Facility design: Achieving overall efficiency in the warehouse environment

by

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Executive Summary

The high pressure of the aggressively competitive modern market prompts many a company to embark on a process of continuous improvement. The survival of companies hinges on their ability to not only adapt to changes but also anticipate future demands from the market placed on their operations.

The discussion at hand revolves around addressing the system inefficiencies at the South African Breweries (SAB) depot in Limpopo. The goal of the report is to apply adequate facilities planning procedure and warehouse operation problems to achieve overall efficiency in the depot.

The argument is structured as follows. The problem is thoroughly examined and defined to form the starting point of the discussion. Literature is then discussed and analysed to aid in the further understanding of the problem. Research into the operations forms the basis of the conceptual design formulated in the latter sections of the report.

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Chapter 1: Overview

1. Introduction

1.1 Background

Since the beginning of the 20th century facilities planning with particular emphasis on the warehousing aspect has been struggling to adequately adapt to the constantly-evolving market demands. In South Africa this is mainly due to the large number of monopolies in the country. Without the threat of competition companies rarely instil a spirit of innovation and continuous improvement into their operations. JIT and lean production strategies offer new challenges to the warehousing environment in that they essentially promote smooth material flow throughout the entire supply chain. This may hinder the agile response to service the volatile downstream marketplace. It may be beneficial to hold strategic inventory at decoupling points (warehouses or distribution centres) to separate lean activities and the marketplace (Christopher and Towill, 2001).

The South African Breweries (SAB) Limpopo warehouse (depot) functionally serves as a buffer (decoupler) for material flow received from various plants namely Polokwane, Rosslyn, Chamdor and Alrode. According to Frazelle (2002a), warehouses are a key aspect of modern supply chains and play a vital role in the success, or failure of businesses today. Viewed from this perspective the buffering function of a warehouse seeks to ensure SAB is able to service customer's needs efficiently. This objective is achieved by being able to accommodate variability in the face of product seasonality and increasing market competition. The SAB warehouse executes the following basic functions: receiving, storage, order picking and shipping. Problems arising as a direct consequence of each function are discussed in following sections of this discussion. A focal point is then stated in terms of the requirements of the SAB facility.

1.2 Problem statement

SAB Tzaneen is currently struggling to service customer needs adequately. Operational efficiency weekly audits depict disturbing variances in the ability of the company to deliver consistently to customers. The company's current operational strategy is failing to provide stability in the execution of activities. The root cause of the chaos is an inability to accurately forecast the regional in order to smooth the supply chain flow.

SAB desires to maximise the utilisation of warehouse space in order to achieve overall efficiency. In the warehouse operation there are several constraints deterring the company from attaining optimality. These constraints identified as follows:

- Space issues around theoretical and actual capacity
- Stacking heights of different SKUs
- Pressures from marketing activities (no. SKUs are increasing) and

- The total allowable time (TAT) to offload and load a truck is 40 minutes with only 2 forklifts available and a bay capacity of 1 truck.

The space concerns in conjunction with the forecasting inefficiencies are contributing to a breakdown in operation at crucial execution points.
The company views their problem as a storage assignment problem; however from practice it is important to note that warehouse functions are interdependent and are part of an operational strategy. Although it is extremely difficult to optimize all the functions simultaneously, It is however vital that the interrelationships between functions be analysed.

2. Project aim

The aim of the project is to design an efficient warehouse layout with optimal storage assignment for attaining maximum space efficiency.

3. Project Objectives

The project seeks to systematically incorporate leaner ideologies into the SAB environment. With Parkinson's Law (All available space will soon be filled) in mind there is a drive in this project to move the company away from solely focusing their attention on the space constraints. Improving overall operational strategy by taking note of all business functions such Sales, Marketing, Operations, Facilities Management, etc. Is the main objective of the SAB Tzaneen warehouse efficiency project.

- Maximise the accessibility of all products
- Ensure compatibility of layout design with organisational mission
- Emphasize overall operational efficiency through the application of industrial engineering techniques

4. Project scope

4.1 Information and skills gathering

This is an integral phase of the project in that this phase facilitates the conduction of intense research efforts which will lead to complete and accurate solutions for the SAB depot. The research (understanding) is divided into two aspects namely: facilities planning and storage assignment algorithm/heuristic research. The literature review will provide the necessary insights to make knowledgeable determinations. Skills gathering would entail gaining knowledge on the simulation software Arena. Time permitting the software will be used to assist in validating the proposed solution.

4.2 Facility layout design proposals

The aspects of facilities planning from the knowledge-base are well understood. From this base layout design proposals are presented which include information such as; location of departments, floor layout, aisle configuration, etc. The common aim is to find an optimal layout with respect to the warehouse objective taking note of the set of limitations and requirements of the facility.

4.3 Storage assignment algorithm/heuristic development

The prerequisite for this phase is detailed design of warehouse infrastructure. Once that is established a set of rules are applied to determine optimal assignment of products to storage locations. A storage assignment policy is selected from the following:

- Random Storage
- Dedicated Storage
- Class-Based Storage

The appropriate algorithm/heuristic is developed in-line with the policy and SAB objectives.

4.4 Testing and improvement

To ensure that a technically sound proposed solution is produced. The robustness of the solution must be tested with regard to varying market influenced warehouse instances. The proposed solution must be evaluated according to extreme instances e.g. exceptionally high product demand for a period, drastically reduced order times, etc. Refinement of the solution commences to mitigate the probability of the solution failing. Simulation is used to validate the application of the proposed solution in the warehouse environment.

4.5 Solution Presentation

Once all the relevant tests and proposed solution analyses are completed the project is presented to the stakeholders. The presentation must be in oral and written form.

Chapter 2: Information gathering

1. Information gathering aim

The information gathering phase is perhaps the most vital stage in any project. The phase provides the foundation for the derivation of potentially optimal strategies and techniques to address the inefficiencies experienced at SAB Limpopo. The information extracted from literature will serve to formulate effective facilities planning solutions with the aid of supplementary Industrial Engineering techniques.

2. Facility design

2.1 Global significance of facilities planning

In a bid to stay competitive in the market companies are opting to focus their strategic outlook on facilities planning. This is noted in the number of facilities built globally every year. The large capital investment signals a growing appreciation of facilities planning as a tool to enhance competitive position. Whether through warehousing, manufacturing plants and distribution centres, facilities hold the key to adequately serving customer requirements. Theoretically the facilities planning process is sound however there exists a gap between academic research and practical implementation in modern industry. This gap draws significant opportunities to improve the facilities planning process. According to Tompkins and White (1984) it is important to consider the following questions to justify the discussion of facilities planning opportunities.

1. What impact does facilities planning have on handling and maintenance costs?
2. What impact does facilities planning have on employee morale and how does employee morale impact on operating costs?
3. In what do organizations invest the majority of their capital and how convertible is their capital once invested?
4. What impact does facilities planning have on the management of a facility?
5. What impact does facilities planning have on a facility's capability to adapt to change and satisfy future requirements?

2.2 The facilities planning process

Facilities' planning acquires its dynamic nature from the continuously changing environment of industry. Due to this dynamic quality facilities planning can be viewed as having a life cycle as opposed to a straight-forward planning and implementation approach. Facilities are planned and revised as needed to remain competitive in the market. The life cycle approach used in conjunction with the engineering design process which is defined below aligns the requirements of the market to facility design objectives

2.2.1 Engineering design process

1. Define the problem
2. Analyse the problem
3. Generate alternative designs
4. Evaluate the alternatives
5. Select the preferred design
6. Implement the design

2.2.2 Facilities Life Cycle

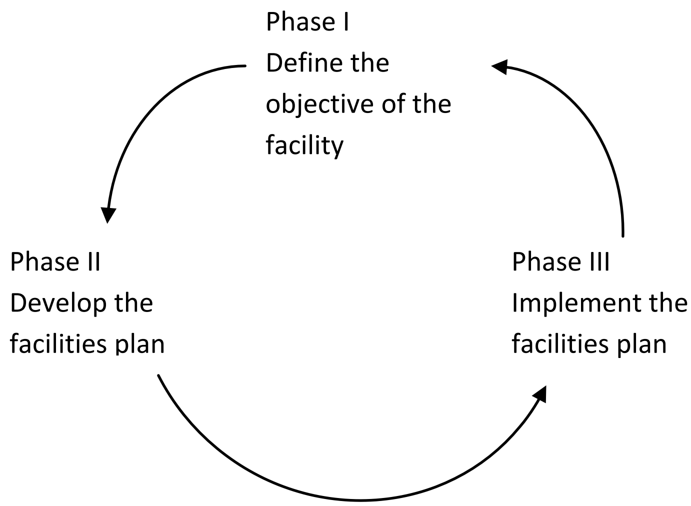


Figure 1 The facilities life cycle

2.3 Basic Warehouse Functions

The facility design process requires that due consideration be given to all the warehouse functions. Literature has proven that the functions are interdependent therefore the overlooking of certain functions invariably results in suboptimal designs. The above mentioned functions are defined as follows (Tompkins et al, 2003).

