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DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

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**Information with regards to the mini-dissertation**

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<b>Abstract</b>	The aim of this project is to increase productivity at Doorco through improving the manual business system, storage system and inventory system. An inventory system was developed which will monitor inventory levels, determine what levels should be maintained, when stock should be replenished, and how large orders should be. The storage system was improved by re-designing the storage bins and creating a fixed location storage system. The manual business system was converted to a computerised business system through the use of Sage Pastel.
<b>Category</b>	Facilities Planning and Operational Management
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## Executive Summary

Doorco, a company that is part of the cupboard manufacturing industry, was chosen for this project because of the industry's local significance and its growth determined by the growth of housing needs in South Africa.

Doorco's market consists of 95 percent housing development projects, which include supplying some of the larger construction companies with kitchen and built-in cupboards. In recent years, Doorco experienced rapid company growth together with facing other industry unique challenges that created a decrease in productivity.

The manual business system currently used at Doorco is inefficient and wastes a lot of time. The storage system is inefficient and the control of inventory is ineffective. The aim of this project is to increase productivity at Doorco by improving the business system, storage system and inventory operations.

A computerised business system had to be designed, which would decrease the time taken to complete important business functions. A new storage system also had to be designed, including an improved layout of the storeroom, which should specify the exact locations of all SKUs (Stock-Keeping Units). Such a system would improve productivity by reducing the time spent searching for parts. An inventory system also had to be designed which would specify the amount and re-supply intervals of all SKUs and such a system would improve productivity by reducing the probability of shortages or oversupply, while also saving space in the storage area. Inventory cost will also be minimized by such a system.

Literature was gathered to aid in the understanding of the problems and relevant techniques that could aid in the problem solving process. Solutions to these problems were developed and presented to the owner of Doorco. The storage system and inventory system were implemented, but the decision of implementation of the computerised business system solution was left to the owner.



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# Chapter 1: Overview

## 1. Company Background

Doorco was established in 2004 and is a manufacturer of wooden cupboards in a large, modern factory equipped with upmarket machinery. They supply some of the larger construction companies with kitchen and built-in cupboards, but they also cater for the needs of private customers in the domestic market. To date, numerous housing developments as well as an endless list of private customer projects have been completed.

The product range includes kitchen, bathroom and built-in cupboards as well as bar and patio cupboards, each that can be customised to cater for all preferences. They have endless possibilities for cupboard finishes, surface work, colours and patterns that can be private customer or construction housing specific.

When Doorco started in 2004, it was a small company and their market consisted solely of private customer projects which included supplying and installing customer-specific products. In 2008, Doorco started expanding their market to housing development projects and in 2009 they experienced rapid company growth when their market developed into 50 percent private customer projects and 50 percent housing developments.

In 2010, Doorco once again experienced rapid company growth where their market changed to 95 percent housing development projects and only 5 percent private customer projects. This is still their market ratio to date, with their main focus being housing development projects. A housing development project typically includes producing and installing kitchen and built-in cupboards (BIC) for approximately 100 houses, over a time period of four months. The housing developer would typically choose the type of surface work, finishes and patterns for all 100 houses and the house owner then has the choice of the colour for the cupboards.





## **2. Project Background**

With the company growth experienced over the last four years, Doorco found that their productivity was decreasing. An employment training opportunity was created by Doorco for an industrial engineering student to assist with the identified problems and this opportunity was awarded to the author of this project. A preliminary work study was conducted, and it was found that the business system and the storage operations were the most significant contributors to the loss of productivity. The main reasons for this were observed to be the manual business system, an unorganised layout for parts, an ineffective labelling system for parts and the lack of an efficient inventory system.

## **3. Problem Statement**

The business system used at Doorco is inefficient, because everything is done manually by the owner. This manual business system include a manual accounting system, with manual creditor and debtor books, a manual filing system and manual payslips and invoices. A great amount of time is wasted with this business system and it leads to a decrease in productivity in the office.

The parts storage system is inefficient, because parts are currently placed anywhere in the storage area. This leads to a loss in productivity due to ineffective time spent searching for parts in order to supply them to the production and installation departments. There is also little control over the parts supplied to production and installation, which creates problems in the inventory system and lead to material shortages or oversupply.

## **4. Project Aim**

Based on the issues highlighted in the problem statement, the aim of this project will be to increase productivity at Doorco through improving the manual business system by converting it to a computerised business system. The storage system used to supply parts to the production and installation departments as well as the inventory system will also be improved.

Improving the storage operations will possibly include designing an improved layout for the storeroom and re-designing the current bins and bin locations in order to allocate exact locations to each inventory item stored. The locations of the bins should be optimised to minimize the time spent searching for parts. To assist the workers in the identification of parts, the bins should be clearly labelled.

In order to assist with the problems currently experienced with the inventory system, the quantities and supply intervals for each inventory item kept need to be specified to eliminate the probability of oversupplying or undersupplying production.

## 5. Project Scope

A manufacturing organisation has four general functions, namely product design, manufacturing planning, manufacturing control and business functions. The scope for the first part of the project is to assist Doorco in improving the manual business system. The diagram below demonstrates the scope of the first part of the project.

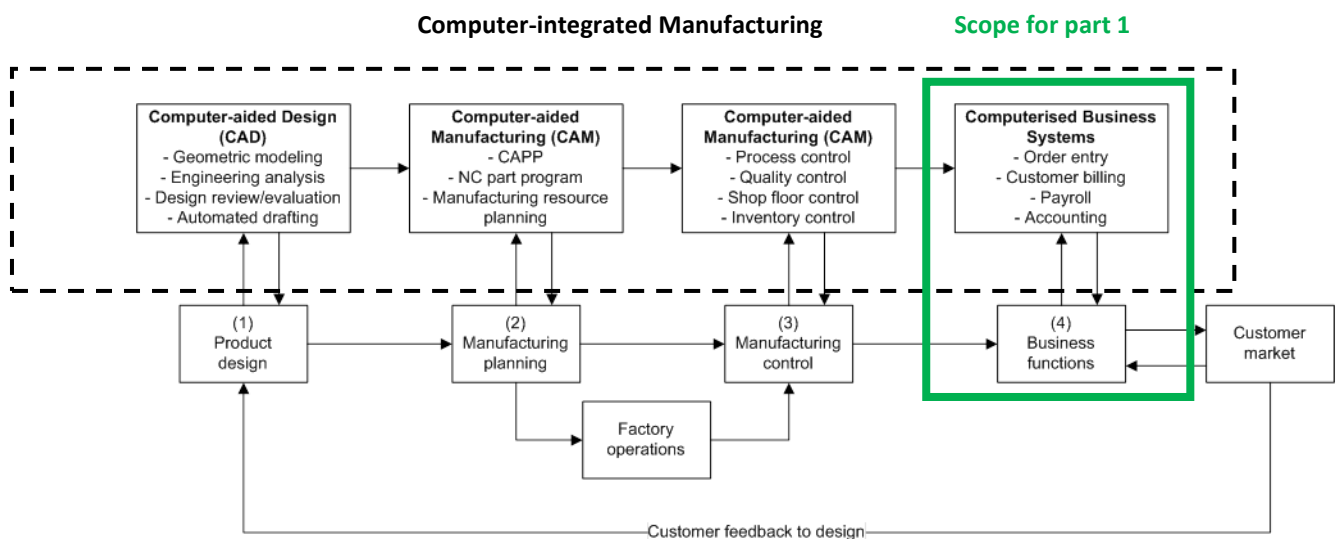
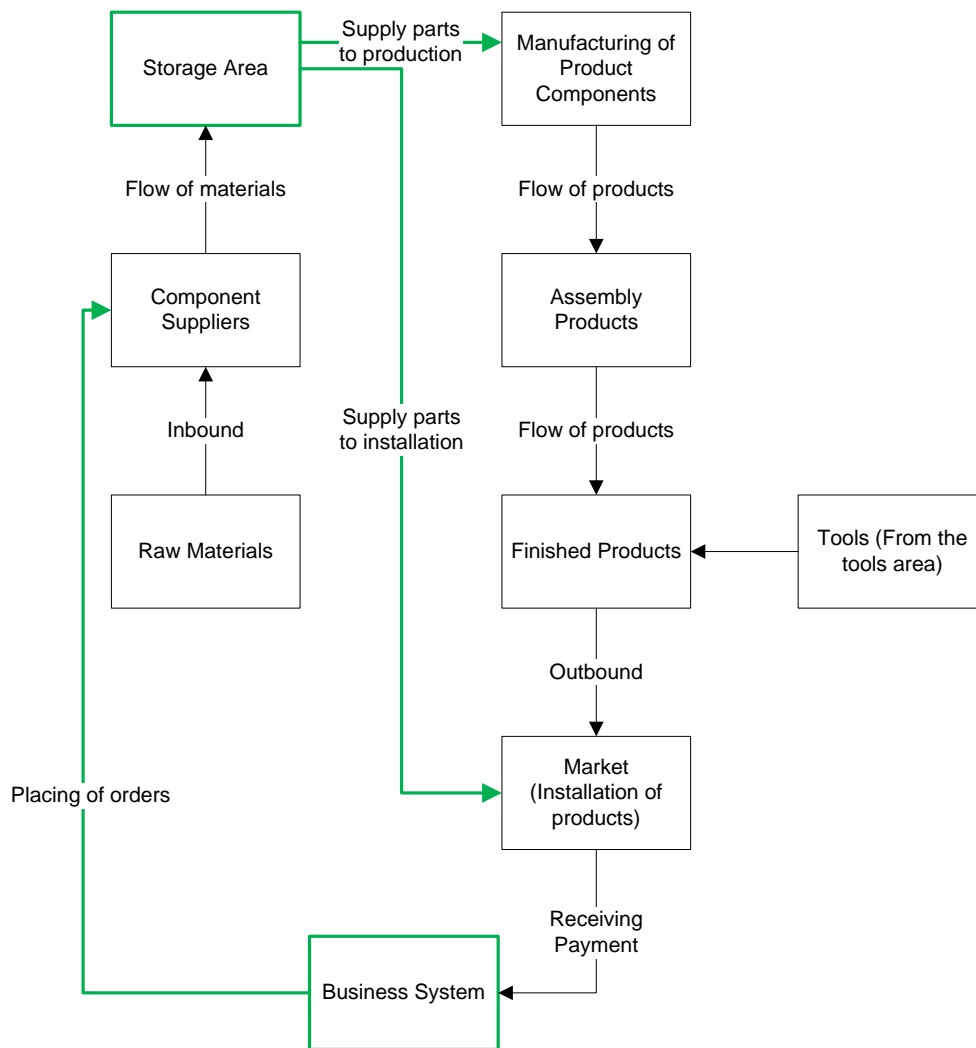


Figure 1: Diagram of Scope - Part 1

It is also important to limit the project to a specific part of the manufacturing process. For the second part of this project, the storage operations and inventory system must be investigated and possibly improved.

The performance of the supply chains on the inbound side (delivery of supplies) and the outbound side (distribution and installation of the finished products) cannot be excluded as possible contributors to the reduction in productivity, but the analysis of these supply chains would stray from the aim of the project and the scope therefore excludes them. This also holds for the measuring of productivity of the factory workers through time studies.

The green lines and blocks in the diagram below demonstrate the scope for this project.



**Figure 2: Diagram of Scope - Part 2**

In summary, the scope of the project will include the business system, the storage area's layout, the storage system and the inventory system. The inbound and outbound supply chains as well as time studies of the workers are excluded.

Methods and tools from the Industrial Engineering field will be used to solve the problems. This includes knowledge gained in relevant subjects during the Industrial Engineering course at the University of Pretoria. ECSA exit-level outcomes 1, 3, 4 and 9 will be taken into consideration throughout the project duration.

## 6. Deliverables

### 6.1 Project deliverables

The deliverables for this project include a Project Proposal, a Preliminary Project Report, an Interim Report, a Final Report which will be bound and become the property of the University of Pretoria, a poster and two presentations to the Industrial Engineering department.

A progress report is presented to Doorco, apart from the Interim and Final reports. The report will include progress made in each part of the project, problems encountered during the time at Doorco, possible solutions and possible implementation procedures.

Deliverable	Date Expected
Project Proposal	20 March 2013
Preliminary Project Report	15 May 2013
Oral Presentation 1	28 – 30 May 2013
Progress Report to Doorco	29 July 2013
Interim Project Report	28 August 2013
Final Project Report	1 October 2013
Poster	29 – 31 October 2013
Oral Presentation 2	29 – 31 October 2013

**Table 1: Project Deliverables**

### 6.2 Proposed project plan

Activities and tasks to be completed are listed below.

- Compile a detailed literature review.
- Select the best alternatives from the literature review.
- Get familiar with the current manual business system.



- Plan regular discussions and meetings with the owner at Doorco, Mr. DC Lubbe, to get specific requirements on the business system and also to discuss problems.
- Convert the current manual business system to a computerised business system.
- Design an improved storage layout and storage system in the storage area.
- Design an effective labelling system for the storage area.
- Determine the optimal amount of items to be stored in the storage area to supply production and installation without shortages or oversupply. This will link with the inventory system.
- Design an effective inventory system.
- Evaluate the project.
- Practical implementation will be included for some of the findings.

See the proposed Gantt chart in Appendix E and the actual Gantt chart in Appendix F for the overall Project Plan.

# Chapter 2: Literature Review

## 1. Purpose of a Literature Review

A literature review is “the use of ideas in the literature to justify the particular approach to the topic, the selection of methods, and demonstration that this research contributes something new” (Hart, 2008).

Hofstee (2006) states that “a high-quality literature review shows that you are aware of what is going on in the field, your credentials, and that there is a theory base for the work you are proposing to do.” A literature review will assist to attain knowledge on the subject at hand and to get acquainted with the company so that a professional can relate to factory workers in a language easily understood by them.

According to (Beile & Boote, 2005), the purpose of a literature review is to provide a context for the research, justify the research, show where the research fits into the existing body of knowledge, enable the researcher to learn from previous theory on the subject, illustrate how the subject has been studied previously, show that the work is adding to the understanding and knowledge of the field, and to help refine, refocus or even change the topic.

A literature review may also be approached as a process with the following sequential steps (Levy & Ellis, 2006):

1. Obtain inputs to the literature review.
2. Process the literature.
3. Produce outputs from the literature review.

From all the above sources, it is clear that a literature review is crucial to the success of this project. A literature review was conducted by gathering information through the following sources: books, journals, internet, experience (interviews with specialists) and self gathering of information (personal observations). Alternatives were researched for each problem identified. The research outputs for each problem are included in the sections that follow and Chapter 3, the Solution Design, provides the best (chosen) alternatives to be pursued in the remainder of this project.



## 2. Manual Business System

Gary Hadler is a qualified accountant who has taught accounting and computerised accounting software for over 18 years. Gary said: "I am continually amazed when I come across a business either not using a computerised accounting package or using spread sheets to do their accounts."

The owner at Doorco is currently creating all quotes, invoices and payslips manually on Excel and uses spread sheets to do his business accounts. Invoice numbers are generated by manually searching for the previous invoice and then entering the new invoice number manually. With the current method there is also no database that keeps track of customer information which means that for every invoice, the customer details must be entered in manually. If the owner wants to view which customer still owes him money, this means manually looking through all the invoices and payments and then calculating the amount payable per customer with a calculator. As one can only imagine, this manual method wastes a lot of time.

A business owner needs to be able to see at a glance the health of his finances and must be able to quickly identify trends and opportunities in his business. In a small business, paper bookkeeping is essentially obsolete and a computerised business system solution is critical. (Hadler, 2005)

## 3. Computerised Business System

The introduction of computerised business systems provides major advantages such as speed and accuracy of operation and most importantly, the ability to see the real-time state of the company's financial position (Hadler, 2005).

A need was identified at Doorco for a computerised business system that consist of functions such as creating quotes and invoices with an automatic numbering system, converting quotes to invoices, automatically adding a customer's details to quotes and invoices, and generating reports that will replace the manual reports currently generated by the owner.



In order to possibly satisfy this need, three alternatives were researched:

1. Free accounting software
2. Creating an accounting program
3. Commercial accounting software

For each alternative, the following aspects were researched:

- a. Information on the alternative
- b. Software available
- c. Advantages and disadvantages

### **3.1 Free accounting software**

#### **3.1.1 Information on free accounting software**

There is an abundance of free software available on the internet to help business owners stay on top of their finances. Choosing the right software that will satisfy the company's needs however, can be difficult. Software often seems overly loaded with bells and whistles with only marginal utility for the company, while other software has less functionality than Microsoft Excel.

Free accounting software can be broken up into two categories, namely open-source software and freeware.

- Open source software refers to a program in which the source code is available to the general public for use and/or modification from its original design, free of charge. The source code is the form of the program when a programmer writes a program in a particular programming language. Open source code is typically created as a collaborative effort in which programmers improve upon the code and share the changes within the community (Beal, 2008).
- Freeware is software that is available for use at no monetary cost or for an optional fee, but usually with one or more restricted usage rights. Freeware is in contrast to commercial software, which is typically sold for profit, but might be distributed for a business or commercial purpose in the aim to expand the market share of a premium product (Beal, 2008).



### 3.1.2 Free accounting software available

Free accounting software is available on the internet and can be downloaded by anyone free of charge. Following is a list of the most popular open-source and freeware software available.

Open-source software available:

- GnuCash
- Grisbi
- Homebank
- KMyMoney
- OpenERP
- Tryton
- TurboCASH
- No Simpler Accounting

Freeware software available:

- BIG4Books
- Microsoft Office Accounting Express
- Outright
- Express Accounting
- Express Invoice
- Invoice Expert XE
- Nevitium
- SSuite Office

### 3.1.3 Advantages and disadvantages of free accounting software

Free accounting software is a viable option for a business system, provided that a program can be found that satisfy the specific needs of the company. Below is a table of the advantages and disadvantages of using free accounting software as a computerised business solution (Stewart, 2005):



Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Free of charge</li><li>• More add-ons, extensions and helpful communities</li></ul>	<ul style="list-style-type: none"><li>• Programs are not supported</li><li>• No help available for technical support issues</li><li>• Because it is free, nobody is under any obligation to help you</li><li>• Unwanted advertisement on the program</li><li>• Could contain viruses that steal your passwords or financial information</li><li>• Software cannot be tailored</li></ul>

**Table 2: Advantages and Disadvantages of using Free Accounting Software**

The main disadvantage of free accounting software is that the software cannot be tailored to satisfy the specific needs of the company. If free accounting software is used, a program must be chosen that satisfy the specific needs of the company, and if such a program cannot be found, free accounting software is not the best solution to the problem.

## **3.2 Creating an accounting program**

### **3.2.1 Information on creating an accounting program**

Small business owners that have minimal accounting knowledge usually create an accounting system on Microsoft Excel. Microsoft Excel is the most popularly used program for small business owners for the following reasons:

- They are familiar with the program.
- Excel is included in the Microsoft Office Package which means that no extra costs have to be incurred for an accounting system.
- Excel has outstanding built-in formulas that can be used with minimal knowledge.
- Excel has a first-class help function that give step-by-step procedures on how to solve a specific problem.

Creating an accounting program can have its advantages, but many business owners only later realise that there are more appropriate programs to use for accounting purposes which include accounting-specific features and extras.

### 3.2.2 Software available for creating an accounting program

Any software can be used to create an accounting program, but the choice of software will determine the feasibility of the company's business system. The most popular software solutions for creating accounting programs are identified as:

- Microsoft Excel
- Microsoft Access

Most people are familiar with Microsoft Excel and the functions that the program includes, but people are not as familiar with Microsoft Access. Accounting templates for Microsoft Access can be downloaded free of charge from the internet and these templates can be a very helpful tool. Following is a table of the business templates that Microsoft Access has available and what these templates are best used for (Access, 2013):

Template	What the Template is best used for
Assets template	Tracking the condition or status of assets or inventory.
Contacts template	Keeping track of customer's key information, buying habits and more.
Issues and tasks template	Tracking the progress of team activities.
Non-profit template	Managing events, donors, members and donations.
Projects template	Keeping track of projects, tasks and people assigned to them.
Services template	Managing quotes, creating invoices and running the business.
Goods template	Tracking inventory, creating invoices and running the business.
Price compare template	Establishing the price and keeping track of competition.

**Table 3: Microsoft Access Templates**

All these templates are accounting-specific and can be very useful, provided that a template can be found that meet the specific requirements of the business.



### 3.2.3 Advantages and disadvantages of creating an accounting program

Both Microsoft Excel and Microsoft Access are excellent programs that have a wide range of deliverables and both are competent to serve as an accounting system.

Following is a table of advantages and disadvantages of using a self-created accounting program:

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• No additional costs, because program is included in the Microsoft Office package</li><li>• Accounting system can be created and tailored to satisfy specific needs of the company (provided that the person has the required knowledge of the program)</li></ul>	<ul style="list-style-type: none"><li>• It is not an accounting-specific software program</li><li>• No automatic links exist that links payments and invoices, for example</li><li>• Reports like customer aging reports, monthly statements, invoice reports, etc. must be created manually</li><li>• Invoice and quote numbers are not generated automatically</li><li>• Customer details are not added automatically by choosing a customer from a list</li><li>• No help available for the accounting program as the program was created</li><li>• Input screens have to been designed for ease of use</li></ul>

Table 4: Advantages and Disadvantages of using a self-created Accounting Program

## 3.3 Commercial accounting software

### 3.3.1 Information on commercial accounting software

As with free accounting software, there is an abundance of commercial accounting software options to choose from. Again, it is about choosing the right software to satisfy the company's specific needs.

### 3.3.2 Commercial accounting software available

Following is a list of the most popular commercial accounting software available off-the-shelf:





- Microsoft Money
- Microsoft Office Accounting Professional
- MYOB (AccountEdge Accounting Software)
- Sage Pastel Accounting
- Peachtree Accounting
- QuickBooks
- SAP Business One
- Omni Accounts

Enterprise Resource Planning (ERP) is an extension of manufacturing resource planning that organises and integrates the information flows in a company through a single, central database shared by common business functions. The functions covered by ERP spread well beyond manufacturing operations and include sales, marketing, purchasing, logistics, distribution, inventory control, finance and human resources. (Groover, 2012)

Sage Pastel is a leading developer of accounting software packages, ERP software solutions and business management software solutions and they are the preferred commercial accounting software of South African businesses (Pastel, 2013).

