

# **Oasis Water – Facilities Improvement**

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# Executive Summary

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Oasis water was established 7 years ago, in the last three years the company grew so much that they now have more than 100 outlets nationwide. Each outlet provides customers with bottled filtrated water of sizes from 300ml up to 20l. They also provide customers with the facility to refill their bottles at a bargain rate of 80c/l. Some of the outlets sell fruit juices and carbonated water as an addition.

The rapid growth of Oasis Water in the last three years is due to the need for a reliable clean and healthy water source. The company has no set standards for ergonomics, health and safety, types of facilities layouts and materials handling equipment. The productivity of the bottle filling process is very low, because they make use of manual valves to fill bottles. Consequently lots of water is wasted when filling the bottles.

With this project the aim is to develop methods and solutions which will not only help with setting standards for different areas within the outlets as mentioned above, but also to improve productivity and minimize cost and wastage.

With the implementation of suggested material handling equipment, facility layouts and automated machines the management of Oasis Water will improve their productivity, flow of materials and utilization of space.

To finish the project successfully within the given deadlines a few tasks and milestones were set to be reached in time.

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# 1.Introduction and Background

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Oasis water was established in December 2003 and currently has over a 100 outlets nationwide which are operated on a franchise basis. Oasis water has already gone so far to open outlets in other African countries such as Botswana and Namibia; they are also looking to enter the international market, because of the need for a clean and reliable water source globally.

Each Outlet consists of a filtration plant, where they then bottle their own filtrated water and also provide their customers with the facility to refill their bottles at 80c/l. Some of the outlets produce juices and carbonated water.

Oasis water makes use of one of the most successful business formats FASA (the Franchise Association of Southern Africa) which is accepted globally. Their aim is : “For each franchise to become an integral part of the community, by bringing the same core values of trust, mutual respect and caring of the old corner store back to the neighbourhood it serves”.

## 2.Problem Description

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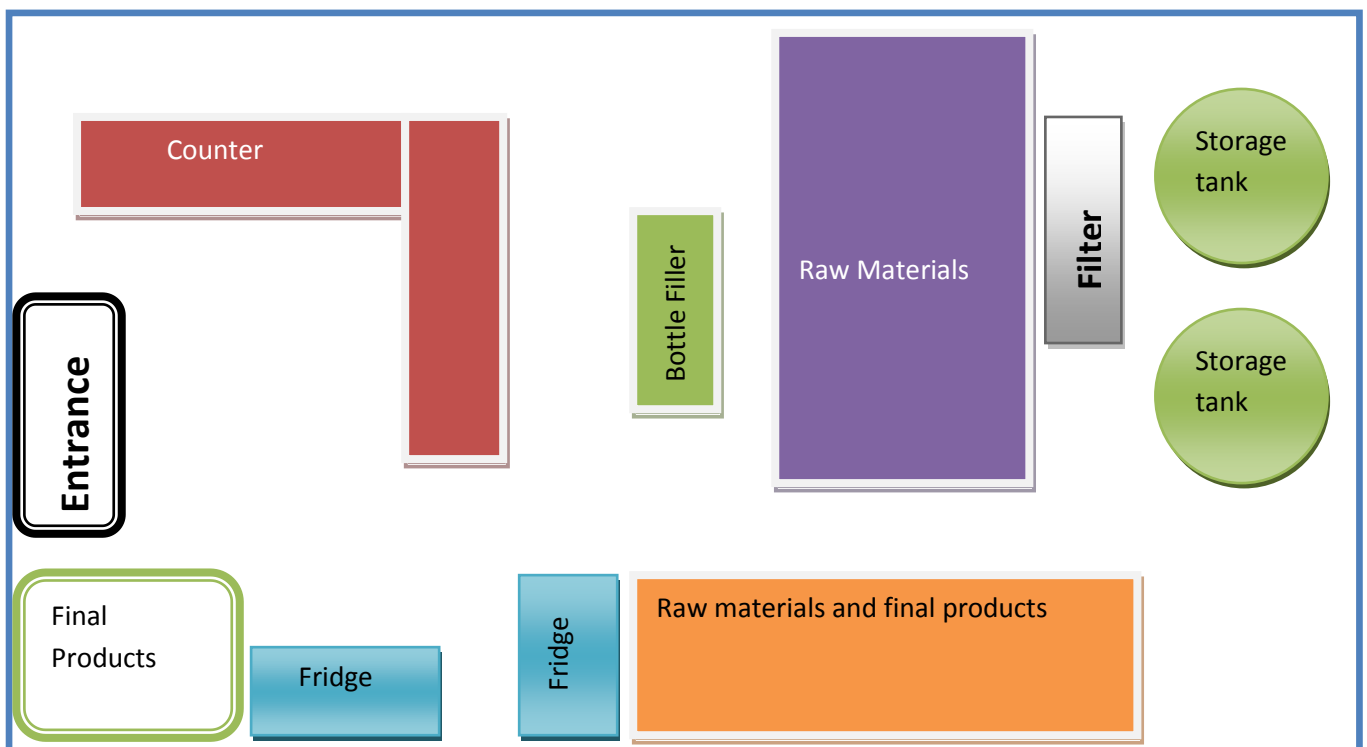
The rapid growth in the number of outlets nationwide in the last three years, led to the problem of not having standards set for the bottling process of the filtrated water, materials handling, hygiene and the layout of different facilities.

A factory that is located in Witbank is responsible for producing larger volumes of bottled water to mines and some of the outlets. The management would like to have a study done regarding their process capabilities and improvement of their facilities layout and productivity that can be implemented at their factory in Witbank. They would also like to investigate the cost implementations for implementing automated machines.

# 3. Project Aim

The aim of this project in the whole is to improve processes within outlets and setting standards for material handling equipment, ergonomics and hygiene. Another aim is to do a study on new product development. In more detail the aim is to:

- Improve the layout of different outlet types and setting a standard for the different types, not only to optimize the processes, but also to minimize cost.



**Figure 1.** Layout of an outlet in Gauteng,

As it can be seen in Figure 1 there is no flow in the process of bottling water.

- Improve the process of bottling water to minimize waste and processing time.



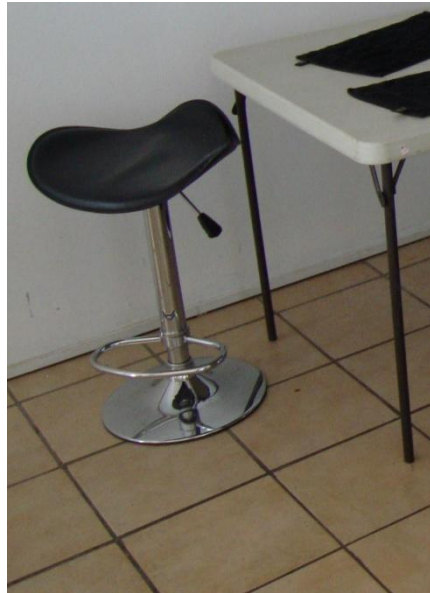
**Figure 2.** Bottle filling machine.



**Figure 3.** Valves used to fill bottles.



- Improve materials handling equipment which will make it easier for workers to move raw materials and final products.
- Improve the ergonomics by using the OHSA as basis for setting standards within outlets.



**Figure 4.** Chair used to sit on when labelling bottles.

- Calculate the minimum space required for an outlet to fully operate, taking into account machine space, isles, storage etc.
- Alternative layout for the factory in Witbank to increase productivity. Implementing material handling systems to minimize the movement of materials.

Due to the lack of time and resources it might be that not all of the problems will be solved.

## 4. Project Scope

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To successfully complete the project some constraints and boundaries needed to be taken into consideration. Some of these boundaries and constraints are:

- Franchisees do have budget constraints; they might not have the capital to purchase the suggested solutions.
- All the different outlets do not have the same layout configuration and size and consequently it will be difficult to set one standard way of setting up the bottling process and the layout.

## 5. Deliverables

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With completion of the project the following will be delivered:

- A standard improved layout for the different outlet types which optimizes productivity and minimizes cost.
- Implementing an automated filling machine which will minimize wastage of filtrated water and improves productivity.
- Implementing materials handling equipment which will make it easier for workers to move raw materials and final products at outlets and the factory.
- Ergonomic standards that should be put into practice by all franchisees.
- A set standard for the minimum space required to fully operate an outlet.
- Alternative layout for the factory in Witbank.
- Cost of implementing automated machines.
- Alternative design for the current bottle filling machine at outlets.

All these will be delivered if the time is available.

## 6. Project Plan

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For the purpose of this report the project plan is not required and therefore it is presented in Appendix A.

# 7.Literature Review

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## 7.1 Importance of a literature review

A literature review is a report that summarizes all of the published work from researchers done on a specific topic. The purpose of the literature review is to convey the management of Oasis water with knowledge about ideas, methods and designs which can be implemented to gain the advantage over their competitors in the market. A literature review was done on the following topics:

- Bottled water
- Facilities Planning
- Material handling
- Automation

The sources to find literature related to a specific problem are found in books, questionnaires, journals, articles, newspapers etc.

