Facility design of the piggery at the school of agriculture (North West University)

by

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Abstract

Growth brings about change and change has a potential of disrupting a system that was otherwise operating on known constraints. Therefore with changes in the resources for a system comes an inevitable necessity for adjustment to the system.

When the Centre of AgriBusiness and Entrepreneurial Training at the North West University received funds from the department of education, they decided to embark on a project to expand their small piggery into a self sustaining (possibly profitable), commercial piggery as well as turn it into an advance piggery that best simulate a commercial farm for the benefit of the students.

This report is focused on the facility layout plan for the proposed piggery, as well as business rules that need to be established to achieve a profitable and functional piggery.
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LIST OF TERMS AND ABBREVIATION

Piggery – Pig pen
Intensive Pig Farming (hog lots) - Factory farming specializing in raising domestic pigs up to slaughter weight

CAET – Centre for Agribusiness and Entrepreneurial Training
CAHS – Centre for Animal Health Studies
NWU – North West University
AEE – Agricultural Economics and Extension
SLP – Systematic Layout System
WAFM – Weighted Average Factor Method
CRAFT – Computerized Relative Allocation of Facilities Technique
MIP – Mixed Integer Programming
LOGIC – Layout Optimization with Guillotine Induced Cuts
SAPPO – South African Pork Producers Organization
Chapter 1: Project Overview

1.1 Introduction and Background

1.1.1 North West University

The North-West University (NWU) has three campuses, located in Potchefstroom, Vaal Triangle and Mafikeng. The NWU is amongst the top three universities that undertake research with the private sector. The NWU was named the most innovative University in South Africa by the Innovation Fund of the Department of Science and Technology in 2008. The University has a number of faculties that offer a variety of curriculum. For the purpose of this project only the School of Agricultural Science will covered in the scope.

1.1.2 School of Agricultural Sciences

The School of Agriculture at the North West University consists of three disciplines Animal Science, Crop Science and Agricultural Economics & Extension. The school also has two centres, the Centre for Animal Health Studies (CAHS) which is located at the main campus and the Centre for AgriBusiness and Entrepreneurial Training (CAET) which is located at the Molelwane campus (refer to figure 1 on page 9 for the structure of the School of Agriculture). The CAHS has a veterinary clinic that is responsible for research in the fields of veterinary public health, animal nutrition, molecular microbiology and toxicology.

The CAET Centre is responsible for giving short courses to farmers, the training of extension officers, and any other contract business such as land assessment and feasibility studies for resettlement. Even though two centres focus on different aspect of the school, they are both dedicated to practical training of its students. The CAET runs a farm where animals are bred for study purposes; one of their projects is a piggery.
1.1.3 The Piggery - Current Situation

Currently the piggery is a small unit that houses a boar, 4 sows and piglets. The piggery is used for educational purposes. Students are taught how to take care of the pigs and how to treat diseases encountered during pig farming. Pigs that are bred are slaughtered and then only sold internally to personnel. Due to this current operational rules and no other form of income the piggery is running at a financial loss.

1.1.4 Problem Statement

The CAET received funds from the Department of Education, and the decision was made to allocate the funds to the projects that benefit the centre and its students the most. One of the projects was to expand their piggery to simulate the processes used by commercial farmers. The lack of a project design and implementation plan for this expansion is causing an indefinite delay.
1.2 Project Aim

The aim of the project is to create a planned facility layout plan for the expanded piggery expansion at the School of Agriculture at the North West University. The appropriate layout planning technique has been determined by literature. The business rules regarding removal of full grown pigs as well as the removal of waste has been determined in conjunction with the facility layout plan.
1.3 Project Scope

The scope of the project includes:

1. **Designing of the piggery**: Research on piggery design and design a piggery to address problems associated with intensive pig farming. Allow for space in the design for students to be able to view processes when being taught.

2. **Management of the piggery**: Investigate and compare distribution channels for the pigs in the piggery (how animals will be eventually sold) as well as ways of disposing waste.

3. **Cost analysis**: Calculate and compile the cost of the planned design for the piggery as well as the day to day running of the piggery (feed, labor, electricity)

The following will be excluded from the scope of the project:

1. Selecting a construction company to build the piggery.

2. Selecting a transportation company; if slaughtering at the abattoir turns out to be the cost effective choice.
1.4 Deliverables

At the end of this project the following will be delivered:

1. **Planned facility layout** - showing the planned location, shape and area allocated to pigs of different ages.

2. **Chosen viable option between:**
   - Building an abattoir, Using one close by, Selling pigs on auction
   - Reusing own waste as manure, Finding a company to remove it

3. **Cost compilation** - The estimated implementation cost of the facility layout plan, as well as the resulting operation expenses.
Chapter 2: Literature Study

2.1 Introduction

Literature study allows the student to investigate the project environment as well as possible solution to a problem.

The primary objective of this project is to create a facility layout plan for a piggery hence an understanding of the facility planning process is critical to the successful completion of the project. There are different kinds of layout planning methods such as Apple’s plant layout procedure, Reed’s plant layout procedure, Muther’s systematic layout planning and the self organization method. Tompkins et al., (2003)

Muther’s systematic layout planning has been chosen as it takes the planning process step by step and thus allows for thorough investigation of the system which will be necessary in this project as it's not a typical manufacturing type problem. Muther’s systematic layout planning uses the flow of material, activity relationships and space requirements to develop alternatives that are compared using the weighted factor comparison method. This chapter will investigate these methods in detail in preparation for use in the subsequent chapters.

The Industrial Engineering tools and techniques that have been used to create the required deliverables include:

- Facility layout planning
- Management accounting
- Standards for pig farming
- Environmental impact of a new piggery facility
2.2 Facility Location consideration for a piggery

The choice of location for the piggery will be affected by a number of factors that have to do with the environment that it can be located in. This is because pig farming can have negative effects on its surrounding such as the destruction of the eco-system to erect a building. The sections below will illustrate all the aspects that must be considered when dealing with a piggery.

2.2.1 Effects of odors on nearby residents

According to Schiffman S et.al, (1994), bad odor has a negative effect on the people residing close to it. The study found that people leaving next to piggeries tend to be angrier, more depressed and experienced more tension. These reactions have been attributed to factors such as:
- unpleasant thoughts that they associate with the odor
- chemosensory disorders
- physical effects of the odor on the nasal and respiratory organs

The factors mentioned above are reasons that make it important to locate a piggery away from the residence.

2.2.2 Protected Species

Protected species are plant and animal species that have been deemed endangered or threatened to be extinct. Protection of endangered species is vital in ensuring that these plants and animals are preserved for the future generation and because they are part of a country’s heritage.

South Africa also has laws that govern the destruction or the hunting of protected fauna and flora. When planning to build and an environmental impact assessment has been deemed necessary, one of the criteria they will look at is whether the
project will result in the destruction of protected plants. The approval to destroy the plants comes from the department of environmental affairs and tourism after they have weighed the pros and cons of the project. Enviroadmin (2010)
The figure 18 in appendix A on page 66 shows a list of protected plants in South Africa

### 2.2.3 Disposal of Waste water and solids

Waste can be described as something that is no longer useful and that has to be thrown away. Waste can be classified as industrial, domestic, agricultural, construction, commercial, hazardous, health care and mining.

When disposing of waste, certain laws apply and it is important to find out which legislations play a part in the chosen industry. Regulations are put into place to ensure that toxic material are not disposed in a way that they will have a negative effect on living organisms as well as the environment.

They also encourage the development of ways of disposing waste that are sustainable. In pig farming, methods that can be used to dispose of waste are incineration, a lagoon as well as making compost.

**A. Incinerator**

Incineration is a process used instead of burying on a farm to get rid of dead animals. Diseases that may occur in a swine herd that may lead to the death of the pigs include swine flu, blue ear disease and anthrax. In South Africa there are certain standards that an incinerator must comply with and the act
B. Lagoon

A lagoon is a small scale waste treatment plant used by farmers to treat their animal excreta. There are three kinds of lagoons anaerobic, aerobic and the two stage lagoon. In South Africa anyone who operates a lagoon must comply with the following act, they must conduct an environmental impact assessment if they temporarily store general waste in a lagoon 3(3), if they store, treat or process animal manure at a facility with a capacity to process in excess of one ton per day 4(17). Section 20(b) of the national environmental management: waste act, 2008 (act no. 59 of 2008)

2.3 Facility layout plan

A piggery differs from a typical manufacturing process for which traditional facility planning techniques are created thus; results will have to be adapted for the piggery environment. Similarities include the importance of relationships between two sections and section’s space considerations depending on what types of product is being housed in that section.

