

**Cost analysis and Financial Modelling for the  
Department of Paraclinical Sciences at the  
Faculty of Veterinary Science at Onderstepoort**

by

**AW Cameron**

**26281105**

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## **Executive Summary**

To be financially feasible is the aim of any company, institution or corporation. An institution will be financially feasible if profits are shown on the books, or even a promise of growth. Otherwise this institution will have no reason for existing.

The Histopathology Laboratory of the Department of Paraclinical Sciences at the Faculty of Veterinary Sciences at Onderstepoort, provides services to three service categories; the Commercial, Interdepartmental and Research sectors. The laboratory is a business function of the Department of Paraclinical Sciences generates an income from these service sectors. A large part of the laboratory's commercial workload is provided by an in-house private laboratory called VetPath. However, the manner in which any of these services are charged are not set on any scientific model or mathematical formulations whatsoever. Management is also uninformed regarding the cost of activities and services provided by the Histopathology laboratory. The Histopathology laboratory is currently unaware of their financial standing and it is unknown whether the laboratory is profitable, breaking even or making a loss and this poses as a huge problem.

Several Industrial Engineering techniques were applied and a detailed study of the Histopathology laboratory's activities and processes were conducted to formulate a suitable financial model.

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# 1. Introduction and Background

## 1.1 Company and background

The Faculty of Veterinary Science at Onderstepoort is one of 46 veterinary faculties in Africa and the only one of its kind in South Africa. It is located about 20km to the north of Pretoria. The Faculty of Veterinary Science at Onderstepoort is responsible for educating and training of veterinarians and veterinary nurses, and furthermore facilitates postgraduate studies in various disciplines.

The focus of this project is on one of numerous laboratories at Onderstepoort specifically the Diagnostic Pathology Reference Histopathology laboratory (known as Histopathology laboratory henceforth) which is part of the Department of Paraclinical Sciences (DPS). Figure 1 illustrates the structure of the Histopathology laboratories of the Department of Paraclinical Sciences.

|   |   |   |   |  |
|---|---|---|---|--|
| <b>Veterinary<br/>Pharmaceutical<br/>Analytical<br/>Histopathology<br/>laboratory</b> | <b>Veterinary<br/>Pharmacology<br/>and Toxicology<br/>Histopathology<br/>laboratory</b> | <b>Environmental<br/>Toxicology<br/>Histopathology<br/>laboratory</b> | <b>Diagnostic<br/>Pathology<br/>Reference<br/>Histopathology<br/>laboratory</b> | <b>Phytomedicine<br/>Histopathology<br/>laboratory</b> |
|---|---|---|---|--|

**Figure 1: Representation of the Histopathology laboratories of the Department of Paraclinical Sciences**

The client base of the Histopathology laboratory includes Vetpath (a private company of Pathologists using the Histopathology lab), other veterinarians requesting tests to be conducted, farmers and other private clients that require the services of the Histopathology lab.

## 1.2 Project Background

The services rendered by the Histopathology laboratory comprise of a vast number of different processes and procedures for performing diagnostic tests. The type of service delivered depends on the need expressed by the client who falls into one of the three specified service categories. The service fee charged differs between these service settings, namely commercial, interdepartmental, research sectors and VetPath. The current problem becomes obvious when considering the fact that these differences are not based on any scientific techniques, particular financial model or formula, but rather on untested assumptions and estimations. The reason for this is that the Histopathology lab has never embarked on a detailed pricing analysis to calculate the actual cost of conducting its

various tests. This analysis needs to take into account the products and consumables used, equipment used, salaries of staff and other related overhead costs.

It was therefore decided to construct a pricing model for two of the most commonly used tests of the Histopathology laboratory. The sections below provide a detailed summary of the problem at hand, the objectives of the project, the proposed solution and the methodology followed in delivering the final pricing tool.

## **2. Project Aim**

The aim is to calculate the price that should be charged to clients of the Histopathology lab in respect of two specific test that have been identified as key contributors to the cost of consumables in the Histopathology lab. The price should be calculated per slide and subsequently per pathology case.

Furthermore, the project aims to do a comparison between the prices currently charged for the selected tests and the prices that the pricing model will propose. This is an extensive exercise as the pricing model provides a much more detailed pricing methodology than the current pricing practices. The reason for this is that each item used throughout the process can be individually selected in the pricing model. The cost prices of these items are then added to the pricing model together with other fixed and variable overhead costs, to calculate the proposed base price per test. The current pricelist tabulated in section 9.1 only has one or two price variables for each test, which is much less detailed than the pricing model.