## 7.2 Bottled water

Bottled water is where drinking water is being packed into bottles in the form of glass or plastic. Due to the unreliable water supply in South Africa the market growth were rapid from 2000 upwards. According the report of BMI foodpack the market grew 30% from 2006 to 2007, for the last 18 months the sales of bottled water decreased as the market started to mature. BMI foodpack also estimate the amount of water to be consumed during the World Cup to be 1.7 million litres.[3][7]

The rapid growth in the market relate to factors such as[3]:

- The poor quality of water from municipalities
- New product launches by existing competitors
- New competitors entering the market
- Bottled water now available nation wide
- Increase in marketing strategies among competitors

### 7.2.1 Types of bottled water

Bottled water is packed with water from different water sources; therefore there are different types of bottled water. These types are [11]:

- Mineral water: Water that is sourced from underground where it was filtered through rock formations at relative constant temperatures. It is bottled at the spring where the water gets to the surface.
- Prepared water: Water that has undergone treatment to remove impurities and bacteria. This water may originate from any type of water supply.

### 7.3 Oasis water

Oasis water is one of the best purified water producers in South Africa. It is ozonated, oxygen enriched and purified to the greatest standards. This means it will aid in living a healthier life. It is also recommended by some of the best homeopaths and other medical clinics in Gauteng. Oasis water has been proven to benefit people with common ailments such as asthma, high blood pressure and migraines only to mention a few[9].

Their filtration process is the basis for their quality of water.

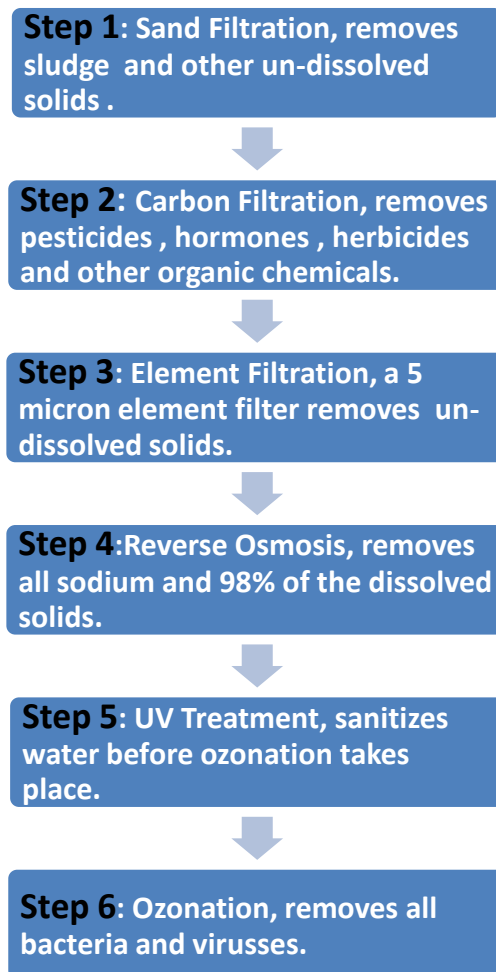
In figure 5 below Oasis water is compared against some of the leading brands in South Africa. Oasis water has the lowest total dissolved solids score and therefore it is known for as one of the cleanest water suppliers.

	Brand 1	Brand 2	Brand 3	Oasis Water
Total Dissolved Solids (TDS)	64 mg/l	52 mg/l	111 mg/l	<20 mg/l
Calcium (Ca <sup>++</sup> )	5 mg/l	3 mg/l	15.4 mg/l	<2 mg/l
Magnesium (Mg <sup>++</sup> )	1 mg/l	2 mg/l	7.12 mg/l	<0.1 mg/l
Sulphate (SO <sub>4</sub> <sup>--</sup> )	< 5 mg/l	< 5 mg/l	2.21 mg/l	<2 mg/l
Nitrate (NO <sub>3</sub> <sup>-</sup> )	1 mg/l	< 0.05 mg/l	0.32 mg/l	<0.3 mg/l

Figure 5. Brand comparison

### 7.3.1 Types of water filtration

a) The filtration process of Oasis Water as from their website is as follows[10]:



**Figure 6.** Oasis water filtration process

Oasis water is also compliant to the SANS(South African National Standards) 241 standards.

#### b) Distillation

In this filtration process the water are boiled the vapour of this boiling water then passes through a condenser where the vapour are then cooled down and collected. [4]

Disadvantages of this process are:

- Consumes lots of energy.
- Costs are high.
- Space requirements are large.
- Not all contaminants are removed.

### c) **Basic Filtration**

In this filtration process the water is poured through three types of filters namely; depth, screen and surface filter. These 3 filters will almost remove 100% of the suspended solids in the water, but it will not remove dissolved inorganics, chemicals, pyrogens and all colloids. This process has high expendable costs.

From these filtration methods mentioned above the process that Oasis use is the most effective and it produce the highest quality of water for least amount of energy. [4]

### **7.3.2 Oasis Water Factory**

The factory of Oasis water is situated in Witbank. The purpose of this factory is to supply some franchises with products that they are not able to produce at their facility. The factory also supplies water in the form of 20 litre containers to the mining group Xstrata close to Witbank. They also supply supermarkets such as Pick and Pay with bottled water. The volume of bottled water produced at the factory is much higher than the volumes of the franchises. Therefore the factory will also be investigated and improved in this project.

## 7.4 Methods Engineering

Methods engineering is a technique that can be used to improve productivity as stated by Niebel and Freivalds (2003:6). Methods engineering use a systematic procedure to develop a work centre, produce a product or provide a service.

The systematic procedure as it is outlined in Niebel and Freivalds(2003:6) is as follows:

1. Select the project.
2. Get and present the data.
3. Analyze the data.
4. Develop the ideal method.
5. Present and Install the method.
6. Establish time standards.
7. Follow up the method

### 7.4.1 Analyze data

The nine primary “operation analysis approaches” as set out by Niebel and Freivalds(2003:72) can be used to evaluate and optimize the gathered data.

1. Operation purpose
2. Part design
3. Tolerances and specifications
4. Material
5. Manufacturing sequence and process
6. Setup and tools
7. Material handling
8. Facilities layout
9. Work design

## 7.5 Facilities Planning

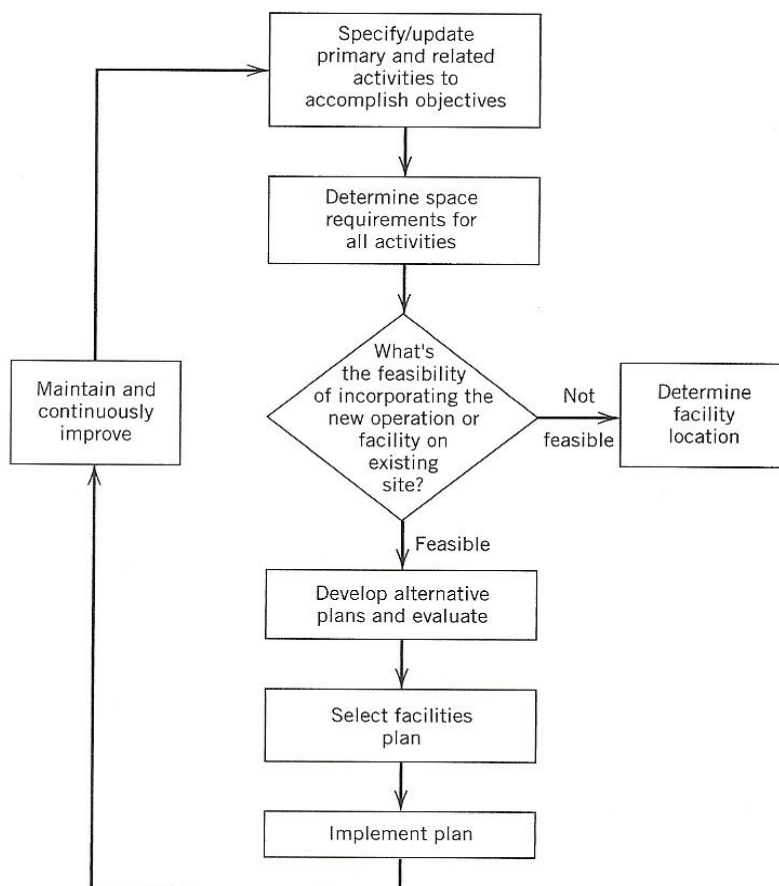
Facilities planning include the location, design and layout of the facility as well as the functions within the facility such as materials handling and manufacturing processes. The main purpose of facilities planning is to achieve excellence within the supply chain.

Customers need to be pulled into the supply chain for companies to maintain a competitive advantage within the market[8][12]. To achieve excellence within the supply chain there is 6 steps according to TOMPKINS, WHITE, BOZER & TANCHOCO (2003, p3-6) namely:

**1. Business as usual** - Let all of the departments in the company strive to maximize their own functions.

- 2. Link Excellence** – Remove all the boundaries between departments so that they will be able to function as one.
- 3. Visibility** - All departments need to know what others do for them to support each other and hereby achieve supply chain excellence.
- 4. Collaboration** – Find the best strategies to meet the customer demands.
- 5. Synthesis** – Improve the flow between supply chain links to achieve customer satisfaction.
- 6. Velocity** – Improve the speed of flow between supply chain links to always stay in front of other competitors.

Companies also need to continuously improve and maintain their facilities plan for supply chain excellence. For companies to continuously improve their facilities planning TOMPKINS, WHITE, BOZER & TANCHOC (2003, p6) developed a continuous improvement facilities planning cycle it can be seen in figure 6 on page 14.