### 3.3.3 Advantages and disadvantages of commercial accounting software

Following is a table of advantages and disadvantages of using commercial accounting software as a computerised business solution:

Advantages	Disadvantages
<ul style="list-style-type: none"><li>• Updates are included in the cost</li><li>• Accountability</li><li>• Programs are supported</li><li>• Help is available for technical support issues</li><li>• No unwanted advertisement</li><li>• Software can be tailored (customized) to satisfy the specific needs of the company</li></ul>	<ul style="list-style-type: none"><li>• Software is not free of charge (monetary disadvantage)</li><li>• Some software have annual fees for support or upgrades</li></ul>

Table 5: Advantages and Disadvantages of using Commercial Accounting Software

The main advantage of using commercial accounting software is that the software can be tailored to satisfy the specific needs of the company. The main disadvantage however is that the software is not free of charge, but the advantages far outweigh this disadvantage.

## 4. Storage Operations

In a business, the parts supply system ensures that the right parts are available at the right time and place in order to manufacture products. The storage system links directly with the parts supply system, because if the storage system is inefficient, parts cannot be located effectively and efficiently and the time to supply parts to production increase. Inefficient storage operations cause production time to increase, which leads to a reduction in productivity.

### 4.1 Storage space planning

There are two major material storage philosophies, namely random location storage and fixed location storage (Tompkins, et al., 2010).

- With random location storage, a stock-keeping unit (SKU) may be assigned to any available storage location. A SKU stored in location A one month might be stored in location B the following month, and a different SKU stored in location A.
- A fixed location storage system is an organised method of storage that places a product in a specific, pre-defined and permanent location in a storeroom. Fixed location storage dictates that a given SKU must always be stored in its assigned space, even if there is available storage space elsewhere. This method has the advantage of making items easy to find, because fixed locations become familiar.

The storage system currently used at Doorco is identified as a random-location storage system, but a need was identified to design a fixed location storage system in order to reduce the time spent searching for parts. The design of a fixed location storage system will include investigating an improved layout of the storeroom as well as the re-designing of storage bins to assign a specific location to each part stored.

## 4.2 Storage Layout Planning

In order to accomplish an effective storage layout plan, several storage area principles like popularity, similarity, size, characteristics and space utilisation must be integrated (Tompkins, et al., 2010).

### Popularity

Vilfredo Pareto's law states that "85% of the wealth of the world is held by 15% of the people" and his law often applies to the popularity of materials stored. Typically, 85% of a company's turnover will be a result of 15% of the materials stored and in order to maximize throughput, the most popular 15% of materials should be stored such that travel distance is inversely related to the popularity of the material.

### Similarity

Items that are commonly received and/or shipped together should be stored together, because these items will usually require similar storage and handling methods. The consolidation of these items in the same area will result in more efficient use of space and more efficient material handling.

### Size

The size philosophy suggests that heavy and bulky items that are difficult to move should be stored close to their point of use to minimize the distance over which they are handled. The distance is minimized, because the cost of handling these items is usually much greater than that of handling other items. Available cubic space should be used in the most efficient way while meeting restrictions on floor-loading capacity. Within typical floor-loading capacity, lightweight material can be stored at greater heights than heavy material.

The size philosophy also asserts that the size of the storage location should fit the size of the material to be stored. A variety of storage locations must be provided so that different items can be stored differently. In addition to looking at the physical size of an individual item, the total quantity of the item to be stored should also be considered.

### Characteristics

Characteristics of materials to be stored often require that they be stored and handled contrary to the method indicated by their popularity, similarity and size. Some important

material characteristic categories include perishable materials, oddly shaped and crushable items, hazardous materials, security items and compatibility of materials.

### **Space utilisation**

Space planning includes the determination of space requirements for the storage of materials. A layout must be developed that will maximize space utilisation while considering popularity, similarity, size and material characteristics. Some factors to be considered while developing the layout are space conservation, space limitations, accessibility and orderliness. Space conservation means maximizing concentration and cube utilisation, and minimizing honeycombing. Orderliness can be achieved by clearly marking aisles and avoiding empty spaces.

## **4.3 Storage Bins**

### **4.3.1 Current design of storage bins**

The storage bins currently used at Doorco were designed for the storing of parts before the company growth took place, but with the change in market, the workload increased and the demand of parts increased and changed.

At Doorco, different parts are required for the installation of different products. For example, the type of hinges required for the installation of private customer products are reach-in hinges, walk in pantry (WIP) hinges and L-shape hinges, but for the installation of housing development products, kitchen hinges and BIC hinges are required. With the increase and change in demand of parts, the storage bins and bin sizes became inefficient.

### **4.3.2 Improved design of storage bins**

Two classifications of bins were investigated:

- a. Static bins
- b. Dynamic bins

Static bins can store only one type of part and they are fixed in a storeroom. These bins assign each SKU to a specific and permanent location in the storeroom. Dynamic bins are movable bins and can store one or multiple SKUs. (Tompkins, et al., 2010)

Both static and dynamic bin sizes are determined by the sizes and quantity of parts to be stored in them.

#### **4.4 Labelling of storage bins**

Ineffective labelling of storage bins confuse workers and therefore increase the time to locate parts that are required for production. Storage bins should be labelled effectively to illustrate the specific and permanent locations of all stock keeping units.

#### **4.5 Developing a Storage Layout**

The easiest method of developing a layout is to develop alternatively scaled layouts and to compare these layouts with the principles of popularity, similarity, size, characteristics and space utilisation (Tompkins, et al., 2010). The steps required to develop a scaled layout are:

1. Draw the overall area to scale.
2. Include all fixed obstacles.
3. Locate the receiving and shipping areas.
4. Locate various types of storage.
5. Assign materials to storage locations.
6. Locate all aisles for equipment and access.

Maintenance of the layout requires that materials be stored in an orderly manner and that stock locations be known. Disorderly storage can cause significant losses in cube utilisation and accessibility, and therefore all materials should be stored in a neat and uniform manner and they should be accessible. Wasted space often results when materials are not properly placed within the assigned areas. All materials within a storage area must be able to be quickly located and picked. If materials are assigned to a fixed location, then stock location is easily performed. (Tompkins, et al., 2010)

### **5. Inventory Models**

According to Winston (2004), the purpose of inventory theory is to determine rules that management can use to minimize the costs associated with maintaining inventory and meeting customer demand. An inventory system is the set of policies and controls that

monitor levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large orders should be (Jacobs, et al., 2009).

## 5.1 Deterministic EOQ Inventory Models

The Economic Order Quantity (EOQ) model considers the trade-off between ordering cost and storage cost in choosing the quantity to use in replenishing item inventories. A larger order-quantity reduces ordering frequency and thus ordering cost, but requires holding a larger average inventory, which increases holding cost. On the other hand, a smaller order-quantity reduces average inventory, but requires more frequent ordering and therefore higher ordering cost. The cost minimizing order-quantity is called the Economic Order Quantity. (Schwarz, 2008)

A business requires an efficient inventory system in order to maximize profit. The Economic Order Quantity model is a commonly used element of a continuous review inventory system and it is based on a formula that calculates the most economical number of items a business should order to minimize costs and maximize value when re-stocking inventory (Harbour, 2009).

The costs involved in inventory models include ordering and setup cost, unit purchasing cost, holding or carrying cost and shortage cost. For the basic EOQ model to hold, certain assumptions are made (Winston, 2004):

1. Demand is deterministic and occurs at a constant rate.
2. If an order of any size is placed, an ordering and setup cost is incurred.
3. The lead time for each order is zero.
4. No shortages are allowed.
5. There is a cost incurred for holding inventory.

Since demand is usually stochastic, this model is not very realistic, but there are many versions of this model that can be used to make optimal inventory decisions when demand is deterministic (known in advance). These models consist of the basic EOQ model, but the above mentioned assumptions are relaxed. Modifications to the deterministic EOQ model also help it to behave more realistically and include quantity discounts, backordering, lead time constraints and order batches (Winston, 2004).



The main advantage of the EOQ model is the customised recommendations provided regarding the most economical number of units per order. The model may suggest buying a larger quantity in fewer orders to take advantage of discount bulk buying and minimizing order costs. Alternatively, it may point to more orders of fewer items if ordering costs are relatively low in order to minimize holding costs. Another advantage of the EOQ model is that it provides specific numbers particular to the business regarding how much inventory to hold, when to re-order it and how many items to order. (Harbour, 2009)

## 5.2 Stochastic EOQ Models

Stochastic EOQ inventory models are used when demand is uncertain or random over a given time period and therefore behave more realistic than deterministic EOQ models. Versions of the EOQ model for uncertain demand incorporate the important concepts of safety stock and service level. The stochastic EOQ models use the same costs as the deterministic models, but add overstocking and under-stocking costs to determine the optimal re-supply amount with continuous stochastic demand. One major disadvantage of the EOQ models is that they can only calculate the optimal value for one future period and therefore calculations need to be repeated for every time step. (Winston, 2004)

## 5.3 Materials Requirement Planning

Material Requirement Planning (MRP) is a production planning and inventory control system used to manage manufacturing processes. MRP systems have been installed almost universally in manufacturing firms, even those considered small. The reason is that MRP is a logical, easily understandable approach to the problem of determining the number of parts, components and materials needed to produce an end item. (Jacobs, et al., 2009)

MRP provides a schedule, specifying when each of these materials, parts and components should be ordered or produced. It generally has no complex inputs, and may be calculated directly from the MPS (master production schedule) and product dependency diagrams. MRP is based on dependent demand, which is caused by the demand for a higher-level item. (Jacobs, et al., 2009)

MRP is a backward scheduling problem intended to simultaneously meet three objectives (Jacobs, et al., 2009):

1. Ensure materials are available for production and products are available for delivery to customers.
2. Maintain the lowest possible level of inventory.
3. Plan manufacturing activities, delivery schedules and purchasing activities.

Information needed for MRP (Jacobs, et al., 2009):

- Demand for all products
- Lead times for all finished goods, components, parts and raw materials
- Lot sizing policies for all parts
- Opening inventory levels
- Safety stock requirements
- Any orders previously placed, but have not been received yet

Information obtained from MRP (Jacobs, et al., 2009):

- Planned orders: replenishment orders to be released at a future time
- Order release notice: notices to release planned orders
- Action notices: notices to speed up, slow down or cancel orders or to change order quantities or due dates
- Priority reports: information regarding which orders should be given priority
- Inventory status information
- Performance reports



# Chapter 3: Solution Design

The research from the literature review point towards a solution design. A solution design is essentially a selection of the best alternatives from the literature review for possible solution alternatives that are to be pursued in the remainder of the project. The chosen solution for each of the three problems identified will be discussed in the chapters that follow.

## 1. Computerised Business System

In the selection of the best alternative for a computerised business system, each of the alternatives in the literature review has to be selected sequentially and customised to Doorco. The reason for this being that if one of the first two alternatives (namely free accounting software or creating an accounting program) should result in the best alternative, it would have no financial implications and that would be the ideal solution.

### 1.1 Selecting Alternative 1: Free accounting software

A free accounting software program was downloaded and installed. Thereafter, company and customer details were added to the program followed by generating a few quotes, invoices and reports. This was shown to the owner to determine whether or not the program will satisfy the specific needs of the company.

The above-mentioned method was followed for all of the following free accounting software programs:

- Express Accounting and Express Invoice
- Microsoft Office Accounting Express 2009
- S Suite Office – Invoice Master 2.0
- Nevitium Invoice Manager 1.5.8.6
- Easy Invoice Creator 3.5.1.12
- GnuCash 2.4.11
- No Simpler Accounting 7.0
- Invoice Expert XE 4.08

None of these programs satisfied the owner's requirements. Following is a table of the problems identified by the owner for each of the free accounting software programs:

Program	Problems identified
Express Accounting and Express Invoice	Reports generated showed unpaid accounts per customer (total) and not per invoice as the owner's requirements.
Microsoft Office Accounting Express 2009	This program satisfied the owner's needs, but only a trial version of the program is available and the program could not be upgraded as it was discontinued in 2009. With the trial version of the program, all the accounting features could not be used.
S Suite Office – Invoice Master 2.0	Reports generated did not satisfy the owner's needs.
Nevitium Invoice Manager 1.5.8.6	The program could not be converted to use ZAR instead of USD, as it was written for companies in America.
Easy Invoice Creator 3.5.1.12	The quotes and invoices satisfied the owner's needs, but reports could not be generated with this program.
GnuCash 2.4.11	The program was not user friendly.
No Simpler Accounting 7.0	The program was not user friendly.
Invoice Expert XE 4.08	The program could not be converted to use ZAR instead of USD, as it was written for companies in America.

**Table 6: Problems identified for each of the Free Accounting Software Programs**

## 1.2 Selecting Alternative 2: Create an accounting program

Microsoft Access was the chosen software for creating an accounting program, because knowledge of the program was gained through a course at the University of Pretoria (BID 320). Other advantages of choosing Microsoft Access included the templates available on the internet and the fact that the owner already had the program on his computer, which would reduce the financial implications of the solution.

The "Services" template was selected and downloaded, because it has built-in features for generating quotes, invoices and reports, which are all requirements for the company's computerised business system. It was explained to the owner that the template database will only serve as an example and that the template could be customised or a new database could be constructed to meet the company's specific requirements.

A few customers were added to the template database and a few quotes, invoices and reports were generated. This was again shown to the owner to determine whether or not the Microsoft Access database will satisfy the requirements of the company.

Provided below is a screenshot of the template database:

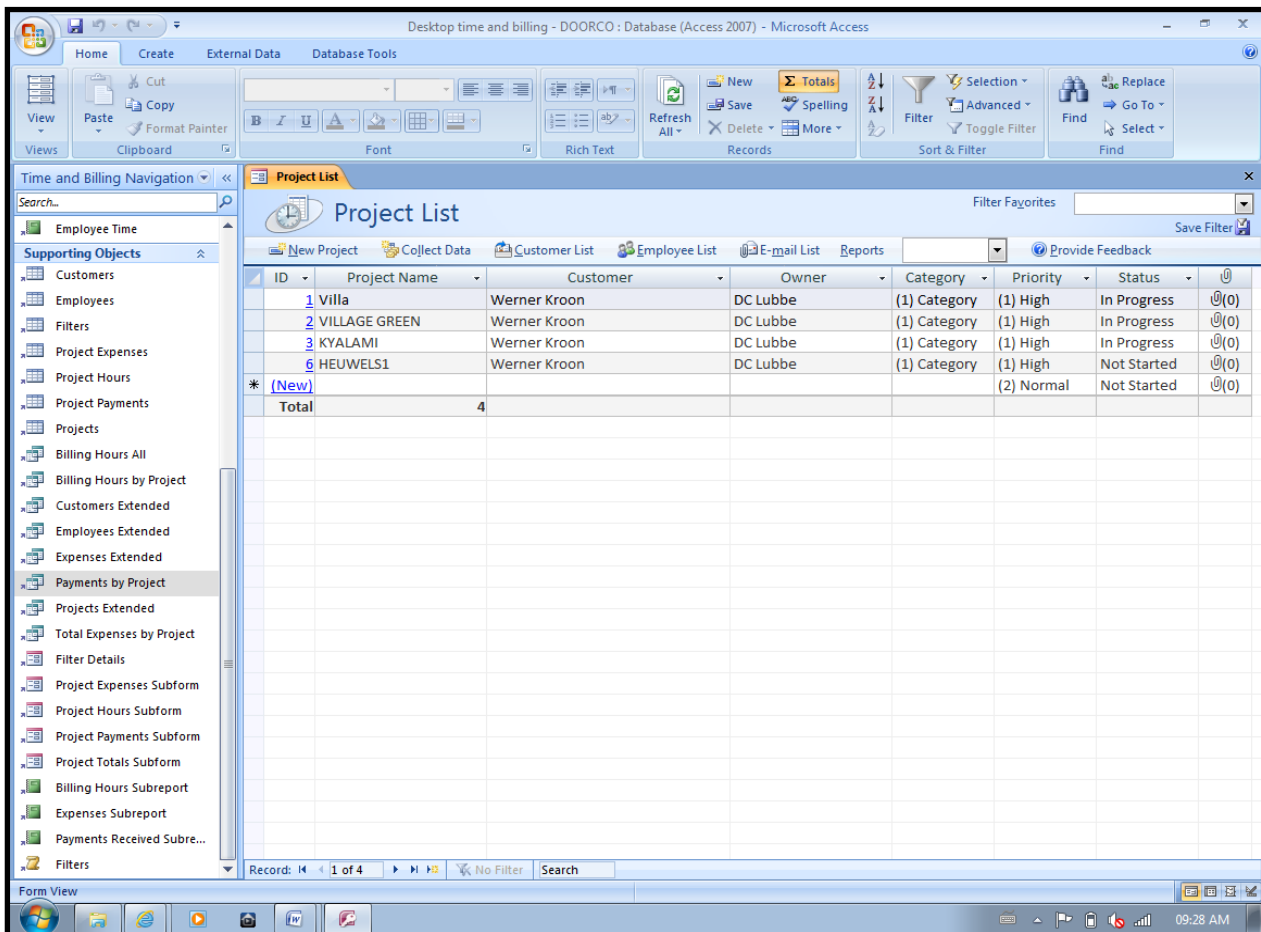


Figure 3: Screenshot of the Template Database created for Doorco

The owner was not satisfied with using Microsoft Access as his business system for the following main reasons:

- Invoice and quote numbers were not generated automatically.
- The database could not store the invoices and quotes without it becoming clustered.
- Data could easily be deleted from the database.
- Quotes and invoices could not be sent directly from Microsoft Access.
- He found that the layout and use of the program was not user-friendly.

### **1.3 Selecting Alternative 3: Commercial accounting software**

As none of the previous alternatives satisfied the company's requirements, the next option was to investigate commercial accounting software.

In the literature study, it was found that the main disadvantage of commercial accounting software is the cost of the software. If it can be motivated however, the cost can be ruled out as a disadvantage completely. Business functions are one of the four core functions (if not the most important function) of a manufacturing company and these functions include order entries, customer billing, payroll and accounting.

Order entries ensure that orders are received and fulfilled in the company. Customer billing includes generating quotes and invoices which is the first contact that a customer has with the company. It is therefore important to create quotes and invoices quickly and efficiently in a manner that looks professional. Payroll and accounting are the business functions that handle directly with the cash of the company, which is extremely important to any business owner. Having a computerised business system that perform all these business functions and satisfy the company requirements is vital and the advantages of the system will far outweigh the cost disadvantage.

The chosen software provider is Sage Pastel as they are the preferred choice of South African businesses. Sage Pastel offers a variety of different accounting software packages; it was about choosing the right package that will satisfy the company's requirements. Craig Rule, a consultant at the sales department of Pastel, advised that the Pastel Express package will satisfy all of the company's specific requirements.





Provided below is the quotation for the Sage Pastel Express package, which includes the software, installation and registration costs:

<b>Quotation</b>							Page 1 of 1	
<b>Sage Pastel a div of Sage South Africa (Pty) Ltd</b> Sage Technology Park 102 Western Service Road Gallo Manor Ext 6				Tax Registration 4350212660 Telephone +27 11 304-3000 Fax +27 11 304-3001				
<b>To:</b> MAX0169 Maxcrete Coatings CC 191 Edison Crescent Hennospark Ext 7 0046								
<b>Account</b>	<b>Date</b>	<b>Order No</b>	<b>Delivery Note</b>	<b>Our Reference</b>				
MAX0169	2013/03/28	Quote		SOQ350751				
<b>Item Code</b>	<b>Item Description</b>	<b>Quantity</b>	<b>Unit</b>	<b>Price (In)</b>	<b>Disc %</b>	<b>Tax</b>	<b>Total (Incl)</b>	
B12XP1/COVER	COVERONLY XPRESS V12 1 USER	1.000		2507.00		307.88	2 507.00	
AAAM12/S	PASTEL ACC V12 BUS INTELL CEN	1.000		2680.00		329.12	2 680.00	
							Total (Excl)	4 550.00
							Tax	637.00
							Total (Incl)	5 187.00
							Discount	0.00
							<b>Total (Incl)</b>	<b>5 187.00</b>
Received by _____								
Date _____								
Signed _____								

**Figure 4: Quotation for the Sage Pastel Express Package**

The owner agreed to purchase the program, provided that a demo version could first be used to confirm whether or not the program is user friendly and satisfies the company's requirements. A 30-day demo of the Pastel Express program was acquired and customisation of the program will be provided in Chapter 4.

## 2. Storage Operations

In the literature study, it was determined that the easiest method of developing a layout is to develop alternatively scaled layouts and to compare these layouts with the principles of popularity, similarity, size, characteristics and space utilisation. These principles were identified at Doorco and are provided below:

### Popularity

The parts used and stored at Doorco can be divided into three categories:

1. parts used for production,



2. parts used for installation of private customer products, and
3. parts used for installation of housing development products.

Currently, there are no designated areas for parts to be stored and all parts, regardless of their popularity, are stored in any available location. The parts used for production were identified as the most popular 15% of materials as they are used daily and the travel distance of these parts should therefore be minimized.

### **Similarity**

Each category of parts identified above should be stored together as they are parts that are commonly used and shipped together.

### **Size**

The material handling principle of the size philosophy does not have an impact on the storeroom layout at Doorco, because all the parts stored are lightweight items. The sizes of the storage locations should however fit the sizes of the materials stored. For example: the storage location for larger items like worktop legs or rail brackets should be larger than the storage location for small items like screws or bolts.

The storage location sizes will also be dependent on the quantity of items to be stored in that location and will be determined by the inventory system. In order to provide a variety of storage locations so that different items can be stored differently, re-designing of the bins will be investigated.

### **Characteristics**

The parts stored at Doorco are not perishable, oddly shaped, crushable or hazardous materials and therefore, the characteristics principle does not apply.

