.

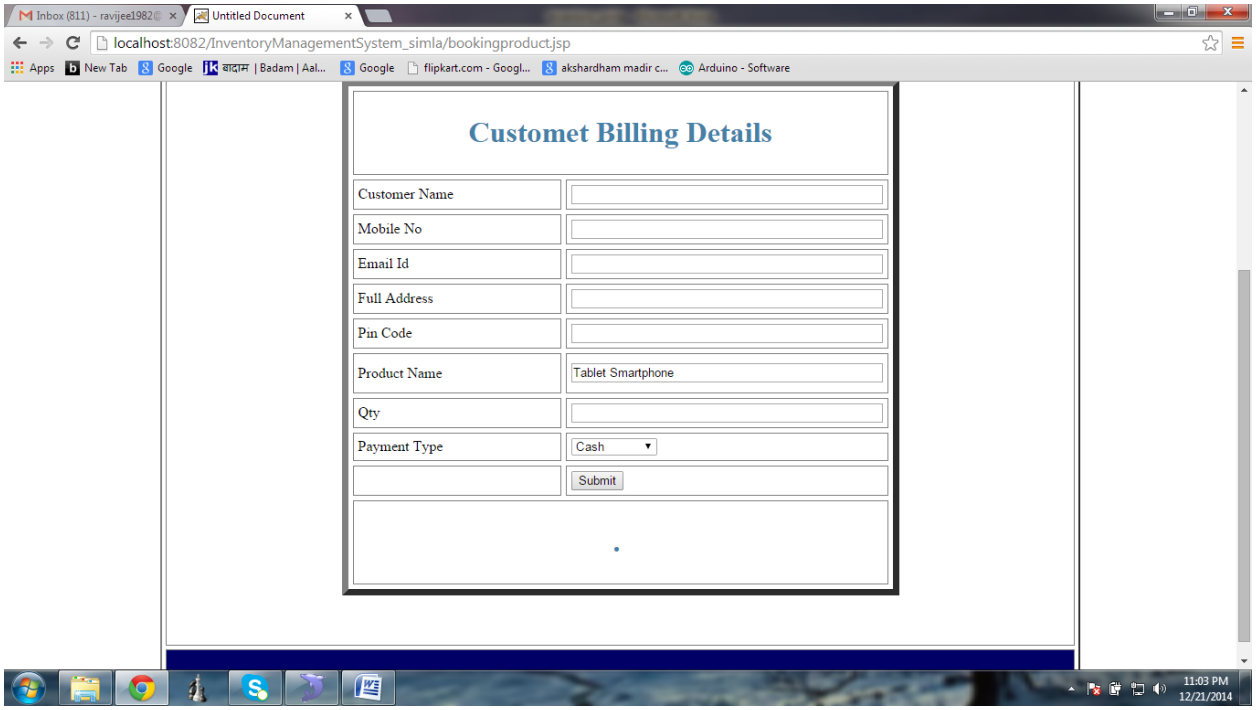
4.5.2 Product Delete:

When the administrator wants to delete a particular product's information from the database, he/she can delete that product by selecting that particular product and pressing the 'Delete' button, and then an alert message is shown to him/her. If the administrator doesn't want to delete the product, then he can select the 'No' button or else press 'Yes' and then the selected product will be deleted.

After pressing the 'Yes' button the software deletes the respective product from the database. After that a message box is shown which says that the product was successfully deleted.