**Figure 7.** Continuous improvement facilities planning cycle.



### 7.5.1 Objectives of Facilities Planning

The customer is an integral part of the supply chain and therefore they should be one of the primary objectives of facilities planning. In general, according to TOMPKINS, WHITE, BOZER & TANCHOCO (2003, p12-13) the objectives of facilities planning are:

- Improve customer satisfaction.
- Increase return on assets (ROA).
- Increase speed to improve customer response.
- Reduce manufacturing costs and increase profitability.
- Improve communication and partnerships within the supply chain.
- Support the organization's vision through improved material handling, material control and good housekeeping.
- Increased utilization of people, equipment, space and energy.
- Maximize return on investments (ROI).
- Let the facility be as flexible as possible to maintain the facility with no difficulty.
- Improve ergonomics within the facility.

Some facilities will not be able to meet all of the objectives mentioned above.

### 7.5.2 Facilities Planning Process

A facility is normally planned once and thereafter the objectives of the facility may change. This means that the facility needs to be improved continuously to satisfy the changing objectives. The traditional engineering process can be used to describe the facilities planning process. The process as from TOMPKINS, WHITE, BOZER & TANCHOCO (2003, p13-14) is as follows:

- 1. Define the problem:** Products to be produced at the facility and quantities to be produced. Define the objectives of the facility.
- 2. Analyze the problem:** Define the interrelationships among different activities. Define the role of the activities within the facility.
- 3. Space Requirements:** Define the space requirements of machine, personnel, raw materials and other activities. Alternative facility plans need to be generated.
- 4. Evaluate alternative plans:** Rank the alternative plans according certain criteria and determine the contribution of each plan towards the facility and its operations.

**5. Select the preferred design:** Select the best alternative plan which satisfies the objectives minimizes cost and which have the greatest contribution towards the facility.

**6. Implement the design:** The design selected need to be implemented, maintained and the objectives of the facility must be redefined constantly.

### 7.5.3 Facility layout types

When designing a layout it needs to be kept in mind that there are different types of layouts. The different layout types are:

#### **Process layout**

A process layout is where generally purpose machines are grouped together according to functions or processes for example milling, forging, bending, etc. Therefore this layout can produce a variety of products with low volumes needed. This is the most flexible layout type.

#### **Product Layout**

A product layout is where resources are arranged sequentially to produce a standardized product with producing large volumes. This layout is less flexible than the process layout.

#### **Fixed position layout**

In this layout the product stays stationary and resources move to work on the product. This layout is not commonly used because it is used to produce large products such as aircrafts.

At oasis water they need to produce high volumes of a standardized product and therefore they would make use of a product layout that is flexible. This should be kept in mind when designing the layout of the facility at the franchises and the factory in Witbank.

### 7.5.4 Space and Ergonomic Requirements

To determine the true space requirements in facilities some factors such as the growth in demand, product size, personnel requirements, aisle widths and machine sizes only to mention a few, need to be taken into consideration.

Ergonomic standards related to the man labour, hygiene, floor types etc also need to be taken into consideration while planning the facility.

#### 7.5.4.1 Work station

To determine the space requirements for a machine the following need to be taken into account[12]:

- Physical geometrics of the machine.
- Space for maintenance on the machine.
- Machine travel.
- Tools and other equipment.
- Space for the operator and other employees at the workstation.
- Space for material handling.
- Raw materials.
- In-process materials.
- Final products.
- Material handling.

#### 7.5.4.2 Aisle

The space requirements for an aisle are primarily based on the type of material handling equipment used and the flow of materials within the facility. Different types of flow require different aisle widths[12]. The recommended aisle widths for different types of flow as recommended by TOMPKINS, WHITE, BOZER & TANCHOCO (2003, p115) are listed in the table below.

Type of Flow	Aisle Width (feet)
Tractors	12
3-ton Forklift	11
2-ton Forklift	10
1-ton Forklift	9
Narrow aisle truck	6
Manual platform truck	5
Personnel	3
Personnel with doors opening into the aisle from one side	6
Personnel with doors opening into the aisle from two sides	8

**Figure 8.** Recommended Aisle Widths For various types of flow.

#### 7.5.4.3 Material Handling

Material handling relates to the movement, protection and control of materials and products within the facility. The type of material handling system used accounts for 25% of employees, 55% of total space required and 87% of the production time as stated by FRAZELLE(1986). The material handling equipment used in a facility is an important component of the facilities design and space requirements[8].

The design of material handling equipment can be done according to the engineering 6 step process. The 6 steps for the design are as follows[12]:

1. Define objectives of material handling equipment.
2. Analyze the requirements.
3. Generate alternative designs of material handling equipment.
4. Evaluate alternative designs.
5. Select the preferred design.
6. Implement and maintain the selected material handling equipment.

Material handling principles developed by the Materials Handling Institute (1998) provides the fundamentals of material handling. These 10 principles are[6]:

1. **Planning Principle:** Material handling plan which define the method to use with taking into account the limitations and functional requirements to meet the performance objectives.
2. **Standardized Principle:** Standardization means that there will be less variation in the methods to be used and less complex designs for equipment to be used.
3. **Work Principle:** The physical work should be minimized and the productivity maximized without influencing the quality of service required.
4. **Ergonomic Principle:** Ergonomic standards must be set, which suit the abilities of the worker.
5. **Unit Load Principle:** A unit load is one entity that is made up by other items. The size of the unit load increase flow and save space.
6. **Space Utilization Principle:** Use three dimensional space as effective as possible.
7. **System Principle:** Entities need to be integrated to form a whole which increase the flow of the system.

8. **Automation Principle:** Implement automated material handling operations where possible to decrease the unsafe man labour.
9. **Environmental Principle:** Environmental impacts need to be taken into consideration when selecting the appropriate equipment and material handling systems.
10. **Life Cycle Cost Principle:** Cost of implementing and maintaining the selected material handling system need to be analyzed thoroughly.

A few questions as it is set up by Selders(2002:1068) can be asked to analyze as if the current material handling system is efficient. If the majority of the answers to the questions are “yes” it means that the current system can be improved. The questions are as follows:

1. Can the number of times the material is handled be reduced?
2. Can the system be more continuous for a smoother flow of materials?
3. Can the speed of handling be increased?
4. Can the materials be handled in larger containers or in greater volumes?
5. Can distances the material is handled be reduced?
6. Are workers kept waiting for material to be moved?
7. Are there times when the equipment is not used to full capacity?
8. Can gravity be used more to move material?
9. Do workers have to make unnecessary movements?
10. Can hand operations be mechanized?
11. Can layout and flow patterns be improved?
12. Can the system be made more flexible?
13. Does the system damage or waste some of the product?

## 7.6 Automation

Wherever humans are at work errors occur. The cost and negative effects resulting because of these errors are:

- Customer dissatisfaction.
- Decrease in quality.
- Decrease of market share.
- Variation in product standards.

- Increase in wastage.

The capital investment to implement automated machines is high, but all of the above costs and negative effects will decrease when a process is automated. If the demand is there the cost of implementing an automated machine will be returned in a short period of time.

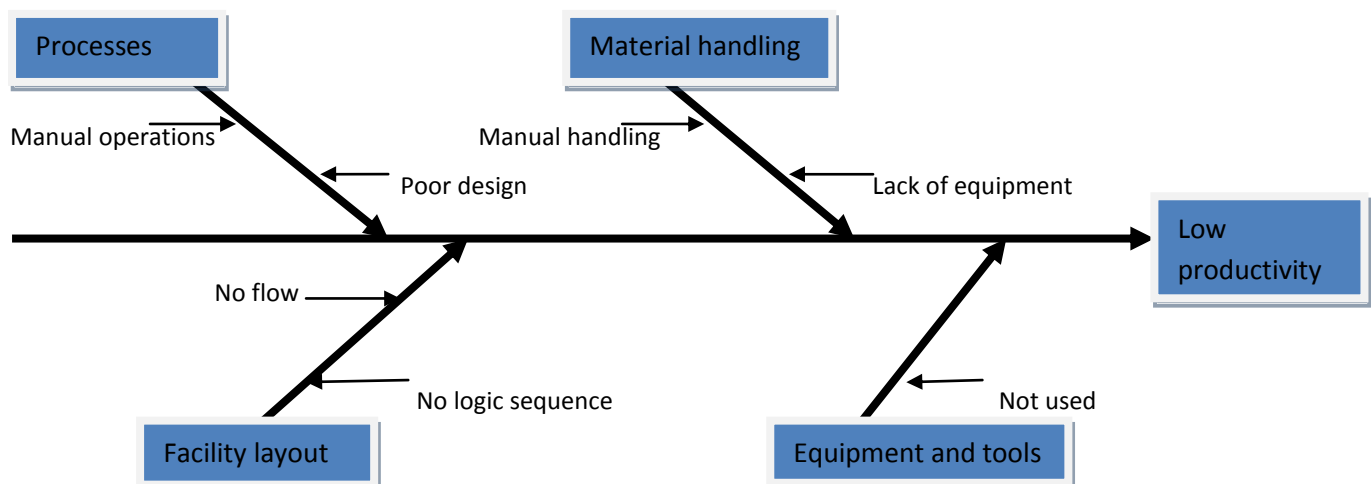
The automated bottle filling technology is so far in advance with technology that no man work is needed to fill, label and cap a liquid filled bottle. Manual filling operations can be replaced by semi- or full automatic machines.

# 8. Selection of Industrial Engineering Methods, Tools and Techniques

To successfully complete this project the appropriate Industrial Engineering Methods, Tools and techniques need to be utilized. Due to the nature of this project a lot of methods, tools and techniques as well as engineering principles will be combined to meet the aim of this project.