1. Receiving
   Suppliers deliver goods to this area at an agreed upon time. Vehicle unloading is executed as soon as goods arrive therefore it is essential that specific times for delivery be arranged to facilitate quick unloading.

2. Identification, incoming inspection and sorting
   Accounting and inspection of stock is executed here to ensure items received conform to specification and agree with the Purchase Order. Activities such as bar coding and labelling commence to sort items into relevant groups in order for items to be entered on the warehouse database.

3. Put Away
   The Put Away activity describes the movement (using material handling equipment) of items received and entered into the database. The goods are transported from the receiving are to the storage area.

4. Storage

Storage is the assignment of specific space to items. Goods are stored until picked in response to a demand for goods. Assignment ensures safekeeping and product location.

5. Order Picking

   The physical retrieval and accumulation of stored items in the preparation of a customer order. Along with storage this function is the most crucial in the warehouse environment. It is both costly and time consuming due to the resources utilised in its execution.

6. Packaging, Labelling and/or Pricing

   Accumulated customers orders are now labelled and package in protective packaging in the preparation of shipping. Protective packaging and labelling ensure reaches the right customer in the right condition.

7. Shipping

   Delivery times and appropriate paperwork are coordinated with the customer, from that the loading and shipping activities are executed.

3. Facility layout

This step requires planners creative and thorough in the generation of ideas and alternatives. The focus of the layout planning procedure is the determination of physical relationships between activities. The relationships are the foundation from which various alternative layout options are generated. From the above mentioned set of alternatives one is selected which aims to carry out the requirements of the facility.

3.1 Layout procedures

Given that no two design projects will have the exact same conditions and requirements, various layout procedures can be followed to achieve optimality of options in each project. The following list of procedure acts as guidelines to generating the most effective facility layout alternatives.

3.1.1 Immer's basic steps

Immer's approach is centred on the enhancement of existing layouts. The future aspect of considering new creative layouts is given little attention. The above highlights the limited application of Immer's procedure more especially in the modern environment (Tompkins and White, 1984).

1. Put the Problem on Paper
2. Show lines of flow
3. Convert flow lines to machine lines

3.1.2 Nadler's Ideal Systems Approach

The system originally designed by Nadler for work systems finds clear application facilities planning in a goal driven philosophical nature. The approach contradicts the views expressed by Immer. The ideal systems approach is more future oriented in that it seeks to move away from present assumptions which may prove to be invalid in the future (Tompkins and White, 1984).

1. Aim for the "theoretical ideal system"
2. Conceptualize the "ultimate ideal system"
3. Design the "technologically workable ideal system"
4. Install the "recommended system"

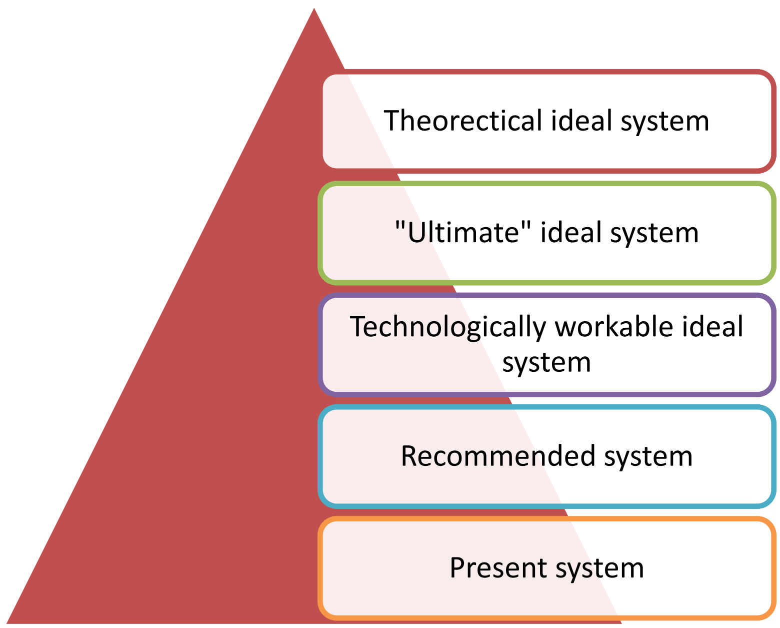


Figure 2 Muther’s ideal systems approach. (Tompkins and White, 1984)

3.1.3 Muther's Systematic Layout Planning (SLP)

Muther's procedure has a distant focus on activities, input data and the relationships between plant/warehouse activities. This procedure can be described as a bottom-up approach in that the fundamental elements (activities) are the source of generation of layout alternatives. The following steps are outlined by Tompkins et al (2003).

1. Chart the relationships.
2. Establish space requirements.
3. Diagram activity relationships.
4. Draw space relationships.
5. Evaluate alternative arrangement.
6. Detail the selected layout plan.

The figure is adapted from the works of Tompkins and White (1984).

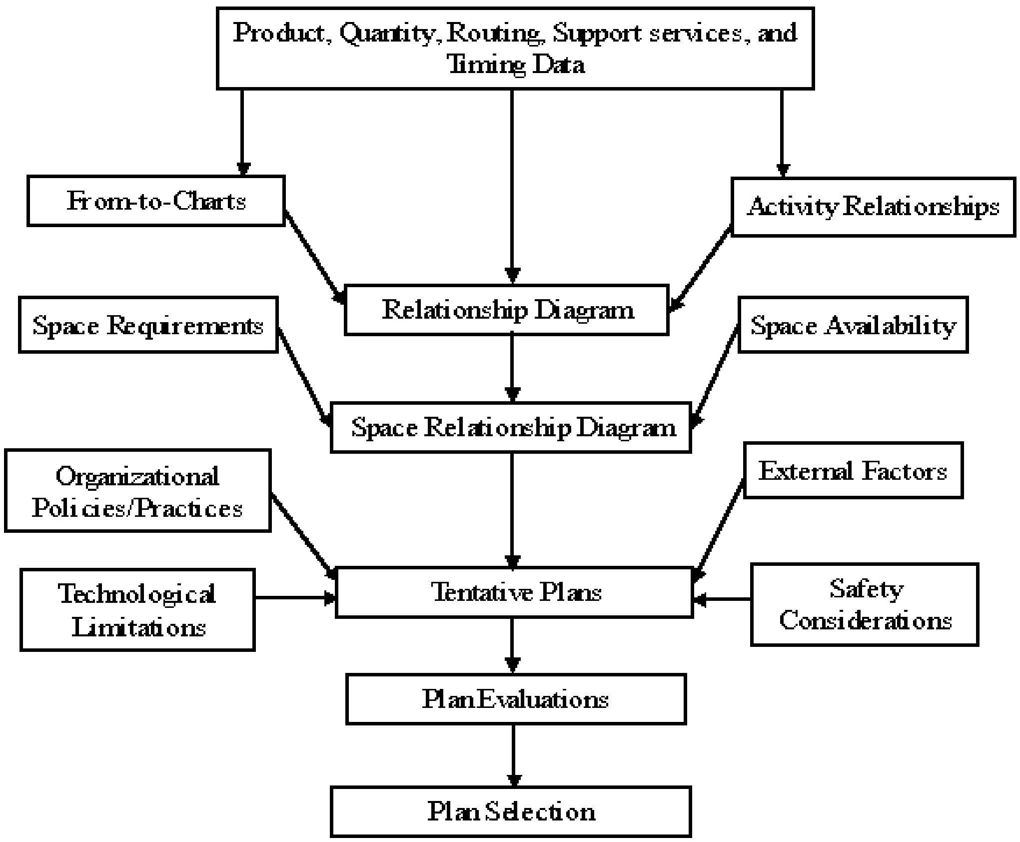


Figure 3 SLP Methodology

3.1.4 Apple's Plant Layout Procedure

The following two layout procedures are the original layout approaches to the layout problem (Tompkins, 2003). The approaches although seemingly primitive are very much relevant in modern layout problems. The steps followed provide a solid foundation for the layout planning process.