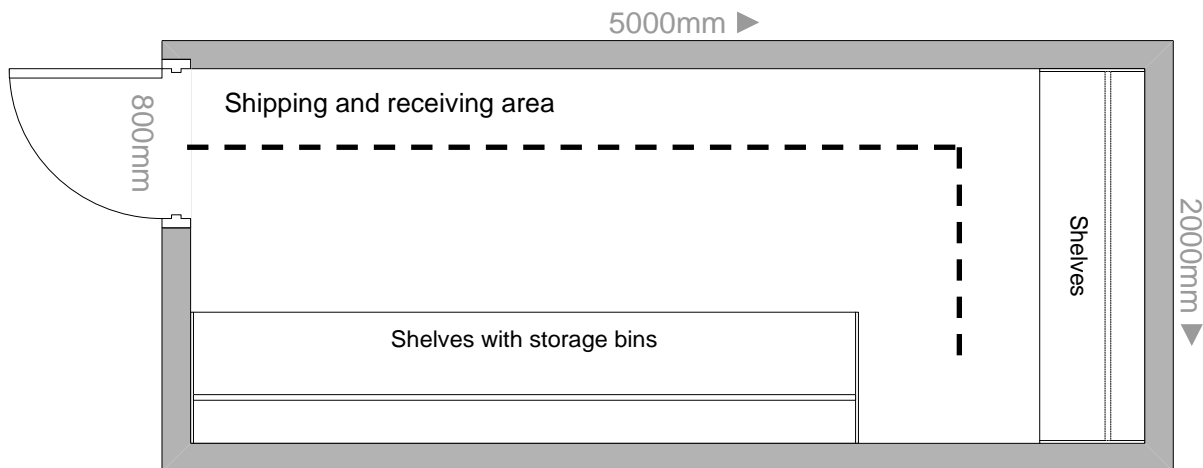
### **Space utilisation**

The storage area is currently not utilising the space optimally, because a lot of items (including old product samples) in the storeroom are not used anymore. There are also empty spaces present which reduce the orderliness of the storeroom. Parts used in production and parts used for the installation of housing development products should be easy accessible, but are currently stored in locations difficult to access. Space is limited, because the storeroom is only 10 square meters in size.

The steps listed in the literature study that are required to develop a scaled layout were followed and the outcomes of these steps are presented below:

**1. Draw the overall area to scale.**

Provided below is the current layout of the storage room.



**Figure 5: Current Layout of the Storage Room at Doorco**

**2. Include all fixed obstacles.**

The fixed obstacles in the storeroom are the shelves and the built-in storage bins. They are shown on the floor layout presented in step 1.

**3. Locate the receiving and shipping areas.**

Materials are shipped to and received from the door in the storeroom, which is also shown on the layout presented in step 1.

**4. Locate various types of storage.**

Fixed location storage is the only storage type that will be used, because a fixed location storage system is to be designed. Therefore, each product will be assigned a specific, pre-defined and permanent location in the storeroom.

**5. Assign materials to storage locations.**

Materials will be assigned to specific storage locations through the use of storage bins. Both classifications of storage bins that were investigated in the literature study will be used in the design of the fixed location storage system.

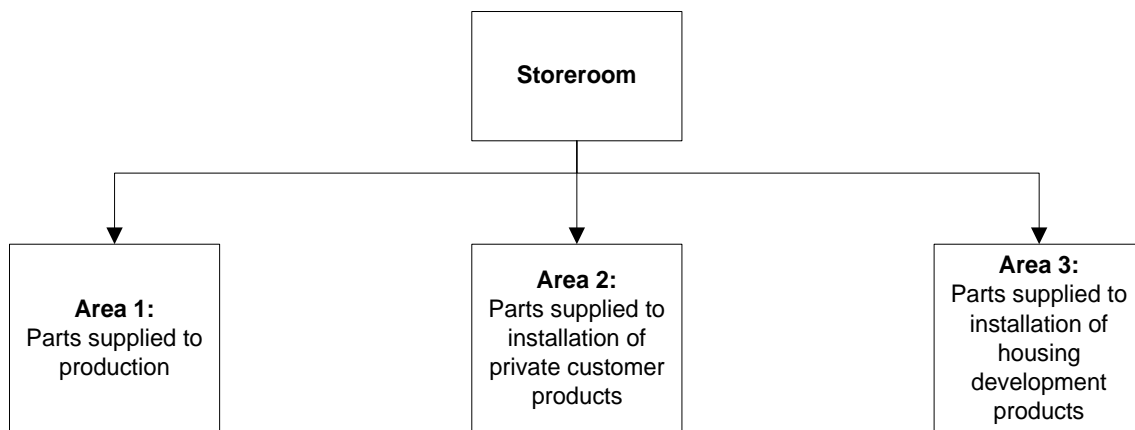
## 6. Locate all aisles for equipment and access.

The storeroom is only 10 square metres in size and space is limited. Aisles are therefore also limited and the only aisle located is shown with a dashed line in the layout in step 1. To ensure accessibility to all parts, the locations of the bins are important and will have to ensure that the parts are easy accessible. Wasted space should also be eliminated.

### 2.1 Possible Storeroom Layout

#### Areas

The storeroom could be divided into three areas to group similar parts that are commonly used and shipped together. A diagram is provided below to assist in the visualisation of the three areas:



**Figure 6: Diagram of the three possible areas in the Storeroom**

The parts used for production were identified as the most popular 15% of materials and in order to minimize the travel distance of these parts, they should be stored close to the production area. The parts used for installation of housing development projects are used more frequently than parts used for installation of private customer projects and should therefore be more accessible.

#### Static Bins

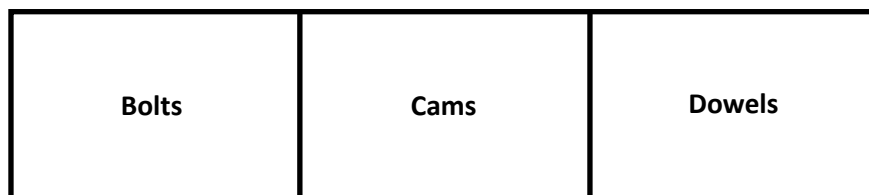
Each of the three areas in the storeroom should consist of multiple static bins; a separate bin for each type of part to be stored.

To make storage locations known and in order to assist the workers in the identification of parts, the static bins should be clearly and effectively labelled. The static bins together with efficient labelling of the bins will reduce the time currently spent searching for parts.

### **Dynamic bins**

Dynamic bins can store multiple parts that are used most frequently in production and should be stored next to the production line in order to reduce the time spent acquiring parts from the storeroom. Once empty, these mobile bins can be taken to the storeroom and filled with parts from the static bins. This method will also assist in ensuring more control over parts supplied to production. The production items used for every product produced in the factory (and therefore the parts most frequently used) were determined as bolts, cams and dowels.

A possible design for the dynamic bins is provided below:



**Figure 7: Possible Design for the Dynamic Bins**

The storeroom layout together with the design of the static and dynamic bins will be presented in Chapter 5.

## **3. Inventory System**

At Doorco, there is very little control over parts supplied to production and therefore the exact quantities of items in storage cannot be determined. This also affects the replenishment of supplies; currently it cannot be determined how many parts are needed. Supplies are ordered when they are required and there are no buffer parts available in storage. This could create shortages which could possibly contribute to the loss in productivity.

As mentioned previously, Doorco's market consists of 95 percent housing development projects and for each project, it is exactly known how many kitchen and built-in cupboards are required. Therefore, demand for higher-level items (end-items) is known. MRP is based

on dependent demand, which is caused by the demand for a higher-level item and therefore a MRP inventory model deemed to be the best option for an inventory system.

Material Requirements Planning minimizes the level of inventory, which has the following potential benefits:

1. The cost of inventory would be reduced.
2. The amount of space consumed by inventory in the storeroom would be reduced.

This is a huge advantage as the storeroom has limited space.

Manufacturing activities, delivery schedules and purchasing activities will be planned, which could possibly solve the problems currently experienced when order replenishment should take place.

MRP deems to be the best solution at this stage, but the chosen inventory system and all components of the solution will be presented in Chapter 6.

# Chapter 4: Customisation of Pastel

Customisation of the acquired 30-day Pastel Express demo program will be presented in this chapter. Firstly, the demo version was installed and Doorco's company details were added.

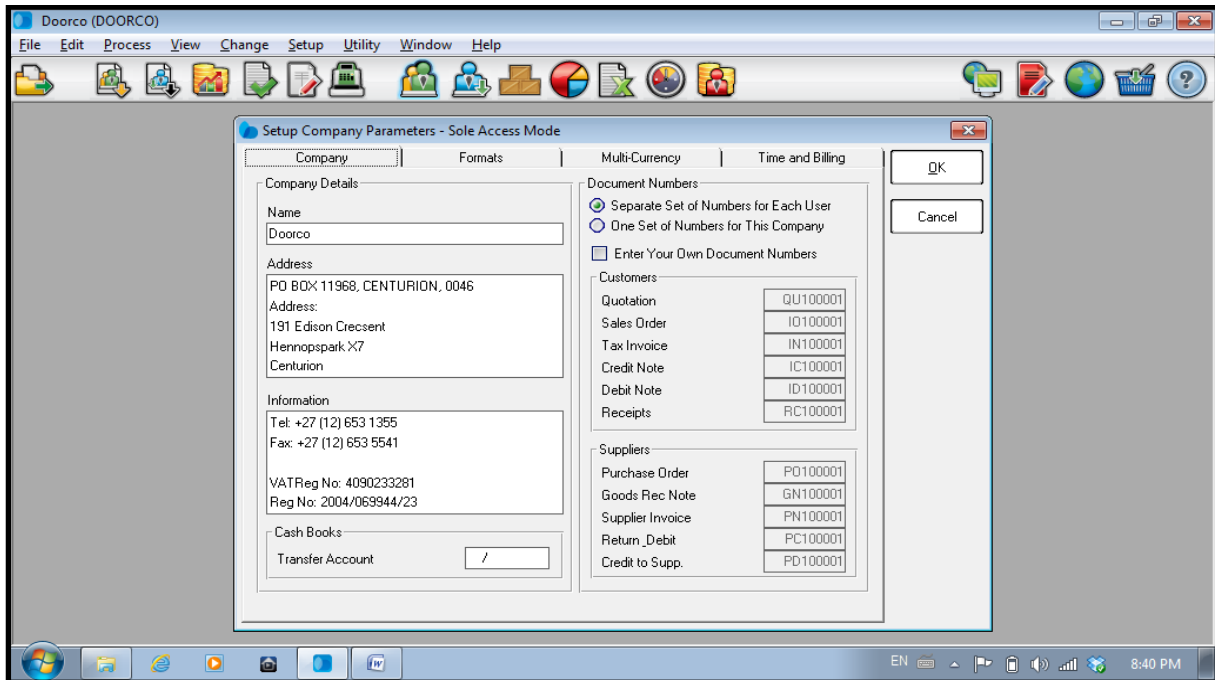


Figure 8: Screenshot of Pastel - Company Details Added

Four customers were added in order to create invoices, quotes, payments and reports.

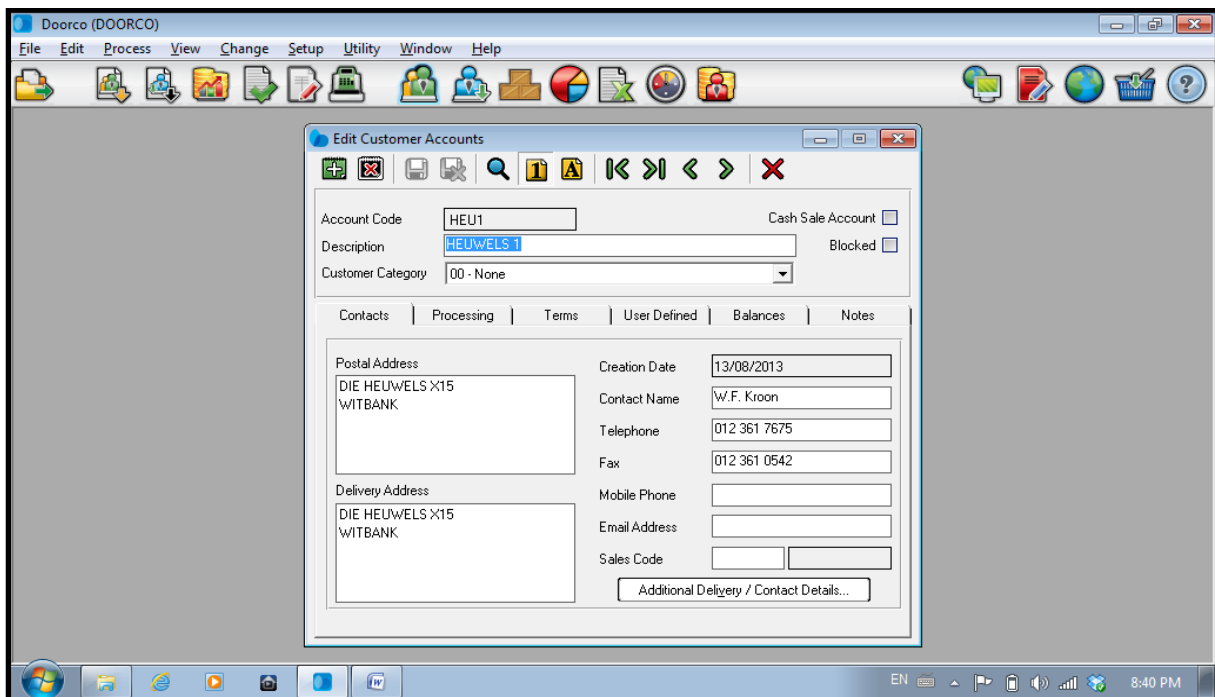
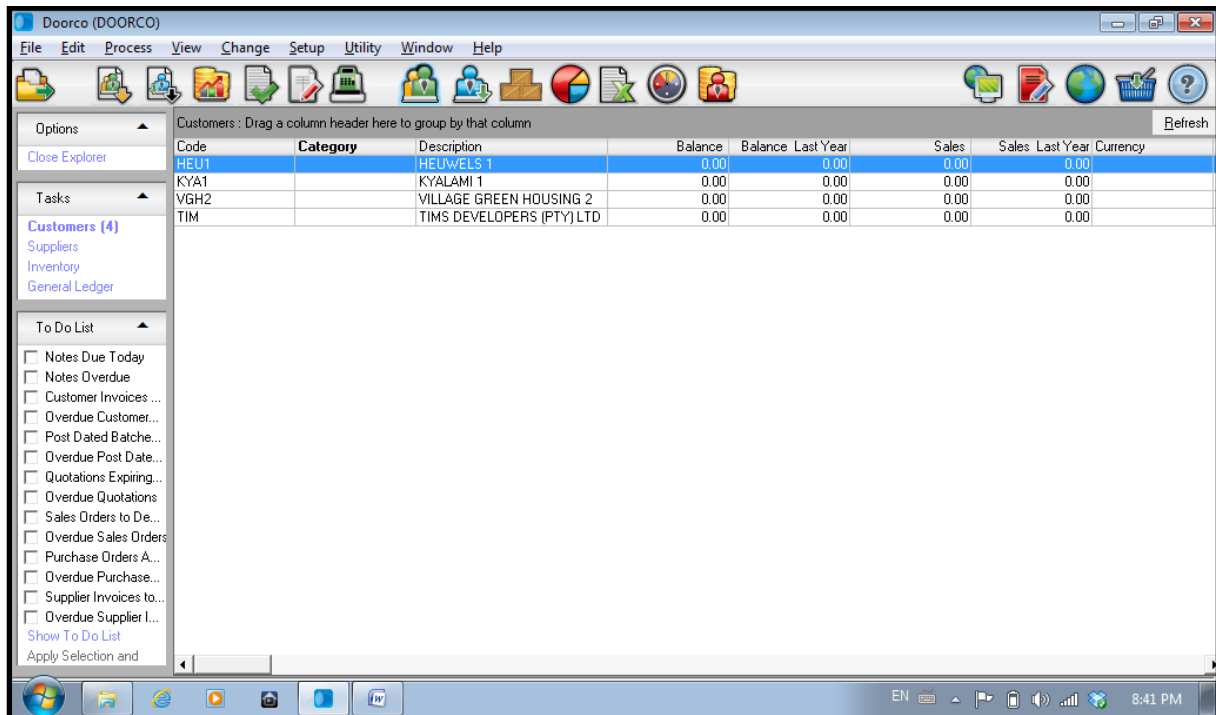


Figure 9: Screenshot of Pastel - Customers Added



Following is a list of the four customers that were created.

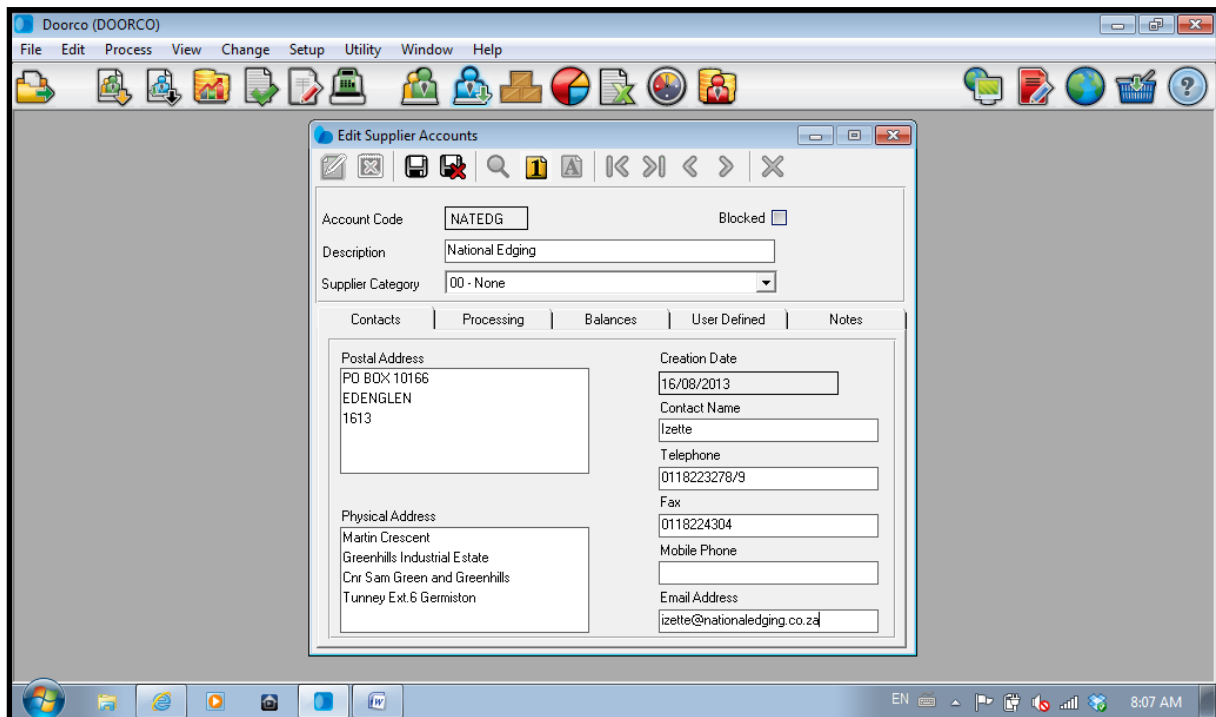


Customers : Drag a column header here to group by that column

Code	Category	Description	Balance	Balance Last Year	Sales	Sales Last Year	Currency
HEU1		HEUWELS 1	0.00	0.00	0.00	0.00	
KYA1		KYALAMI 1	0.00	0.00	0.00	0.00	
VGH2		VILLAGE GREEN HOUSING 2	0.00	0.00	0.00	0.00	
TIM		TIMS DEVELOPERS (PTY) LTD	0.00	0.00	0.00	0.00	

Figure 10: Screenshot of Pastel - List of Customers

Three suppliers were added in order to create supplier payments and reports.



Edit Supplier Accounts

Account Code: NATEDG  Blocked

Description: National Edging

Supplier Category: 00 - None

Contacts | Processing | Balances | User Defined | Notes

Postal Address: PO BOX 10166, EDENGLLEN, 1613

Physical Address: Martin Crescent, Greenhills Industrial Estate, Cnr Sam Green and Greenhills, Tunney Ext.6 Germiston

Creation Date: 16/08/2013

Contact Name: Izette

Telephone: 0118223278/9

Fax: 0118224304

Mobile Phone:

Email Address: izette@nationaledging.co.za

Figure 11: Screenshot of Pastel - Suppliers Added

Provided below is a list of the three suppliers that were created.

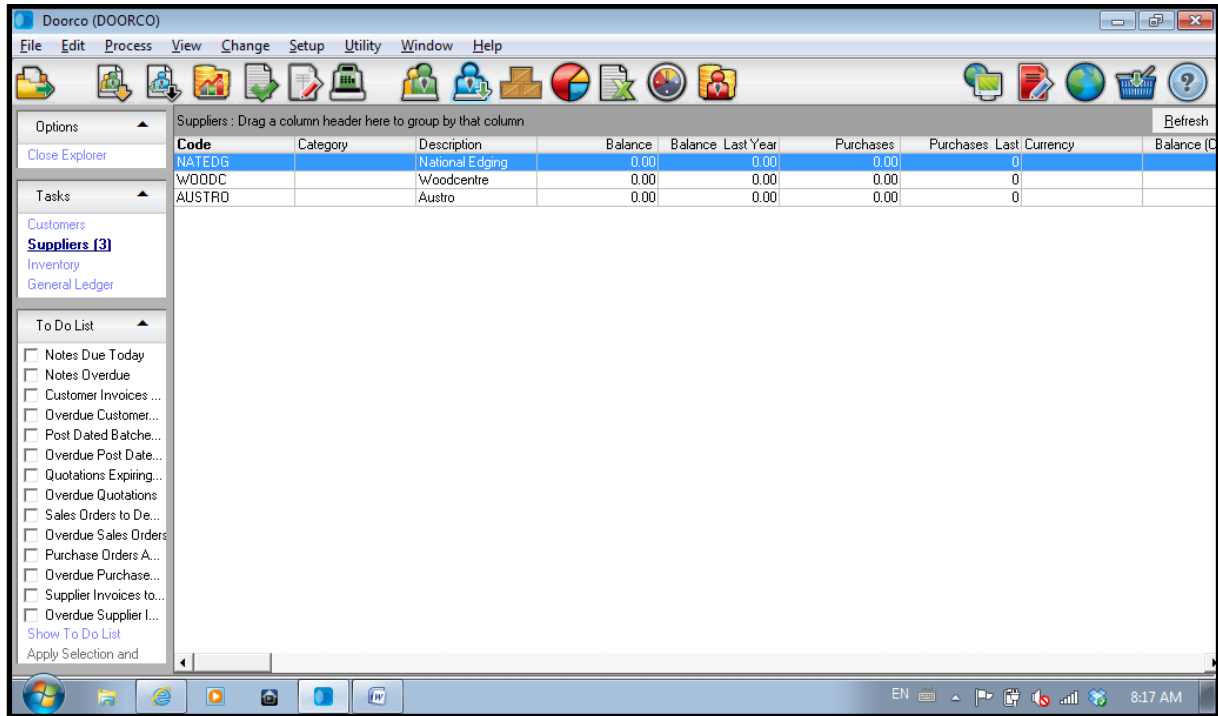


Figure 12: Screenshot of Pastel - List of Suppliers

A few invoices were then created for each of the four customers.