Planning can be defined as the act of organizing your thoughts on a subject in detail before doing it and facility can be defined as something intended for a particular purpose (Oxford, 1995) therefore facility planning can mean organizing your thoughts in detail in advance on what you are going to do with your planned facility.

Facility planning can be divided into facility location and the facility design. The facility location incorporates the distance from the building to other buildings, such as customers or suppliers. Facility design shapes the facility system and facility outline, including material handling systems. Tompkins et al., (2003). A facility plan allows the planner to visually arrange different department close to one another and
investigate problems that can arise from a configuration without physically building or arranging the facility. A facility provides a backdrop on which security, lighting, controlled temperature and sanitation can be provided. Paul R.I, (2008). The most important step in a facility planning problem is defining the problem, by defining the problem all the requirements of a facility become clear. The facility planning requirements for the piggery are shown in figure 2 on page 18.

Figure 2: Facility planning of a piggery
2.3.1 Facility Planning Process

The Traditional Facility Planning process can be seen to have six sections (phases), starting with: Tompkins et al., (2003)

1. Define the problem
   - Which entails understanding the product at hand, procedures that are necessary in the producing the product. The amount of product to be handled in that facility must be found. All activities (main and support) that are necessary to be able to meet the facility’s objective must be identified.

2. Analyze the problem
   - Identify how all the activities interact with one another by identifying activity relationships by considering organizational, flow, control, environmental and process relationships.

3. Determine space requirements
   - Space required by each activity must be calculated. Space allocated must be able to support the activity, personnel and machinery that will be used in that space. Space requirements for support structures such as restroom, employee change room must be accounted for.

4. Evaluate alternatives
   - Strength and weaknesses of different facility designs will be compared against one another. A criterion can be used with the weighted average method to determine the alternative that ranks better.

5. Select the preferred design

6. Implement the design
2.3.2 Systematic Layout Planning.

SLP is a method that is used to generate facility layout alternatives by considering the best arrangement of areas. The aim is to get alternative block layout and to compare them using a weighted average method. Tompkins et al., (2003), Filmore, (1992)

Figure 3 on page 21 shows a summary of the SLP process. The ten steps required are as follows:

Step 1: A from-to chart showing the flow of material in the facility must be drawn.

Step 2: An activity relationship chart is developed and shows the dependency of the areas on each other.

Step 3: Results from steps 1 and 2 are used to create a relationship diagram, which shows the relationship between activities.

Step 4 and 5: Consider space requirements for different activities and the space available for the facility. In the consideration of space requirement, space must be allocated for equipment, materials as well personnel.

Step 6: Results from steps 3, 4 and 5 are used to draw a space relationship diagram and this diagram depicts how much space an activity needs compared to the other activity.

Step 7 and 8: Practical limitation/restrictions are factored into the layout design, this allows for activities that are hazarders to one another to be well away from each other.

Step 9: Results from steps 7 and 8 are used to construct alternatives. Different methods can be used to develop alternative block diagrams these methods include the pairwise exchange method, graph-based method, CRAFT,BLOCPLAN, MIP and LOGIC. The graph-based method is a construction type layout method and is simpler than the BLOCPLAN, MIP, LOGIC which are also construction methods.
Step 10: Evaluation of the alternatives. Alternatives can be compared by listing advantages and disadvantages, ranking, WFCM or and by economic comparison.

Figure 3: SLP procedure

2.3.3 Graph-based Method

The graph-based method is used to develop alternative block layout of the facility. It uses the relationships between the departments as its objective function and the aim is to maximize this relationship.
This method is a construction-type layout algorithm that assumes that building dimensions are given.

The graph – based consist of the following five steps: Filmore, (1992)

Step 1: Create a relationship chart that uses numerical weights instead of alphabets. From this chart select the department with the highest weight.

Step 2: Now insert the third department by determining the weights of each of the department with respect to the chosen departments in step one.

Step 3: Evaluate the sum of the weights of the unselected department and place the one with the highest weight in the face of the graph.

Step 4: Continue using step three until all the departments have been placed.

Step 5: Construct the block layout based on the adjacency graph.

2.3.4 Weighted Factor Comparison Method

The weighted factor comparison method is used to evaluate alternatives against each other. Factors that have the potential to affect the choice of alternative are listed and a weight is assigned to them.

All the alternatives are then scored against the listed factors and the score is then multiplied by the weights and the products are summed for all the factors. Tompkins et al., (2003), Winston (2004)

For example, if you have factors:

$F_1, F_2, \ldots, F_{n-1}, F_n$ with weights $W_1, W_2, \ldots, W_{n-1}, W_n$

If there are three alternatives $A_1$, $A_2$ and $A_3$ to choose from and the rating of each alternative with respect to each factor is given by $R_{ij}$ in the table below, $i=1, 2, 3$ and $j=1,2,\ldots,n$
Factors | Alternatives
---|---
A₁ | A₂ | A₃
1 | R₁₁ | R₂₁ | R₃₁
2 | R₁₂ | R₂₂ | R₃₂
. | . | . | .
n-1 | R₁(n-1) | R₂(n-1) | R₃(n-1)
N | R₁n | R₂n | R₃n

Table 1: Rating of alternatives according to factors

The score $S_{ij} = W_i \times R_{ij}$. The sum of all $S_{ij}$ for each alternative $i$ are used to compare it to the other alternatives. Tompkins et al., (2003)

A. Computing $W_i$ for Analytic Hierarchy Process

The $W_i$ is computed by first establishing the pairwise relationship between all the factors $F_1 - W_n$. The relationship $P_{ij}$ shows the importance of a factor $i$ as compared to another $j$. The Table 1, on page 21 shows the relationship matrix $P$, $P_{ij}$ can have values 1, 5, 10, 1/5 and 1/10 with the following meaning

1 = equally important
5 = significantly more important
10 = extremely more important
1/5 = significantly less important
1/10 = extremely less important

Factor | $F_1$ | $F_2$ | … | $F_{n-1}$ | $F_n$
---|---|---|---|---|---
$F_1$ | $P_{11}$ | $P_{12}$ | $P_{1(n-1)}$ | $P_{1n}$
$F_2$ | $P_{21}$ | $P_{22}$ | $P_{2(n-1)}$ | $P_{2n}$
. | . | . | . | .
$F_{n-1}$ | $P_{(n-1)1}$ | $P_{(n-1)2}$ | $P_{(n-1)(n-1)}$ | $P_{(n-1)n}$
$F_n$ | $P_{n1}$ | $P_{n2}$ | $P_{n(n-1)}$ | $P_{nn}$

Table 2: Pairwise relationship between factors
The next step is to find $P_{\text{norm}}$ by dividing each column entry of matrix $P$ by the sum of the column entries of $P$. The approximation of $W_i$ will be the average of the row entries of $P_{\text{norm}}$.

**B. Short coming of the method**

You must be objective

**2.4 Space and facility requirements for a piggery**

**2.4.1 Set Standards**

Since the problem involves the housing of live pigs, information on the set standards of housing pigs has to be consulted. The standards state space requirements for different types of pigs, with this floor space will have to be added in to cater walking aisles.

According to A. Maton (1984) the breeding house consists of:

1. The service house – This is where dry sows, boars and just served sows are housed. The house can have group division for sows and boars(with space provision of 5.4 m$^2$) with not more than five sows in a group pen(with space provision of 1.5 m$^2$ per sow) or it can have individual stalls with length of 1.8 m and width of (0.60 – 0.65) m. A space of 1m from the outside wall to the first crate must be provided, this space is used in cleaning as well as placing the trough for the feed.