## **3. Project Scope**

A major component of the project revolves around collecting the data required to construct the pricing model. A detailed understanding of the two tests, and all possible products that could be used in these tests, is critical. Once this database has been established, understanding how much of each product is used per test, per case or per week has to be defined. The current retail prices of the various products, together with information on how each product should be diluted is then used to calculate the price per week, per slide and per case of each individual item.

This database of information, together with all the assumptions made will be taken into account in this project. This is then programmed to automatically calculate the price of a slide and the price per case, provided the user includes all relevant information associated with any given case.

It will be ensured that the pricing model is user friendly and that any information applied throughout the process can be updated to ensure the longevity of the use of the model. The Histopathology laboratory can therefore decide to update the input assumptions (price per product, number of cases handled monthly etc) on an annual, monthly or any incremental basis.

The pricing model will then be tested to ensure that all results obtained are reasonable and usable. If any outlier prices are obtained, this will be discussed with the Histopathology laboratory to ensure that the original input data is in fact correct.

Current prices charged by the Histopathology laboratory for the two tests selected in this project, will be compared with prices generated by the model. Conclusions and recommendations will be made after analyzing these results.

Once the accuracy of the pricing model has been determined, it will be delivered to the Histopathology laboratory to use in setting future prices associated with the two tests analysed in this project. Staff will be trained on how to use the model and how to update the input data and assumptions.

The project therefore consists of four phases. Each of the phases mentioned below focuses on a certain part of the project.

1. Data gathering and Process analysis and understanding
2. Development of cost model
3. Testing and refinement
4. Model delivery

## **4. Literature Review**

### **4.1 Operations Management**

Operations management is the management of resources needed, to obtain the services provided and products supplied by an institution (Adendorff and De Witt, 2003:2). Jacobs, Chase and Aquilano (2009:7) define operations management as the design, operation, and improvement of the system that create and deliver the firm's primary products and services.

#### **4.1.1 Purpose and use of Operations Management**

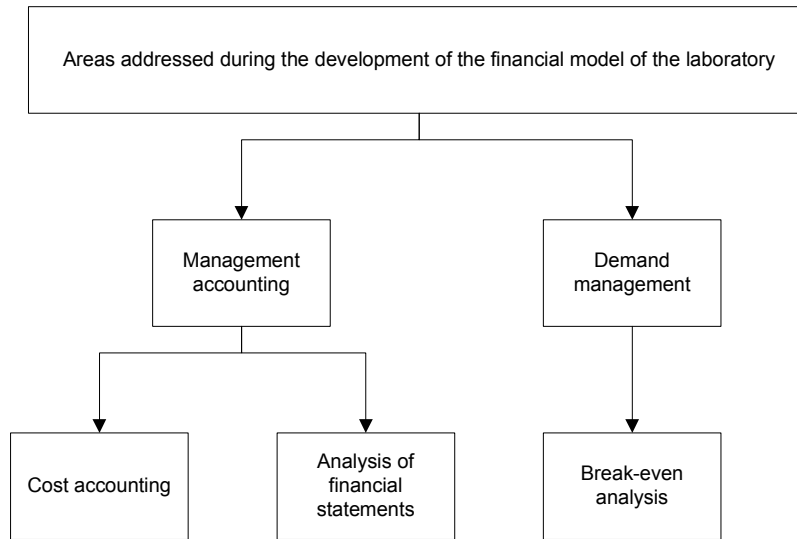
The Histopathology laboratory's problem is a common decision-making problem and there are numerous elements to contemplate when aiming to make the optimal decision. These elements include problem statement, model formulation, various solutions and choosing the most suitable solution for the problem, implementation of the decision, and monitoring the outcome.

#### **4.1.2 Methods tool and techniques for Operations Management**

According to van Sittert (2010:8) various tools are available when attempting to solve problems which include using quantitative solution methods, models or the systems approach. Furthermore, from an operational point of view, as well as from an industrial approach, mathematical models are the most applicable and important problem solving technique. Additionally, schematic models such as process maps, flow charts, graphs and diagrams can be used in addition, to portray ideas, processes and methods.