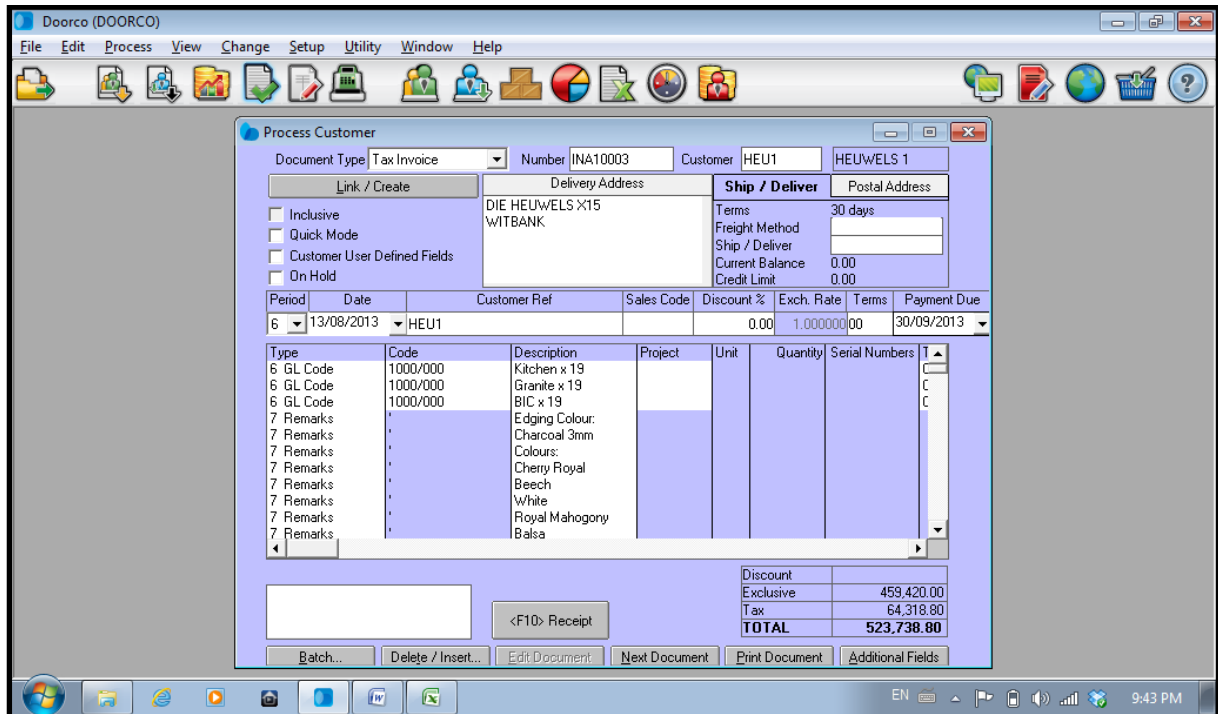


Figure 13: Screenshot of Pastel - Invoices Created for Customers

Following is a list of all the invoices that were created for customers.

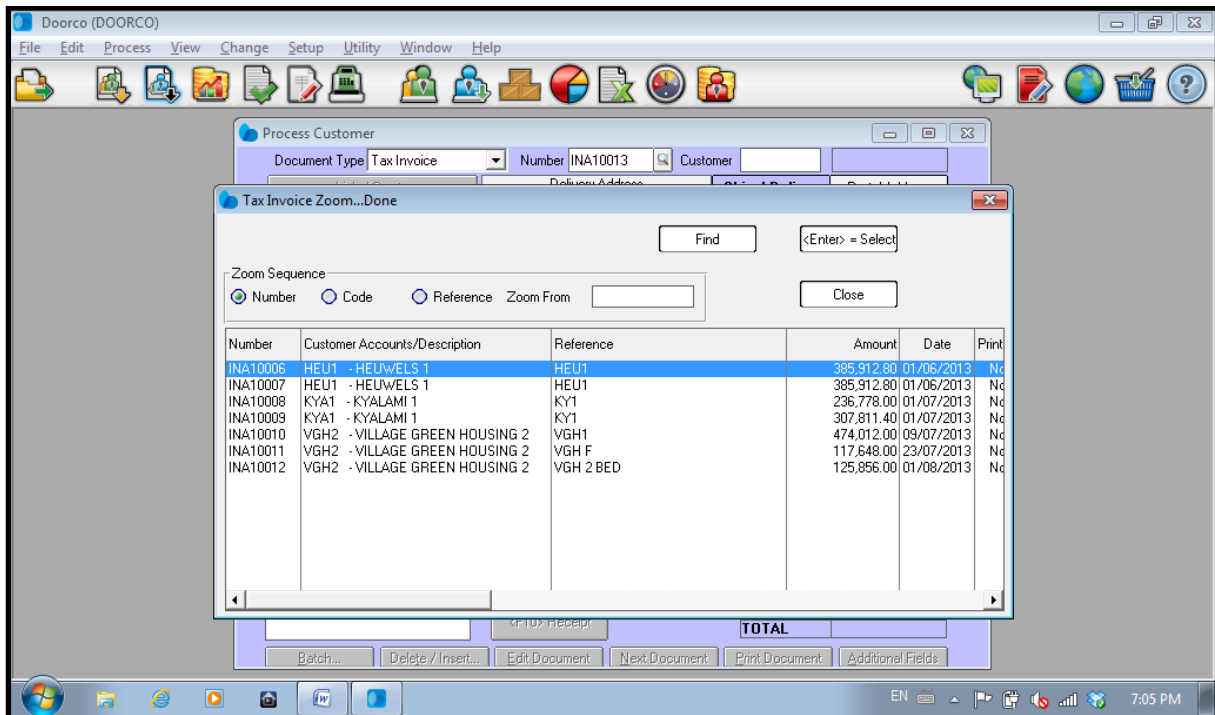


Figure 14: Screenshot of Pastel - List of Customer Invoices Created



Provided below is an example of a customer invoice created with Pastel.

Tel: +27 (12) 653 1355 Fax: +27 (12) 653 5541 VATReg No: 4090233281 Reg No: 2004/069944/23		<b>Copy Tax Invoice</b>											
Doorco PO BOX 11968, CENTURION, 0046 Address: 191 Edison Crescent Hennospark X7 Centurion		Date	13/08/2013										
		Page	1										
		Document No	INA10002										
TIMS DEVELOPERS (PTY) LTD STAND 2075 WATERFALL COUNTRY ESTATE		Deliver to STAND 2075 WATERFALL COUNTRY ESTATE											
Account	Your Reference	Tax Exempt	Tax Reference	Sales Code									
TIM	W2076	N	4650198999	Exclusive									
Code	Description	Quantity	Unit	Unit Price	Disc%	Tax	Nett Price						
1000000	Kitchen					14.00%	58,163.00						
1000000	BIC					14.00%	29,978.00						
1000000	Patio Granite					14.00%	2,970.00						
1000000	Vanities					14.00%	8,400.00						
Received in good order  Signed _____ Date _____ © Softline (Pty) Ltd		<table border="1"> <tr> <td>Sub Total</td> <td>99,511.00</td> </tr> <tr> <td>Discount @ 0.00%</td> <td>0.00</td> </tr> <tr> <td>Amount Excl Tax</td> <td>99,511.00</td> </tr> <tr> <td>Tax</td> <td>13,931.54</td> </tr> <tr> <td><b>Total</b></td> <td><b>113,442.54</b></td> </tr> </table>		Sub Total	99,511.00	Discount @ 0.00%	0.00	Amount Excl Tax	99,511.00	Tax	13,931.54	<b>Total</b>	<b>113,442.54</b>
Sub Total	99,511.00												
Discount @ 0.00%	0.00												
Amount Excl Tax	99,511.00												
Tax	13,931.54												
<b>Total</b>	<b>113,442.54</b>												

Figure 15: Screenshot of Pastel - Example of Customer Invoice Created

A few tax invoices received from each supplier was captured on Pastel.

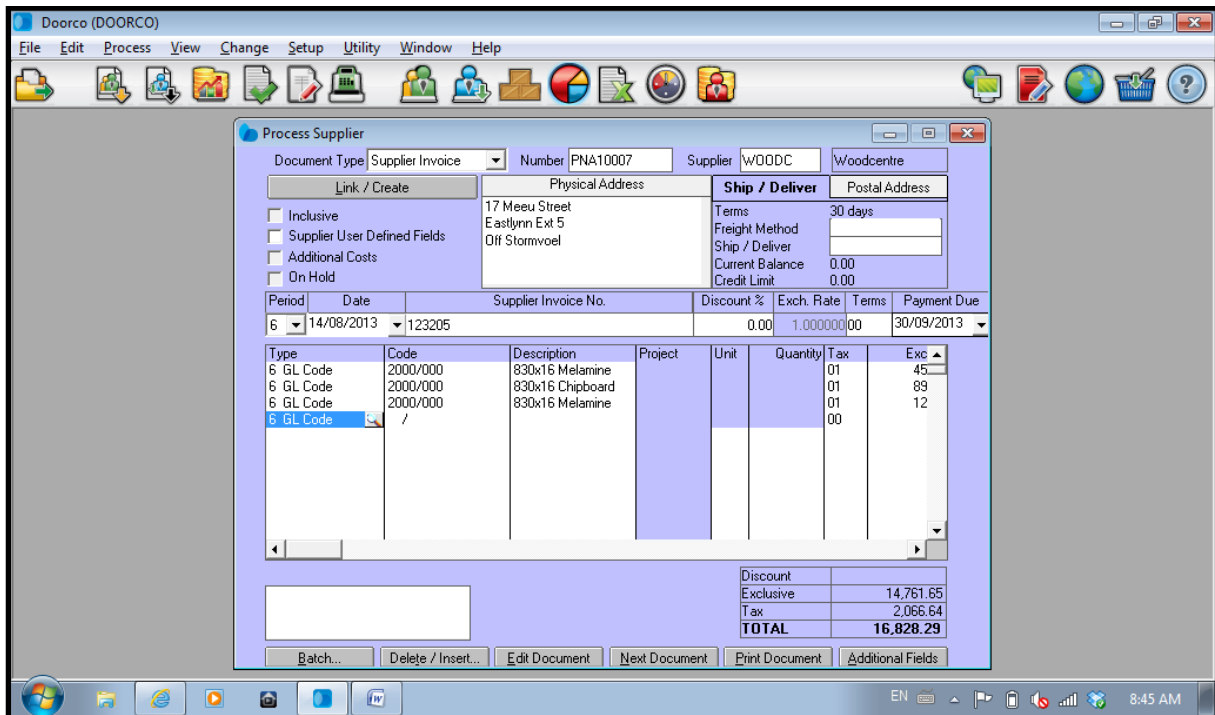


Figure 16: Screenshot of Pastel - Invoices Captured from Suppliers

Following is a list of all the tax invoices that was captured.

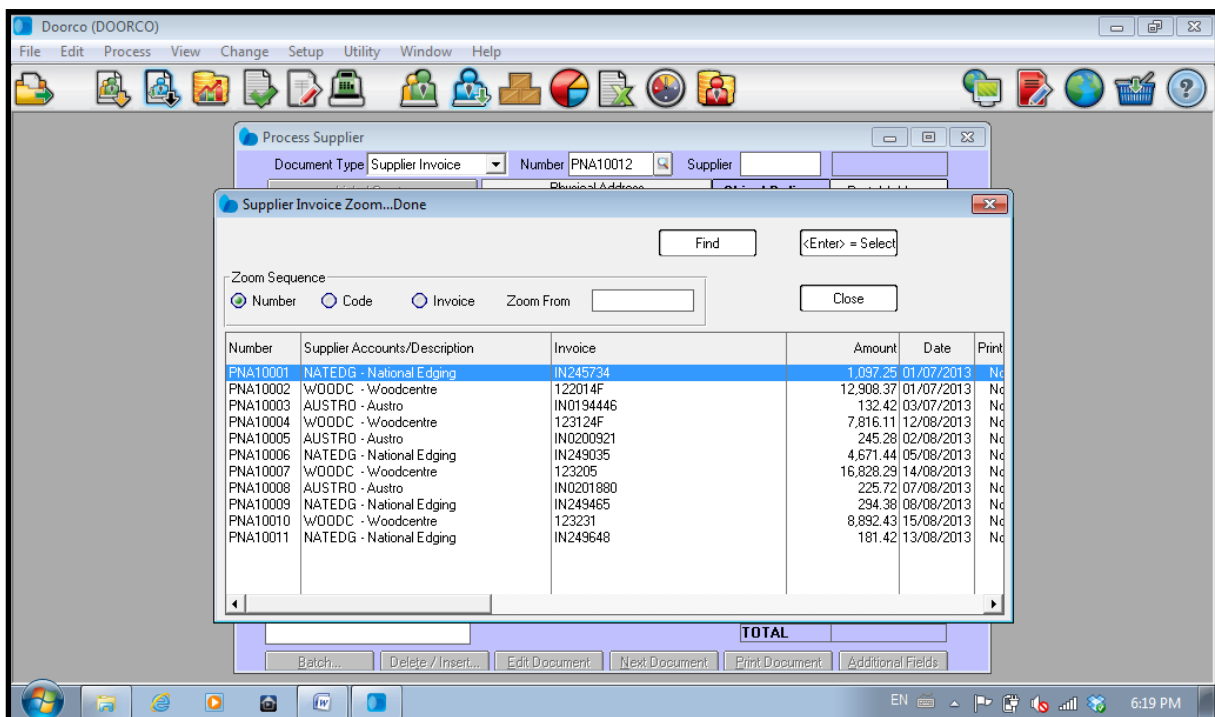


Figure 17: Screenshot of Pastel - List of Supplier Invoices Captured



On the Pastel home screen, customer and supplier balances can be viewed. These balances are updated automatically every time a payment is received or made.

Customer balances:

Code	Category	Description	Balance	Balance Last Year	Sales	Sales Last Year	Currency
HEU1		HEUVELS 1	1,285,564.40	0.00	1,136,460.00	0.00	
KYA1		KYALAMI 1	846,119.40	0.00	742,210.00	0.00	
VGH2		VILLAGE GREEN HOUSING 2	952,812.00	0.00	835,800.00	0.00	
TIM		TIMS DEVELOPERS (PTY) LTD	113,442.54	0.00	99,511.00	0.00	

Figure 18: Screenshot of Pastel - Customer Balances on Home Screen

Supplier balances:

Code	Category	Description	Balance	Balance Last Year	Purchases	Purchases Last Year	Currency
NATEDG		National Edging	-5,244.49	0.00	-5,477.62	0	
WOODC		Woodcentre	-46,445.20	0.00	-40,741.39	0	
AUSTRO		Austro	-603.42	0.00	-529.32	0	

Figure 19: Screenshot of Pastel - Supplier Balances on Home Screen



## Customer Payments

One of the customers (Heuwels) paid all his outstanding invoices in full.

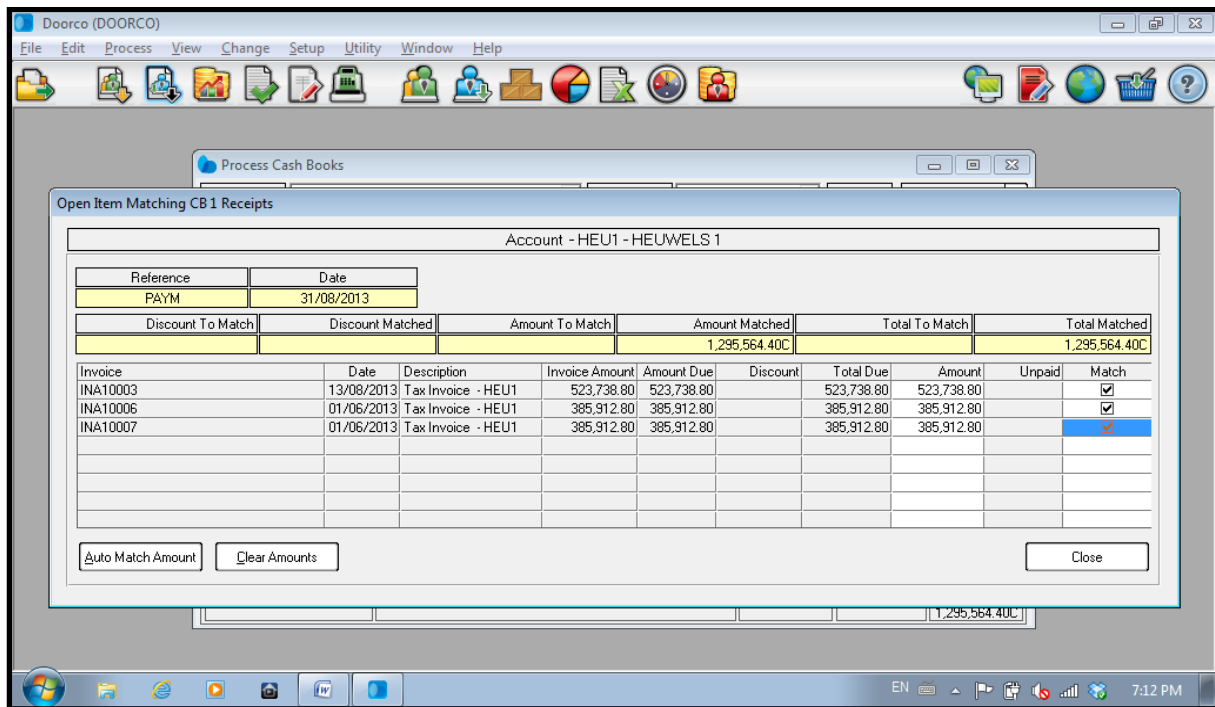


Figure 20: Screenshot of Pastel - Full Customer Payment

Another customer (Tim Developers) only paid R100,000.00 on his outstanding balance. Pastel automatically calculated the unpaid (outstanding) amount of R13,442.53.

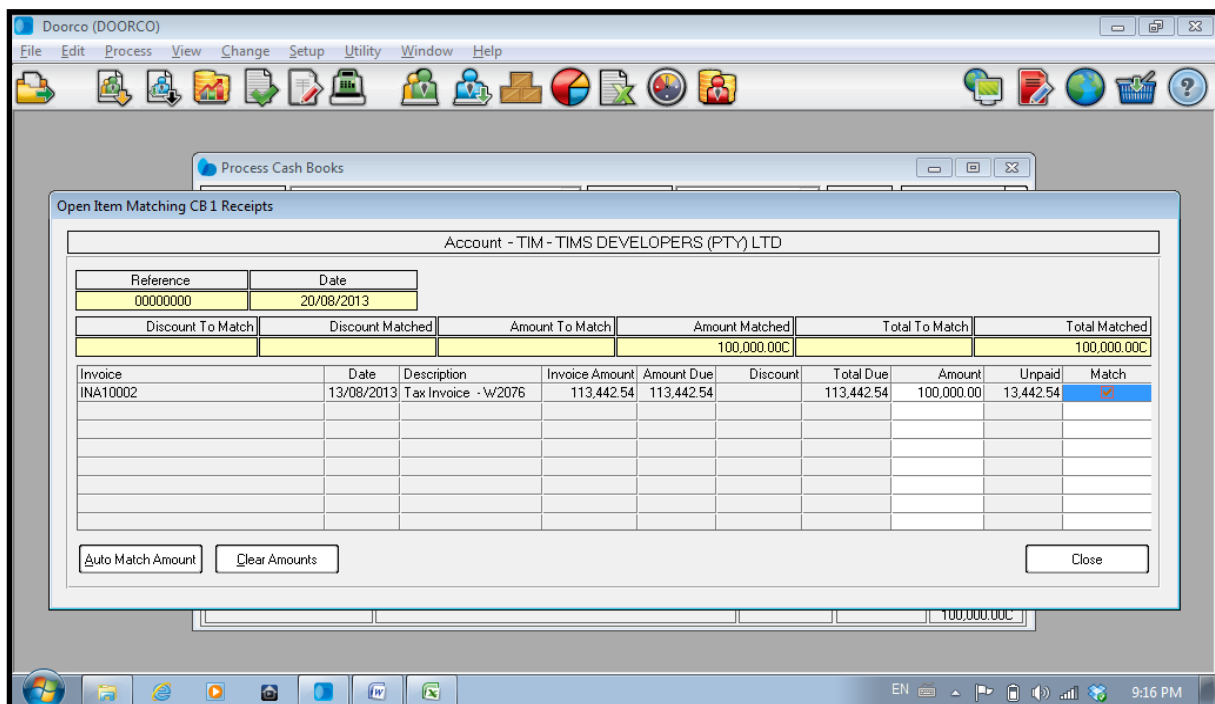


Figure 21: Screenshot of Pastel - Partial Customer Payment

Kyalami, another customer, paid only one invoice that was due according to his 30 day payment terms. Pastel automatically matches the payments to the invoices created.

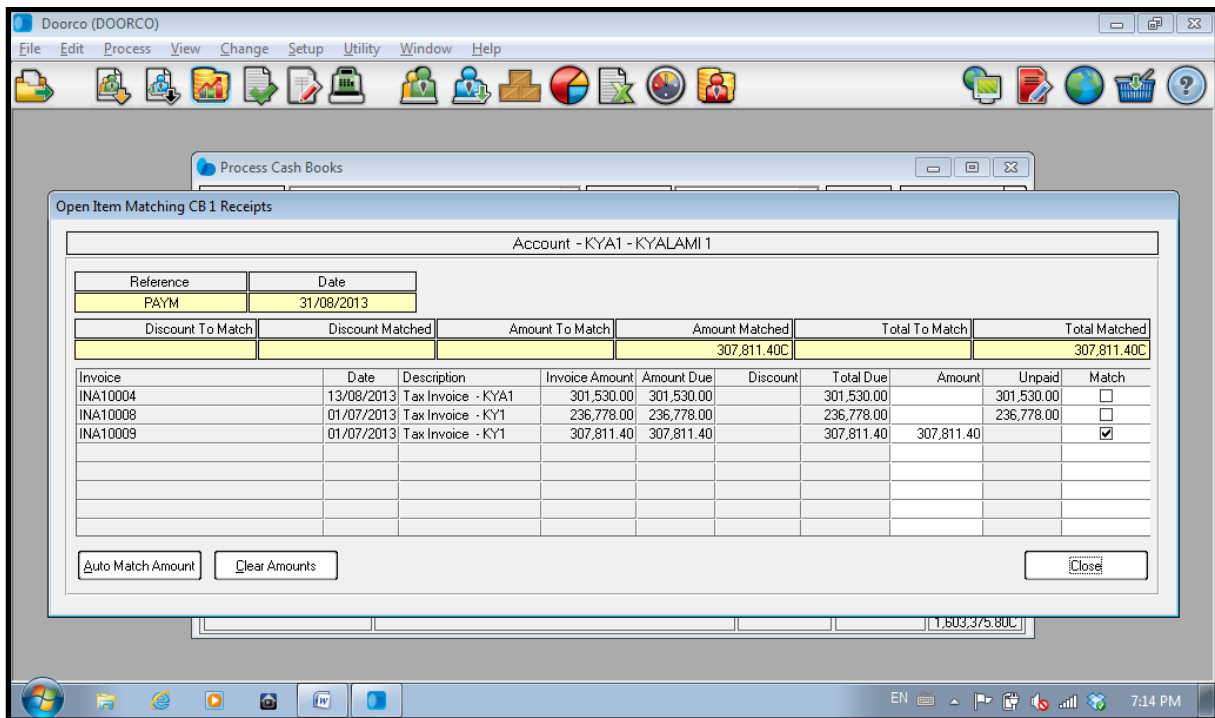


Figure 22: Screenshot of Pastel - Customer Payment

On the home screen, the balances are automatically updated as payments are received.