2. House for pregnant sows – Sows that have been confirmed pregnant (4 weeks after copulation) are taken to this house. The individual pen stall size is the same as that for the dry sows (1.8 m in length and (0.60 – 0.65) m wide.
3. Farrowing house – Sows nearing the delivery date are transferred to the furrowing house, the sows must be washed for hygiene purposes.

4. Weaner house – Piglets that have been weaned are placed in this house until they reach the age of ten weeks (for selling at 20 kg) or 15 weeks (on the farrow-to-finish farms). The house has rows of pens with a width of (0.8 – 1) m and can accommodate up to 12 weaners.

5. Rearing house

Changes in standards

The space requirements for pigs has changed in recent years, this is due in part to animal rights groups who felt and demonstrated against individual sow stalls for being inhumane. Donham (1998)

Below are recent space requirements for pig. (Department of Agriculture, Forestry and Fisheries, 2010)

1. The service house – This is where dry sows, boars and just served sows are housed. The house can have group division for sows and boars. Boars must have space provision of (9 - 10) m² per boar. The sow pen must not have more than five sows (with space provision of 5 m² per sow).

2. House for pregnant sows – Sows that have been confirmed pregnant (24 days after copulation) are taken to this house. The individual pen stall size is the same as that for the dry sows 5 m in length and 1 m wide.

3. Farrowing house – Sows nearing the delivery date are transferred to the furrowing house, the temperature has to be right to ensure that the sow and piglets are warm. Each pen 2m wide and 2.5 in length with a 1 m on the north and a 1m dung passage on the south side. The pen is dived into a farrowing crate for the pig and a creep area for the piglets (600 mm x 600 mm). The temperature of the creep area must be between 27°C and
A five or six farrowing pen is advisable, these should measure between 13.25 m and 15.5 m in length respectively with a width of 4m. Distance between the outside walls and the first pen must be 1m.

4. Weaner house – This house must be 40 m in length and 9 m wide. Individual pens must be 4m x 3m.

5. Rearing house – This house must be 40 m in length and 9 m wide. Individual pens must be 4m x 3m.

### 2.4.2 Departmental Standards

Departmental requirements for a breeding house are: (Maton, 1984)

1. Ventilation – Must be provided through windows and stacks in the service house, house of pregnant sows as well as the farrowing house. In the weaner house exhaust fans can be used for ventilation.

2. Watering facility – Automatic drinking bowls, nipple drinkers and bite drinkers can be used and must be installed per pen.

3. Sow shower – is built in between the house for pregnant sows and the farrowing house. It must measure (1.2 – 1.3) m in width and the length depends on how many sows will be washed at the same time. E.g 4 m for six sows.

### 2.4.3 Other space required

Space for main aisles

Aisles must be wide enough to accommodate the pig movement as well as movement of personnel/students. Thompkins et.al, 2003 gives the following aisle widths for personnel as listed in table 3 on page 27.
<table>
<thead>
<tr>
<th>Type of flow</th>
<th>Aisle Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>0.91 m</td>
</tr>
<tr>
<td>Personnel with doors opening into aisle from one side</td>
<td>1.83 m</td>
</tr>
<tr>
<td>Personnel with doors opening into aisle from two side</td>
<td>2.44 m</td>
</tr>
</tbody>
</table>

*Table 3: Aisle width for different flows*

The main aisles must be wide enough to allow students to stand in groups with a lecturer and observe a procedure.

### 2.5 Management Accounting

#### 2.5.1 Decision making using relevant cost and cost benefit analysis

**A. Relevant cost**

Decision making using relevant cost is a financial method that is used to compare alternatives. Only those costs and benefits that differ in total between alternatives are relevant in a decision (W. Seal et al., 2009).

To make a decision:

1. Cost components of different alternatives are collected
   
   Cost that will arise from choosing an alternative should be listed and all the costs that differ between the alternatives will be considered relevant.

2. Benefits of the different alternatives are collected
   
   Benefits that will result from choosing an alternative should be found and weighed against the benefits from the other alternatives.
B. Cost Benefit analysis

Cost benefit analysis is a financial accounting method that can be used to compare alternatives by finding, quantifying and adding all benefits and then subtracting all the cost of each alternative and then comparing the results against the other alternatives. (Economic library, 2010)

In any project, other factors have to be considered in choosing alternatives. These factors include the availability of funds, availability of resources as well delays that an option can cause

2.6 Conclusion

Chapter 2 highlights all the necessary literature study required to execute the problem. The facility layout process was discussed as well as the piggery requirements and factors that affect the building of a new facility.
Chapter 3: Facility planning

3.1 Introduction

Literature reviewed in chapter 2 showed the procedures to be followed as well as information that have to be gathered in order to solve the problem. In this chapter the location as well as the design problem has been solved using the methods discussed in chapter 2. Please note that the distribution and waste management problems will be dealt with in chapter 5.

3.2 Facility planning process

As discussed in section 2.3 on page 17, the facility planning process has six steps. Below the process will be done for the NWU piggery.

1. Define the problem - The location and facility design of a piggery is required. The 30 sow piggery facility must house pigs at all the stages of pig farming.
2. Analyze the problem – This step will be done in the SLP procedure
3. Determine space requirements – will be done in the SLP procedure
4. Evaluate alternatives – Alternatives created using the graph based method, current layout and farm manager’s input are evaluated.
5. Select preferred design – preferred solution that satisfies all requirements will be chosen

3.3 Facility location

Two alternative areas can be used for the planned facility, the area that houses the current piggery or a new area. The current area A is 100 m by 60 m and the new area B 80m by 56 m. The areas are shown on figures 19 and 20 on page 68 in appendix B.

The area that will be chosen for the construction must allow for:
1. Ease of building, without destruction of protected species

   Area A will need the destruction of 7 Acacia erioloba trees in order to clear up the area for construction while area B is in an open field

2. It must offer an opportunity for future expansion

3. It must be close to its support structures

4. It must be situated where it will not cause pollution (noise and smell)

   Both alternatives are located far away from the main admin block and there are no people residing in close proximity.

5. It must be accessible

   Both the alternatives do not have clear roads leading to them from the main gate. However construction of clear ways is possible in both cases.

The above requirements have been used as factors in determining the best location using the weighted average method in conjunction with the scale given in table 4 on page 30, values in between are also used for rating. Factors where rated with the help of the farm manager and input from environmental assessor.

Scale:

   1 = equally important
   5 = significantly more important
   9 = extremely more important
   1/5 = significantly less important
   1/9 = extremely less important

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>½</td>
<td>1</td>
<td>1/5</td>
<td>¼</td>
<td>1/3</td>
</tr>
<tr>
<td>3</td>
<td>1/3</td>
<td>5</td>
<td>1</td>
<td>7</td>
<td>½</td>
</tr>
<tr>
<td>4</td>
<td>½</td>
<td>4</td>
<td>1/7</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>1/8</td>
<td>3</td>
<td>2</td>
<td>½</td>
<td>1</td>
</tr>
</tbody>
</table>

*Table 4: Pairwise comparison of the factors in location problem*
Table 5: $P_{\text{norm}}$ for the pairwise comparison

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.4067</td>
<td>0.13</td>
<td>0.473</td>
<td>0.186</td>
<td>0.676</td>
<td>0.3743</td>
</tr>
<tr>
<td>2</td>
<td>0.2034</td>
<td>0.07</td>
<td>0.032</td>
<td>0.023</td>
<td>0.028</td>
<td>0.0713</td>
</tr>
<tr>
<td>3</td>
<td>0.1356</td>
<td>0.33</td>
<td>0.158</td>
<td>0.651</td>
<td>0.042</td>
<td>0.2633</td>
</tr>
<tr>
<td>4</td>
<td>0.2034</td>
<td>0.26</td>
<td>0.023</td>
<td>0.093</td>
<td>0.169</td>
<td>0.1497</td>
</tr>
<tr>
<td>5</td>
<td>0.0508</td>
<td>0.2</td>
<td>0.3153</td>
<td>0.047</td>
<td>0.085</td>
<td>0.1414</td>
</tr>
</tbody>
</table>

Table 6: WFCM for choosing the location

<table>
<thead>
<tr>
<th>Factor</th>
<th>Alternative A</th>
<th>Alternative B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weight(W)</td>
<td>Rating Score</td>
</tr>
<tr>
<td></td>
<td>$R_{ij}$</td>
<td>$S_{ij}$</td>
</tr>
<tr>
<td>1</td>
<td>37</td>
<td>2   74</td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>5   35</td>
</tr>
<tr>
<td>3</td>
<td>26</td>
<td>9   234</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>10  150</td>
</tr>
<tr>
<td>5</td>
<td>14</td>
<td>7   98</td>
</tr>
<tr>
<td>Total</td>
<td>591</td>
<td>761</td>
</tr>
</tbody>
</table>

Therefore area B has been chosen for the expansion project

### 3.4 Systematic Layout Planning Process

The SLP process that was discussed in section 2.3.2 on page 18 has been used to design the planned facility layout. The flow of material, relationship charts as well block layouts have been created in preparation for the evaluation phase.