4.6 : Client Side User Interface

4.6.1 : Billing Module



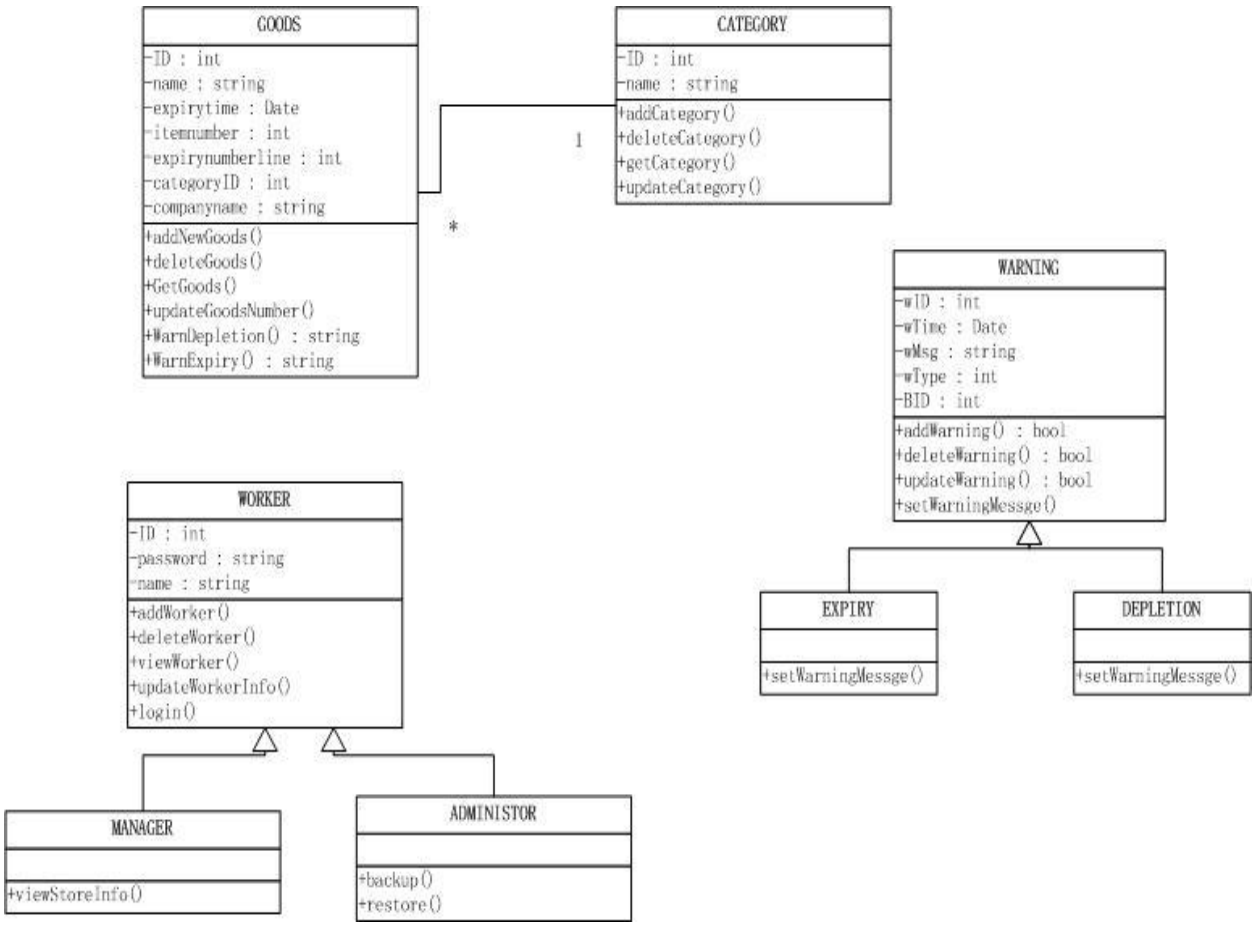
The above form contains two text boxes for entering Username and Password. The sales person has to enter his appropriate Username and Password. The sales person will not be logged-in unless he specifies correct Username and password.

After the sales person enters his Username and Password he has to press the ‘LOGIN’ Button in order to login. His/her Username and Password are compared with the Username and Password present in the ‘userlogin’ Table of the database. If both the fields match then the user is authenticated and the Billing form opens.