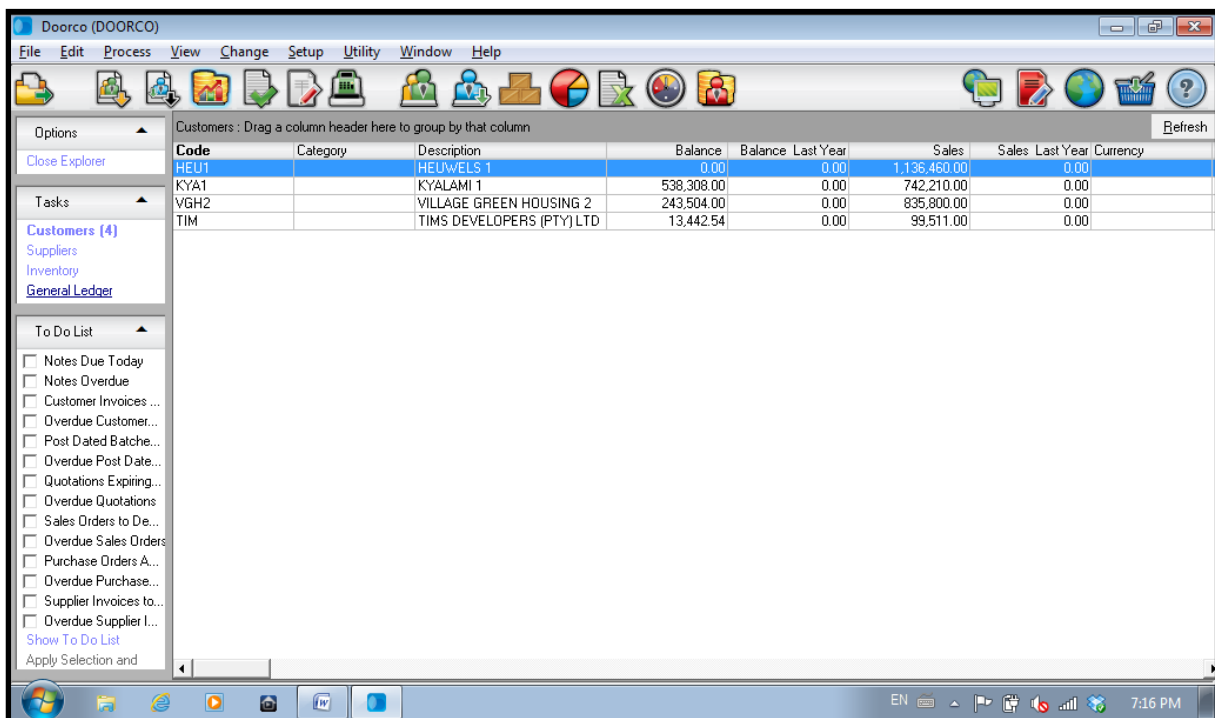


Figure 23: Screenshot of Pastel - Updated Customer Balances on Home Screen



## Supplier Payments

A supplier, Woodcentre, was paid in full. Pastel automatically links the payments to all the outstanding tax invoices.

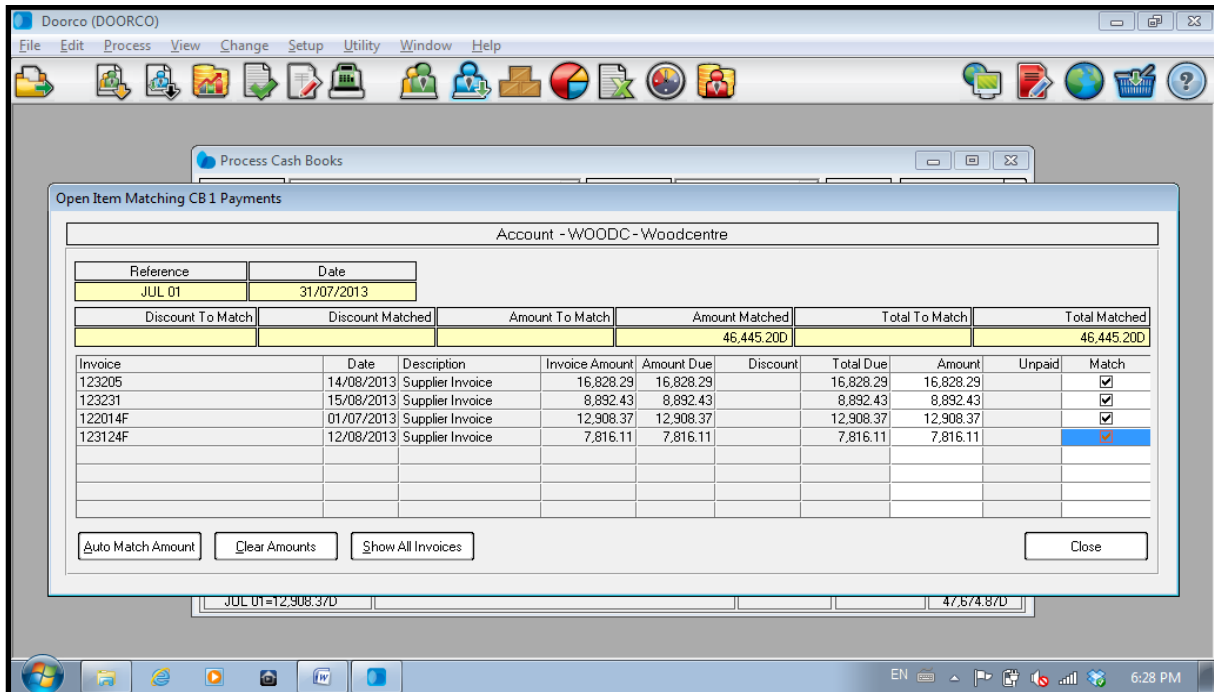


Figure 24: Screenshot of Pastel - Full Supplier Payment

For another supplier, National Edging, only one invoice was paid (the invoice payable according to the 30 day payment terms).

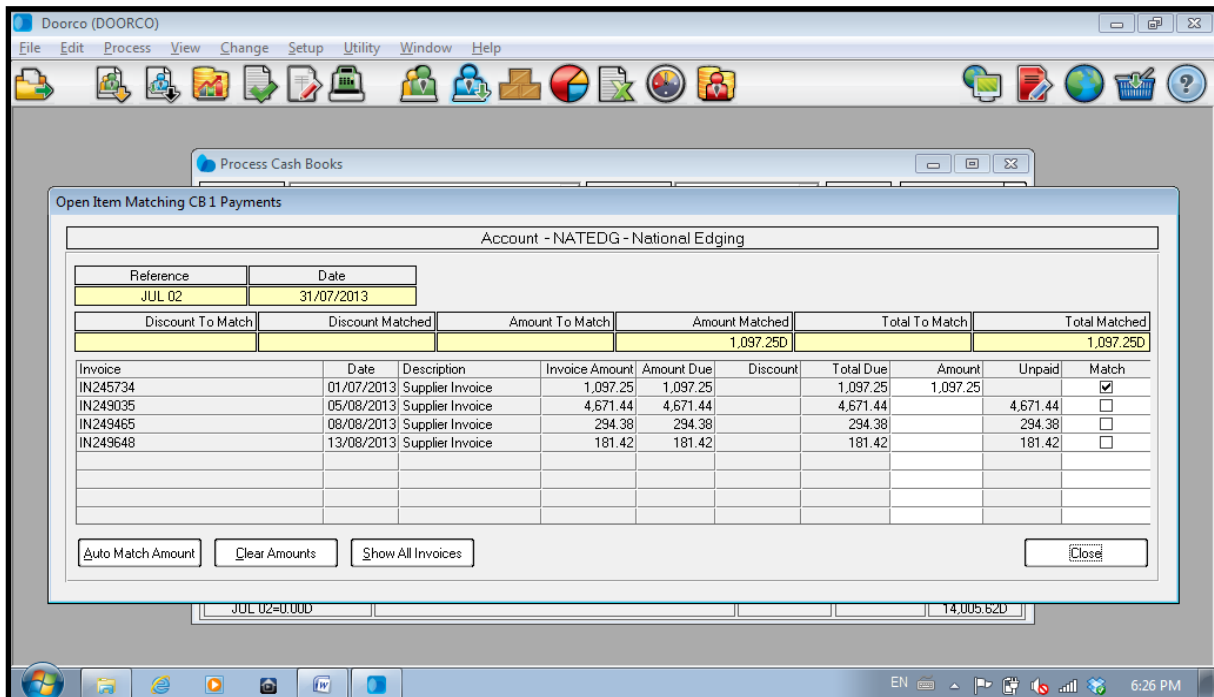


Figure 25: Screenshot of Pastel - Partial Supplier Payment

On the home screen, the balances are automatically updated as payments are made to suppliers.

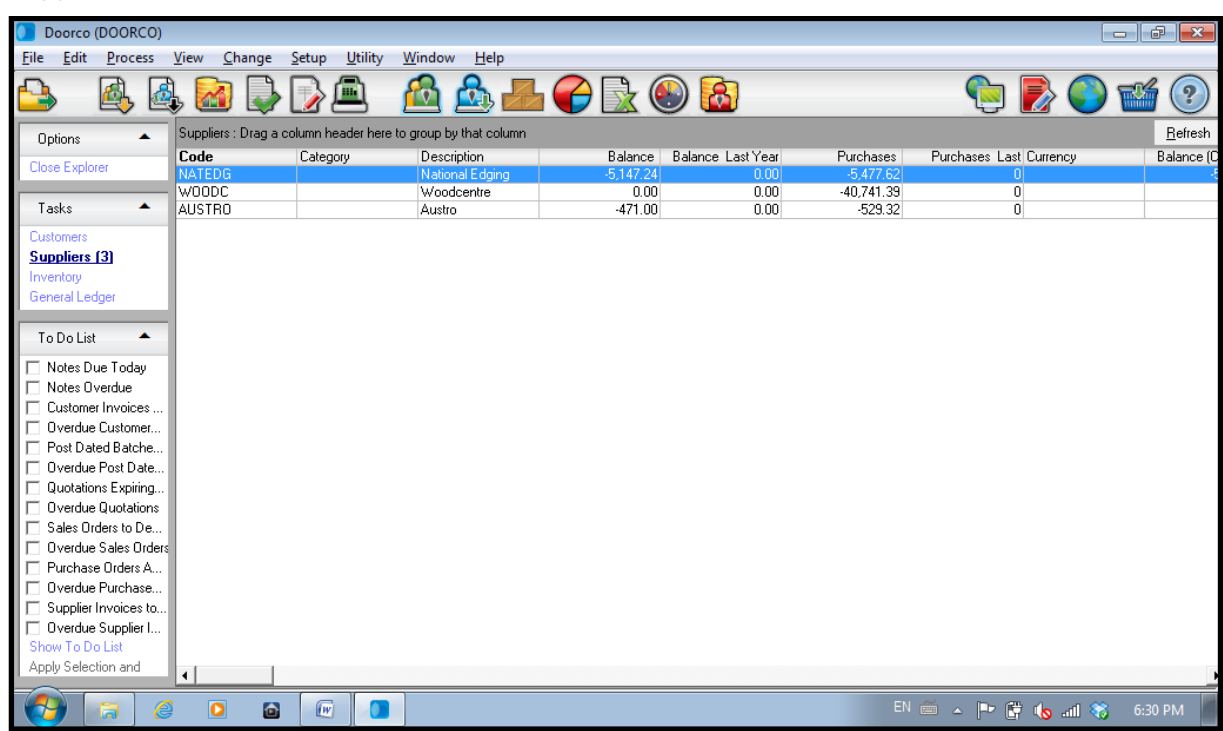


Figure 26: Screenshot of Pastel - Updated Supplier Balances on Home Screen

## Reports

Following is a screenshot of all the reports that can be created for customers.

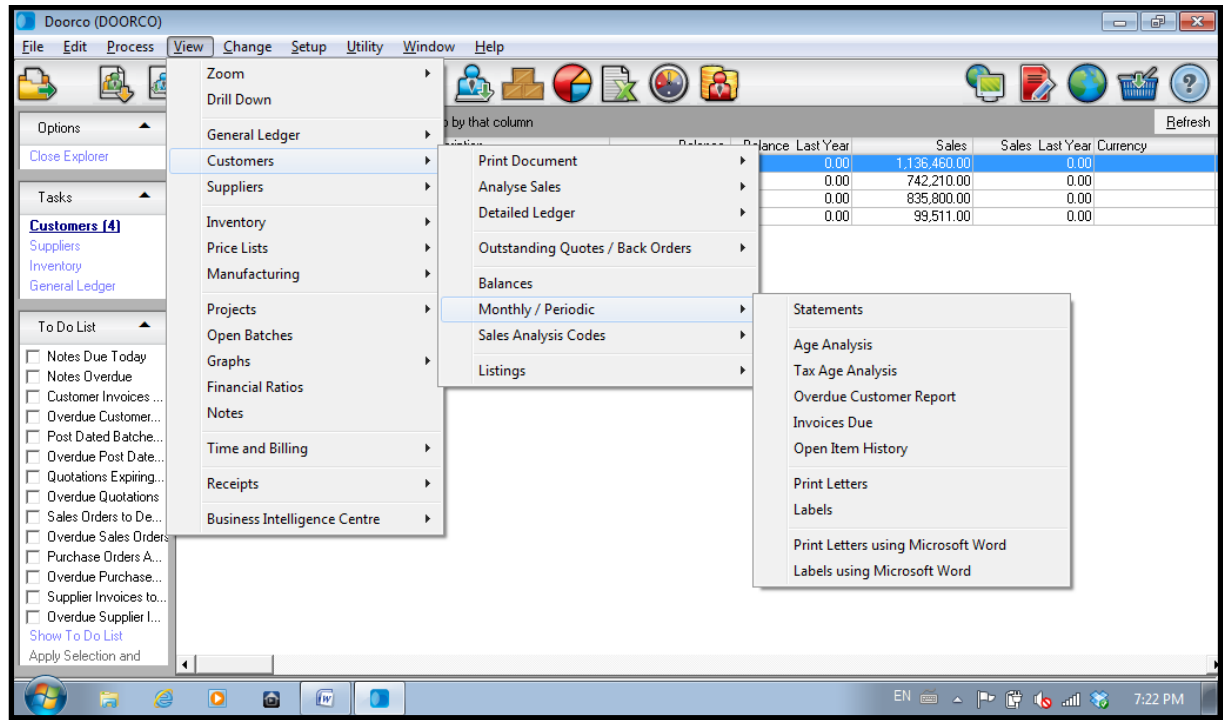


Figure 27: Screenshot of Pastel - Possible Customer Reports

Provided below is a screenshot of all the reports that can be created for suppliers.

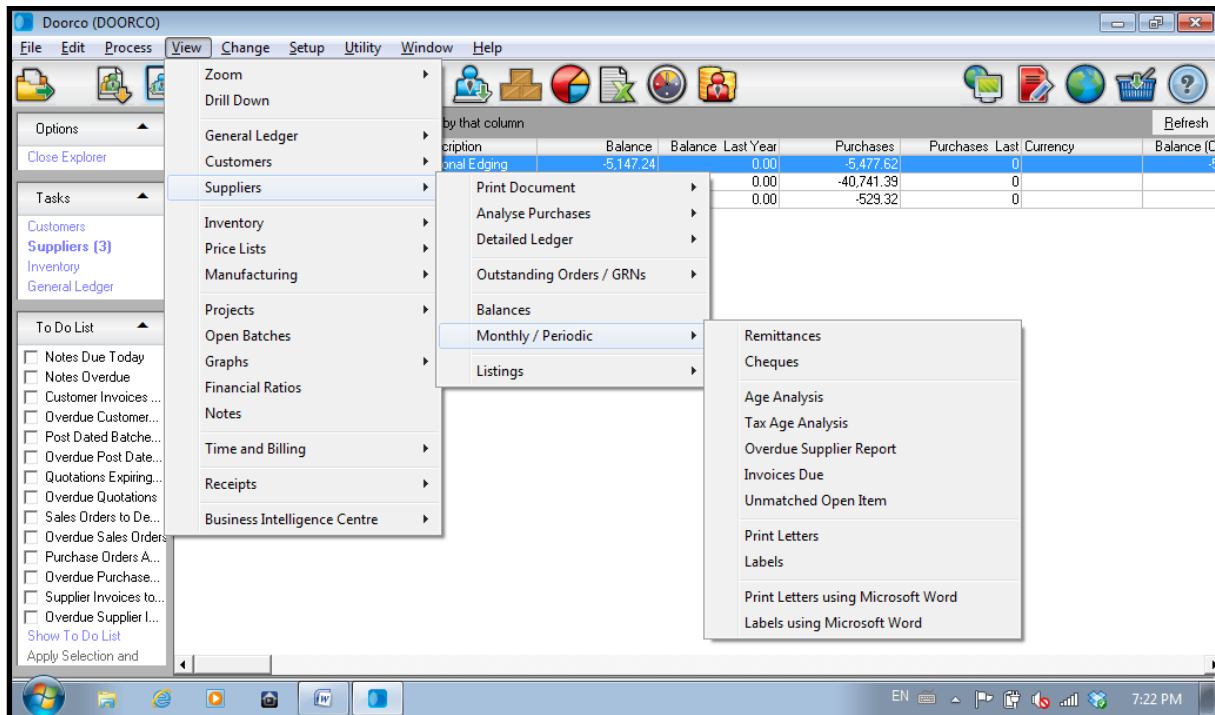


Figure 28: Screenshot of Pastel - Possible Supplier Reports

## Customer Reports

The screenshot provided below is a detailed ledger report of a customer (Kyalami), also known as a customer aging report. The report shows all the invoices created for a customer and the outstanding payments per invoice, which is a specific request of the owner. Payment received per customer is also shown as well as the exact dates when each of the customer's invoices was created on Pastel.

The user can specify the dates for which the report should be viewed.

All the invoices listed in blue are direct links to the invoices created for that customer. This is very useful if the owner wants to view a customer invoice again. Once an invoice is paid in full, the payment is shown on the report and the link is removed.

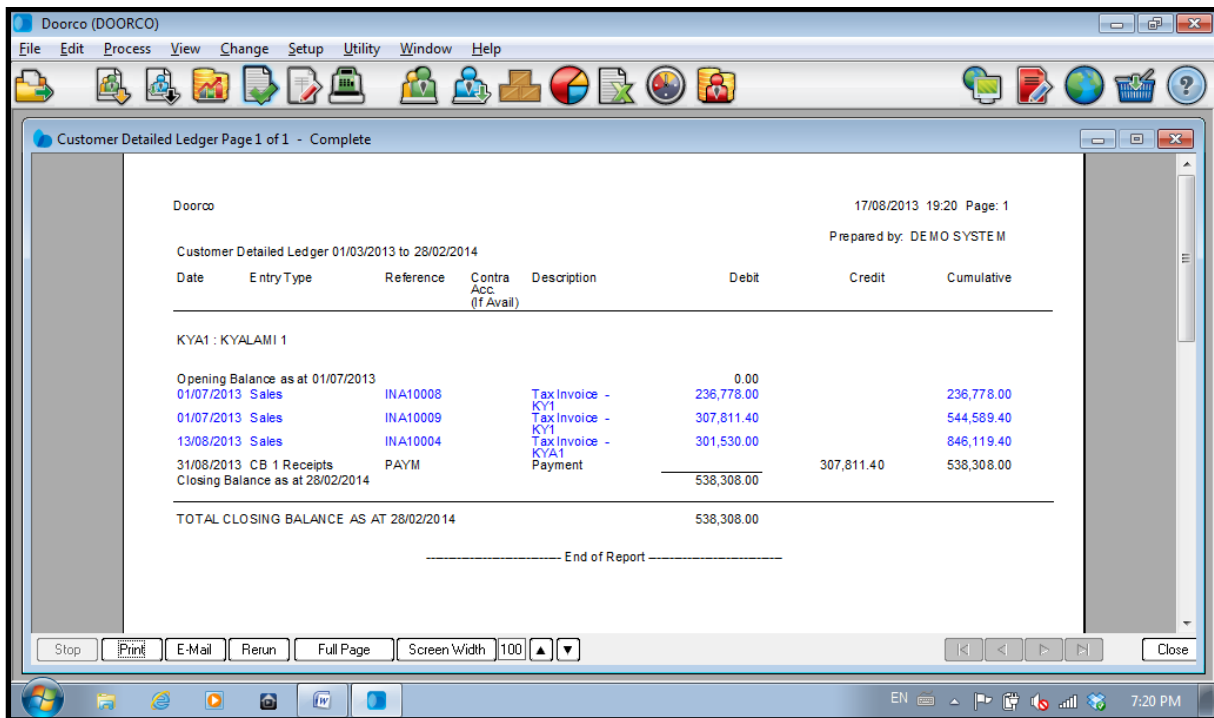


Figure 29: Screenshot of Pastel - Customer Aging Report

A second report for customers that is equally useful is the payment report per customer, also known as an invoices due report. This is where the owner can view which customer still owes him money and specifically for which invoices. Once again, the blue lines are links to the invoices created.