#### 3.4.1 Movement of pigs in a piggery

The movement of the pigs in the piggery is important as this helps in determining where to place a department in order to minimize the movement of the pigs.

**Boar**
Boars stay in their boar pen

**Sows**

Sows move from the dry sow room to the sow room. When they are on heat they are moved to the boar pen for service, after copulation they are taken to the dry sow room up until they are ready for delivery and are moved to the farrowing house and after the piglets have been weaned the sows are taken back to the dry sow room.

**Piglets**

Piglets move from the farrowing house to the grower or weaner/rearing house. The chosen reared piglets will then be moved to the dry sow house.

### 3.4.2 Activity Relationship

An interview with the farm manager Mr. Mogoje highlighted different divisions that the piggery must have. The number of units in these divisions was also given. These are the sow room with two stalls, the boar room with 2 stalls, dry sow room with 30 individual stalls, a farrowing room with 6 farrowing crates, storage room, feed store, grower room with 6 grower pens, a wearing room which can either be a single pig housing, group pens or individual stalls, a rearing division with flatdecks which is part of the weaner room and a still room. The location must also house a separate office block that must have 4 showering facilities, an office, Medical store, Feed store, Store and 2 toilet facilities. The location must be close to an open area where a lagoon can be built if the need arises.

**A. Factors**

As mentioned in section 2.3.2 on page 20, activity relationship diagram is used to determine the relationship between two departments by highlighting the importance of having two departments close or apart from each other. Factors that have been
considered when considering the closeness of the departments in the piggery are shown below in table 7 on page 33, the codes are used in finding the relationship chart.

<table>
<thead>
<tr>
<th>Codes</th>
<th>Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hygiene/Health</td>
</tr>
<tr>
<td>2</td>
<td>Flow of material</td>
</tr>
<tr>
<td>3</td>
<td>Mating</td>
</tr>
<tr>
<td>4</td>
<td>Movement of pigs</td>
</tr>
</tbody>
</table>

Table 7: Factors affecting the closeness of department

Hygiene/Health

Health and hygiene are important factors in pig farming, mainly because an outbreak of a disease could wipe out the piglets. The areas where piglets will be kept have to be kept clean and contact with older pigs should be limited to only their mothers while in the farrowing room. Tools used for cleaning areas where grown pigs live should not be used where smaller pigs stay.

Flow of material

This is the movement of tools and feed from the stores to the different sections of the piggery.

Mating

Sows are moved into the sow room in order to prepare them for mating. Being close to the boars triggers heat, after which the sows will be taken to the boar room.
Movement of pigs

This is the flow of pigs in the piggery and has been discussed under the flow of materials in section 3.4.1 on page 31. Paths that pigs have to travel a lot have an absolutely necessary relationship as moving pigs is difficult.

B. Line codes

The table below contains the colour and line codes that have been used to show the necessity of having two departments next to each other. These line codes are used in constructing the Relationship Diagram.

<table>
<thead>
<tr>
<th>VALUE</th>
<th>CLOSENESS</th>
<th>COLOUR CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Absolutely Necessary</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Especially Important</td>
<td>. . . . . . . .</td>
</tr>
<tr>
<td>I</td>
<td>Important</td>
<td>— — — — — —</td>
</tr>
<tr>
<td>O</td>
<td>Ordinary Closeness</td>
<td>. . .</td>
</tr>
<tr>
<td>U</td>
<td>Unimportant</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>Undesirable</td>
<td></td>
</tr>
</tbody>
</table>

*Table 8: Line codes used in drawing activity relation chart*
C. Activity Relationship Chart For the piggery

<table>
<thead>
<tr>
<th>Departments</th>
<th>A. Sow Room</th>
<th>B. Boar Room</th>
<th>C. Dry sow Room</th>
<th>D. Farrowing Room</th>
<th>E. Storage Room</th>
<th>F. Feed Store</th>
<th>G. Grower room</th>
<th>H. Weaner Room</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X  X</td>
<td>X</td>
<td>X</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>U</td>
<td>O</td>
</tr>
<tr>
<td></td>
<td>1  1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>O  O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>U</td>
<td>U</td>
<td>A</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>U  U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 9: Activity relationship chart
Department E and F, as well as G and H have been merged together because the relationship that they have with other departments are identical and thus it was done to reduce the mesh on the diagram. The similarities in the relationship also hold as backup that these departments must be housed together. These factors can also explain why these rooms are grouped together in one house or division in commercial piggeries.
3.4.3 Space requirements

The space requirements for the piggery have been determined by calculating space necessary for housing the pigs as well as space for the aisles. Literature discussed in section 2.4 on page 24 in conjunction with information provided by the farm manager in section 3.4.2 on page 32 has been used in determining space needed for the pigs. Aisle space is important in a piggery as it allows for easy cleaning of the individual stalls as well as in farrowing pens. Aisles are also important for the movement of people, pigs and material in between departments.

A. Space requirements for the individual houses

Space that will be allocated to the pigs are given in the table below

<table>
<thead>
<tr>
<th>Departments</th>
<th>Space required</th>
<th>No required</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Sow Room</td>
<td>5m² per sow</td>
<td>2 sow</td>
<td>10m²</td>
</tr>
<tr>
<td>B. Boar Room</td>
<td>10 m² per boar</td>
<td>2 boar</td>
<td>20 m²</td>
</tr>
<tr>
<td>C. Dry sow Room/House of pregnant sows</td>
<td>1.17m² per sow</td>
<td>30 sows</td>
<td>35.1 m²</td>
</tr>
<tr>
<td>D. Farrowing Room</td>
<td>5m² per stall</td>
<td>6 stalls</td>
<td>30m²</td>
</tr>
<tr>
<td>E. Storage Room</td>
<td>16.8 m²</td>
<td>1</td>
<td>16.8 m²</td>
</tr>
<tr>
<td>F. Feed Store</td>
<td>16.8 m²</td>
<td>1</td>
<td>16.8 m²</td>
</tr>
<tr>
<td>G. Grower room</td>
<td>21.9 m² per pen</td>
<td>6 pens</td>
<td>131.4 m²</td>
</tr>
<tr>
<td>H. Weaner Room</td>
<td>102.2 m²</td>
<td>1</td>
<td>102.2 m²</td>
</tr>
</tbody>
</table>

*Table 10: Space requirements for the pigs*
B. Space provision for aisles in the dry sow and farrowing rooms

In departments that must have individual stalls, an area of width of 1m from the walls has been left for easy feeding of the pigs, moving of pigs as well as employee and for the easy cleaning of the stalls.

Departmental Aisle Space requirements

The department space for the dry sow and farrowing has been determined by adding the 1m space allowance. Figures 5 and 6 on page 39 show the new layout of the two departments to better explain how the 1m is added.