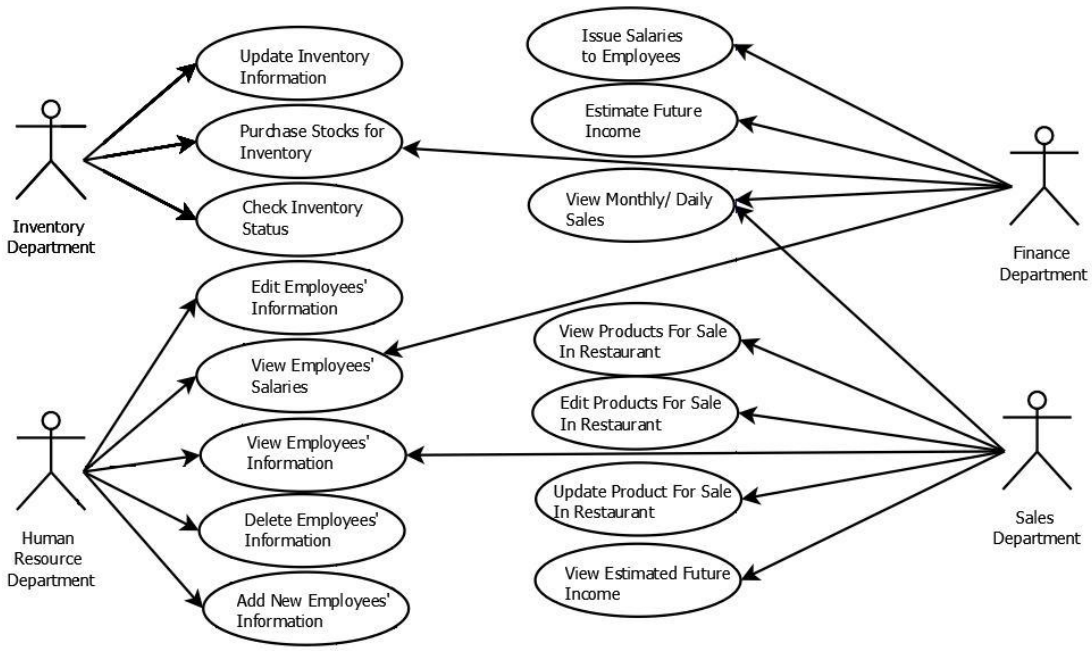
4.6.2 : Change of Password:

The sales person can change his Password by clicking the ‘CHANGE PASSWORD’ button on the billing form. After clicking that button the above form pops up and there are three textbox fields viz. current password, new password, re-type new password. The sales person has to fill these textboxes in order to change his password and then click the ‘CHANGE PASSWORD’ button on this form.

5. CLASS DIAGRAM



6. USE CASE DIAGRAM



7. POTENTIAL ERP BENEFITS

ERP should in theory be able to improve the inventory process at several points as the conceptualization part of this research indicated earlier. ERP-vendors claim that various improvements in terms of efficiency and process optimization are possible. This section is aimed at the identification of these benefits and locates them onto the business process depicted in

7.1 MRP (Improved planning)

ERP software packages originated from Material Resource Planning (MRP) solutions. In most ERP packages thus advanced MRP capabilities are included. According to what the ERP-vendors claim, ERP software should be able to make more accurate predictions, because of their years of experience with MRP algorithms and calculations. Also due to the link with finance and sales within ERP, the software is able to take more factors into account, and as a consequence do better forecasts based on previous sales for instance as well. Using stand alone modules to perform MRP-runs can be more difficult, because less external factors can then be incorporated into the calculation. ERP-vendors claim that their MRP solutions are strength of ERP as well and may offer significant benefits at the forecasting process.

7.2 Vendor contracting registration

ERP can support and streamline the purchase process due to the registration of contracting vendors. Typically if a large number of contracts with vendors need to be managed it is very useful to use software for this. Performing vendor contracting within an ERP environment provides benefits in terms of sharing information between departments: finance can use the same data (see advantage 11) when invoices have to be paid which is the result of purchase buying goods. Price negotiations are incorporated in new orders and budgets immediately as well. Due

to the registration of delivery times within the software it is also better to observe whether the engagements are met.

7.3 Assign approved suppliers

Approved suppliers are suppliers which satisfy certain quality standards and products ordered with them are for instance immediately accepted at the quality check. Furthermore only certain suppliers might be ‘approved’ because they have proven to be reliable in terms of on time delivery of their products. Assigning approved suppliers within ERP therefore forms an easy control to manage quality and budgets. Within ERP approved suppliers can be configured and shared amongst other departments (see point 11 as well) quit simply. It is useful to assign approved suppliers for preselecting suppliers that are reliable. It can concern a financial matter: for example only a few suppliers might be approved, because finance made contracts with those parties in order to bargain for discounts. Also only a selected group of suppliers may be approved, due to quality restrictions.

7.4 Advanced budget control

Within ERP it is possible to create hard restrictions concerning the budgets. This is not a unique characteristic, but when these restrictions are made in real time by the finance department for example it does become a unique aspect of ERP. To prevent purchase from overrunning their budget, it can sometimes be necessary to create a hard restriction in the software: within ERP this can be managed easily.