1. Procure the basic data.
2. Analyse the basic data.
3. Design the productive process.
4. Plan the material flow pattern.
5. Consider the general material handling plan.
6. Calculate equipment requirements.
7. Plan individual workstations.

8. Select specific material handling equipment.
9. Coordinate groups of related operations.
10. Design activity interrelationships.
11. Determine storage requirements.
12. Plan service and auxiliary activities.
13. Determine space requirements.
14. Allocate activities to total space.
15. Consider building types.
16. Construct master layout.
17. Evaluate, adjust, and check the layout with the appropriate persons.
18. Obtain approvals.
19. Install the layout.
20. Follow up on implementation of the layout.

3.1.5 Reed's Plant Layout Procedure

1. Analyze the product or products to be produced.
2. Determine the process required to manufacture the product.
3. Prepare layout planning charts.
4. Determine workstations.
5. Analyze storage area requirements.
6. Establish minimum aisle widths.
7. Establish office requirements.
8. Consider personnel facilities and services.
9. Survey plant services.
10. Provide for future expansion.

4. Warehouse design and operation problems

4.1 Framework for warehouse design and operation problems

The framework developed by Gu et al (2007) below serves as a comprehensive description of warehouse operation as a whole. In seeking to attain efficiency in the warehouse both the design and operations aspects must be given due consideration.

4.1.1 Warehouse design

1. Overall structure

- Material flow

- Department identification
- Relative location of departments

2. Sizing and dimensioning
    - Size of the warehouse
    - Size and dimension of departments
3. Department layout
    - Pallet block-stacking pattern (for pallet storage)
    - Aisle orientation
    - Number, length, and width of aisles
    - Door locations
4. Equipment selection
    - Level of automation
    - Storage equipment selection
    - Material handling equipment selection
5. Operation strategy
    - Storage strategy selection
    - Order picking method selection

4.1.2 Warehouse operation

1. Receiving and Shipping
    - Truck-dock assignment
    - Order-truck assignment
    - Truck dispatch schedule
2. Storage

    SKU-department assignment
    - Assignment of items to different warehouse departments
    - Space allocation

    Zoning
    - Assignment of SKUs to zones
    - Assignment of pickers to zones

    Storage location assignment
    - Storage location assignment
    - Specification of storage classes
3. Order Picking

    Batching
    - Batch size
    - Order-batch assignment

    Routing and sequencing
    - Routing and sequencing of order picking tours
    - Dwell point selection (for AS/RS)

    Sorting
    - Order-lane assignment

4.2 Warehouse functions and operation problems

The following discussion brings to light various operation problems found both in academic research and in practice. Order Picking and Storage being the driving functions in any warehouse naturally define the warehouse optimization tools and techniques to be applied as seen in the preceding framework. Below these two functions are further described in terms of the operation problems stemming from each.

4.2.1 Storage

The determination of where the SKUs should be stored is essentially the core service given by the storage function. Diverse solutions methods exist in determining the SKU storage location that fit the needs of various warehouse designs. According to Gu et al (2007) the two criteria responsible for the location decisions are namely storage efficiency and access efficiency. This highlights the interdependence of warehouse functions.

4.2.1.1 Assigning SKUs across departments

The **forward-reserve problem**: assigning a separate picking area for high-demand products. The forward area is more accessible therefore order picking, travel times and material handling costs are reduced. Critical assignment of SKUs to the forward area is crucial due to the limited space in the area.

4.2.1.2 Assigning SKUs across zones

Storage departments are divided in order to enable more efficient order picking. The distance the picker travels is decrease due to repeatable order picking activities enabled by zoning.

4.2.1.3 Storage location assignment

The **storage location assignment problem (SLAP)**: assigning products based on the information available and level of technology in the warehouse. Three different classes exist for the SLAP and they are elaborated below.

1. SLAP based on item information: comprehensive information is available pertaining to the flow of the items in and out of the warehouse environment.
2. SLAP based on product information: This particular variation of the problem assigns products to locations according to certain product characteristics described by Frazelle (2002) below.

    - Popularity (defined as the number of storage /retrieval operations per unit time period)
    - Maximum inventory (defined as the maximum warehouse space allocated to a product class)
    - Cube-Per-Order Index (COI, which is defined as the ratio of the maximum allocated storage space to the number of storage /retrieval operations per unit time)

3. SLAP based on no information.

There are several storage assignment policies which aid in structuring of storage assignment decisions. These policies are as follows (De Koster et al, 2007).

- Random storage
- Dedicated storage
- Full-turnover storage
- Class-based storage

4.2.2 Order picking

Order picking is defined as the process of picking items in preparation for shipment to specific company customers. This function is comprised of the following steps; batching routing and sequencing, and sorting.

4.2.2.1 Batching

Batching simply stated is the accumulation of a set of orders into a group (batch) which will be shipped in the same time period. Gu et al (2007) describe the partitioning of orders among the pickers as a variation of the classical vehicle routing problem (VRP). In literature it is seen that two main heuristics stem from the VRP namely the seed and savings algorithms.

4.2.2.2 Sequencing and routing

Sequencing and routing clearly defines the movement of order pickers/order picking equipment around the warehouse which increases order picking time efficiency. The exploration of various routes (locations to visit in a set sequence) determines how the picked item will flow through the warehouse. The sequencing and routing problem resembles the Travelling Salesman Problem (TSP).

Chapter 3: Analysis and conceptual design

1. Analysis of current environment

This analysis is an essential part of any development process. The analysis of the current environment serves to extract vital system characteristics which need to be considered in the development of facility designs. Constraints and system inefficiencies inherent in any system are brought to light by the analysis of the current system.

1.1 Layout

The SAB warehouse in Tzaneen due to the nature the products carried by the firm opts to use bin floor demarcations as opposed to racks for stacking purposes. Each SKU is assigned to a bin; this is the case because SKUs have different stacking characteristics. Stacking in the warehouse is accomplished through the use of wooden pallets. These stacks can either be 2 high or 3 high depending on the type of product on the pallet e.g. cans and returnable bottles (RB) are 3 high but dumpies (330 non-returnable bottles) are on two high.

The stacking on a specific pallet in a bin varies thus the stacking requirements of cans, quarts (RB) and dumpies are defined as in the table 1.

Table 1: Stacking

Product Type (Packed in Cases)	Base	Stacking Configuration on Pallet
Quarts (750 or 660ML)	11	6 High
Dumpies (330 or 340ML)	10	7 High
Except Black Label (Thin neck)	10	8 High
Cans		
330ML	9	13 High
440ML	9	10 High

Figure 4 NRB Stacking max 2 high

1.2 Warehouse activities overview

The general warehouse functions are executed at the Tzaneen warehouse. The trucks arrive at the depot from Alrode (Supplier), inspection of goods then commences. In addition to inspection the reconciliation of goods received must be undertaken in term of the following questions:

- What number of goods Alrode claim to have sent?
- What is physically received at delivery?

- What is dispatched on the system?

The goods are transported from the receiving point to the storage area by means of forklift. Goods are stored in terms of the storage assignment policies in place.

The order picking and storage activities are executed according to the ABC classification strategy. This strategy is elaborated in the next section of the document.

The SAB warehouse receives and releases goods on a daily basis therefore productivity in all operations is the key to efficiency. One measure of productivity in place is measurement of the turnaround time: defined as the time from when a delivery vehicle enters the premises to final dispatch. The company uses this metric to evaluate how effective/productive the checking, loading/off-loading, storing and picking functions are.