<table>
<thead>
<tr>
<th>Departments</th>
<th>Space requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Sow Room</td>
<td>5m² per pig, need 2 sow divisions = 10m²</td>
</tr>
<tr>
<td>B. Boar Room</td>
<td>10 m² per pig, need 2 boar divisions = 20 m²</td>
</tr>
<tr>
<td>C. Dry sow Room/House of pregnant sows</td>
<td>21.5 m in length, 3m in width = 64.5 m²</td>
</tr>
<tr>
<td>D. Farrowing Room</td>
<td>14 m in length, 3.5m in width = 49 m²</td>
</tr>
<tr>
<td>E. Storage Room</td>
<td>16.8m²</td>
</tr>
<tr>
<td>F. Feed Store</td>
<td>16.8m²</td>
</tr>
<tr>
<td>G. Grower room</td>
<td>They need 6 group pens which are 7.3 m long and 3m wide = 131 m²</td>
</tr>
<tr>
<td>H. Weaner Room</td>
<td>14m long and 7.3m wide = 102.2m²</td>
</tr>
<tr>
<td>I. Flatdecks room</td>
<td>76m²</td>
</tr>
<tr>
<td>Total</td>
<td>486.3 m²</td>
</tr>
</tbody>
</table>

Table 11: Space requirements including the aisles in a piggery

Main aisles have been calculated as 2 m and will be added in when the final layout has been chosen.
Figure 5: Figure of how the 1m is added in the dry sow room

Figure 6: Figure of how the 1m is added in the farrowing room
C. **Space relationship diagram**

Block relationship diagram of the closeness has been drawn. The blocks are drawn to a scale that shows the relative size of each department to the other.
3.4.4 Generating Block layout alternatives

The most important step in a facility planning problem is the generation of alternative block layout. This step demands that a facility planner must have intuition, judgement as well as experience. Tompkins (2003). It is for these reasons that the block layout alternatives where not only constructed using the algorithmic approach but were also constructed from looking at the layout of the current piggery as well as consultation with the farm manager who has a better understanding of what makes a good piggery.

A. Alternative A, generated using Graph-based method

The first block layout has been determined using the graph based method discussed in section 2.3.3 on page 21. The relationship chart is shown in the figure below with alphanumeric values replaced by numeric values. The necessity for closeness is rated on a scale of 0-20, Zero being not needed and 20 being absolutely necessary.

\[
\begin{array}{|c|c|c|c|c|c|}
\hline
\text{Departments} & \text{Departments} \\
& GH & EF & D & C & B \\
\hline
\text{A. Sow Room} & 0 & 5 & 0 & 14 & 20 \\
\hline
\text{B. Boar Room} & 0 & 5 & 0 & 5 & \\
\hline
\text{C. Dry sow Room} & 0 & 7 & 19 & \\
\hline
\text{D. Farrowing Room} & 5 & 10 & \\
\hline
\text{E. Storage Room/ F. Feed Store} & 10 & \\
\hline
\text{F. Grower room/H. Weaner Room} & 1 & \\
\hline
\end{array}
\]

*Figure 7 Relationship chart using weights*
Constructing an Adjacency graph

Step 1: Department A and B has the highest weight

Step 2: Department C enters the graph next because of the high total in weight

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>14</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>EF</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>GH</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Step 3: Department D enters the graph next

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>0</td>
<td>0</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>EF</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>17</td>
</tr>
<tr>
<td>GH</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Step 4: Department EF is placed into the graph as it scores the best total weight

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EF</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>10</td>
<td>27</td>
</tr>
<tr>
<td>GH</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Department EF can be placed on the BDC or the ADC face as the scores add up to 22 on each face. The chosen phase is the ADC face

Step 5 Department GH could be placed on either face ADEH or face DCEH as the total weight is 15 on both faces.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>EF</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>
The resulting adjacency graph

![Adjacency Graph Image]

*Figure 8: Adjacency graph*

Resulting block layout

![Block Layout Image]

*Figure 9: Block layout from adjacency graph*
B. Alternative B, generated from the current layout

The current facility layout is not a good representation of a commercial piggery. The department placement that has been practised does give an indication of how to place departments in a way that is acceptable even though it is not the best practise. The figure below shows the piggery arrangement as is and is immediately followed by the block layout representation.

![Current piggery layout diagram](image)

**Figure 10: Current piggery layout**

<table>
<thead>
<tr>
<th>EF</th>
<th>G</th>
<th>H</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>A</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Alternative block layout diagram](image)

**Figure 11: Alternative block layout from the current piggery**
C. Alternative C, generated from industry

The alternative that has been given by the farm manager is in terms of what he has seen in the industry. Some of the justifications for this block layout have also been given below.

1. The weaner/grower department is housed in a separate building away from the other departments. This is because the weaner/grower house requires a ventilation system as well as controlled temperature environment.

2. The building that houses the other department must be divided into the clean and dirty side. The clean side must house the farrowing room as well as the stores. This ensures that contaminants from the dirty side do not cause health issues to the piglets that have just been born in the farrowing pens. The entrance to this building must also be on the clean side and the exit located in the dirty side.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>EF</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>G</td>
<td>H</td>
<td></td>
</tr>
</tbody>
</table>

Figure 12: Alternative layout from farm manager’s input

3.5 Evaluation of layouts

Evaluation is the step that precedes selection of the winning layout. Alternative layouts A, B and C have been evaluated using WFCM with the following factors, these factors and their ratings where developed with the help of the farm manager.
1. Ease of supervision and control
2. Hygiene and health
3. Ease of interdepartmental movement
4. Temperature and air control

Scale:

1 = equally important
5 = significantly more important
9 = extremely more important
1/5 = significantly less important
1/9 = extremely less important

<table>
<thead>
<tr>
<th>Factor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1/7</td>
<td>1/3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7</td>
<td>1</td>
<td>9</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1/9</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1/2</td>
<td>1/2</td>
<td>1/3</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

The weights of the factors have been found by pairwise comparison method and are given by

\[ W_1 = 10.48 \]
\[ W_2 = 51.43 \]
\[ W_3 = 30.86 \]
\[ W_4 = 7.23 \]

And then evaluating the alternatives using the weighted factor comparison form

<table>
<thead>
<tr>
<th>Factor</th>
<th>Weight</th>
<th>( A )</th>
<th>( B )</th>
<th>( C )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rating</td>
<td>Score</td>
<td>Rating</td>
<td>Score</td>
</tr>
<tr>
<td>1</td>
<td>10.48</td>
<td>7</td>
<td>73</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>51.43</td>
<td>8</td>
<td>411</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>30.86</td>
<td>9</td>
<td>278</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>7.23</td>
<td>5</td>
<td>36</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>798</td>
<td>518</td>
<td>10</td>
</tr>
</tbody>
</table>

*Table 12: Weighted comparison form for the block alternatives*

From this analysis alternative A is recommended as it has the highest weighted average, however combining aspects of the layout of alternative A with those of alternative C will result in an even better layout, as both of them score high values.

D. Mixed layout, generated from alternative A and alternative C

The mixed layout has been chosen as it combines the best of alternatives A and C.

The department GH is placed in a different building as in alternative C as this is good for the hygiene as well as control of the piggery, while department EF is made to touch departments A, B, C, and D as in alternative A as this reduces the flow distance.
Figure 13: Selected block layout
Chapter 4: Detailed Planned Facility Layout

Apart from the block layout of the piggery facility, other design details must be considered and added to the selected block layout to ensure that the piggery is practical. In the following chapter the interior departmental requirements as well as office block requirements are listed.

4.1 Interior departmental requirements

The interior requirements of each department have been listed in Table 13 on page 47. This highlights all necessities that the pigs will require when they are in all the piggery departments.

<table>
<thead>
<tr>
<th>Departments</th>
<th>Interior requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Sow Room</td>
<td>- Water nipple</td>
</tr>
<tr>
<td></td>
<td>- Through</td>
</tr>
<tr>
<td></td>
<td>- Drainage facility</td>
</tr>
<tr>
<td>B. Boar Room</td>
<td>- Water nipple</td>
</tr>
<tr>
<td></td>
<td>- Through</td>
</tr>
<tr>
<td></td>
<td>- Drainage facility</td>
</tr>
<tr>
<td>C. Dry sow Room/House of pregnant sows</td>
<td>- Water nipple</td>
</tr>
<tr>
<td></td>
<td>- Through</td>
</tr>
<tr>
<td></td>
<td>- Drainage facility</td>
</tr>
<tr>
<td>D. Farrowing Room</td>
<td>- Water nipple</td>
</tr>
</tbody>
</table>
| E. Storage Room | -Through
| -Drainage facility
| -Heater
| -Lamp
| Windows
| -Shelves
| -Lights
| F. Feed Store | -Shelves
| -Lights
| G. Grower room | -Water nipple
| -Through
| -Drainage facility
| -Ventilation system
| H. Weaner Room | -Water nipple
| -Through
| -Drainage facility
| -Ventilation system
| I. Rearing division | -Flatdecks
| -Ventilation system
| -Drainage facility
| -Heater

*Table 13: Interior departmental requirements*
4.2 Office block
The office block that must have 4 showering facilities, an office, Medical store, Feed store, Store and 2 toilet facilities. The farm manager determined the necessary capacity of the feed store, meds store as well as the equipment store by approximating the usage of the resources. The area of the feed store has been given as 24 m² and the area of the medical store and equipment store is a combined 8 m².