7.5 Three-way-match

The so called three-way-match is a strong characteristic of ERP where the integration of different departments becomes very clear. The three-way-match is a check between the ordered goods (at purchase), the receipt goods (receipt at the warehouse location) and the invoice (which usually is

delivered at the finance department). The type, number and quality of ordered goods have to match with the delivery done by the supplier and the invoice the supplier sends accordingly. If this information is stored across different software packages, it can be more difficult to match this information (see point 11 as well) and in the most inconvenient case these checks have to take place by hand. ERP can improve and automate7 this because it is possible to monitor the whole process from ordering to delivery to the payment finally.

7.6 Supplier reliability monitoring

Due to the integration of the goods receipt and the purchase department within ERP it is easy to evaluate when a purchase was done and at what date the goods were actually delivered. A simple check between the promised arrival date and the actual date is a good measure of the supplier reliability. This information can be used when selecting supplier. In some cases the delivery times might be very critical and a good history of each supplier is than useful to select the ones that have proven to be reliable.

7.7 Inventory turnover visibility

With ERP it is possible to monitor the inventory turnover more easily, because the relevant information is available in one central database and can be combined in real time. Information about the average inventory is needed, as well as the sales statistics: within an ERP environment this information is stored in the same database. A low turnover means that goods are kept longer in stock and therefore this indicates a waste of capital (i.e. the capital is tied up in inventory and cannot be used for other purposes).

7.8 Dead stock visibility

Related to the turnover ratio, also ‘dead stock’ or slow moving stock can be made visible more easily. Because information from sales and inventory can be combined it is relative easy to see

what goods are moving fast, and which goods are slow moving or even only are being used very scarcely.

7.9 Less waste through better information

If the expiration date of certain goods is passed, these goods have to be thrown away and this is a waste of products and capital. With less waste the expiration of goods is indicated in this case; not waste of packing materials. Typically waste of products only due to the fact that they have been lying around for too long is very inefficient and costs unnecessary money. Monitoring what articles have to be used first and when they will expire is a good thing to monitor and combined with automatic alarming could save money. Because of better managing the information around the inventory, the waste of goods due to expiration can be prevented. Stand-alone software, specially written for inventory management, is also able to do this. But because it is also a feature of ERP and provides benefits to the process as well it is worth mentioning over here as well.

7.10 Better handling rush orders

Before implementing ERP, first the processes taking place have to be analysed, because these have to be logical and are used to configure the ERP software. This requires that the processes are described and defined as clear as possible. Due to the streamlined processes that have to be thought trough before implementing ERP, rush orders can be better handled afterwards. It can be easier to go from one process step to the next in ERP than in an unstructured stand alone software environment. Also the number of orders that classify as rush orders can be reduced, because due to the optimised process rush orders can easily follow the normal path through the system as well.

Conclusion:

Thus, we have successfully completed our project on 'Inventory Control System of Supermarket'. We have included many features that are necessary for an Inventory Control System of Supermarket.

The features are as follows:

1. Detailed Sales Analysis
• Product Comparison
• Time Line Analysis
2. Checking of Alerts
3. Product Information Management
4. Reorder Strategy
5. Vendor Information Management
6. Billing Module

While making the software, every effort has been taken to make a very easy to use Graphical User Interface (GUI). We have tried our best to include as much features as we can in the available time limit.

The aim of this research was to develop a performance measurement tool for inventory management. As a result a unique framework is developed which enables organisations to measure their operational inventory management's performance. The final framework is shown in chapter six and (a larger version in) Appendix D. The framework consists of five business process steps and attached to each process step KPIs that are useful to measure. The framework provides a specific set of metrics, categorised along the whole process from beginning to the end. This enables its users to see the coherence between the different aspects of inventory management. The framework also enables performance measurement of inventory management in a structured way, due to the pre-described set of metrics. The framework presents a unique approach towards performance evaluation of inventory management, because of the way the

model is built up. The framework provides two main advantages over previous measures or models. First of all, contrary to existing literature the model provides a business process overview of inventory management and the relevant metrics. The structure provided by the framework gives organisations something to hold on to. With the model the inventory process can be evaluated from beginning to the end. This way issues and causes of problems can be better investigated. Uncertainties along the process, which form an important reason for keeping inventories, can be investigated for instance using the structured approach presented in the framework. Secondly, different actors are represented by the framework due to the span of the framework. This is a good thing, as it makes sure that the accent is not on a single process or output only. Cost drivers for instance are not the only KPIs to steer on and therefore it is useful to measure a whole set of KPIs in order to trace and tackle problems and finally achieve an optimal result which scores good on all goals and towards all parties. Along with the framework, also a first attempt was made to test the benefits of ERP and the framework in practice.

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