1.3 Warehouse strategies

The warehouse implements a FIFO for the flow of goods out of the warehouse. The main issue to consider with this strategy is that products have a certain shelf and products are released according to their DOM (date of manufacture) dates. The FIFO system induces double handling under the current system because new stock cannot be stacked on top of existing stock in the bin. The company employs the Julian Calendar System which displays on the packaging the DOM date, year produced, line number and the exact time the product moved off the production line.

Reverse logistics is another strategy employed in the warehouse. Returned bottles are warehoused until pulled by demand to the production plant where they are used to fill new orders. It is important to consider space for this activity when planning the facilities design.

SAB currently employs a class-based storage policy. The ABC analysis allocates SKU space solely based on demand. For the SAB warehouse this translates into priority being given to the bulk packs namely the 750ml and 660ml packs (returnable bottles, quarts). The driving principle behind the ABC analysis is that the fast-moving products be given the most ideal locations in the warehouse (near the door).

1.4 Material handling equipment

The warehouse in a quest for ultimate efficiency uses a double-forklift which carries two wooden pallets at a time. The double forklift ensures high equipment utilisation and reduces the turnaround time. The reduction in turnaround time is realised when delivery vehicles are loaded and offloaded. The forklift ensures for example that if 30 pallets are offloaded then the same number of empty pallets must loaded back on to the truck before it leaves the premises. During loading/offloading no forklift may be idle.

Figure 5 Double Forklift

2. Conceptual design

2.1 Key questions to evaluate

Before embarking on a mission to design optimal facilities; the needs, constraints and inefficiencies of the current system must be well defined. The key questions to evaluate in terms of the SAB warehouse are defined as follows:

- What can be done to reduce the double handling?
- Is allocating storage space solely according to demand optimal?

From the evaluation of these questions the focus of the facilities planning process is clear and distinct.

2.2 Focus of the design

The focus of the SAB Limpopo design project will essentially centre on the storage warehouse function. Although it may be ideal to optimize all the warehouse functions simultaneously it is not feasible given the time and resource constraints. The project seeks to determine whether the inputting of other factors in the class assignment will increase the efficiency of the warehouse operation.

A specific storage assignment policy will be selected in terms of its appropriateness to the SAB warehouse. The appropriateness may be broken down into elements evaluating the potential benefits provided by the policy. Flexibility for growth, efficient flow through warehouse and ultimate cost savings achieved in reduced material handling are the suitability metrics of the proposed solution.

Experimentation with various layout designs will be based fundamentally on the storage assignment policy selected.

2.3 Storage location assignment

Gu et al (2005) discussed storage assignment methods based on the level of information available. The three methods are as follows:

- Storage location assignment problem based on item information
- Storage location assignment based on product information
- Storage location assignment based on no information

Given that SAB relies heavily on knowing at all times how brands are performing in the market. The product information is readily available; this is also reflected by the company's implementation of the ABC classification which uses demand as a metric for evaluation.

The project will naturally focus on the storage assignment based on product information. In addition to this the criteria defined by Frazelle (2002) will be incorporated into the ABC analysis. This serves to determine the effectiveness of the complete consideration of factors against the incorporating of demand exclusively as a metric for evaluation.

The criteria are popularity, maximum inventory, and Cube-Per-Order Index.

2.4 Layout design steps

Muther's Systematic Layout Procedure (SLP) is selected as the most suitable to address the layout design aspects of the project design. Although warehouse activities are not nearly as pronounced as production plant activities they still however need to be thoroughly considered. The focus of the project narrows the discussion to mainly the storage function. As a result of this the layout planning steps need to consider activities, relationships between activities and roles of activities. The following analyses are performed in Muther's procedure (Tompkins et al, 2003):

- Material flow analysis (from-to –chart)
- Activity relationship analysis (activity relationship chart)

Alternative layout procedures such Immer's and Nadler's are relatively primitive in comparison to the SLP. They fail to address the problems in design at activity because of the top-down approach employed.

2.5 Palletization table

The palletization table acts as a validation tool of the recommended layout designs. The table is completed based on the stacking configurations of SKUs in the warehouse. The warehouse applies a common measure for volume of SKUs which is hector litres.

Once the design is completed the hector litres assigned to specific SKUs must be examined and given as a percentage of sales.

80 percent of the hector litre allocation must come from the bulk packs (750ml and 660ml). If this essential requirement is not met the proposed design is infeasible for the SAB warehouse because 80 percent of sales are generated by bulk packs.

Chapter 4: Solution Design

1. Facilities Improvement

The improvement of facilities often takes on a top-down approach which incorporates the entire system as a whole to ensure adequate integration of operations and functions to form unitary whole. The following pyramid according to Tompkins et al (1984) describes how the objectives of the SAB project are translated into an implementation plan.

Figure 6 Transforming strategies into action

The design of the SAB warehouse solution is as a result of an analysis of the operation of the depot as a whole. The depot naturally houses a variety of functional areas which are multi-dimensional in that they work to support the common goal of the depot. Even though each functional area such as Sales, Procurement and Distribution has its own set of strategies, the Facilities Planning strategy developed will impact the whole system operation. With that in mind the importance of facilities planners participating in the development of a plan is highlighted. Without this participation the plan developed will fail to support the overall strategic plan.

The SAB Tzaneen Warehouse Efficiency project has embraced the three dimensions of facilities improvement in order to produce efficient design proposals. The three dimensions according to Tompkins et al (1984) are depicted below.

In terms of the Time aspect of improvement, adequate planning was done with the end in mind. This is the most crucial part of the project. Inadequate planning invariably results in poor designs which fail to satisfy the needs of all stakeholders. This is why all manners of extracting vital information are exhausted. The physical aspect is discussed in further detail in terms of the layout design.

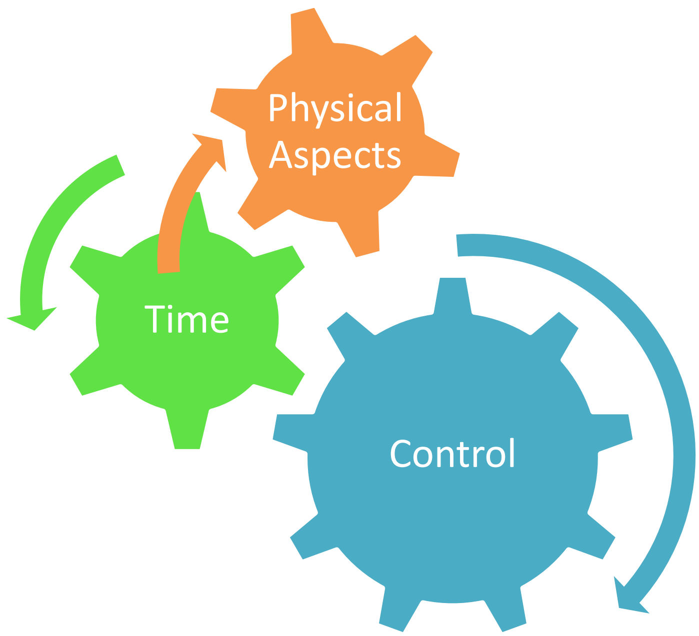


Figure 7 Three Dimensions of Improvement

2. Layout Design

The warehouse layout was the perfect platform from which to launch depot efficiency improvements given the severe space constraints in the warehouse. The layout design starts with an execution of Muther's Systematic Layout Planning (SLP) to get a view of the various activities performed in and around the warehouse. The SLP procedure performed on SAB intentionally excludes a space relationship diagram. The diagram is redundant for the SAB layout design solution because the depot has committed to the current overall layout of the facility. This in essence means that only the warehouse is up for rearrangement, therefore only the warehouse layout improvement alternatives are explored in detail.

2.1 Systematic Layout Planning

The steps followed in the section are outlined in the thorough discussion on literature earlier in the document.