4.2.1 Showers

The office block has to cater for both employee and piggery needs. Hygiene has been deemed important and it is for this reason that the piggery must include a showering facility. The system that has to be practised is the shower in shower out. The showering facilities have been placed in such a way that the coming in shower is close to the main entrance of the admin block while the exit door of the shower out leads straight to the piggery. The shower facilities must have lockers. Tompkins et.al, 2003 gives an allowance of 0.762 m by 0.762 m for the toilets.
4.2.2 Office

An office houses all administration paperwork and it is the receiving area for anyone who is coming to the piggery. The office has been designed to house a table, 3 chairs as well as cabinets for filing.

Thompkins et.al, 2003 gives the following data as space requirements for offices

<table>
<thead>
<tr>
<th>Position</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>President’s office</td>
<td>23.23 – 37.16 m²</td>
</tr>
<tr>
<td>Vice president’s office</td>
<td>14 – 23.23 m²</td>
</tr>
<tr>
<td>Executive office</td>
<td>9.3 – 14 m²</td>
</tr>
<tr>
<td>Supervisor (partitioned)</td>
<td>7.43 – 10.21 m²</td>
</tr>
</tbody>
</table>

Table 14: Space requirement for different offices

The office has been considered an executive office with an area of 12 m².
Figure 15: Layout of the office
Chapter 5: Business Rules

The alternatives for the business rules have been determined using advantages and disadvantages (cost benefit analysis). All relevant aspects that will contribute to the cost when choosing an alternative have been listed as well as all the benefits. Estimates of the these cost have been used

5.1 Distribution channel

Raising pigs is only part of the supply chain in the pig industry, every farmer has to decide on how he will distribute/sell his stock or he might run the risk of overstocking his farm. Nkosi et.al, 1993 says that in developing areas five channels are used by farmers to market their livestock, these methods are auctions, speculators, butchery, abattoirs and private buyers. In this document selling at an auction, building a butchery and building a butchery and abattoir have been compared. The speculators and private buyers have been left out as these two modes of distribution can take place in conjunction with the three that have been compared.

5.1.1 Selling at an auction

To sell at an auction, the farmer has to locate an auctioneering company, find out the dates of the auction and location and then transport the livestock to the place on the day of auction. Since this method involves the transportation of livestock, regulation on transportation of livestock must be adhered to.

A. Requirements of the vehicle transporting pigs

1. Non slip floor
2. Adequate ventilation and light
3. Adequate protection against exhaust gasses
4. Protection against direct sunlight

5. No projection from the roof, floor or sides to prevent injuries

6. Sidewalls high enough to prevent animal from escaping or falling out

7. Floors that provide proper drainage

8. Recommended floor space per animal

-0.3 m$^2$ per porker

-0.4 m$^2$ per baconer

-0.8 m$^2$ per adult pig

B. Aspects contributing to cost

1. Truck

2. Fitting extras to make truck ready to transport pigs

3. Petrol/Diesel

4. Service

5. Lost opportunity to the students to learn more about abattoir

C. Benefits

1. Can be implemented without delay, no need for permits

2. Does not require further construction

3. Allows the farm a chance to concentrate on a section of pig farming
5.1.2 Taking to an abattoir and building a butchery
This method involves the transportation of pigs as well as building a butchery, requirement for the truck as mentioned in the section 5.1.1 on page 52 above applies as well as requirements for refrigerated vehicle and requirements to operate a butchery

A. butchery

A butchery is one of the distribution channels for meat to the public, restaurants and caterers. They put value into the meat by transforming it into everyday usable cuts that people use and into specialised meat product such as biltong and boerewors.

The complexity of the butchery depends on the meat products that the butcher chooses to supply. The choice of meat products affects the size of the butchery as well as the equipment in the butchery. Every butcher must have a licence.

B. Regulation for vehicle transporting slaughtered pigs

1. Every vehicle transporting meat from an abattoir shall be lined with an impervious jointless material which shall be capable of being easily cleaned.

2. The truck must be a size that when meat is suspended using rails and hooks, the meat should not hit the floor.

C. Aspects affecting cost

1. Cost of building a butchery

2. Equipment for butchery (band saws, fridges, scales)

3. Labour

4. Petrol
A van to take the pigs to the abattoir
A refrigerated van to bring back the meat

**D. Benefits**

Opens up the market to people who want to buy prepared pork
Removes the responsibility of building and running an abattoir

**E. Disadvantages**

Market analysis - A proper market analysis of the demand of prepared pork must be done before choosing the location to avoid loss to slaughtered rotting meat
Space to locate the butchery – Location of the butchery will be greatly determined by the current and future customers.

**5.1.3 Building an abattoir and a butchery**

**A. Abattoir**
An abattoir converts livestock into meat. When building an abattoir many requirements have to be considered that either affects the cost or speed at which an abattoir can start operating. Some of the acts that an abattoir operator must comply with include: Department of Agriculture, Forestry and fisheries, 2010
Meat Safety Act, Act No. 40 of 2000
Agricultural Product Standards Act, Act No. 119 of 1990
Abattoir Hygiene Act, 1992 - Act No. 121 of 1992
Animal Diseases Act, 1984 - Act No. 35 1984
A pig abattoir consists of the stunning area, bleeding area, scalding area, dehairing and scrapping area, evisceration area and a splitting area. A picture showing the flow is given in the figure below.

![Flow diagram of a pig abattoir](image)

*Figure 16: Flow diagram of a pig abattoir*

**B. Factors affecting the speed**
1. Application for a licence at the department of agriculture
2. Building the abattoir and butchery
3. Training of staff

**C. Aspects contributing to cost**
1. Labour
2. Building the structure
3. Equipment (stunning equipment,

**D. Requirements**
Space – An area of 1800 m²

Market analysis
Location of the butchery and abattoir will be greatly determined by the current and future customers.

E. Advantages/Benefit
1. Currently the animal health department takes their students on field trips to an abattoir in rustenburg to gain practical experience in public health which includes antemortem inspection, post-mortem inspection, HACCP, waste management and abattoir management. If an abattoir is built, Animal health can use it for their studies.

2. The abattoir can be used for disease surveillance.

5.1.4 Comparison

<table>
<thead>
<tr>
<th></th>
<th>Auction</th>
<th>Butchery</th>
<th>Abattoir</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Certification needed</strong></td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Labour level</strong></td>
<td>Low</td>
<td>medium</td>
<td>High</td>
</tr>
<tr>
<td><strong>Level of Management</strong></td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Speed of application</strong></td>
<td>No delay</td>
<td>Delay</td>
<td>Delay</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td><strong>Approximate cost of implementation</strong></td>
<td>500 000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Table 15: Comparison of alternatives*
5.2 Disposing of waste

Pig manure is an excellent source for nitrogen, phosphorus and potassium. (Martin, 2010) Currently all manure that is produced of the farm is used by crop science, the school maintenance department to fertilize grass on all the three campuses. The university does not have a licence to reuse their manure and hence they are faced with a decision to both get a licence and build a lagoon or to get the municipality to take the manure as waste. In this section the approximate amount of waste produced has been calculated and approximate values of cost have been used to compare the alternatives.

5.2.1 Waste produced

A 100 sow production unit produces 1710 tons of undiluted waste, when you add washing water the total waste can exceed 6000 tons. Therefore a 30 sow production Unit produces approximately 513 undiluted waste and roughly 1800 tons/year.