## 8.1 Project selection

For the selection of the project a cause-and-effect diagram was used. This was completed in the first phase of the project. From this cause-and-effect diagram was found that the facilities layout, material handling and manual operations was the main problems which led to low productivity and wastage of water within facilities.



**Figure 9.** Cause-and-effect diagram.

The material handling systems implemented at the different outlets and at the factory in Witbank was investigated by means of an audit checklist. The following problems revealed opportunities for improving material handling systems at the facilities:

- Long distances of material handling
- Manual handling of materials
- Insufficient utilization of material handling equipment
- Material packed directly on to floor
- Insufficient use of unitizing principles

- Processes stopped to handle material
- Poor utilization of 3 dimensional space
- Flow of materials can be improved
- Lots of time wasted by handling materials
- Backtracking of materials

## **8.2 Facilities Planning**

As stated in 7.4.2 of this project report the traditional engineering design steps was used to execute the Facilities Planning Process. Flow diagrams will be used to display current as well as proposed layouts for the factory and the ideal franchise. Microsoft visio is used to draw the layouts.

## **8.3 Material handling**

To optimize the material handling equipment in use and to design or select other material handling equipment the principles and design steps discussed in section 7.5.3.3 was used as guidelines. The questions mentioned in 7.5.3.3 were used to identify opportunities to improve the current material handling system.

## **8.4 Automation**

To improve productivity and minimize wastage the manufacturing processes need to be automated. The basics and logics of machine design are used to improve the manufacturing process. The selection of automated machines to replace manual operations is guided by the traditional engineering design steps and general knowledge of automated machines.



# 9.Data, Design and Solutions

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## 9.1 Facility layout

### 9.1.1 Factory

The factory of Oasis Water located in Witbank produces a variety of products. The 3 main products produced at the facility are bottled water, carbonated water and fruit juice. The factory makes use of a “Just In Time”(JIT) production approach. The demand for the different products determines which product or products will be produced at what time and the number of workers allocated to machines.

Due to the nature of the products they produce they have a seasonal demand which means the demand is much higher in the summer seasons than it is in the winter seasons.

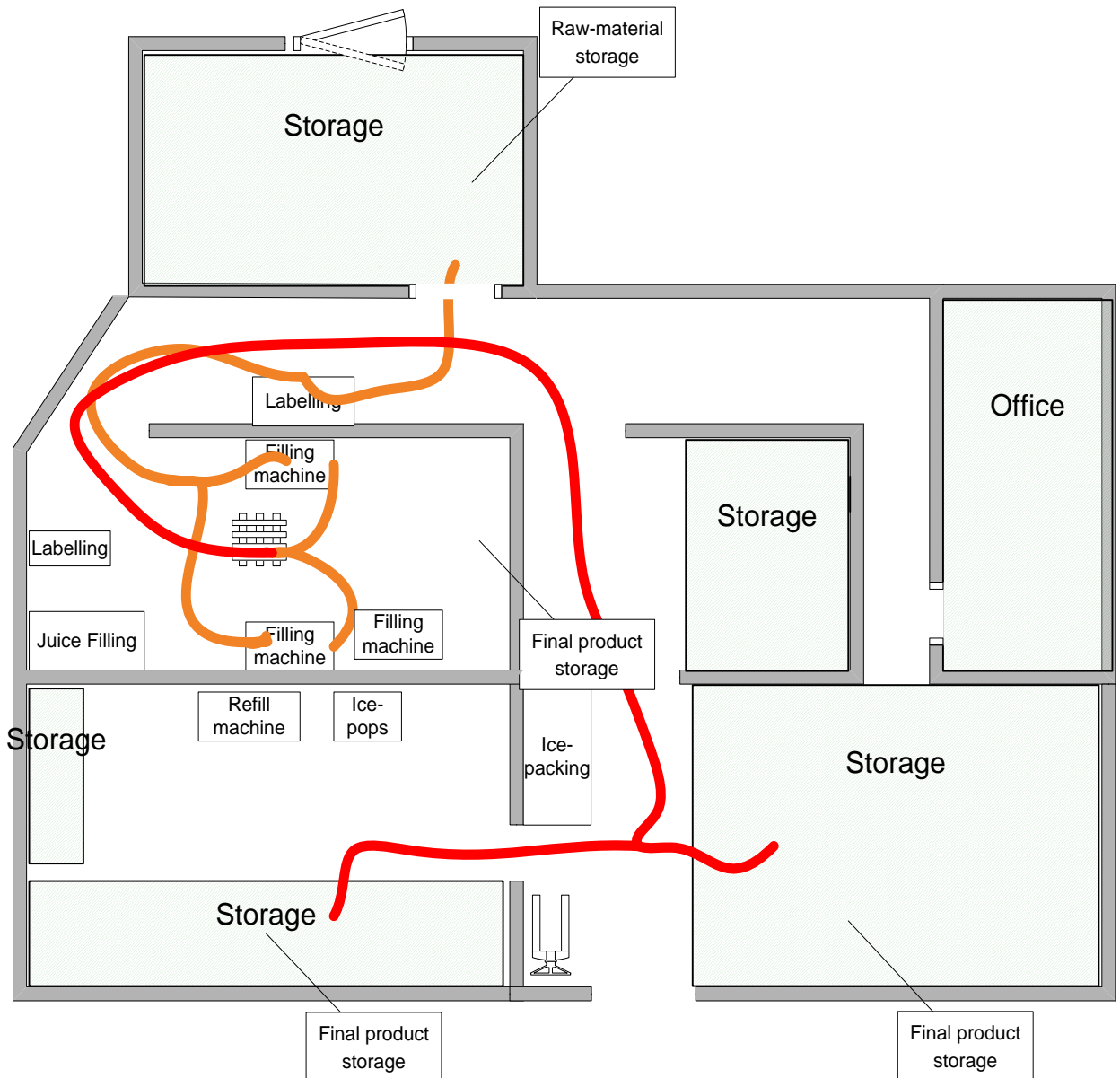
Therefore the factory makes use of seasonal contracts for employing workers. Some of the products the franchise and the factory produce can be seen in figure 9.



**Figure 10.** Oasis Water products

### 9.1.1.1 Current layout

In figure 11 the current layout is showed as well as the flow of materials within the facility.



**Figure 11.** Current layout of factory.

Currently the main concern is that the production capacity is too low and that the demand for bottled water will not be met. The facility is producing at its full capacity. Therefore the proposed solutions will focus on improving productivity through improved material handling, machine automation and facility layout. For this project the refill of 25l dispensers and ice-pops will not be investigated due to time constraints.

This facility consists of the following areas:

1. Raw-materials storage
2. Production(filling, capping, packing)
3. Final product storage
4. Refill of 25l drums and ice pops production
5. Offices

**Production process steps:**

1. Raw-materials(bottles, caps, labels) are currently received at the door on the top of the facility layout in figure 11 where they are piled to heights of approximately 6m. A worker then makes use of a folding ladder to collect bottles from the top of the pile.
2. Bottles moved to labelling area where 2 workers label bottles manually.
3. Labelled bottles then moved to production area to fill with water by two manual filling machines(figure 20) and then capped manually.
4. Bottles then packed into boxes and placed onto a pallet.
5. Full pallet moved to final product storage area by means of a manual pallet truck where they are ready for delivery.

The workers at the carbonated water and juice filling machines are responsible for labelling, filling and capping of their product. This is because the demand for these two products is low.

The following problems revealed opportunities for improvement within the facility:

- Collection of bottles by means of a large folding ladder is not safe for workers.
- Manual handling to move bottles makes it timely and difficult for workers to move materials.
- Manual filling machine is timely.
- Materials are moved long distances.
- Backtracking of materials.
- Lack in the flow of production processes.
- Bottlenecks at the filling machines.

**Resources:**

## Workers

- 3 permanent workers
- 4 seasonal contract workers
- 1 production manager
- 1 manager
- 4 admin workers