Figure 8 Activity Relationship Chart

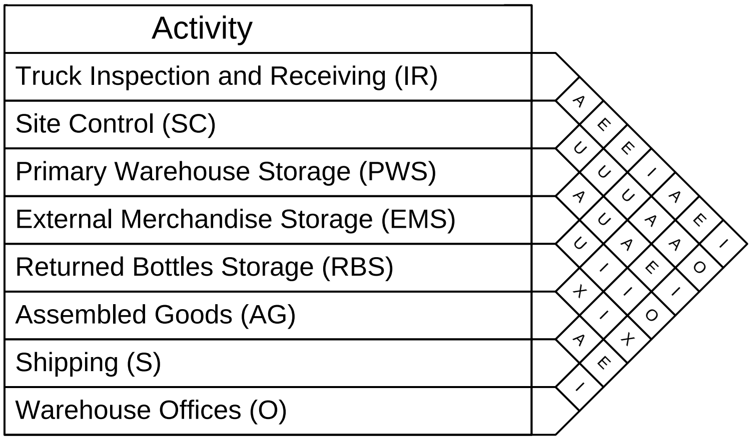


Table 2: Closeness ratings for activity relationship chart

Reasons behind the "Closeness" Value

Code	Reason
1	Same Deck
2	Flow of Material
3	Service
4	Convenience
5	Inventory Control
6	Communication
7	Same Personnel
8	Cleanliness
9	Flow of Parts

"Closeness" Rating

Value	Closeness	Lines
A	Absolute Necessary	
E	Especially Important	
I	Important	
O	Ordinary	
U	Unimportant	
X	Undesirable	

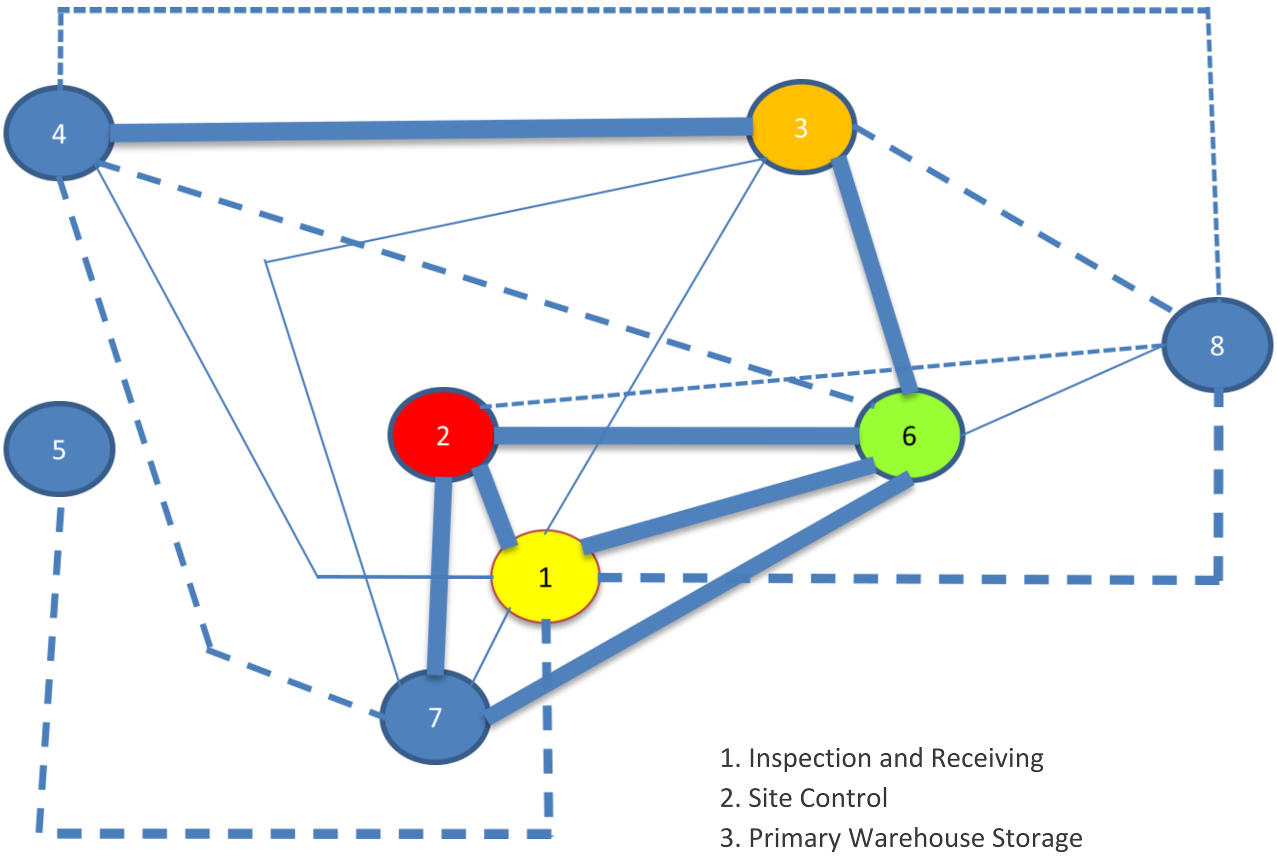
Table 3:

Reasons behind the allocated "Closeness"								
	IR	**SC**	**PWC**	**EMS**	**RBS**	**AG**	**S**	**O**
IR		5,6,7	2	2	2	5	5	6
SC	5,6,7					3,5	6,7	
PWC	2			2		1,2	5	
EMS	2		2			2	2	
RBS	2							
AG	5	3,5	1,2				5,6,7	
S	5	6,7	5			5,6,7		6
O	6						6	

The relationship chart serves to depict the relationship of different activities in and around the warehouse area. The relationships and closeness ratings aid in determining the flows and interactions necessary to maintain the proper execution of warehouse activities. These relationships are taken into account when the layout design improvement alternatives are created. The relationships ensure that infeasible designs that fail to recognise the physical limitations of the facility are not proposed.

The next step is the relationship diagram which graphically depicts the flows and relationships of the warehouse encompassing are together the supporting functional areas.

Figure 9 Relationship Diagram



1. Inspection and Receiving
2. Site Control
3. Primary Warehouse Storage
4. External Merchandise Storage
5. Returned Bottles Storage
6.Assembled Goods
7. Shipping
8. Office

2.2 Layout Alternatives

To avoid redundancy in the evaluation of proposed alternatives, only two designs for the warehouse are presented for the SAB problem. Severe space constraints limit the extent of rearrangement while keeping costs low. The layouts as such in themselves do not provide the absolute solution to the concerns expressed by the depot. Integration of the layout alternatives with other Industrial Engineering techniques such Demand Management and Business Logistics yields a more complete proposal.

The layout alternatives are split and evaluated in terms of storage assignment policies namely; popularity and physical similarity. Therefore in total four layout proposal are evaluated in terms of their compatibility with organizational operation of SAB Tzaneen depot.

Table 4: Description of Layout Alternatives

No.	Layout	Storage Assignment Policy
1	Alternative Layout A:	Popularity
2		Physical Similarity
3	Alternative Layout B:	Popularity
4		Physical Similarity