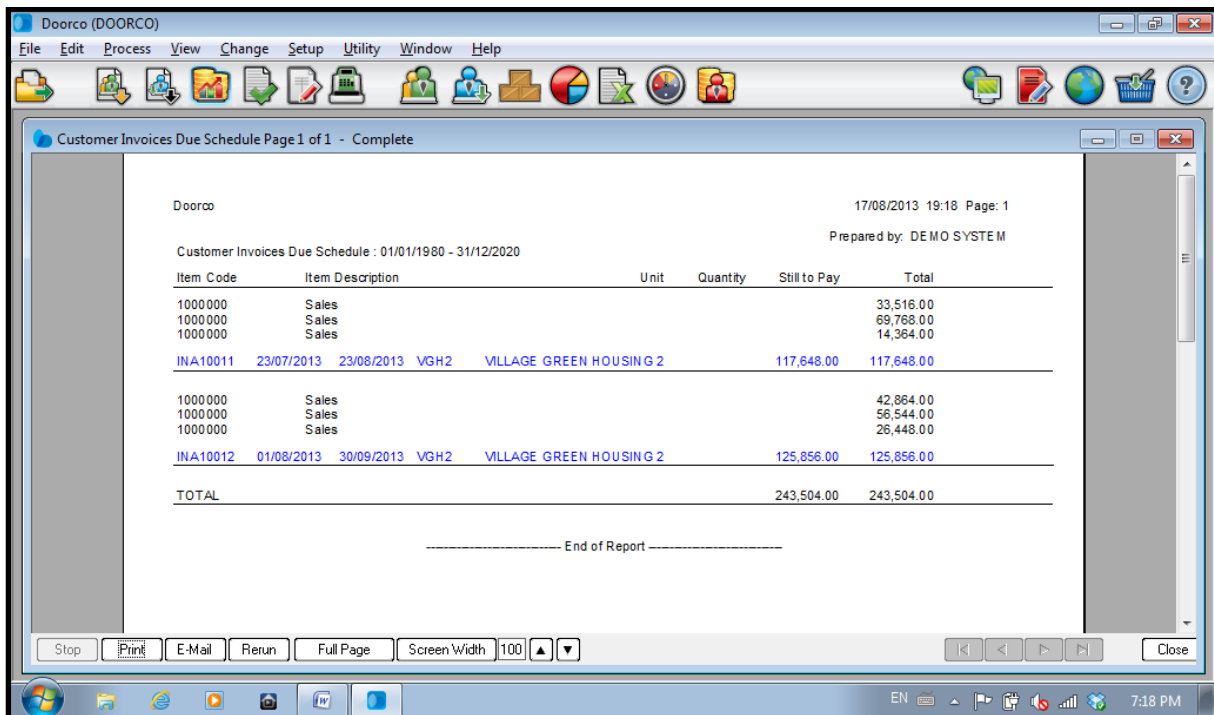


Figure 30: Screenshot of Pastel - Customer Invoice Due Report



## Supplier Reports

The following screenshot is a detailed ledger report of a supplier (Woodcentre). The report shows all the tax invoices received from a certain supplier, the outstanding payments (credit), as well as all the payments made to the supplier (debit). It also shows the exact dates when each of the tax invoices and payments was captured on Pastel.

The user can specify the dates for which the report should be viewed.

All the tax invoices listed in blue are direct links to the tax invoices captured on Pastel. This is very useful if the owner wants to view a tax invoice from a supplier again. Once a supplier is paid in full, the payment is shown on the report and the link is removed.

The screenshot shows a window titled 'Doorco (DOORCO)' with a menu bar (File, Edit, Process, View, Change, Setup, Utility, Window, Help) and a toolbar. The main window displays a 'Supplier Detailed Ledger Page 1 of 1 - Complete' report for 'Doorco' from 01/03/2013 to 28/02/2014. The report is prepared by 'DEMO SYSTEM' on 17/08/2013 at 18:29. The table below shows the ledger entries for 'WOODC : Woodcentre'.

Date	Entry Type	Reference	Contra Acc. (if Avail)	Description	Debit	Credit	Cumulative
WOODC : Woodcentre							
Opening Balance as at 01/07/2013					0.00		
01/07/2013	Purchases	PNA10002		Supplier Invoice - 122014F		12,908.37	-12,908.37
31/07/2013	CB 1 Payments	JUL 01		Woodcentre	46,445.20		33,536.83
12/08/2013	Purchases	PNA10004		Supplier Invoice - 123124F		7,816.11	25,720.72
14/08/2013	Purchases	PNA10007		Supplier Invoice - 123205		16,828.29	8,892.43
15/08/2013	Purchases	PNA10010		Supplier Invoice - 123231		8,892.43	0.00
Closing Balance as at 28/02/2014					0.00		
TOTAL CLOSING BALANCE AS AT 28/02/2014					0.00		

----- End of Report -----

The screenshot also shows a control bar at the bottom with buttons for Stop, Print, E-Mail, Rerun, Full Page, Screen Width (100), and Close. The Windows taskbar at the bottom shows the system tray with the time 6:29 PM and language set to EN.

Figure 31: Screenshot of Pastel - Supplier Detailed Ledger Report



### **Advantages of using Pastel Express as a computerised business system:**

It was determined that Pastel can do all of the following, all of which are specific requirements of the owner at Doorco:

- Create customers and suppliers with all their details, including address, contact details, tax reference number, payment terms, credit limit, etc.
- Create invoices with automatic invoice numbers.
- Create quotes with automatic quote numbers.
- A customer's details are added automatically to quotes and invoices, once the customer is selected from a list. The same can be done for suppliers on tax invoices.
- Convert quotes to invoices.
- Create payments received from customers and these payments are automatically linked to the invoice numbers.
- Create payments made to suppliers, which are also linked to tax invoices received from suppliers.
- Pastel calculates outstanding balances of customers automatically and adds it to the customer's aging report.
- On the home screen, outstanding balances are shown and automatically updated each time a payment is made or received.
- Pastel has a number of useful reports that can be used.
- A detailed ledger report can be created for a customer, which shows all the invoices that was created for that specific customer and calculates a cumulative amount that the customer owes the company.
- Create a detailed ledger report for a supplier. This report shows all the tax invoices that was captured for the specific supplier and calculates a cumulative amount that the company owes the supplier.
- The above mentioned detailed ledger reports have links to the specific invoices and also show payments made and received. Once a payment was made or received, the link to that specific invoice is automatically removed.

The Pastel Express program is very user friendly and satisfies all of the owner's specific requirements. The reports generated by Pastel Express especially satisfied all the owner's requirements.

# Chapter 5: Improved Storage Operations

This chapter provides information on all the improvements made to the storage room at Doorco. The suggestions were made to the owner where after approval was given to implement all the suggested changes.

## 1. Storeroom Layout

The first step of the improvement process was to design an improved layout of the storeroom that will maximize space utilisation while considering the principles of popularity, similarity, size and material characteristics. Other factors that were taken into consideration were the accessibility of parts and orderliness of the storeroom.

It was decided that the layout of the storeroom will remain unchanged. The reason for this being that the storeroom layout is sufficient for the space available in the storeroom and that the current layout satisfies all the principles mentioned above.

The layout of the storage room at Doorco:

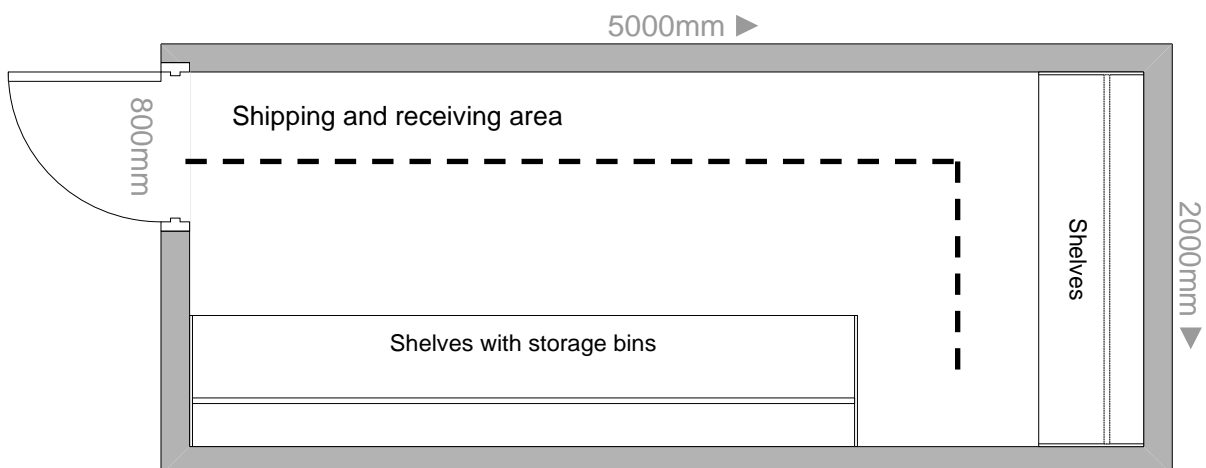


Figure 32: Storeroom Layout at Doorco

## 2. Space utilisation

The available space in the storeroom was not utilised optimally, because a lot of items (including old product samples) in the storeroom are not used anymore.



The pictures provided below demonstrate the storeroom before the improvements were made. The random location storage system and the unused samples can be observed.



**Figure 33: Doorco's Current Space Utilisation**

All the unnecessary and unused items that were in the storeroom were removed to create space for other items and to clear the aisle in the storage room. This improved the orderliness of the storeroom and ensured that all parts will be easily accessible from the aisle.

### **3. Storage Bins**

Maintenance of the storeroom layout will require that materials be stored in an orderly manner and that all stock locations be known. Disorderly storage can cause significant losses in cube utilisation and accessibility, and therefore all materials should be stored in a neat and uniform manner and they should be accessible. By creating effective storage bins, it ensured that all stock keeping units were stored in a neat and uniform manner.



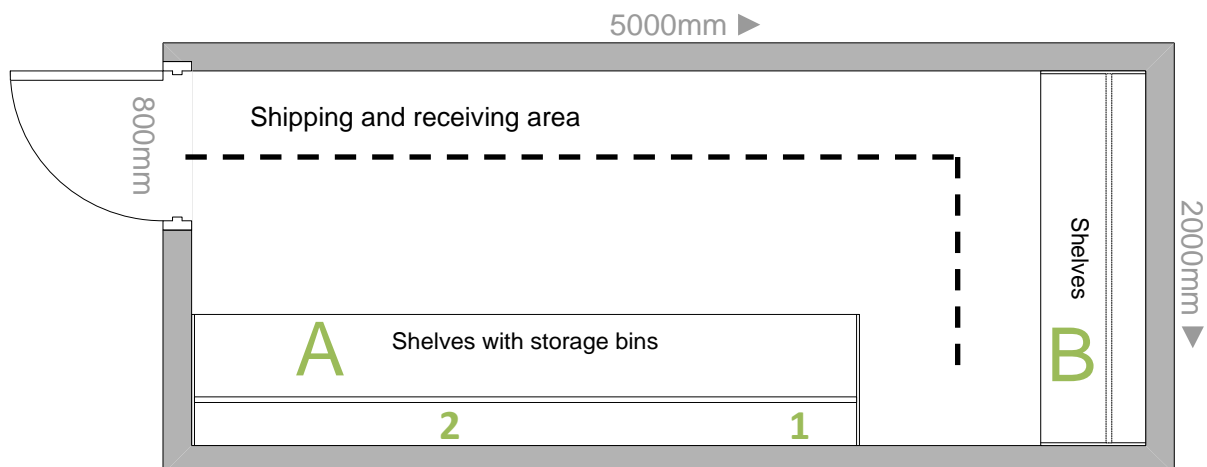
The focus of the improved storage operations was on re-designing the current storage bins and bin locations in order to allocate specific, predetermined and permanent locations to each inventory item stored. With this, a fixed location storage system was implemented at Doorco.

The principles of popularity, similarity, size, characteristics and space utilisation were considered and applied in designing the improved layout and size of each static storage bin. The inventory system and safety stock of each item was also used to determine the sizes required for each bin.

### 3.1 Re-designing the Static Bins

Wasted space often results when materials are not properly placed within their assigned areas. All materials within a storage area must be able to be quickly located and picked. By creating effective static storage bins in the storeroom, materials are assigned to a fixed location, and stock location and picking is performed more efficiently.

The static bins in the storeroom were re-designed, taking all the above mentioned factors into account. On the layout of the storeroom below, the two main areas of the storage room is marked with an A and a B to aid in the description of the re-designing of the bins below.



**Figure 34: Storeroom Layout with Improved Areas and Groups**

The locations of the static bins in area A and B were optimised to minimize the time spent searching for parts.

### 3.1.1 Area A

The parts stored in area A are the parts used for production and the parts used for the installation of housing development projects. These parts were identified as the most popular parts that are used most frequently and they are therefore stored close to the production, shipping and receiving areas.

Provided below are the designs for the improved storage bins in area A as well as the photos of the bins after implementation. Area A was again divided into two groups.

#### Group 1:

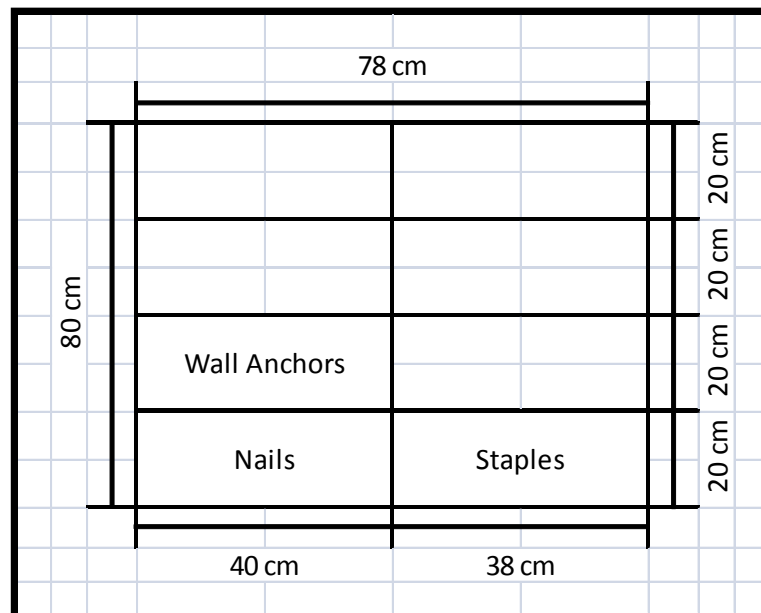


Figure 35: Design of the Static Bins in Area A, Group 1

The static bins in group one will be used to store nails, staples and wall anchors. These parts are removed from the storeroom in their original packaging (small boxes) and single units of the products are never removed or stored.

The products in group one is therefore stored in their original boxes in static bins in the storage area. The parts stored in these bins are lightweight and could therefore be stored at a greater height.

Provided below is a photo of the static bins that were manufactured on the design above:



**Figure 36: Storage Bins Created in Area A, Group 1**

**Group 2:**

The static bins in group two will be used to store the most popular materials (materials used most frequently). Bolts, cams and dowels are used only for production and the workers in the production department fill their dynamic bins from these bins in the storeroom. Parts stored in these static bins are removed from their original packaging and single units can be stored or removed from storage.

The parts used for installation are also stored both in their original packaging (as they are received from suppliers) and in single units. Lightweight items are stored in higher bins and the heavier items, like the BIC and kitchen hinges, are stored at the bottom.

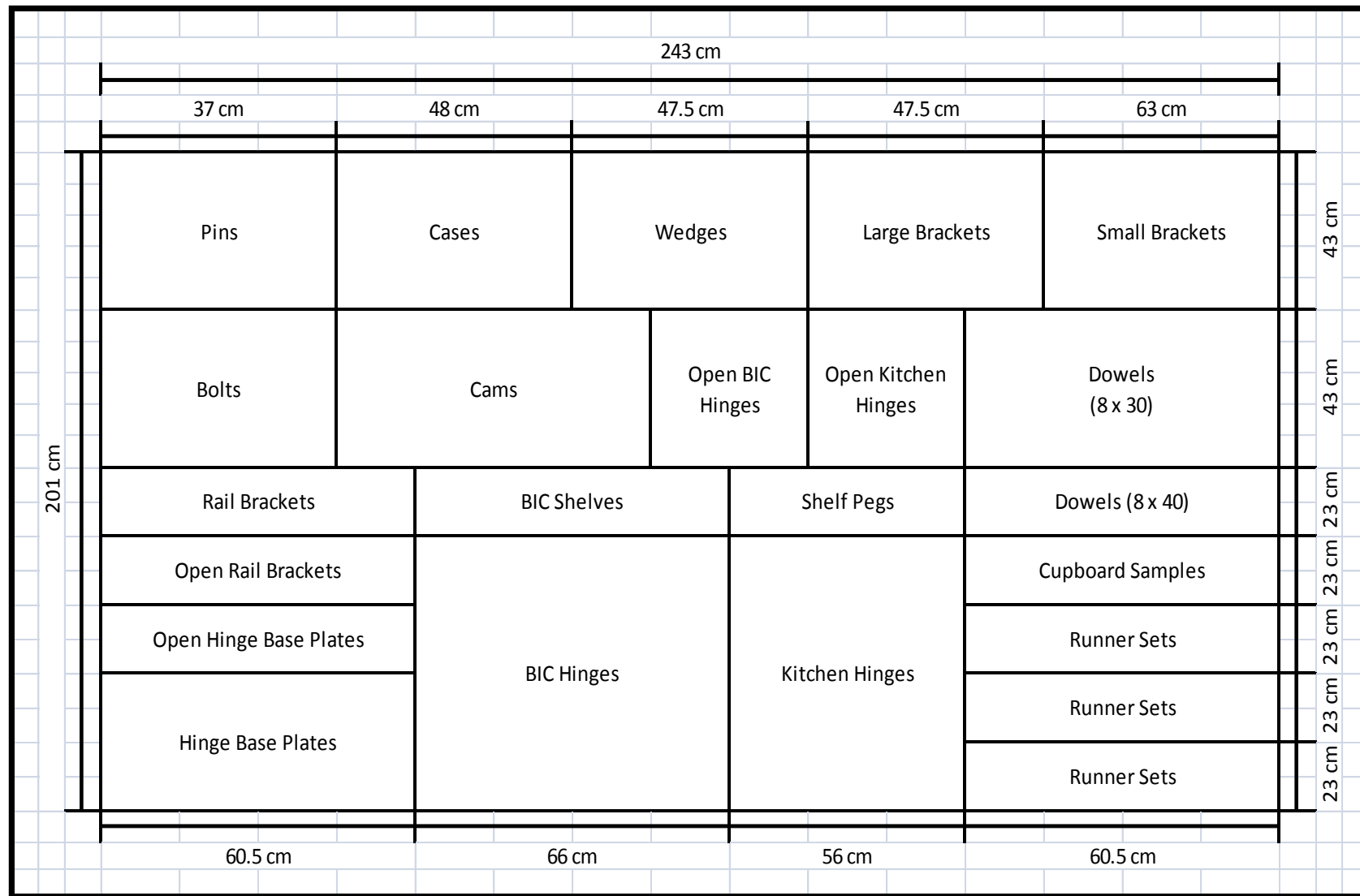


Figure 37: Design of the Static Bins in Area A, Group 2

Provided below is a photo of the bins that were created from the design above:

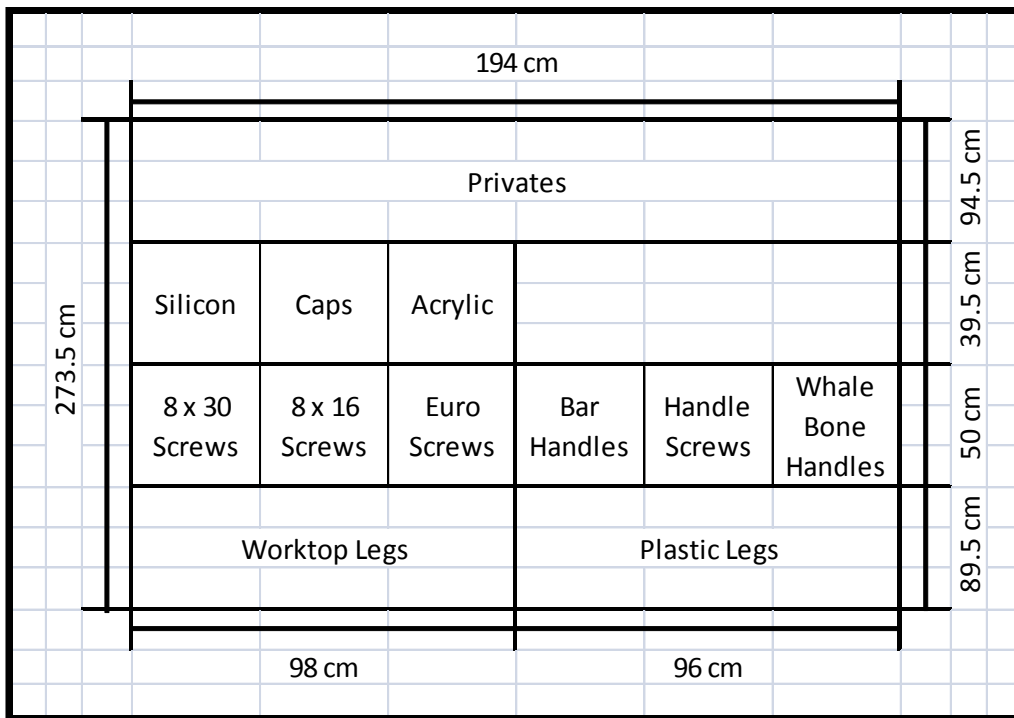


**Figure 38: Storage Bins Created in Area A, Group 2**

### **3.1.2 Area B**

The parts stored in area B are the parts used for the installation of private customer projects and the parts used for the installation of housing development projects. These parts are used less frequently and are therefore stored at the back of the storeroom. The parts used for private customer projects are stored on the top shelf as these parts are rarely used. The other parts are stored in static bins on the shelves in the order of their weight.

Provided below is the design for the improved storage bins in area B as well as a photo of the bins after implementation.



**Figure 39: Design of the Static Bins in Area B**

Provided below is a photo of the bins created from the design above:



**Figure 40: Storage Bins Created in Area B**

### 3.2 Re-designing the Dynamic Bins

Dynamic bins are movable bins and were designed to store multiple parts that are used most frequently in production. Each worker in the production department will have a dynamic bin next to his station to assist him with parts required for the production and assembly of products. Instead of constantly walking to the storeroom, workers can now reach to their dynamic bins for parts. This will increase productivity at Doorco by minimising the time spent acquiring parts from the storeroom.

Once a worker's dynamic bin is empty, a signed note from the owner must be acquired, which will give the worker permission to fill his dynamic bin. This note must accompany the worker to the storeroom, where the factory foreman will refill the worker's dynamic bin.