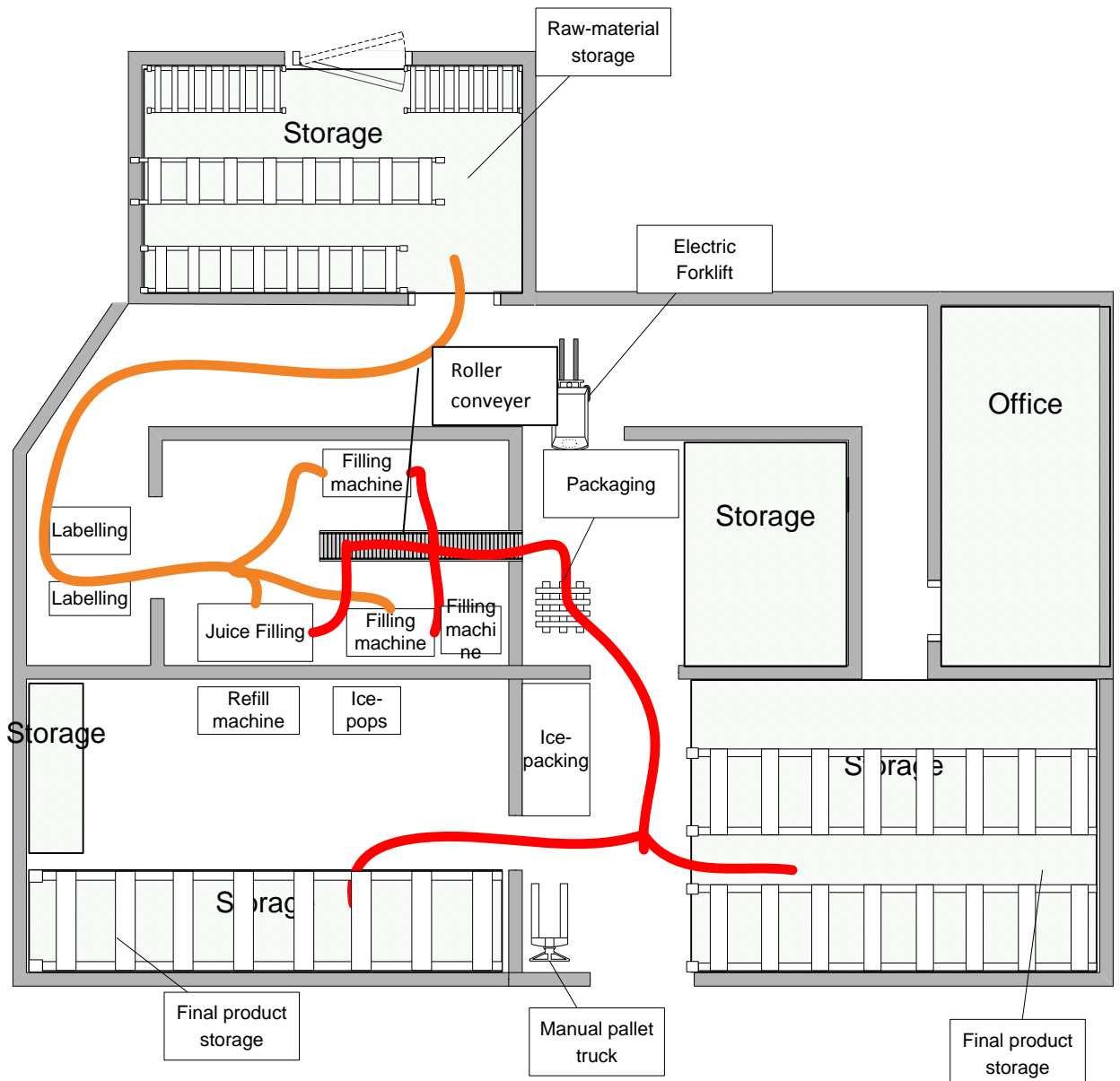
## Machines:

- 2 water filling machines
- 1 carbonated water filling machine
- 2 juice filling machines

## Material handling equipment:

- 1 manual pallet truck

### 9.1.1.2 Proposed layout 1



**Figure 12.** Proposed layout 1 for factory.

Recommendations made to improve the facility:

- Double storage racks as in figure 13 should be implemented to utilize 3 dimensional space and to improve stock keeping.



**Figure 13.** Storage racks.

- Labelling, filling and packaging need to be in 3 different areas for the company to comply with HACCP-Based Standard Operating Procedures, which make the factory able to supply all of the retail stores.
- Electronic forklift to improve speed of material handling and loading of final products onto carriers.
- A roller conveyer should be connected to the filling machines where bottles can then be placed into containers as in figure 18 where they then move down the conveyer to the packaging area where they are boxed and packed onto a pallet.



**Figure 14.** Roller conveyer.

- In section 9.3.3 an improved design for the current filling machine is showed, which will improve the productivity for bottle filling.
- Labelling for juice and carbonated water done at labelling process.
- Ergonomic seating at different operations.
- Make use of platform trucks (figure 15) to move empty labelled bottles to the filling machines.



**Figure 15.** Platform trolley.

For this proposed layout the conveyer will contribute the most for improving productivity and flow of materials. The cost of implementing a 6m conveyer will be ±R10000.

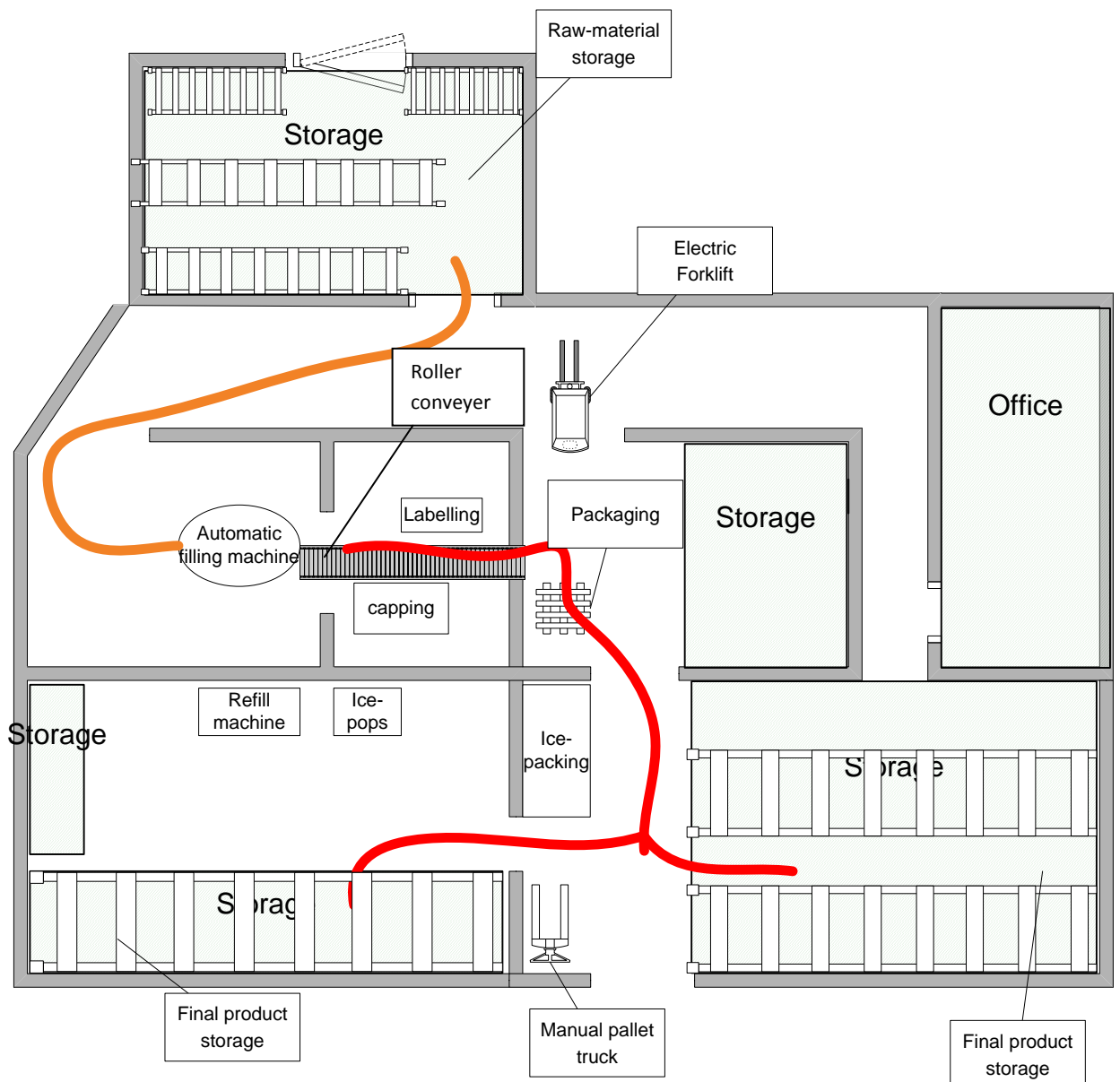
#### ***9.1.1.2.1 Evaluation of proposed layout 1***

The initial costs of implementing the recommendations will be high, but these improvements will lead to:

- Increase in productivity
- Materials moved shorter distances
- Less manual handling of materials
- Improved flow of materials
- Better stock control
- Improved safety
- Improved quality of work
- Minimize time lost by moving materials between processes
- Improved ergonomic standards

The time saved by the improved flow of materials will mean that workers will be able to improve their productivity and produce more bottles per day.