5.2.2 Reusing as manure

In accordance with the good agricultural practices, the amount of nitrogen that must be used on a hectare is 170kg per year. (Department of Agriculture, Forestry and Fisheries, 2010)

<table>
<thead>
<tr>
<th>Class or species</th>
<th>Maximum number of animals per ha equivalent to 170kg N/ha/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piglets</td>
<td>74</td>
</tr>
<tr>
<td>Breeding sows</td>
<td>6,5</td>
</tr>
<tr>
<td>Pigs for fattening</td>
<td>14</td>
</tr>
<tr>
<td>Other pigs</td>
<td>14</td>
</tr>
</tbody>
</table>

*Table 16: Nitrogen per year/hectare for pigs Department of Agriculture, Forestry and Fisheries, 2010*
A. Advantages

1. The university can continue to reuse its waste and avoid paying for manure and cut down on their water bill by using the water from the lagoon to water the fields

2. By getting the certificate, they will be able to start selling the manure to the public and therefore generate income.

B. Disadvantage
1. The cost of another Environmental Impact Analysis

5.2.3 Disposing of waste
The waste can be collected in a drum that the municipal can come collect the waste from. They use suction pumps and after collection the waste is disposed.

A. Advantage
1. No need for an environmental assessment

2. The problem of disposal is shifted to the municipal

B. Disadvantages

1. The school has to buy manure from outside

2. Lost income from the private sales they could have made
5.2.4 Comparison

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disposing</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Save on buying manure</td>
<td>- No need for certification</td>
</tr>
<tr>
<td>- Can sell manure to the public</td>
<td>- Shift the disposal problem</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Cost of an Environmental Impact assessment</td>
</tr>
<tr>
<td>- Cost of building a lagoon</td>
</tr>
</tbody>
</table>

*Table 17: Comparison of alternatives*

5.3 Compile statements

Estimated cost of building the piggery are given in appendix D on page 71
Chapter 6: Conclusion

The literature considered as well as data collected helped in solving the facility planning problem. The school must use the new area for the expansion. This will result in an environmentally acceptable design that the Department of agriculture, forestry and fisheries can approve.

Adapting components of alternatives A and C will result in a piggery design that ensures health for the piglets and proper control of the piggery. Having stores next to all the departments reduces the flow of material and helps in ensuring that tools are only used in the correct department, this also helps in ensuring that proper food is given to the correct class of pigs.

Auctioning the pigs is viable as the other methods demand heavy and proper management as well as the construction of extra structures that the school can’t afford at the moment.

Reusing the waste will generate income for the farm and even though another environmental assessment is necessary the return will justify the investment.
Chapter 7: References


3. DEPARTMENT OF AGRICULTURE, FORESTRY AND FISHERIES, 2010

4. ENVIROADMIN, Protected tree list, 2010


12. WINSTON WL 2004, Operations Research, Thomson, Canada


15. www.environment.co.za

17. http://webcache.googleusercontent.com/search?q=cache:Kx5FDUMn2xUJ:ww.fao.org/docrep/010/ai410e/AI410E06.htm+A+great+deal+of+improvement
## Appendix A

<table>
<thead>
<tr>
<th>Botanical Name</th>
<th>English Common Names</th>
<th>Other Common Names</th>
<th>National Tree Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acacia erioloba</td>
<td>Camel Thorn</td>
<td>Kameeldoring (A), Mogokho (NS), Mogobhlo (T)</td>
<td>168</td>
</tr>
<tr>
<td>Acacia xanthomorphan</td>
<td>Grey Camel Thorn</td>
<td>Vaaikaameeradering (A), Mokholo (T)</td>
<td>169</td>
</tr>
<tr>
<td>Adansonia digitata</td>
<td>Baobab</td>
<td>Kremetart (A), Seboli (NS), Mowana (T)</td>
<td>467</td>
</tr>
<tr>
<td>Afromelia quadraenias</td>
<td>Pod Mahogany</td>
<td>Peulmahonie (A), Mutokota (Y), Inkheili (Z)</td>
<td>207</td>
</tr>
<tr>
<td>Boscia subsp.</td>
<td>Torchwood</td>
<td>Groendoring (A), Ugobandlovu (Z)</td>
<td>251</td>
</tr>
<tr>
<td>Maghawanii</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barringtonia racemosa</td>
<td>Powder-puff Tree</td>
<td>Poeierkwasboom (A), Ioboq (Z)</td>
<td>524</td>
</tr>
<tr>
<td>Boscia albitrunca</td>
<td>Shepherd's Tree</td>
<td>Witgat (A), Mohlo (NS), Motlhop (T), Muvhuwhe (Y), Umgeomgoomo (X), Umvuthi (Z)</td>
<td>122</td>
</tr>
<tr>
<td>Brachystegia spiciformis</td>
<td>Msasa</td>
<td>Msasa (A)</td>
<td>158.1</td>
</tr>
<tr>
<td>Bretrofolia salicina</td>
<td>Natumi</td>
<td>Mingerhout (A), Moholimi (NS), Mutu-lume (Y), Umfonto (Z)</td>
<td>684</td>
</tr>
<tr>
<td>Bruguiera gymnorrhiza</td>
<td>Black Mangrove</td>
<td>Smaart-wortelboom (A), Isikhangati (X), Isikhudane (Z)</td>
<td>527</td>
</tr>
<tr>
<td>Cassipourea swaziianensis</td>
<td>Swazi Onionwood</td>
<td>Swazi-sihloot (A)</td>
<td>531.1</td>
</tr>
<tr>
<td>Catha edulis</td>
<td>Bushman's Tea</td>
<td>Boesmanste (A), Mohlatse (NS), Iqwaka (X), Umhliwazi (Z)</td>
<td>404</td>
</tr>
<tr>
<td>Ceratops tagal</td>
<td>Indian Mangrove</td>
<td>Indiese wortelboom (A), Isihekhan (Z)</td>
<td>525</td>
</tr>
<tr>
<td>Cissocentus schlechteri var. schlechteri</td>
<td>False Tamboti</td>
<td>Vals-tambotte (A), Umzithi (Z)</td>
<td>320</td>
</tr>
<tr>
<td>Colubrina nicolobii</td>
<td>Pondo Weeping Thorn</td>
<td>Pondo-reurdering (A)</td>
<td>453.8</td>
</tr>
<tr>
<td>Combretum imberbe</td>
<td>Leadwood</td>
<td>Hardkooi (A), Mohlewere-tshiki (NS), Motawiri (T), Impendoedlovu (Z),</td>
<td>539</td>
</tr>
<tr>
<td>Curtisia dentata</td>
<td>Assegai</td>
<td>Assegai (A), Umguane (X), Umagunda (Z)</td>
<td>570</td>
</tr>
<tr>
<td>Euclea dentata</td>
<td>Assegai</td>
<td>Assegai (A), Umguane (X), Umagunda (Z)</td>
<td>570</td>
</tr>
<tr>
<td>Eucalyptus transaeriana</td>
<td>Bushveld Saffron</td>
<td>Bosveld-saffraan (A), Momokane (T), Ingwawuma (Z)</td>
<td>416</td>
</tr>
<tr>
<td>Erysistrophyta transaeriana</td>
<td>Bushveld Red Balloon</td>
<td>Bosveld-rooklapperbos (A), Hofelaatsane (T)</td>
<td>436.2</td>
</tr>
<tr>
<td>Eucalyptus dealbatus</td>
<td>Ebony Gummi</td>
<td>Ebbenhout -gharre (A)</td>
<td>598</td>
</tr>
<tr>
<td>Ficus trichopoda</td>
<td>Swamp Fig</td>
<td>Moerasiy (A), Umvubu (Z)</td>
<td>54</td>
</tr>
<tr>
<td>Leucadendron argenteum</td>
<td>Silver Tree</td>
<td>Silverboom (A)</td>
<td>77</td>
</tr>
<tr>
<td>Lumniciera racemosa var. racemosa</td>
<td>Tonga Mangrove</td>
<td>Tonga-wortelboom (A), Isikha-a-ebomvu (Z)</td>
<td>552</td>
</tr>
<tr>
<td>Lydenburgia abietii</td>
<td>Pondo Bushman's Tea</td>
<td>Pondo-boesmanste (A)</td>
<td>407</td>
</tr>
<tr>
<td>Lydenburgia casimiroae</td>
<td>Sibhukhuni Bushman's Tea</td>
<td>Sibhukhuni-boesmanste (A)</td>
<td>406</td>
</tr>
<tr>
<td>Nimusops califrta</td>
<td>Coastal Red Hillwood</td>
<td>Kusoomelkhout (A), Umthunzi (X), Umzikhayi (Z)</td>
<td>583</td>
</tr>
</tbody>
</table>