At the end of each week the factory foreman will provide the owner with all the notes, which the owner will use to update the inventory system. This system will increase control over parts in the storage room and will ensure that all parts removed from the storeroom is accounted for. The main advantage of this system is that it will assist the owner in managing the inventory system more accurately.

Following is the design for the dynamic bins:

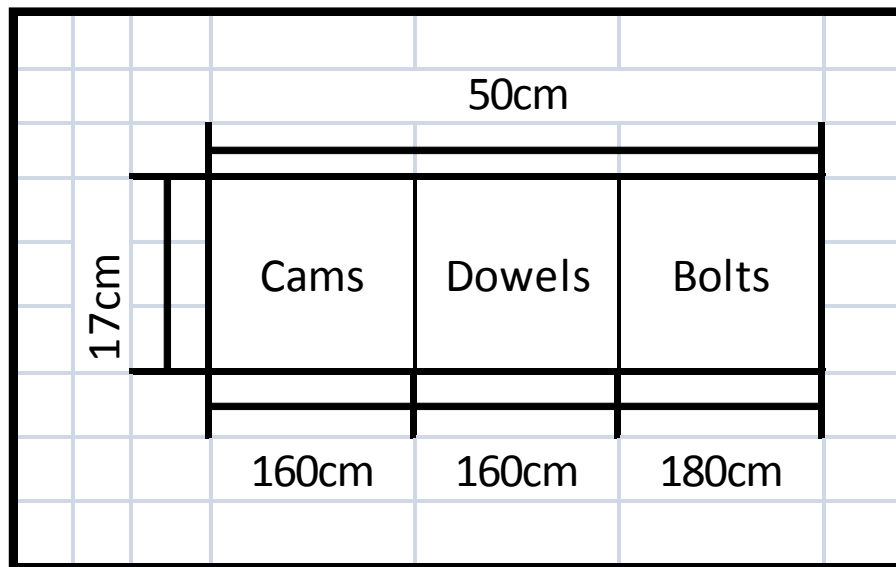


Figure 41: Design of the Dynamic Bins



Provided below is a photo of a dynamic bin created from the design above:



Figure 42: Dynamic Bins Created

#### 4. Labelling of the bins

To assist the workers in the identification of parts, all the bins were clearly labelled. This will eliminate confusion and therefore reduce time spent searching for parts in the storage room.

Provided below is a photo of the effective labelling of the bins:



Figure 43: Labelling of the Static Bins



## 5. Improved Storage Operations

In summation, the steps that were followed to achieve the improved storage system are:

- The layout of the storage room was kept unchanged.
- All unused items were removed from the storage room in order to create space and increase orderliness.
- The static bins were re-designed with regards to sizes and locations.
- All stock keeping units were assigned to specific, predefined and permanent locations (storage bins) to create a fixed location storage system.
- The static bins were effectively labelled in order to eliminate confusion and minimise time spent searching for parts.
- Dynamic bins were created to reduce time spent acquiring parts from the storeroom.

The pictures provided below represent the storeroom at Doorco before and after the improved storage operations were implemented:

**BEFORE**



**AFTER**



**Figure 44: Before and After Photos of Doorco's Storeroom**

## Chapter 6: Improved Inventory System

It was determined in the literature review that an inventory system is the set of policies and controls that monitor levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large orders should be.

At Doorco, there is very little control over parts supplied to the production and installation departments and therefore the exact quantities of items in storage cannot be determined. These unknown levels of inventory affect the replenishment of supplies as the owner does not know when stock should be replenished and how large the orders should be. Another problem that was identified is that there is no system that the owner can use to determine how many parts the installation department should take to a project which also contributes to the unknown levels of inventory.

In order to eliminate the above mentioned problems and reduce the probability of material shortages or oversupply, an inventory system had to be designed. The owner is most comfortable with Microsoft Excel and requested that the inventory system be designed in Excel.

In the literature review, material requirements planning (MRP) was defined as a logical, easily understandable approach to determine the number of parts, components and materials required to produce an end item. At Doorco, all products are customer specific and therefore it was challenging to produce a MRP that will account for all the types of products produced. As a result, the improved inventory system was based on an MRP, but requires input from the owner regarding the number of components required to produce each end item.

The improved inventory system consists of two parts, namely:

- Parts Program
- Inventory Program



## 1. Parts Program

The parts program was designed to determine exactly how many parts are used for a project and this program works in conjunction with the inventory program.

A bill of materials was designed in Excel and consists of the two main product types at Doorco, namely kitchen and built-in cupboards. The owner specified the amount of kitchen and built-in cupboards that the program should account for to cover all project possibilities. The following table provides a list of the products that were included:

Kitchen Cupboards	Built In Cupboards
1 x Grocery Cupboard	1 x Main Bedroom
4 x Floor Units	4 x Extra Bedrooms
3 x Wall Units	Extras – Hanging Rails
Extras – Worktop Leg	

**Table 7: Kitchen and Built In Cupboards in the Parts Program**

The bill of materials was designed for one house in a housing development or private project. The owner specifies the amount of parts that each cupboard consists of and the amount of cupboards that will be installed in a house. The program then calculates a complete bill of materials for each house.

The bill of materials sheet is connected with a second sheet, the product sheet, which calculates a complete bill of materials for each house. There is also a function where the owner can specify the amount of houses that will be completed during the week and the program then calculates the exact amount of materials that will be required for the week. This function will be used only for housing development projects as multiple houses are completed in a week.

The parts program will aid the owner in knowing exactly how many parts are used per week for each project. The information from the parts program is carried over to the second program, the inventory program.

Provided below are screenshots of the parts program.



Sheet 1: Bill of Materials

Bill of Materials			
<b>Kitchen Cupboards</b>			
<b>G450</b>		<b>F600/4</b>	
Bolts	0	Bolts	0
Cams	0	Cams	0
Dowels	0	Dowels	0
8 x 30 Screws	0	8 x 30 Screws	0
8 x 16 Screws	0	8 x 16 Screws	0
Kitchen Hinges	0	Euro Screws	0
Hinge Base Plates	0	Runner Sets	0
Shelf Pegs	0	Bar Handles	0
Bar Handles	0	Whale Bone Handles	0
Whale Bone Handles	0	Plastic Legs	0
Plastic Legs	0	Large Brackets	0
Large Brackets	0	Wall Anchors	0
Wall Anchors	0		
		<b>F1000</b>	
		Bolts	0
		Cams	0
		Dowels	0
		8 x 30 Screws	0
		8 x 16 Screws	0
		Kitchen Hinges	0
		Hinge Base Plates	0
		Shelf Pegs	0
		Bar Handles	0
		Whale Bone Handles	0
		Plastic Legs	0
		Large Brackets	0
		Wall Anchors	0
		<b>F900</b>	
		Bolts	0
		Cams	0
		Dowels	0
		8 x 30 Screws	0
		8 x 16 Screws	0
		Kitchen Hinges	0
		Hinge Base Plates	0
		Shelf Pegs	0
		Bar Handles	0
		Whale Bone Handles	0
		Plastic Legs	0
		Large Brackets	0
		Wall Anchors	0
<b>Built In Cupboards</b>			
<b>Main Bedroom</b>		<b>Bedroom 2</b>	
Pins	0	Pins	0
Cases	0	Cases	0
Wedges	0	Wedges	0
Large Brackets	0	Large Brackets	0
Wall Anchors	0	Wall Anchors	0
Small Brackets	0	Small Brackets	0
8 x 16 Screws	0	8 x 16 Screws	0
Euro Screws	0	Euro Screws	0
BIC Hinges	0	BIC Hinges	0
Hinge Base Plates	0	Hinge Base Plates	0
Bar Handles	0	Bar Handles	0
Whale Bone Handles	0	Whale Bone Handles	0
Rail Brackets	0	Rail Brackets	0
Runner Sets	0	Runner Sets	0
		<b>Bedroom 3</b>	
		Pins	0
		Cases	0
		Wedges	0
		Large Brackets	0
		Wall Anchors	0
		Small Brackets	0
		8 x 16 Screws	0
		Euro Screws	0
		BIC Hinges	0
		Hinge Base Plates	0
		Bar Handles	0
		Whale Bone Handles	0
		Rail Brackets	0
		Runner Sets	0
		<b>Bedroom 4</b>	
		Pins	0
		Cases	0
		Wedges	0
		Large Brackets	0
		Wall Anchors	0
		Small Brackets	0
		8 x 16 Screws	0
		Euro Screws	0
		BIC Hinges	0
		Hinge Base Plates	0
		Bar Handles	0
		Whale Bone Handles	0
		Rail Brackets	0
		Runner Sets	0

Figure 45: Parts Program - Bill of Materials Sheet

Sheet 2: Product Sheet

Product Sheet Per House		Product Sheet Per Week	
Houses Per Week	Installation Parts	Production Parts	Installation Parts
	0	Bolts	0
	0	Cams	0
	0	Dowels	0
	0	Pins	0
	0	Cases	0
	0		Wedges
	0		Small Brackets
	0		Large Brackets
	0		Kitchen Hinges
	0		BIC Hinges
	0		Hinge Base Plates
	0		Shelf Pegs
	0		Runner Sets
	0		8 x 30 Screws
	0		8 x 16 Screws
	0		Euro Screws
	0		Wall Anchors
	0		Rail Brackets
	0		Worktop Legs
	0		Plastic Legs
	0		Bar Handles
	0		Whale Bone Handles
	0		Hanging Rails (m)

Figure 46: Parts Program - Product Sheet



## 2. Inventory Program

The inventory program (also created in Microsoft Excel) consists of multiple functions. The program is designed for a whole year and consists of 12 sheets (one for each month).

The table in Appendix C provides information on all the parts in the storeroom, including the safety stock specified by the owner and the order policies provided by the suppliers. All the parts have economic order quantity policies. The information provided in Appendix C was used for the inventory program.

The table below provides the column headings in the inventory program and information on each column.

Column Heading	Information
Beginning stock	Beginning stock of the month (opening balance).
Stock used (in units)	Stock used during the month.
Stock purchased (in units)	Stock purchased from suppliers during the month.
Stock in hand	Amount of stock that should be in the storeroom.
Actual stock take	Amount of stock that there actually is in the storeroom (output of stock take at month end).
Difference in stock	Difference between the stock in hand and the actual stock take.
Order policy	Order policy of each part, provided by the supplier.
Safety stock	Safety stock kept for each part, provided by the owner.
To purchase	Amount of stock that should be purchased at the end of the month in order to maintain the safety stock.
Actual amount purchased	The actual amount of stock that was purchased from suppliers at the end of the month.
Ending stock	Ending stock of the month (closing balance).




**Table 8: Inventory Program Column Headings and Information**

The first column is the beginning stock of the month, which will be the ending stock of the previous month. The program automatically carries the ending stock of one month over to the beginning stock of the next month.

The next few columns are designated to the stock that was used during the month. This is where the parts program links with the inventory program. Each time a product sheet is created on the parts program, the owner will enter the calculated amount of each part into these columns as stock used during the month. This will ensure that all stock in the storeroom is accounted for. There are also a few designated columns where stock purchased from suppliers during the month can be entered into.

The stock in hand is automatically calculated (Stock in hand = beginning stock + stock purchased – stock used) and is the amount of stock that should be in the storeroom at any given time. This column is set with conditional formatting to notify the owner of the following situations and to reduce the probability of shortages.

The table below provides the conditional formatting icon set symbols used in the “Stock in Hand” column and their meanings.




Symbol	Meaning
	This symbol warns the owner that the stock is reaching a level below the safety stock and that the stock should be replenished soon.
	This symbol illustrates that the stock in the storeroom is greater than the required safety stock.
	A red cross warns the owner that there is no more stock of that particular part in the storeroom and that the stock should be replenished immediately, before completion of the job.

**Table 9: Stock in Hand Conditional Formatting Symbols and Meanings**

The column “Actual Stock Take” is where the owner enters the amount of stock that is actually in the storeroom. This will be done at the end of each month where the foreman will do stock take in the store room.

The next column, namely “Difference in Stock” automatically calculates the difference between the “Stock In Hand” and the “Actual Stock Take”. This is done so that the owner can see how many parts are lost during the month. The owner specified an amount of each part that he is willing to write up as rejects or faulty parts.

Conditional formatting was set on this column to warn the owner if the difference is more than the amount specified so that he can take that up with his workers. The table below provides the conditional formatting icon set symbols used in the “Difference in Stock” column and their meanings.

Symbol	Meaning
	Difference in stock is between 0 and the owner’s specified amount.
	Difference in stock is 0.
	Difference in stock is greater than the owner’s specified amount.

**Table 10: Difference in Stock Conditional Formatting Symbols and Meanings**

The “To Purchase” column automatically calculates the amount of stock that should be replenished at the end of the month. It takes into account the amount of safety stock of each part and the actual amount of parts in the storeroom. If the amount of parts that is actually in the storeroom is greater than the amount of safety stock, the program tells the owner not to purchase anything. If however the amount of parts in the storeroom is equal to or smaller than the amount of safety stock, the program tells the owner to replenish materials. The amount of parts to be purchased is equal to the order policy of the specific part.

The last two columns, “Actual Amount Purchased” and “Ending Stock”, are completed at the end of the month. The “Actual Amount Purchased” column is where the owner has the option to either purchase the exact amount of parts specified in the “To Purchase” column or any increment of the order policy. If the owner wants to purchase fewer parts than the order policy allows, conditional formatting will change the value to red and thereby warns the owner that the amount that he want to purchase is not according to the supplier’s order policy.

The “Ending Stock” column automatically calculates the ending stock of the month (which is the sum of the actual stock take and the amount of stock purchased at the end of the month). This “Ending Stock” value is automatically carried over to the following month’s “Beginning Inventory”.





Provided below is a screenshot of the inventory program.

Inventory: January 2013															
SKU	Beginning Stock	Stock Used (In Units)			Stock Purchased (In Units)			Stock in Hand	Actual Stock Take	Difference in Stock	Order Policy	Safety Stock	To Purchase	Actual Amount Purchased	Ending Stock
Bolts							0	0	0	2000	500				0
Cams							0	0	0	2000	500				0
Dowels							0	0	0	1000	500				0
Pins							0	0	0	100	500				0
Cases							0	0	0	100	500				0
Staples							0	0	0	5000	5000				0
Nails							0	0	0	5000	5000				0
Wedges							0	0	0	100	500				0
Small Brackets							0	0	0	500	100				0
Large Brackets							0	0	0	400	100				0
Kitchen Hinges							0	0	0	100	500				0
BIC Hinges							0	0	0	100	500				0
Hinge Base Plates							0	0	0	100	1000				0
Shelf Pegs							0	0	0	100	200				0
Runner Sets							0	0	0	25	25				0
8 x 30 Screws							0	0	0	10000	5000				0
8 x 16 Screws							0	0	0	10000	5000				0
Euro Screws							0	0	0	10000	5000				0
Wall Anchors							0	0	0	100	100				0
Rail Brackets							0	0	0	100	100				0
Worktop Legs							0	0	0	4	8				0
Plastic Legs							0	0	0	4	120				0
Bar Handles							0	0	0	10	100				0
Whale Bone Handles							0	0	0	25	100				0
Hanging Rails (m)							0	0	0	5	50				0
Acrylic							0	0	0	25	25				0
Silicon							0	0	0	25	25				0

Figure 47: Inventory Program





### 3. Practical Application of the Programs

A real life example was used on both the programs in order to show how the programs work and how they work together. The example that was used was based on a housing development project where six kitchen cupboards and three built in cupboards were produced and installed in each house. Screenshots were taken at each step of the program and is provided in the sections that follow, together with a description of each step.

#### 3.1 Practical Application of the Parts Program

Firstly, the parts program was used to determine the amount of parts required for the production and installation of the following kitchen and built-in cupboards:

Kitchen Cupboards	Built In Cupboards
1 x Grocery cupboard	1 x Main bedroom cupboard
4 x Floor unit	1 x Bedroom 2 cupboard
1 x Wall unit	1 x Bedroom 3 cupboard

**Table 11: Kitchen and Built In Cupboards in the Parts Program's Practical Application**

In the parts program, the kitchen cupboards are named in the following way:

- G450 (Grocery cupboard)
- F600/4 (Floor unit with four drawers)
- F600 (Floor unit)
- 2 x F900 (Floor units)
- W750 (Wall units)

One worktop leg is provided per house for the kitchen granite top as well as 10 metres of hanging rail for the installation of built in cupboards. Both these items are listed as extras in the parts program.

The first step in the parts program is the bill of materials and this is where the owner specifies how many parts are used to produce and install one cupboard. The owner also specifies the amount of each specific type of cupboard that will be produced and installed in each house (in the green block). The program then automatically calculates the amount of parts required for each type of cupboard.

Following are screenshots of the bill of materials sheet, where the owner specified the parts and number of cupboards for the above mentioned project.

### 3.1.1 Bill of Materials

#### Kitchen Cupboards

<b>Bill of Materials</b>					
<b>Kitchen Cupboards</b>					
<b>G450</b>	<b>1</b>			<b>F600/4</b>	<b>1</b>
Bolts	8	8		Bolts	8 8
Cams	8	8		Cams	8 8
Dowels	8	8		Dowels	8 8
8 x 30 Screws	4	4		8 x 30 Screws	2 2
8 x 16 Screws	8	8		8 x 16 Screws	4 4
Kitchen Hinges	3	3		Euro Screws	16 16
Hinge Base Plates	3	3		Runner Sets	4 4
Shelf Pegs	12	12		Bar Handles	4 4
Bar Handles	1	1		Whale Bone Handles	0 0
Whale Bone Handles	0	0		Plastic Legs	4 4
Plastic Legs	4	4		Large Brackets	2 2
Large Brackets	2	2		Wall Anchors	2 2
Wall Anchors	2	2			

Figure 48: Parts Program - Bill of Materials 1

<b>F600</b>	<b>1</b>			<b>F900</b>	<b>2</b>
Bolts	8	8		Bolts	8 16
Cams	8	8		Cams	8 16
Dowels	8	8		Dowels	8 16
8 x 30 Screws	2	2		8 x 30 Screws	2 4
8 x 16 Screws	4	4		8 x 16 Screws	4 8
Kitchen Hinges	2	2		Kitchen Hinges	4 8
Hinge Base Plates	2	2		Hinge Base Plates	4 8
Shelf Pegs	4	4		Shelf Pegs	4 8
Bar Handles	1	1		Bar Handles	2 4
Whale Bone Handles	0	0		Whale Bone Handles	0 0
Plastic Legs	4	4		Plastic Legs	4 8
Large Brackets	2	2		Large Brackets	2 4
Wall Anchors	2	2		Wall Anchors	2 4

Figure 49: Parts Program - Bill of Materials 2

<b>W750</b>			<b>Extras</b>		
	<b>1</b>			<b>1</b>	
Bolts	8	8	Worktop Leg	1	1
Cams	8	8			
Dowels	8	8			
8 x 16 Screws	8	8			
Large Brackets	4	4			
Wall Anchors	4	4			
Kitchen Hinges	4	4			
Hinge Base Plates	4	4			
Bar Handles	2	2			
Whale Bone Handles	0	0			
Shelf Pegs	4	4			

Figure 50: Parts Program - Bill of Materials 3

Built In Cupboards

<b>Built In Cupboards</b>					
<b>Main Bedroom</b>			<b>Bedroom 2</b>		
	<b>1</b>			<b>1</b>	
Pins	60	60	Pins	28	28
Cases	60	60	Cases	28	28
Wedges	60	60	Wedges	28	28
Large Brackets	12	12	Large Brackets	6	6
Wall Anchors	12	12	Wall Anchors	6	6
Small Brackets	18	18	Small Brackets	8	8
8 x 16 Screws	64	64	8 x 16 Screws	28	28
Euro Screws	60	60	Euro Screws	28	28
BIC Hinges	20	20	BIC Hinges	9	9
Hinge Base Plates	20	20	Hinge Base Plates	9	9
Bar Handles	0	0	Bar Handles	0	0
Whale Bone Handles	6	6	Whale Bone Handles	3	3
Rail Brackets	4	4	Rail Brackets	2	2
Runner Sets	0	0	Runner Sets	0	0

Figure 51: Parts Program - Bill of Materials 4

Bedroom 3		1	
Pins	28	28	
Cases	28	28	
Wedges	28	28	
Large Brackets	6	6	
Wall Anchors	6	6	
Small Brackets	8	8	
8 x 16 Screws	28	28	
Euro Screws	28	28	
BIC Hinges	12	12	
Hinge Base Plates	12	12	
Bar Handles	0	0	
Whale Bone Handles	4	4	
Rail Brackets	2	2	
Runner Sets	0	0	

Extras		1	
Hanging Rails (m)	10	10	

Figure 52: Parts Program - Bill of Materials 5

### 3.1.2 Product Sheet

Product Sheet Per House			
Houses Per Week		6	
Production Parts		Installation Parts	
Bolts	48	Wedges	116
Cams	48	Small Brackets	34
Dowels	48	Large Brackets	38
Pins	116	Kitchen Hinges	17
Cases	116	BIC Hinges	41
		Hinge Base Plates	58
		Shelf Pegs	28
		Runner Sets	4
		8 x 30 Screws	12
		8 x 16 Screws	152
		Euro Screws	132
		Wall Anchors	38
		Rail Brackets	8
		Worktop Legs	1
		Plastic Legs	20
		Bar Handles	12
		Whale Bone Handles	13
		Hanging Rails (m)	10

Figure 53: Parts Program - Product Sheet per House

The screenshot provided above is from the second sheet of the parts program, namely the product sheet. The “Product Sheet Per House” automatically calculates the number of parts used per house for production and installation. The owner then also has the option to specify the amount of houses that will be completed in the week (in the green block). This function will be used only for housing development projects as all the cupboards are exactly the same for all the houses and more than one house is completed in a week. In this example 6 houses were completed per week. The program then automatically calculates the number of parts that will be used per week.

<b>Product Sheet Per Week</b>			
<b>Production Parts</b>		<b>Installation Parts</b>	
Bolts	288	Wedges	696
Cams	288	Small Brackets	204
Dowels	288	Large Brackets	228
Pins	696	Kitchen Hinges	102
Cases	696	BIC Hinges	246
		Hinge Base Plates	348
		Shelf Pegs	168
		Runner Sets	24
		8 x 30 Screws	72
		8 x 16 Screws	912
		Euro Screws	792
		Wall Anchors	228
		Rail Brackets	48
		Worktop Legs	6
		Plastic Legs	120
		Bar Handles	72
		Whale Bone Handles	78
		Hanging Rails (m)	60

**Figure 54: Parts Program - Product Sheet per Week**

After completion of the part program, the owner enters the calculated number of parts on the “Product Sheet Per House” or “Product Sheet Per Week” into the “Parts Used” column in the inventory program. This is where the parts program links with the inventory program.