### 9.1.1.3 Proposed layout 2

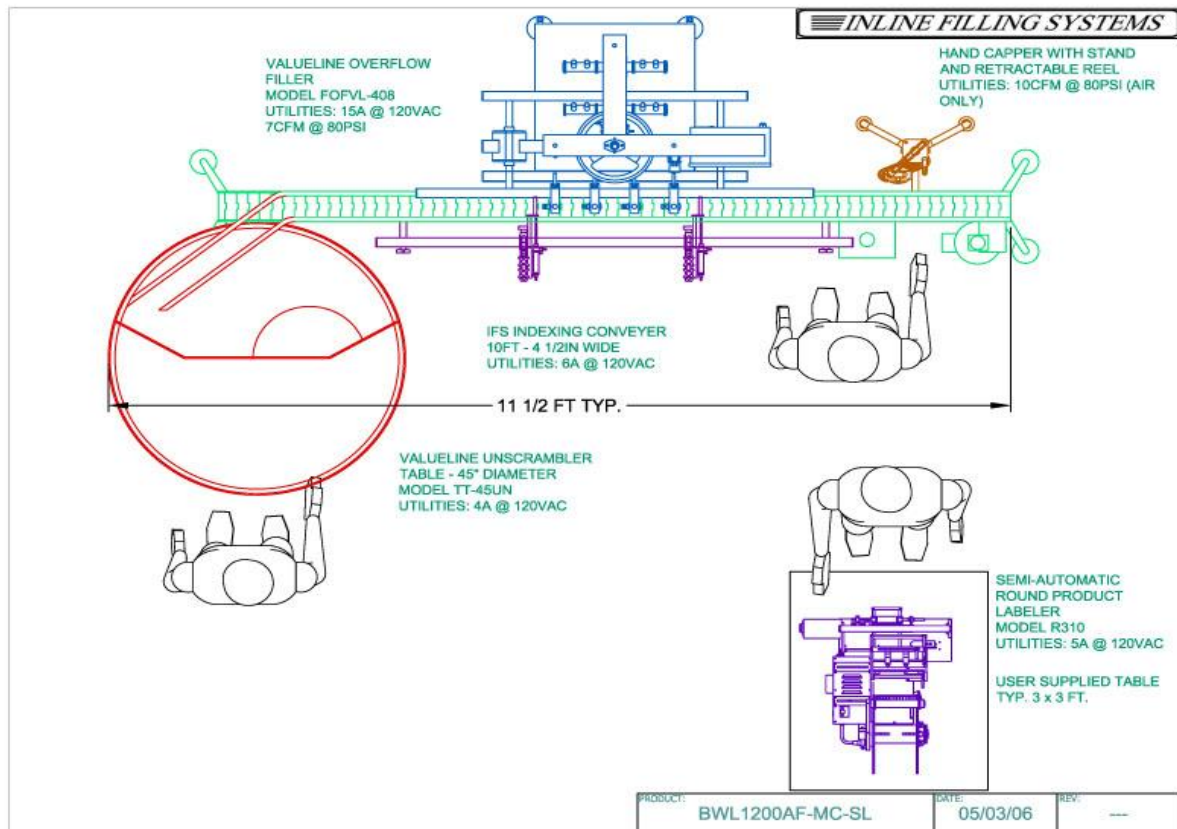


**Figure 16.** Proposed layout 2 for factory.

Recommendations made to improve the facility:

- Fully automatic filling, capping and labelling machine. A sketch of a fully automated machine from the website of Inline Filling Systems can be seen in figure 17.





**Figure 17.** Automated machine layout.

- Electronic forklift which will improve the speed of moving material and loading final products onto carriers.
- Storage racks to fully utilize 3 dimensional space and improve stock control.
- Ergonomic seating at different operations.

#### **9.1.1.3.1 Evaluation of Proposed layout 2**

A cost analysis was done to determine the payback time of implementing an automated filling machine. For this calculation the maintenance cost was left out because this cost will be approximately the same for the old and new machine.

Currently the factory produces one type of product per day for example on the first day 500ml bottles will be produced, the second day 1500ml will be produced and the third day 5000ml will be produced. The demand equals the production for the day. This means the production capacity is full. A market study revealed that the demand is 10% higher than the current production capacity. Therefore the factory has lost sales because of the demand that is not met.

The production capacity as well as the increase in productivity can be seen in table 1. Time studies revealed that the current production rate is 250 bottles per hour. The new machine has a production rate of 1800 bottles per hour, but with a stoppage allowance of 20% the machine will be able to produce 1440 bottles per hour. The current demand will not fill this capacity, but demand forecasts show that the demand will fill the capacity of the new machine in the near future.

**Table 1.** Production capacity comparison.

**Production Capacity**

	<b>Units per hour</b>	<b>Units per day</b>
<b>Old machine</b>	250	2000
<b>New machine</b>	1440	11520
<b>Increase in productivity</b>		576%

The new machine makes use of only 4 workers instead of 7, this means there is a saving of R300 per day. The increase of 10% in demand will increase the daily turnover.

The calculations in table 2 show that the increase in the average daily contribution will be R1091.67. This means that the recommended machine with a cost of R346575 will be paid back in 317 days or 0.87 years. This payback period will be much shorter because the increase in demand annually is not taken into consideration for this calculation.

**Table 2.** Contribution analysis between new and old machine.

**Inputs**

Labour cost per day p/worker	R 100.00			
Maintenance	R 0.00		500ml	1500ml 5000ml
Demand per day			2000	1800 1500
Demand per day +10%			2200	1980 1650
Cost of automated machine	R 346 575.00			

**Contribution of current machine**

	500ml			1500ml			5000ml		
	Units	Price	Total	Units	Price	Total	Units	Price	Total
Sales	2000	R 3.90	R 7 800.00	1800	R 6.50	R 11 700.00	1500	R 11.50	R 17 250.00
Materials cost	2000	R 2.00	-R 4 000.00	1800	R 2.50	-R 4 500.00	1500	R 3.00	-R 4 500.00
Labour cost	2000	R 0.35	-R 700.00	1800	R 0.39	-R 700.00	1500	R 0.47	-R 700.00
Cotribution p/u			R 1.55			R 3.61			R 8.03
Total contribution			R 3 100.00			R 6 500.00			R 12 050.00

**Contribution of automated machine**

	500ml			1500ml			5000ml		
	Units	Price	Total	Units	Price	Total	Units	Price	Total
Sales	2000	R 3.90	R 7 800.00	1800	R 6.50	R 11 700.00	1500	R 11.50	R 17 250.00
Materials cost	2000	R 2.00	-R 4 000.00	1800	R 2.50	-R 4 500.00	1500	R 3.00	-R 4 500.00
Labour cost	2000	R 0.20	-R 400.00	1800	R 0.22	-R 400.00	1500	R 0.27	-R 400.00
Cotribution p/u			R 1.70			R 3.78			R 8.23
Additional cont p/u			R 0.15			R 0.17			R 0.20
Savings on labour			R 300.00			R 300.00			R 300.00
Increase in sales			10%			10%			10%
new cont p/u			R 1.72			R 3.80			R 8.26
Total contribution			R 3 780.00			R 7 520.00			R 13 625.00

Increase in contribution	R 680.00	R 1 020.00	R 1 575.00
Total increase in cont(3days)	R 3 275.00		
Total increase in cont(p/day)	<b>R 1 091.67</b>		
Pay back time(days)	<b>317</b>		
Pay back time(years)	<b>0.87</b>		

## 9.1.2 Franchise layout

### 9.1.2.1 Workstation space requirements

A workstation, like all facilities, includes space for equipment, materials and the personnel operating at the workstation[12].

The space required for equipment consists of:

- The equipment
- Machine travel
- Maintenance on the machine
- Plant service

The space required for materials consists of:

- Receiving and storage of inbound materials
- In-process materials
- Storage of outbound materials
- Tools, fixtures, jigs, dies, and maintenance materials

The space required for personnel consists of:

- The operator
- Material handling
- Operator ingress and egress

**Table 3.** Workstation space requirements

No.	Workstation	Equipment			Personnel			Material			TOTAL (m <sup>2</sup> )
		Width (mm)	Length (mm)	Total (m <sup>2</sup> )	Width (mm)	Length (mm)	Total (m <sup>2</sup> )	Width (mm)	Length (mm)	Total (m <sup>2</sup> )	
1	Filling	600	1300	0.8	1500	1800.0	2.7	1000	1200	1.2	4.7
2	Labelling	600	2300	1.4	1000	2300.0	2.3	500	500	0.3	3.9
3	Filtration	550	1700	0.9	1700	2000.0	3.4	0	0	0.0	4.3
4	Tank	2200	2200	4.2	500	7612.0	3.8	0	0	0.0	8.0
5	Fridge	650	1150	0.7	1000	1150.0	1.2	500	800	0.4	2.3
6	Counter	600	2000	1.2	2000	4000.0	8.0	0	0	0.0	9.2

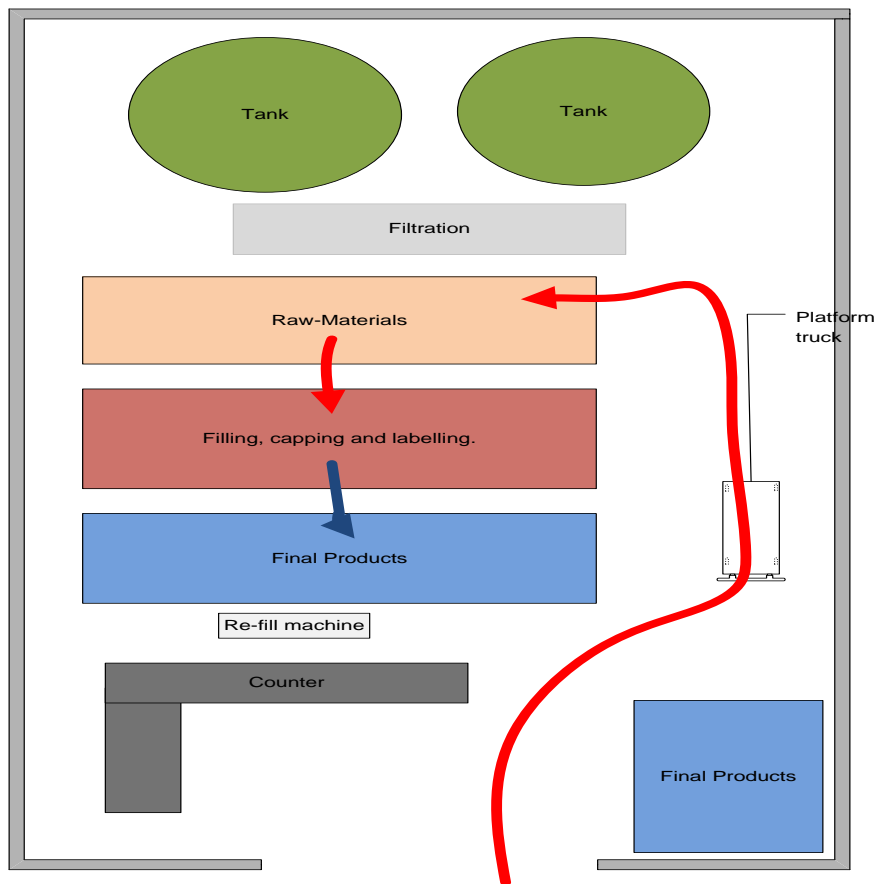
The minimum space required for an outlet is determined by adding the area of the individual workstations within the outlet. The aisle allowance for the outlet is added as a percentage of the sum of the workstations. Additional space for wastage, storage and other operations within the facility were also considered. Table 4 shows the minimum space required for an Oasis Water outlet.