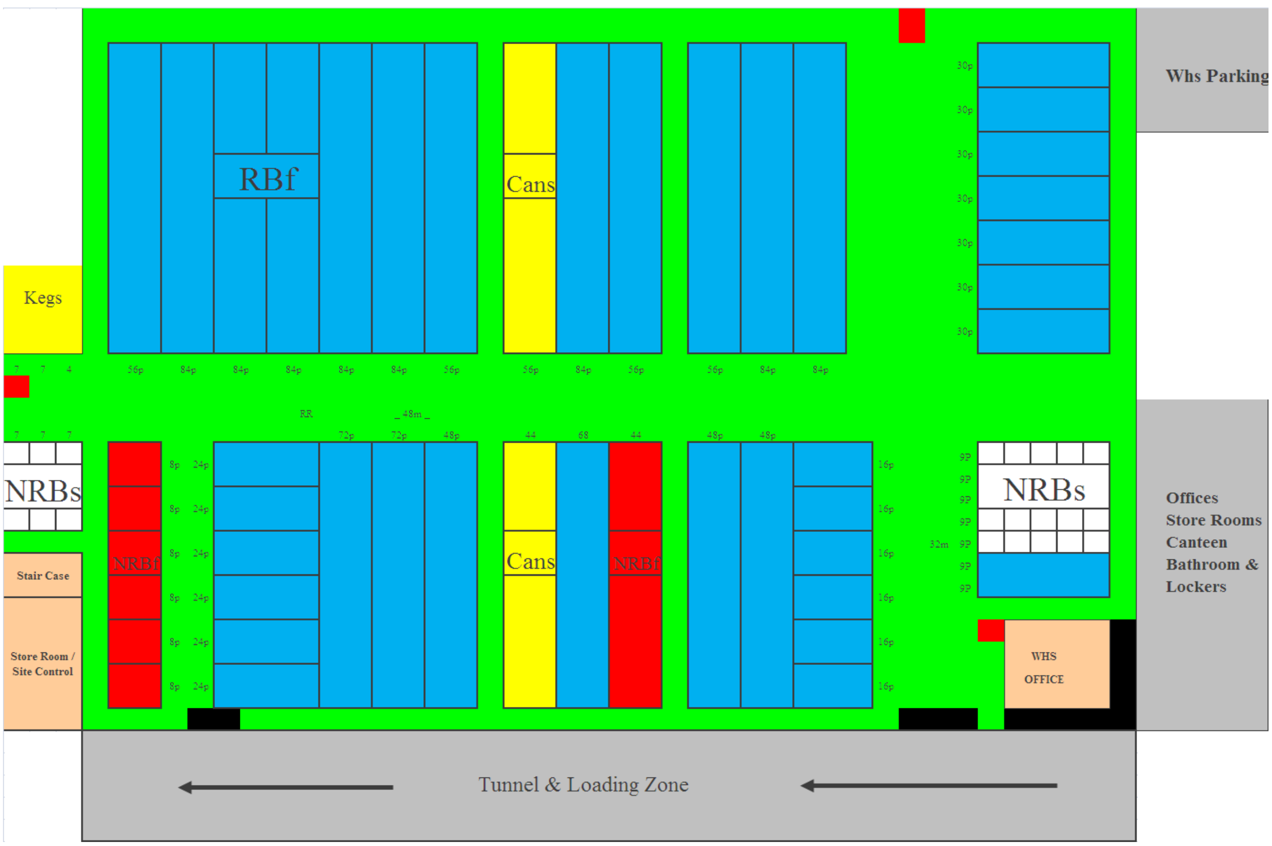


Figure 10 Layout A: Popularity Assignment Policy

Figure 11 Layout B: Popularity Assignment Policy

The layout alternatives presented in the solution design share one common factor. The door on the left of the layout is usually closed to alleviate the space constraint under the current system implemented at SAB. The current layout (Appendix A) in as much as it adds more capacity it also subjects the warehouse to a whole host of new concerns. Travel distances are drastically increased and with it the ability to effectively service trucks in the required turnaround time (TAT) is reduced.

The alternative layouts with the opening of the 2nd offer enhanced accessibility, supervision and inventory control. The proposed layouts due to proper planning and consultation actually increase the capacity of the warehouse. Fluctuations in quantities can thus be dealt with more effectively.

The contrasting of storage assignment policies gives a broader more comprehensive analysis of the warehouse environment and SAB operational strategy. The contrasting of these policies using the 2 layout proposals seeks to determine which policy best suites the operational strategy of the organisation in the long run.

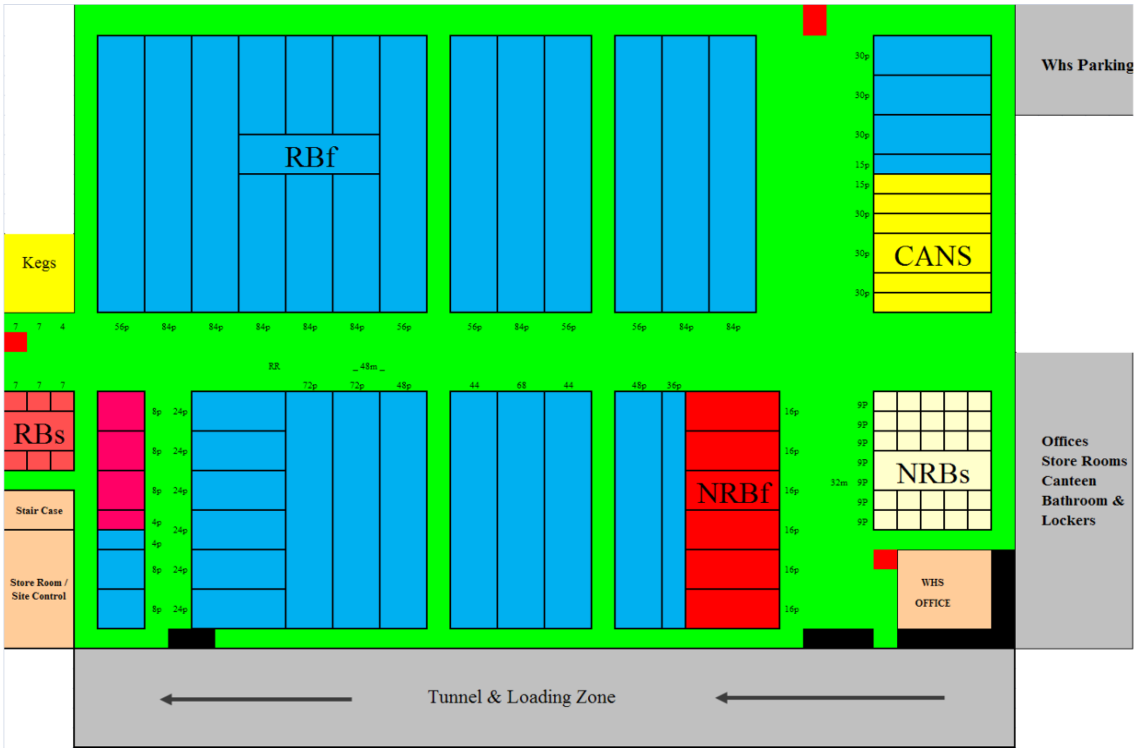


Figure 12 Layout A: Physical Similarity Assignment

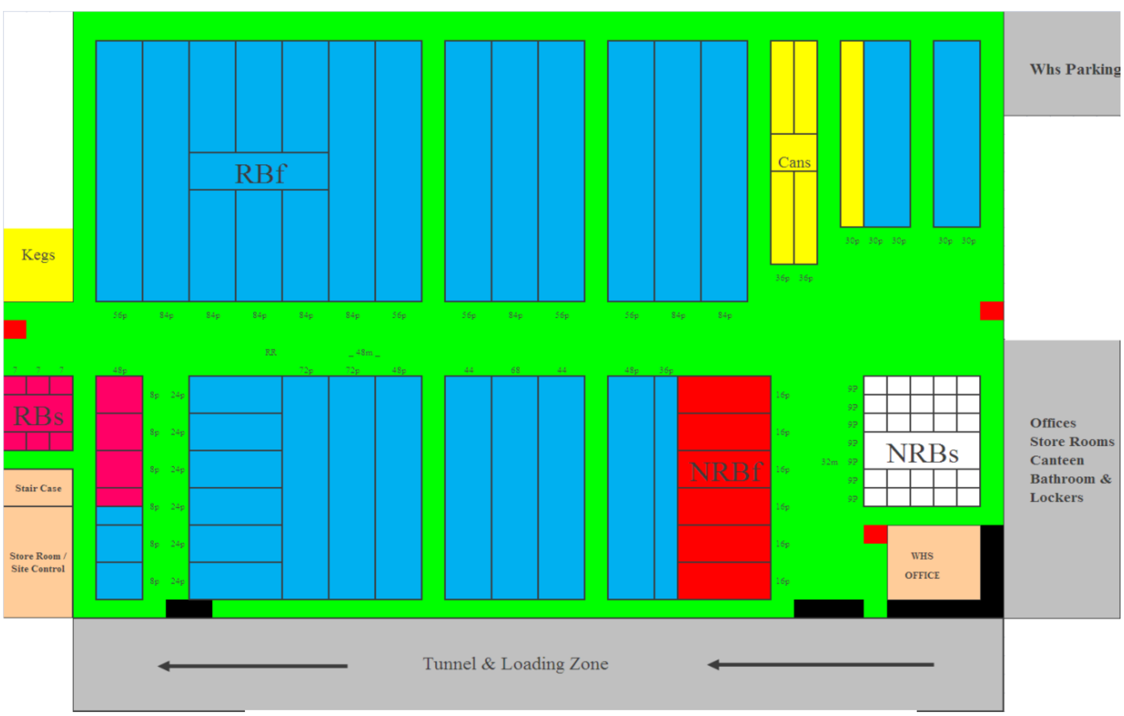


Figure 13 Layout B: Physical Similarity Assignment

2.2.1 Space Utilisation

With the implementation the storage assignment policies sum storage capacity is sacrificed to attain benefit in the form of the following:

- Versatility and flexibility to accommodate fluctuations in products, quantities and delivery times
- Aligning of facilities planning strategies with overall company vision
- Alleviation of most of the effort involved with order accumulation
- Ease of supervision
- Enhanced housekeeping practices

Table 5: Space Utilisation

	Layout 1		Layout 2		Layout 3		Layout 4	
	Pallet Spots		Pallet Spots		Pallet Spots		Pallet Spots	
Pack	Available	Used	Available	Used	Available	Used	Available	Used
Cans	60	60	60	60	60	60	60	60
Non-Returnable Bottels(NRBs)	33	33	33	33	33	33	33	33
Non-Returnable Bottels(NRBf)	60	60	60	60	60	60	60	60
Returnable Bottle (Rbslow)	48	48	48	48	48	48	48	48
Returnable Bottle (Rbfast)	574	573	574	530	584	583	584	543
Total	775	774	775	731	785	784	785	744

Space Utilisation	0.99871		0.943226		0.99873		0.947771	
Bulk Pack %		80.2%		79.1%		80.5%		79.4%

The space utilisation of the physical similarity storage assignment policy is relatively inferior however the benefits of the policy will be analysed when the layouts are evaluated in the latter part of the discussion. The bulk pack percentage will be assessed in terms feasibility requirements as stipulated by SAB.

3. Operational Efficiency

Operational efficiency encompasses the third dimension for improvement that being the control aspect. SAB is evaluated in terms of how it manages its operational activities. The activities discussed in the project are namely; supply chain management, owner-driver initiative, sales and marketing, and demand management.

With due consideration given to the above techniques and functions, SAB should be steering their operational practices in a leaner direction in order to service customers with precision. The following are aspects of a lean warehousing organisation.

- Fully exercising the function of a warehouse or distribution centre, in other words full knowledge of the role of Warehouse function
- Reduction of stock on hand

- Reduction of 7 deadly wastes
- Real-time supply chain communication

3.1 Procurement and Demand Balancing

Currently the space concerns expressed by SAB management are as a direct result of the supply chain activities inadequately executed by the firm. On the surface the company seems to be running all operations with optimal efficiency due to the sophisticated and rigorous evaluation practices implemented right throughout the organisation.

These practices assess all the operational aspects right down to the micro-level analyzing delivery times, waste scores, productivity scores, etc. Below is a depiction of an Operational Efficiency (OEA) scorecard.

Figure 14 Operational Efficiency Analyses

		YTD	YTD Scores	Weighting	Targets	MTD
WASTE	FBR Vol %	0.01%	1.00%	1%	0.30%	0.01%
	FBR Inc %	0.21%	0.00%	0%	1.00%	0.21%
	UBR Vol %	0.01%	0.50%	0.5%	0.03%	0.01%
	UBR Inc %	0.14%	0.00%	0.5%	0.01%	0.14%
	RSC Vol %	0.06%	1.80%	2%	0.00%	0.06%
	BIT Vol %	0.007%	1.00%	1%	0.03%	0.007%
	BIT Inc %	0.28%	0.00%	0%	2.00%	0.28%
	WASTE SCORE		**4.30%**	**5%**		**4.30%**
CUSTOMER SERVICE	Perfect Deliveries	86.31%	0.00%	0%	85.00%	86.31%
	On Delivery Day		10.00%	10%	99.00%	
	On Time (PTD)	95.26%	13.00%	13%	85.00%	95.26%
	In Full Deliveries		5.00%	5%	97.00%	
	OASIS Util %	100.00%	5.00%	5%	99.50%	100.00%
	RSC Inc %	0.62%	2.75%	4%	0.00%	0.62%
	FLO Util %	99.93%	3.94%	4%	100.00%	99.93%
	PVA % (1st Loads)	97.58%	4.39%	5%	100.00%	97.58%
	PVA % (2nd Loads)	73.68%	0.00%	0%		73.68%
	RSA %	98.06%	4.00%	4%	98.00%	98.06%
	Late Delivery %	6.17%	0.41%	2%	3.00%	6.17%
	CUSTOMER SERVICE SCORE		**48.50%**	**52%**		**48.50%**
PRODUCTIVITY	Depot Sales Vol	118.12%	10.00%	10%	102.00%	118.12%
	PD TAT	35.30	7.00%	7%	40/60	35.30
	RTI %	98.81%	3.02%	5%	100.00%	98.81%
	SD TAT (SAB)		3.00%	3%	50	
	PRODUCTIVITY SCORE		**23.02%**	**25%**		**23.02%**
3RD PARTY	OD STD Hrs	11.90	1.01%	5%	9.5-11.5	11.90
	Paid vs Actual Hrs	94.96%	3.98%	4%	95%-105%	94.96%
	Paid vs Actual Km	104.68%	4.00%	4%	95%-105%	104.68%
	SD TAT (OD)	0:34:56	5.00%	5%	40	0:34:56
	3RD PARTY SCORE		**13.99%**	**18%**		**13.99%**
	OEA SCORE		***89.81%***	***100%***		***89.81%***
	WEIGHTED OEA SCORE		89.49%			89.49%

Waste Score is interpreted as follows:

- Full Beer Returns (FBR): these are full orders that have been incorrectly invoiced to a customer and the driver realises this upon delivery

- Un-invoiced Beer Returns (UBR): these are basically human (driver) errors when inputting how much stock was actually delivered to a customer
- Route Settlement Correction (RSC): Does the driver follow the route specified for delivery accurately?
- Breakage-in-Transit (BIT): Product damaged while en route to customer locations

Customer Service is viewed as follows:

- Promise to Deliver (PTD): this metric basically evaluates whether deliveries were executed exactly as requested by the customer
- FLO and Oasis Utilisation: Simply evaluates the use of the handheld devices for stock counting and the logistical monitoring and scheduling software
- Paid versus Actual (PVA): Does the amount loaded onto the trucks correlate with what has been paid for?

Productivity is interpreted as follows;

- Depot Sales volume essentially depicts whether the depot sales and marketing activities are effective
- RTI evaluates the no. of times the forklift drivers meet the required turnaround time
- PD TAT: evaluation of turnaround time of procured goods (Primary Distribution)
- SD TAT: evaluation of turnaround time of depot trucks (Secondary Distribution)

3.1.2 Stock on Hand

Currently SAB carries too much stock at any given instant. Since SAB exercises transport consolidation and product mixing the problem must solely rest on poor supply chain communication. The SAB supply chain is encouraged to integrate intense information-sharing practices into their operations. This approach enables real-time supply communication, meaning that goods movement can be tracked accurately right through the supply chain. Traceability ensures that all members of the chain know "When and How Much" stock is to be delivered.

Reduction in uncertainty is directly proportional to a reduction in safety stock carried. Demand management for SAB is already done effectively given that SAB's demand is regionally divided. Regions are serviced on specific days of the week e.g. Tzaneen and Polokwane may be serviced on a Tuesday. The main issue is the relaying of this information to customers and in-turn customers accurately relaying their needs to the depot (real-time exchange).

SAB brands have a shelf-life, some shorter than others therefore the greater the stock on hand the higher the "Risk" of products becoming ineligible for sale. The higher the safety stock the greater the waste. Below is an illustration of products that are at risk of being ineligible for sale.