### 3.1.3 Advantages of the Parts Program

- The parts program will aid the owner in knowing exactly how many parts are required for a project. This is a great advantage as the owner can plan ahead for each week and ensure that there are no shortages or oversupply.
- The parts program is very user friendly and calculates everything automatically, which will save the owner a lot of time and increase productivity in the office.

### 3.2 Practical Application of the Inventory Program

The inventory program is the set of policies and controls that monitor levels of inventory at Doorco and determine what levels should be maintained, when stock should be replenished, and how large orders should be. The inventory program is designed to be a program that is used monthly at Doorco.

Following is a practical example of the inventory program and for the purpose of the demonstration, only the first five parts in the program will be used.

The beginning stock in the first column is automatically carried over from the previous month's ending stock. The data in the "Stock Used (In Units)" column is carried over from the "Product Sheet Per Week" in the parts program, as it would have in reality. The table below provides the data that was carried over:

Part	Amount used per week
Bolts	288
Cams	288
Dowels	288
Pins	696
Cases	696

**Table 12: Product Sheet per Week Data for the Inventory Program's Practical Application**

When data is entered into the "Stock Used" column, the first column that the owner needs to pay attention to is the "Stock In Hand" column as the conditional formatting in this column warns the owner if there are not enough parts in storage for the project or if the stock is

moving into the safety stock. These icon sets tell the owner when stock should be replenished.

Provided below is a screenshot of the first four columns in the inventory program.

SKU	Beginning Stock	Stock Used (In Units)		Stock in Hand
Bolts	540	288		! 252
Cams	880	288		✓ 592
Dowels	512	288		! 224
Pins	2000	696		✓ 1304
Cases	500	696		✗ -196

Figure 55: Inventory Program - Screenshot 1

When considering the example above, there are not enough cases in storage to complete the project at hand and 196 cases should be replenished before the project can be completed successfully.

The next column, “Stock Purchased (In Units)”, is used when stock is purchased during the month. The owner should replenish all stock up to a level where the stock in hand is greater than the safety stock (when there is a green tick in the “Stock in Hand” column).

In the screenshot provided above, it can be seen that bolts, dowels and cases should be replenished. The amount of parts that are purchased must be in increments of the order policy, specified by the supplier.

The screenshot below provides the order policies of the parts.

SKU	Order Policy
Bolts	2000
Cams	2000
Dowels	1000
Pins	100
Cases	100

Figure 56: Inventory Program - Screenshot 2



In line with the order policies provided above, the owner purchased 2000 bolts, 1000 dowels and 700 cases.

SKU	Beginning Stock	Stock Used (In Units)	Stock Purchased (In Units)	Stock in Hand
Bolts	540	288	2000	✓ 2252
Cams	880	288		✓ 592
Dowels	512	288	1000	✓ 1224
Pins	2000	696		✓ 1304
Cases	500	696	700	✓ 504

Figure 57: Inventory Program - Screenshot 3

In the above screenshot, it can be seen that the purchases made during the month changed all the symbols in the “Stock In Hand” column to green, which means that there are enough parts in storage to complete the project successfully.

The last few columns in the inventory program are only completed at the end of a month. The “Actual Stock Take” column is where the factory foreman will do stock take in the storeroom. Once a month the foreman will provide the owner with the stock take figures which the owner then enters into the inventory program. Provided below is a table of the actual stock take during the month:

Part	Actual Stock Take
Bolts	2200
Cams	590
Dowels	1224
Pins	1304
Cases	500

Table 13: Actual Stock Take Data for the Inventory Program's Practical Application

The “Difference In Stock” column automatically calculates the difference between the “Stock In Hand” and the “Actual Stock Take”. This is done so that the owner can see how many parts are lost during the month. The owner specified an amount of each part that he is willing to write up as rejects. Provided below is a table of the amount specified by the owner for the five parts used in the example:





Part	Amount willing to write up as rejects
Bolts	50
Cams	50
Dowels	50
Pins	50
Cases	50

Table 14: Rejects Data for the Inventory Program's Practical Application

Provided below is a screenshot of the actual stock take and the difference in stock columns:

SKU	Stock in Hand	Actual Stock Take	Difference in Stock
Bolts	✓ 2252	2200	● -52
Cams	✓ 592	590	● -2
Dowels	✓ 1224	1224	● 0
Pins	✓ 1304	1304	● 0
Cases	✓ 504	500	● -4

Figure 58: Inventory Program - Screenshot 4

The red dot in the first row indicates that there are more than 50 bolts lost during the month. The owner can take this up with the workers so that all parts are accounted for.

The “To Purchase” column automatically calculates how many parts should be replenished at the end of the month and takes into account the safety stock of each part type. Parts should be replenished if the actual stock take is less than or equal to the safety stock.

It can be seen in the screenshot below, that the program notified the owner to purchase 100 cases, because the actual 500 cases is equal to the safety stock.

SKU	Stock in Hand	Actual Stock Take	Difference in Stock	Order Policy	Safety Stock	To Purchase
Bolts	✓ 2252	2200	● -52	2000	500	0
Cams	✓ 592	590	● -2	2000	500	0
Dowels	✓ 1224	1224	● 0	1000	500	0
Pins	✓ 1304	1304	● 0	100	500	0
Cases	✓ 504	500	● -4	100	500	100

Figure 59: Inventory Program - Screenshot 5



The “Actual Amount Purchased” is the amount of parts replenished at the end of the month. If the value is less than the order policy, conditional formatting will change the value to red to warn the owner that the order is not according to the supplier’s order policy.

The “Ending Stock” column calculates the ending stock of the month and these values are automatically carried over to the following month’s “Beginning Inventory” column.

The following screenshots demonstrate these last two columns. The first one is where the owner purchased 50 parts (less than the order policy) and the second is where he purchased 300 parts (in agreement with the order policy).

SKU	Order Policy	Safety Stock	To Purchase	Actual Amount Purchased	Ending Stock
Bolts	2000	500	0		2200
Cams	2000	500	0		590
Dowels	1000	500	0		1224
Pins	100	500	0		1304
Cases	100	500	100	50	550

Figure 60: Inventory Program - Screenshot 6

SKU	Order Policy	Safety Stock	To Purchase	Actual Amount Purchased	Ending Stock
Bolts	2000	500	0		2200
Cams	2000	500	0		590
Dowels	1000	500	0		1224
Pins	100	500	0		1304
Cases	100	500	100	300	800

Figure 61: Inventory Program - Screenshot 7

The screenshot provided below demonstrate the complete example:

Inventory: August 2013											
SKU	Beginning Stock	Stock Used (In Units)	Stock Purchased (In Units)	Stock in Hand	Actual Stock Take	Difference in Stock	Order Policy	Safety Stock	To Purchase	Actual Amount Purchased	Ending Stock
Bolts	540	288	2000	✓ 2252	2200	⚠ -52	2000	500	0		2200
Cams	880	288		✓ 592	590	⚠ -2	2000	500	0		590
Dowels	512	288	1000	✓ 1224	1224	🟢 0	1000	500	0		1224
Pins	2000	696		✓ 1304	1304	🟢 0	100	500	0		1304
Cases	500	696	700	✓ 504	500	⚠ -4	100	500	100	300	800

Figure 62: Inventory Program Complete Example



### 3.2.1 Advantages of the Inventory Program

- One major advantage of the program is that the owner can plan ahead for projects in order to reduce the probability of shortages and therefore increase productivity.
- Conditional formatting creates a much more visual program and will ensure that errors are noticed and fixed quicker and easier. The conditional formatting in the “Stock in Hand” column will ensure that the owner always have enough stock to complete projects and therefore also reduce the probability of shortages.
- The inventory program monitors the levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large the orders should be.
- The program requires minimal input from the owner, automatically calculates most of the values, and the ending stock of one month is automatically carried over to the beginning stock of the next month. These functions will save the owner great amounts of time and will therefore increase productivity in the office at Doorco.

## Chapter 7: Conclusions

The aim of this project was to increase productivity at Doorco through improving the manual business system, storage system and inventory system. Literature was gathered and numerous tools were used to aid in the understanding of these problems as well as relevant techniques that could be used to possibly solve them.

Doorco's manual business system was converted to a computerised business system through the use of commercial accounting software. A demo version of the Sage Pastel Express package was customised specifically to Doorco where after quotes, invoices, payment and reports were generated. This Pastel program satisfied all of the owner's specific requirements and will save the owner an immense amount of time in the office. Productivity in the office would increase by using this software as the business functions can be completed more effectively and efficiently.

Improving the storage operations included creating a fixed location storage system by re-designing the current bins in order to allocate a specific, predetermined and permanent location to each inventory item stored. The static bins' locations were optimised in order to minimize picking time in the storeroom. To assist the workers in the identification of parts and to reduce the time spent searching for parts, the bins were clearly labelled. Dynamic bins were created to reduce the time workers spend acquiring parts from the storeroom. The improved storage operations increased worker efficiency at Doorco, reduced the production and installation loading time, and increased the orderliness of the storeroom.

An inventory system was designed for Doorco in order to monitor the levels of inventory and determine what levels should be maintained, when stock should be replenished, and how large the orders should be. A parts program and an inventory program were designed and these two programs work together as the inventory system. With effective use of these two programs, the owner can plan ahead for projects to ensure that there is always enough stock, thereby reducing the probability of shortages or oversupply.

The storage operations and inventory system were implemented at Doorco. The computerised business system was not implemented but was strongly suggested and responsibility of implementation was assigned to the owner.



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## Appendices

### Appendix A: Industry Sponsorship Form



**Department of Industrial & Systems Engineering**  
**Final Year Projects**  
**Identification and Responsibility of Project Sponsors**


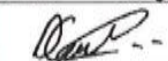
All Final Year Projects are published by the University of Pretoria on *UPSpace* and thus freely available on the Internet. These publications portray the quality of education at the University and have the potential of exposing sensitive company information. It is important that both students and company representatives or sponsors are aware of such implications.

**Key responsibilities of Project Sponsors:**

A project sponsor is the key contact person within the company. This person should thus be able to provide the best guidance to the student on the project. The sponsor is also very likely to gain from the success of the project. The project sponsor has the following important responsibilities:

1. Confirm his/her role as project sponsor, duly authorised by the company. Multiple sponsors can be appointed, but this is not advised. The duly completed form will be considered as acceptance of sponsor role.
2. Review and approve the Project Proposal, ensuring that it clearly defines the problem to be investigated by the student and that the project aim, scope, deliverables and approach is acceptable from the company's perspective.
3. Review the Final Project Report (delivered during the second semester), ensuring that information is accurate and that the solution addresses the problems and/or design requirements of the defined project.
4. Acknowledges the intended publication of the Project Report on UP Space.
5. Ensures that any sensitive, confidential information or intellectual property of the company is not disclosed in the Final Project Report.

**Project Sponsor Details:**

<b>Company:</b>	Doorco
<b>Project Description:</b>	The Design of a Computerised Business System, Storage System and Inventory System
<b>Student Name:</b>	Harris, T.J.
<b>Student number:</b>	29115273
<b>Student Signature:</b>	
<b>Sponsor Name:</b>	DC Lubbe
<b>Designation:</b>	Owner
<b>E-mail:</b>	dc@doorco.co.za
<b>Tel No:</b>	012 653 1255
<b>Cell No:</b>	072 486 6106
<b>Fax No:</b>	012 653 5541
<b>Sponsor Signature:</b>	





## Appendix B: Table of parts stored in the storage room

Parts used for production	Parts used for installation of private customer projects	Parts used for installation of housing development projects
Bolts	Reach-in Hinges	Wedges
Cams	WIP Hinges	Small Brackets
Dowels	L-shape Hinges	Large Brackets
Pins	Ball Bearing Runners	Kitchen Hinges
Cases	Meta-box Runners	BIC Hinges
Staples	Handles	Shelf Pegs
Nails	Hinge Base Plates	Runner Sets
		8 x 30 Screws
		8 x 16 Screws
		Euro Screws
		Wall Anchors
		Rail Brackets
		Acrylic
		Silicon
		Worktop Legs
		Plastic legs
		Bar Handles
		Whale Bone Handles
		Hanging Rails
		Hinge Base Plates

Table 15: Parts stored in Storeroom at Doorco



## Appendix C: Information on Parts in Storeroom

Part Name	Information		
<b>Production Parts</b>			
Production Parts	Lead time	Safety Stock	Order Policy
Bolts	1 day	500	2000
Cams	1 day	500	2000
Dowels	1 day	500	1000
Pins	1 day	500	100
Cases	1 day	500	100
Staples	1 day	5000	5000
Nails	1 day	5000	5000
<b>Installation Parts</b>			
Private Customer	Lead time	Safety Stock	Order Policy
Reach-in Hinges	1 day	0	100
WIP Hinges	1 day	0	100
L-shaped Hinges	1 day	0	100
Ball Bearing Runners	1 day	0	25
Meta-box Runners	1 day	0	25
Handles	1 day	0	10
Hinge Base Plates	1 day	0	100
Projects	Lead time	Safety Stock	Order Policy
Wedges	1 day	500	100
Small Brackets	1 day	100	500
Large Brackets	1 day	100	400
Kitchen Hinges	1 day	500	100
BIC Hinges	1 day	500	100
Shelf Pegs	1 day	200	100
Runner Sets	1 day	25	25
8 x 30 Screws	1 day	5000	10000
8 x 16 Screws	1 day	5000	10000
Euro Screws	1 day	5000	10000
Wall Anchors	1 day	100	100
Rail Brackets	1 day	100	100
Acrylic	1 day	25	25
Silicon	1 day	25	25
Worktop Legs	1 day	4	4
Plastic Legs	1 day	120	4
Bar Handles	1 day	100	10
Whale Bone Handles	1 day	100	10
Hanging Rails (m)	1 day	50m	5m
Hinge Base Plates	1 day	1000	100

Figure 63: Information on Parts stored in Storeroom at Doorco



## Appendix D: Budget

The following is a rough outline of the costs expected to be incurred by the student during the execution of this project:

Expense	Estimated Budget
Internet usage	R400.00
Cell phone bill (approximation only)	R100.00
Transportation: Visiting Centurion once a week for approximately 15 weeks at 30km per return trip (cost taken at AA rates)	R680.00
Labour (approximation only) 400 (minimum hours required for BPJ 410 & BPJ 420) x R60.13 *	R24 052.00
Printing & binding of reports	R400.00
Stationary	R50.00
Total expenditure:	<b>R25 682.00</b>

**Table 16: Project Budget**

\* Rates calculated according to the guideline hourly rates for temporary employment of Industrial Engineering students during practical training (2012) – 4 years of study completed.



## Appendix E: Gantt Chart (Proposed Dates)

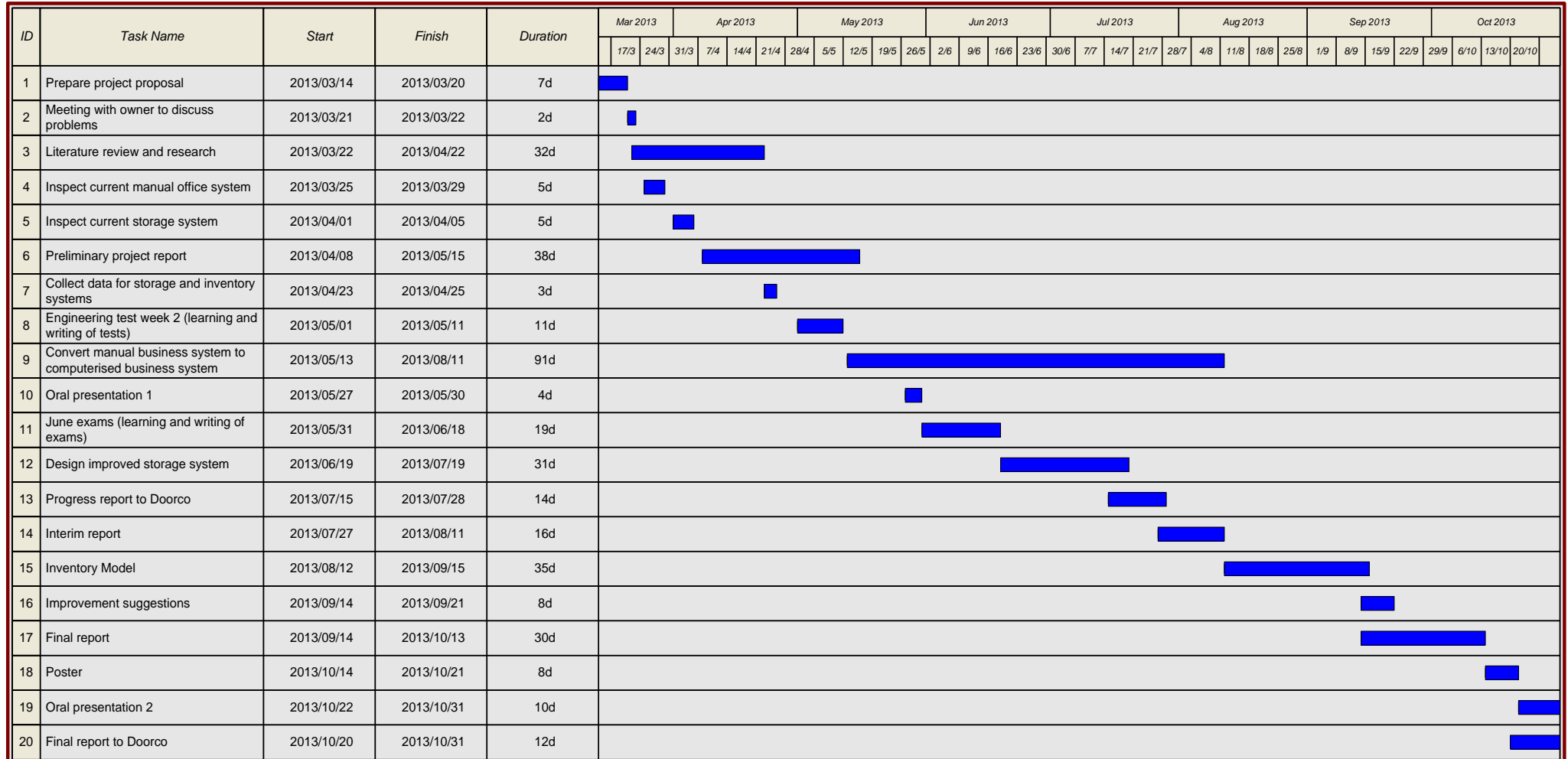


Figure 64: Gantt Chart for Project with Proposed Dates



## Appendix F: Gantt Chart (Actual Dates)

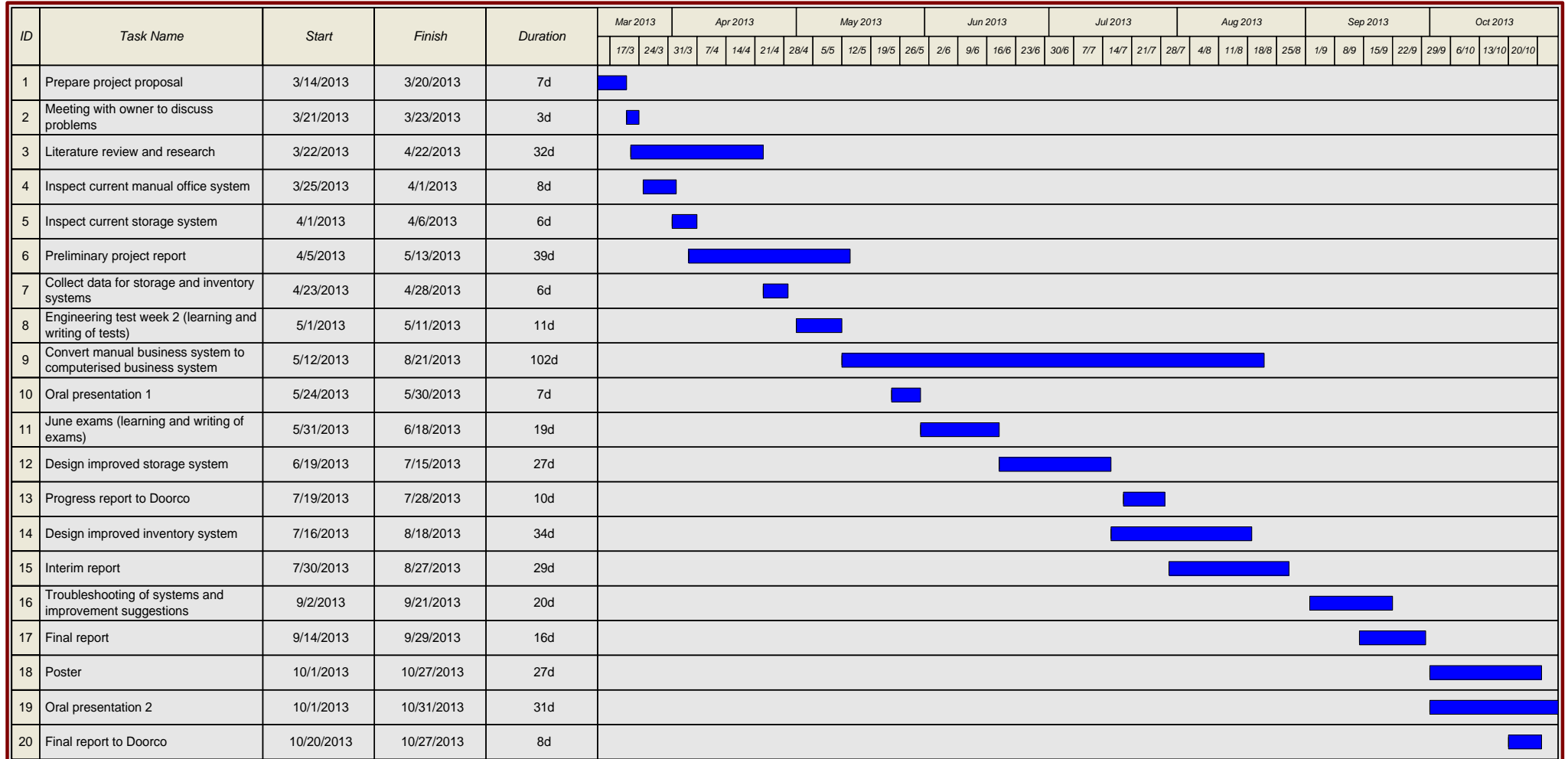


Figure 65: Gantt Chart for Project with Actual Dates