Figure 17: Protected tree list of South Africa
<table>
<thead>
<tr>
<th>Scientific Name</th>
<th>Common Name</th>
<th>Synonyms</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newtonia hildebrandii var.</td>
<td>Lebombo Wattie</td>
<td>Lebombo-veratil (A), Umfomothi (Z)</td>
<td>191</td>
</tr>
<tr>
<td>Ocotea bullata</td>
<td>Stinkwood</td>
<td>Stinkhout(A), Umhliungulu (X), Umnukane (Z)</td>
<td>118</td>
</tr>
<tr>
<td>Goua namaquensis</td>
<td>Gareep Resin Tree</td>
<td>Gareep-harpulskoese (A)</td>
<td>373.2</td>
</tr>
<tr>
<td>Philanoptera violacea</td>
<td>Apple-leaf</td>
<td>Appelilaar (A), Mphata (NS), Hohata (T),</td>
<td>238</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ishomohomo (Z)</td>
<td></td>
</tr>
<tr>
<td>Pittosporum viridiflorum</td>
<td>Cheesewood</td>
<td>Kassur (A), Kgalagangwe (NS), Umkhwenkwe (X), Umfusanya (Z)</td>
<td>139</td>
</tr>
<tr>
<td>Podocarpus elATUS</td>
<td>Breede River Yellowwood</td>
<td>Breederivier-geelhout (A)</td>
<td>15</td>
</tr>
<tr>
<td>Podocarpus falkatus</td>
<td>Oosteniqa Yellowwood</td>
<td>Ostniekwa-geelhout (A), Mogobagoba (NS), Umkhoba (X)/ Umsonti (Z)</td>
<td>16</td>
</tr>
<tr>
<td>Podocarpus henkeli</td>
<td>Henkeli's Yellowwood</td>
<td>Henkel-se-geelhout (A), Umsonti (X), Umsonti (Z)</td>
<td>17</td>
</tr>
<tr>
<td>Podocarpus latifolius</td>
<td>Real Yellowwood</td>
<td>Oprenge-geelhout (A), Mogobagoba (NS), Umcheya (X), Umkhoba (Z)</td>
<td>18</td>
</tr>
<tr>
<td>Protea comptonii</td>
<td>Saddleback Sugarbush</td>
<td>Barberton-sukerbos (A)</td>
<td>88</td>
</tr>
<tr>
<td>Protea curvata</td>
<td>Serpentine Sugarbush</td>
<td>Serpantynsukerbos (A)</td>
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<td>Prunus africana</td>
<td>Red Stinkwood</td>
<td>Roo-stinkhout(A), Umkhakhase (X), Umdumezulu (Z)</td>
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</tr>
<tr>
<td>Pierocarpus angolensis</td>
<td>Wild Teak</td>
<td>Klaat (A), Horotô (RS), Mokne (T), Hutoando (V), Umlongo (Z)</td>
<td>336</td>
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<td>Rhipogonum macronota</td>
<td>Red Mangrove</td>
<td>Roo-wortelboom (A), Isilhangathi (X), Umhlume (Z)</td>
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</tr>
<tr>
<td>Sclerocarya birrea subsp. caffra</td>
<td>Haralia</td>
<td>Haroela (A), Morula (NS), Morula (T), Umgana (Z)</td>
<td>360</td>
</tr>
<tr>
<td>Securidaca longependulculata</td>
<td>Violet Tree</td>
<td>Krinkhout (A), Hamba (T)</td>
<td>303</td>
</tr>
<tr>
<td>Sideroxylon inerme subsp. inerme</td>
<td>White Milkwood</td>
<td>Wit-melkhout (A), Ximahana (Z), Umakhwelaflingane (Z)</td>
<td>579</td>
</tr>
<tr>
<td>Tephrosia pendaensis</td>
<td>Pond Fish-poison Pea</td>
<td>Pondo-gifertjik (A)</td>
<td>226.1</td>
</tr>
<tr>
<td>Warburgia salutaris</td>
<td>Pepper-bark Tree</td>
<td>Peperbasboom (A), Moloka (NS), Mulanga (V), Isihaha (Z)</td>
<td>488</td>
</tr>
<tr>
<td>Widdingtonia cedarbergensis</td>
<td>Clanwilliam Cedar</td>
<td>Clanwilliam-seder (A)</td>
<td>19</td>
</tr>
<tr>
<td>Widdingtonia schwartzii</td>
<td>Willowmore Cedar</td>
<td>Saviansiloof-seder (A)</td>
<td>21</td>
</tr>
</tbody>
</table>

Figure 18: Protected tree list of South Africa. Enviroadmin (2010)
Appendix B

Figure 19: Current piggery area

Figure 20: New area
Figure 21: Picture of a loading ramp

Figure 22: Picture of the dry sow house

Figure 23: Picture of the farrowing crate
## Appendix C

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount in $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric stunning equipment (imported)</td>
<td>2 000</td>
</tr>
<tr>
<td>Electric hoist (for bleeding and loading vat)</td>
<td>1 500</td>
</tr>
<tr>
<td>Scalding vat 1.5x2.5 m (electrical heating and discharger)</td>
<td>3 000</td>
</tr>
<tr>
<td>Dehairing machine</td>
<td>30 000</td>
</tr>
<tr>
<td>Scrapping/gambrelling table (stainless steel)</td>
<td>1 500</td>
</tr>
<tr>
<td>Gambrelling hoist</td>
<td>1 000</td>
</tr>
<tr>
<td>Railing system (galvanized)</td>
<td>6 000</td>
</tr>
<tr>
<td>Hooks, gambrels (galvanized/stainless steel)</td>
<td>3 000</td>
</tr>
<tr>
<td>Platforms (galvanized)</td>
<td>2 000</td>
</tr>
<tr>
<td>Electric splitting saw (imported)</td>
<td>5 000</td>
</tr>
<tr>
<td>Breastbone saw</td>
<td>2 000</td>
</tr>
<tr>
<td>Miscellaneous equipment</td>
<td>5 000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>62 000</strong></td>
</tr>
</tbody>
</table>

*Table 18: Approximation of cost of equipment in an abattoir, (Food and Agricultural organization, 2010)*
## BUILDINGS

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Boar pens @ R 15,000 per pen</td>
<td>R 30,000</td>
</tr>
<tr>
<td>30 dry sow crates @ R 3,000</td>
<td>R 90,000</td>
</tr>
<tr>
<td>5 furrowing crates @ R 15,000</td>
<td>R 75,000</td>
</tr>
<tr>
<td>Weaner standing space (55 x 5) = 275 @ R1,500</td>
<td>R 412,500</td>
</tr>
<tr>
<td>Grower standing space (55 x 10) = 550 @ R 1,400</td>
<td>R 770,000</td>
</tr>
</tbody>
</table>

## INFRASTRUCTURE

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assessment for EMP</td>
<td>R 70,000</td>
</tr>
<tr>
<td>Power requirements</td>
<td>R 10,000</td>
</tr>
<tr>
<td>Water requirements</td>
<td>R 20,000</td>
</tr>
<tr>
<td>Fencing</td>
<td>R 15,000</td>
</tr>
<tr>
<td>Office and feed store</td>
<td>R 35,000</td>
</tr>
<tr>
<td>Channel ways and water reticulation</td>
<td>R 30,000</td>
</tr>
<tr>
<td>Effluent handling</td>
<td>R 40,000</td>
</tr>
</tbody>
</table>

## ANIMALS

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R</td>
</tr>
</tbody>
</table>

## RUNNING COSTS

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>R 850,000</td>
</tr>
</tbody>
</table>

## GROSS AMOUNT REQUIRED

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>R 2,447,500</td>
</tr>
</tbody>
</table>

*Table 19: Estimated rates, NWU business plan, (2010)*