**Table 4.** Minimum space required for an outlet

Outlet Space Requirement			
Workstation	Quantity	Area	Total(m <sup>2</sup> )
Filling	2	4.7	9.4
Labelling	1	3.9	3.9
Filtration	1	4.3	4.3
Tank	2	8	16
Fridge	1	2.3	2.3
Counter	1	9.2	9.2
Storage			10
Total			55.1
	Aisle allowance		15%
	<b>Total area required</b>		<b>63</b>

#### 9.1.2.2 Proposed Oasis Water outlet layout

In figure18 the proposed layout for an outlet is showed. Processes within the outlet need to be sequenced and consequently the flow within the facility will improve. This will improve productivity and an organised facility layout.



**Figure 18.** Proposed outlet layout

## 9.2 Material handling

A material handling system was developed for each of the alternative factory layouts. The problem is that the factory currently only has one manual pallet truck which is used to move the pallet with final products on it. The rest of the materials are moved by hand labour. This means the proposed solutions will need large amounts of costs to implement other material handling equipment. The following alternatives are suggested for further use by the management:

- They can implement an electronic forklift which will increase the speed of material movement and which will make it possible to retrieve raw materials from racks.
- Platform trucks can be implemented so that bottles can be moved from labelling to the filling machine and that materials are not piled on the floor.
- A gravity roller conveyer can be installed to move materials from the bottling area to the packing area which will increase the flow of the materials.

- Containers must be implemented to unitize the bottles to move them down the roller conveyer. The ideal container which folds up and takes up minimal space is showed in figure 19.
- The franchise outlets do not have to move large volumes of materials. Therefore they need to use small material handling equipment. A platform trolley and a 2 wheel hand truck as is in figure 20 can be used to move materials within the outlet.



**Figure20.**Two-wheel hand truck.

**Figure 19.** Containers.

### 9.3 Automation

The filling machine used to re-fill bottles and to fill bottles is shown in figure. This machine is used in the franchises and the factory to fill and refill bottles. The productivity of this machine is very low and the machine accounts for a lot of wasted water.



**Figure 21.** Current refill and filling machine.

A set of questions were asked to franchisees and observations were made to determine the problems of the machine. The following problems revealed opportunities for improving the current filling machine:

- The taps that are used on the machine starts to leak after about a month. The taps then need to be replaced at a cost of R70 per tap.
- The tap heights are not set to a standard height. This means the tap is located to low for a 25l dispenser to fit below the tap and it is located to high for a 5l therefore the workers needs to hold the bottle close to the tap.
- The taps are located to close to the back of the table. This means it is difficult to fit the bottle straight below the tap.
- Wastage on these machines is high.
- The filling level varies due to the use of taps to fill the bottle.
- Normally only one tap is used to fill bottle, because the worker have to hold the bottle in place.
- Customers complain about the hygiene of the rubber extension pipes used.
- Manual handling of bottles.

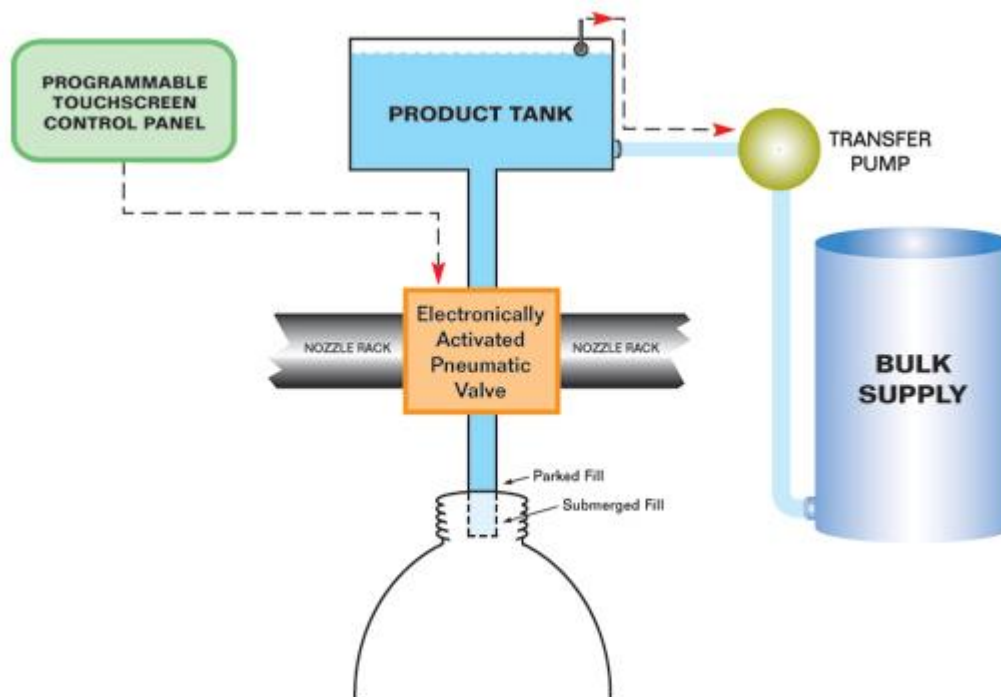
### 9.3.1 Solutions

To improve the filling machine a few recommendations are listed below:

- One of the main concerns is the tap that starts to leak after about a month. The problem was investigated and it was found that the sealing rubber gets brittle and was not sealing properly anymore. The sealing rubber becomes brittle because of the ozone in the filtrated water. The solution to this problem will be to install a tap with a silicon seal. Two other alternatives to replace the tap with are shown below.



**Alternative 1: Semi-automatic gravity liquid filler**

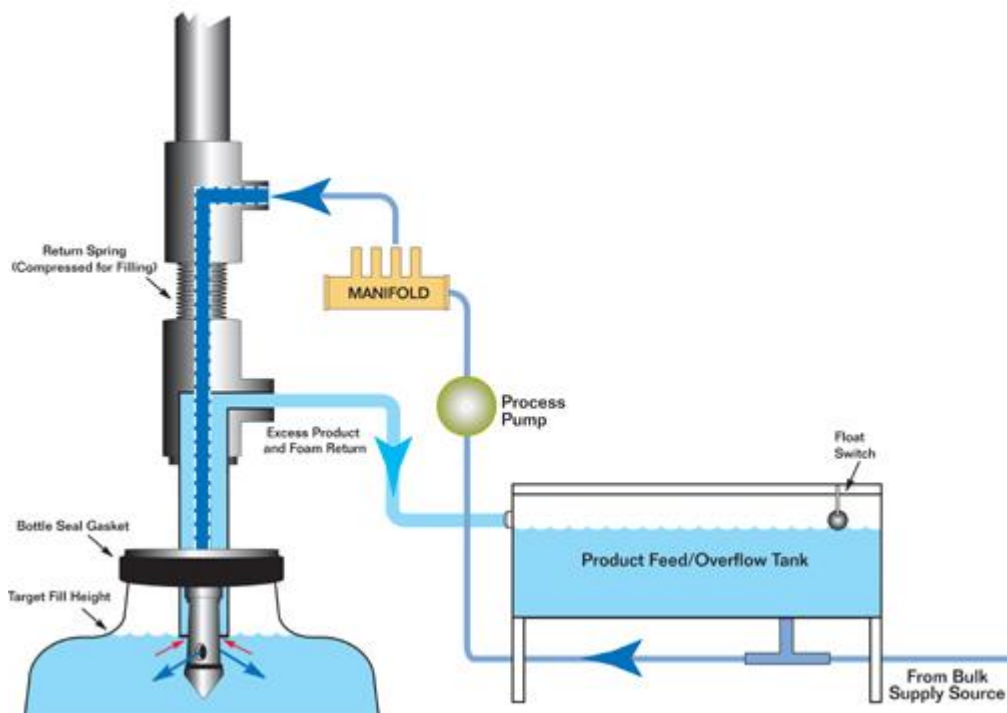


**Figure 22.** Semi-automatic gravity liquid filler.

How it works:

The filtrated water is pumped into the bulk supply tank, from here the water is then pumped into the product tank where an electronically activated pneumatic valve is used to fill the bottle. This method minimizes waste and it fills to a target fill height.[1]

## Alternative 2: Semi-automatic Overflow filler



**Figure 23.** Semi-automatic Overflow filler.

How it works:

The filtrated water is pumped into the product feed/overflow tank, from here the filtrated water is pumped to the nozzle. The top of the bottle is then pressed against the nozzle for the filling process to start. When the bottle is filled to the target fill height the nozzle returns the excess water to the product feed tank and this means the waste of filtrated water is minimized. [2]