RISK STOCK

Aged Beer - Tzaneen Depot	HL	Cases	DOC	Expiry date	R	Commentary
Pilsner Urquell 330ml NRB	1.188	15		2010/11/05	2,019.45	Availability
BF Litchi A 660ML RB	1.2672	16		2010/07/22	1,160.16	Availability
BF Lemon A 660ml RB	4.356	55		2010/10/12	3,765.30	Availability
BF Mango A 660ML RB	2.6136	33		2010/08/13	2,284.26	Availability
Castle 400ml NRB 4x6 (Ironman)	7.3920	77		2010/07/22	11,600.82	
Hansa 330ml CAN : SCS 30 x 1	7.5240	76		2010/07/26	4,883.76	Outstanding stock for Pick n Pay
					25,713.75	

Figure 15 Products at Risk of Expiring

3.1.3 Reduction of Variation

The variation in actual and forecasted demand is creating havoc on from the outbound logistics standpoint. The SAB demand is naturally assumed to exhibit trend and seasonality. Analysis of Actual vs. Forecasted reveals a definite lack of an effective process and technique for the derivation of forecasts. It is commonly agreed that a forecast is always wrong; however it should be as close a possible to actual demand. Industrial Analysis techniques such the Winter's forecasting (factors in trend and seasonality) method should be incorporated into the forecasting process.

With all the historical data at their disposal it is surprising that the variation is so out of control. Variation creates uncertainty and uncertainty leads to high stock levels. Below is a view of the demand variation is depicted.

Table 6: Variance

19-Jun-10			26-Jun-10			3-Jul-10		
SSF	Actuals	% Variance	SSF	Actuals	% Variance	SSF	Actuals	% Variance
1774	1792	1%	1800	1532	-18%	1692	2078	19%
5	3	-50%	4	2	-190%	2	4	43%
14	16	10%	17	12	-48%	19	18	-7%
0	0	0%	0	0	0%	0	0	0%
120	101	-19%	112	92	-21%	160	85	-88%
0	0	0%	0	0	0%	0	0	0%
5	3	-38%	5	5	-3%	4	4	-15%
32	29	-9%	26	32	18%	42	31	-36%
1	1	-22%	1	2	40%	1	1	-44%
644	794	19%	644	676	5%	739	804	8%
46	13	-252%	21	11	-89%	13	14	8%
0	0	0%	0	0	0%	0	0	0%
0	0	0%	0	0	0%	24	24	1%
0	0	0%	0	0	0%	0	0	0%
17	15	-18%	17	14	-20%	28	9	-215%
0	1	100%	0	0	100%	0	1	100%
0	0	0%	0	1	100%	6	0	0%
7	2	-304%	6	7	15%	5	0	0%
0	0	0%	0	0	0%	0	0	0%
94	77	-22%	79	53	-49%	113	87	-30%

Chapter 5: Layout Evaluation and Selection

1. Evaluation Factors

The following factors are derived from Tompkins et al (1984)

- Space Utilisation (How well does the layout use the capacity created?)
- Accessibility (Are products easily retrieved from storage areas?)
- Ease of future expansion (How easily can the layout accommodate further increase?)
- Travel distances (How far does material handling equipment have to traverse to execute warehouse activities?)
- Integration with and ability to serve the warehouse operations (Does the layout facilitate the effective execution of warehouse operations?)
- Compatibility with operating organisation (How well does the layout meet the requirements of SAB)
- Ease of supervision and control (Does the layout promote accurate inventory control)
- Versatility and adaptability of the system to accommodate fluctuations in products, quantities, and delivery times (Accommodation of the continuous revision of storage allocations)
- Safety and Housekeeping (Does the layout promote safety through visible safety equipment?)
- Limitations imposed by handling methods on the flexibility and ease of expansion of the layout (Does the forklift impose serious spatial limitations on the layout?)

2. Weighted Factor Comparison

Table 7: Weighted Factor Comparison

		Alternatives							
		1		2		3		4	
Factor	Weight	Rt.	Sc.	Rt.	Sc.	Rt.	Sc.	Rt.	Sc.
1. Space Utilisation	10	25	250	16	160	28	280	18	180
2. Accessibility	6	20	120	26	156	19	114	23	138
3. Ease of Future Expansion	3	8	24	12	36	9	27	14	42
4. Travel Distances and Time	5	20	100	26	130	24	120	19	95
5. Integration with and ability to serve Warehouse Operations	7	19	133	26	182	19	133	27	189
6. Compatibility with the requirements of SAB	8	22	176	24	192	23	184	25	200
7. Ease of Supervision and Control	4	17	68	26	104	13	52	21	84
8. Fluctuations in products, quantities and delivery times	9	25	225	18	162	26	234	19	171
9. Safety and Housekeeping	1	12	12	23	23	11	11	21	21
10. Limitations imposed by handling	2	13	26	18	36	10	20	16	32
Totals:			1134		1181		1175		1152

3. Justification of Selection

Alternative 2 is the layout which addresses the warehouse issues most comprehensively. This layout with the physical similarity storage policy assigned to it provides the least capacity. This is an important point because it illustrates that a top-down system approach is necessary when developing facilities plans. The bottom-up approach tends to give certain factors such as Space Utilisation too much emphasis and thus pre-empting the result of any facilities planning endeavours. If such an approach was applied to this design project the winning alternative may have been overlooked right from the onset.

The layout is most compatible with the SAB operation. With the enhanced versatility, flexibility and accessibly it assures the efficient performance of warehouse activity.

4. Testing and Validation

The validation of the selected alternative will be based on the hector litre allocation of SKUs this was discussed earlier in the conceptual design. SAB requires that the proposed layout represent the market forces exerted by customer demand. The feasibility criterion for the winning layout is that 80 percent of the allotted space be assigned to the bulk packs. The table below illustrates the palletization the winning layout in terms of hector litre allocation.

Table 8: Space Allocation of Alternative 2

Pack	Pallet Spots	No. of Packs	Conversion	Hector Litres	% Allocation
660	58	142	5.22	741.24	6.69%
750	520	1360	5.71	7765.6	70.07%
NRB	84	156	5.71	890.76	8.04%
Pints	9	16	4.41	70.56	0.64%
Cans	60	170	9.5	1615	14.57%

Total Hector Litres	11083.16
Hector Litres % assigned to Bulk Packs	76.75%

The testing of the proposed solution will be done over a period of 6 months. This due to the fact that operational changes will be effected over 3 months and the impact of such improvements will be monitored over the remaining period.

The effectiveness of solution will be evaluated primarily according to the following criteria:

- Compatible of solution with organizational structure
- Effectiveness of solution in addressing the problem
- Ease of implementation
- Turnaround time
- Order Assembling time

- Travel distances

Quantitative evaluation of the above is necessary to assess the completeness of the solution. The measuring will be conducted under the normal operation of the SAB plant.

Chapter 6: Conclusion

The winning layout according to the feasibility criteria defined by SAB that at least 80% of the allotted storage space should belong to the bulk packs. Alternative 2 allocated only 76.75% to bulk packs in the warehouse. As a result the impact of this layout on the overall efficiency would not have been seen. The aim of this design project is to emphasize the importance of facilities planning on a strategic level not just at the tactical or operational levels.

The external storage area is sufficient to make up for the shortfall in storage allocation within the warehouse. Given that brown bottles are less susceptible to damage from the sun. The external storage is ideal when the warehouse capacity is stretched. If the operational efficiency points emphasized earlier are applied there shouldn't be a capacity constraint in the warehouse. In that scenario the external storage will provide a contingency.

The various Industrial Engineering techniques discussed in this document serve to provide efficiency at system level. A narrow focus which purely looks into the space related concerns shuts down any real possibilities of a company attaining continuous improvement.

SAB should seriously undertake to improve their forecasting efforts, with their demand region it should be easier to forecast accurately, by emphasizing the needs of specific regions. To attain these need real-time information sharing needs to be integrated in to the supply chain to create smooth flow. Knowing demand reduces uncertainty which in turn reduces safety stock on hand.

In concluding it is important for SAB to realise that in attaining overall operational efficiency, the company can no longer make decisions in a vacuum. The involvement all the supply chain partners in critical to the success of the plant.

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Appendix A: Current Layout