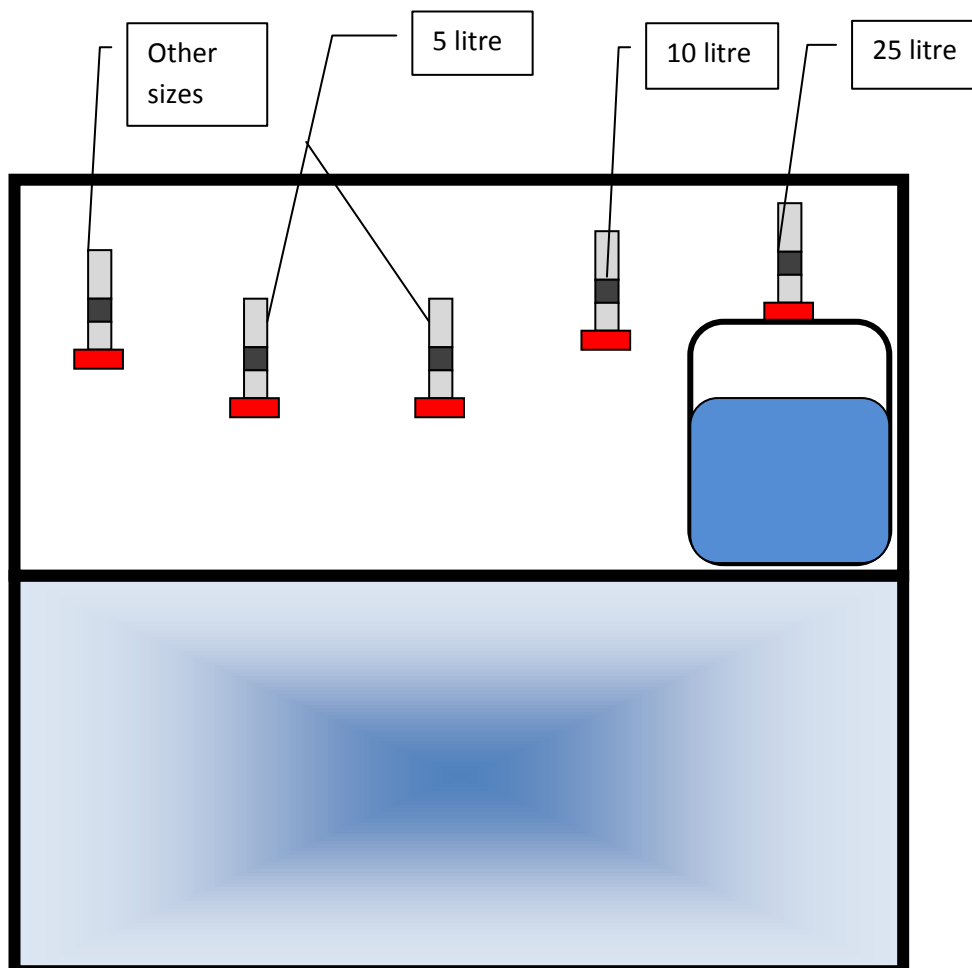
- The nozzles should be placed to a standardized height. This can be solved by locating the nozzles according to bottle heights. Another solution can be to supply the franchisee with stainless steel extensions which can be screwed onto the nozzle to obtain the desired heights.
- The dispensing nozzle must be located a greater distance from the back this can be done by just extending it with a stainless steel extension.

### 9.3.2 Proposed design for the refill machine

The proposed design is a more standardized machine. The valve heights will be standardized according to the demand of bottle types to be refilled. According to historical data it shows that the bottles refilled the most are:

1. 5 litre bottle
2. 25 litre dispenser
3. 10 litre bottle

These 3 bottles will have fixed nozzle heights. The nozzle used in the design is the one proposed in alternative 2 figure 23.



**Figure 24.** Proposed design for refill machine.

#### Method

1. Worker collect empty bottle from customer.
2. The bottle size determines which nozzle will be used. The worker then pushes the bottle into the nozzle where it fills to a target height automatically.

3. When bottle is filled to target height the worker removes bottle.
4. Put cap on.
5. Deliver to customer.

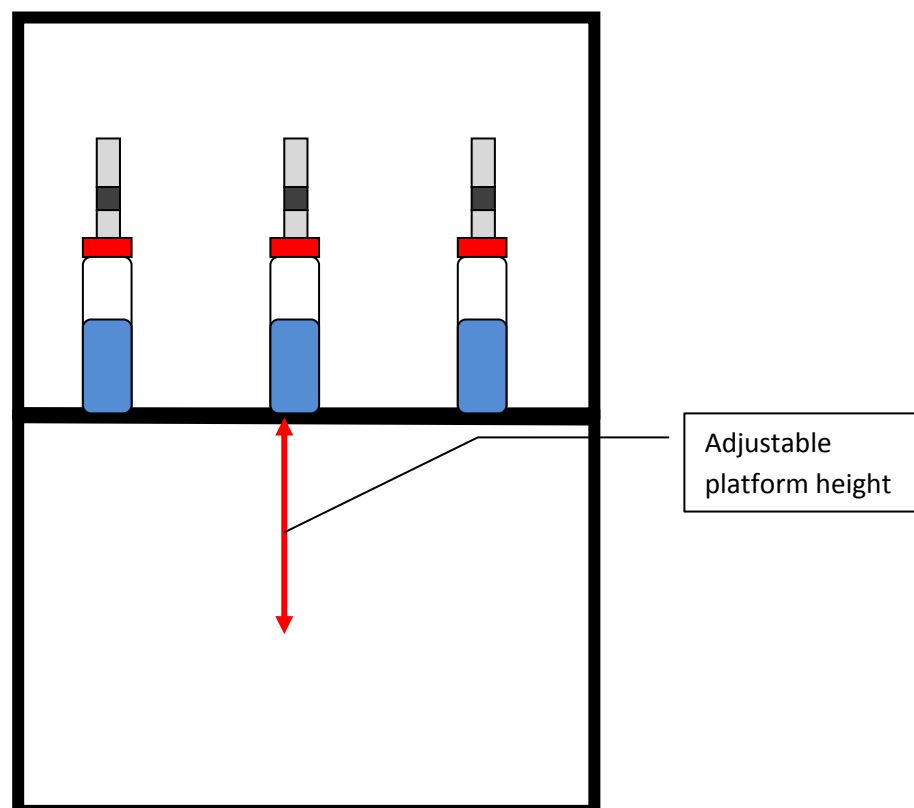
### 9.3.2.1 Evaluation of design

With the implementation of this design the following will be delivered:

- Increase in productivity
- Less manual handling by workers
- Improved hygiene standards
- Customer satisfaction
- Minimized wastage
- Accurate filling heights

### 9.3.3 Proposed design for bottle filling machine

This bottle filling machine will use the valve showed in alternative 2 figure22. The purpose of this machine is to make it flexible to fill all types of bottles by adjusting the platform where bottles are placed on. This smaller machine can be used in franchises and the factory.



**Figure 25.** Proposed design for the filling machine.

## Method

1. Worker adjusts the platform where bottles are placed to the height of bottles to be filled.
2. Place 3 empty bottles into the nozzles.
3. Bottles filled to target height.
4. Worker removes bottles.
5. Cap the bottles.
6. Pack into boxes.

### 9.3.3.1 Evaluation of design

Currently workers make use of only one nozzle to fill bottles because they have to hold the bottle while it is filled. The new machine enables workers to place three bottles into the nozzles to be filled. This means that 3 bottles will be filled at a time instead of 1 filled by the old machine. With the implementation of the proposed design the following will be delivered:

- Increase in productivity
- Less manual handling
- Minimized wastage
- Improved hygiene
- Accurate filling heights
- Less space required

# 8. Conclusion

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In the last few years the meaning of facilities planning changed. In the past facilities planning was described as a science. Today facilities planning are a strategy which gives companies the competitive advantage over other companies in the global market. With a dynamic approach towards the planning and the design of a facility with taking into consideration the methods and principles of facilities planning as well as other constraints, excellence within the supply chain will be achieved.

Based on the principles of material handling existing material handling equipment can be improved or new material handling equipment can be designed. The improvement of material handling systems will lead to more efficient manufacturing flows. It will also improve ergonomics and flow of material within the facility.

The implementation of automated machines will lead to improved productivity and process efficiency. It will also decrease wastage.

The literature reviewed in this document provides the possible methods and principles which can be used to successfully plan a facility. These methods and principles will improve layout designs, ergonomics, process capabilities, material handling and other operations within the facility.

With the implementation of the proposed layout designs, material handling equipment and automated machines it showed that it will:

- Improve flow of materials
- Improve productivity
- Minimize wastage
- Enhance a safer working environment

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# Appendix A

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## 6.1 Activities and Tasks

To make sure the project is completed within the deadlines some tasks and milestones were set. These tasks and milestones are laid out in Appendix A: Gantt Chart with starting and finishing dates. These milestones are crucial to be reached within time so that the project can be completed successfully.

## 6.2 Project Resources

To successfully complete the project the following resources will be used

- Computer
- Books, Journals and magazines related to facilities planning.
- Internet
- Financial Support
- Koos de la Rey- Oasis water
- Mr. E Brett- Project Leader
- Transport
- Stationeries
- Franchisees

This is only a projection of resources that is going to be used. During the project the number of resources will increase as different problems and scenarios arise.

## 6.3 Project Budget

The following is an estimation of costs expected to be incurred by the student during the executing of the project. The sum amount estimated to be incurred is **R800-00**.

Expense	Amount
Stationary	R50-00
Internet	R100-00
Transport	R300-00
Printing and binding	R200-00
Telephone	R100-00
Other expenses	R50-00
<b>Total</b>	<b>R800-00</b>