A financial model is a representation of the activities of an organization depicting the quantitative relationships among financial variables. Financial variables consistently have an economic or accounting importance and their relation to each other are typically expressed through formulas. (Van Sittert 2010:8)

A Result of inefficient and inaccurate planning, financial management, operations management and forecasting, or the total lack thereof, the need for an operations management problem solution exists. A combination of the above mentioned problem solving techniques is applied, including the use of models and the quantitative solution methods.



**Figure 2: Areas addressed during the development of the financial model for the laboratory**

## **4.2 Management accounting**

Management accounting according to Schwarz (2010:104) is defined as the process of identification, measurement, accumulation, analysis, preparation, interpretation and communication of information used by management to plan, evaluate and control within an entity and to assure appropriate use of and accountability of its resources.

### **4.2.1 Purpose and use of management accounting**

Management accounting can be applied in various ways. The majority of results obtained will provide important information regarding the firm's performance, especially the production and cost utility. (Kaye 1994:24) These types of results can be very significant in this project as it will aid in addressing the problem of determining the cost-to-company of running the Histopathology laboratories.

### **4.2.2 Methods, tools and techniques for management accounting**

To get an overview of the laboratory's financial state, applicable financial management techniques are identified. Key areas have to be identified where financial management has an input into management decision making.

According to Whiteley(2004:6) these areas include:

- Selling and Pricing
- Cost accounting
- Risk management

- Fraud prevention
- Tax compliance and planning
- Treasury management
- Forecasting
- Budgeting
- Internal and financial controls
- Audit – external and internal
- Analysis of financial statements

The key areas identified as applicable to this project include; cost accounting, analysis of financial statements as well as pricing and will be reviewed and researched accordingly.

### **4.3 Cost accounting**

Baggot (1973:1) stated that cost accounting originated in financial accounting as well as engineering and could be applied as an effective decision-making tool in business management.

#### **4.3.1 Purpose and use of Cost accounting**

Cost accounting and cost analysis is required in the managerial industry and according to Dearden (1978:132) with increase in competition and prices, it is vital for service companies to know the true costs of running their operations, as the business' financial health and even existence may depend on it.

According to Van Sittert (2010:10) cost accounting is a tool which aids an institution in operational functions such as planning, control and decision making on the optimal pricing policy or evaluating alternative actions. Morse (1978:5) reasons that based on the outcome of cost accounting, decisions can be made whether or not to continue providing a service or manufacturing a product. The opportunity to identify areas where costs can be minimized or reduced also exists.

#### **4.3.2 Methods, tools and techniques for Cost accounting**

According to Hernandez (2003:440) few studies have been conducted to address the cost-effectiveness of laboratory testing, particularly the cost-effectiveness when dealing with direct and indirect costs. However, some strategies have been identified on cost accounting which can be applied to the laboratories at the faculty.

According to Wood (1985:4) cost centre is one of the key concepts identified with regards to cost accounting. Cost centre characterizes the smallest unit of production to which costs can be allocated. A cost centre can represent a process, a single item or a set of items.

According to Garrison et al. (2009:33) it is important to identify and define different types of cost:

- **Direct Costs:** Costs that can be easily and conveniently traced to the particular cost project under consideration.
- **Indirect Costs:** Costs that can not easily be traced to the particular cost object under consideration.
- **Fixed Costs:** Costs that remain constant regardless to change in the level of activity.
- **Variable Costs:** Costs that varies, in total, in direct proportion to change in the level of activity.
- **Overhead Costs:** These costs include all indirect production costs, consisting of, production costs excluding direct labour and direct material.

The total cost can be calculated by either adding the direct and indirect cost, or by adding the fixed and variable costs. In some instances direct costs may be classified as a fixed or variable cost.

Whiteley (2004:91) describes 4 methods of costing:

- **Standard Costing:** Standard costing is a method where the cost of each item produced is calculated, consisting of fixed and variable costs. These calculations should be done under standard conditions.
- **Absorption Costing:** Absorption costing allocates fixed costs to the amount of direct labor hours in a pro rata fashion.
- **Activity based Costing:** This costing method places more emphasis on establishing the true cost of cost centers – consisting of processes, single items, batches etc.
- **Throughput Costing:** This costing method identifies bottlenecks in order to present appropriate cost information, and is applied to manufacturing plants.

Brezmes et al. (2002:582) undertook a study to estimate the true cost of each of the tests performed in a general hospital's clinical microbiology laboratory. This study made use of the workload register method developed by the college of American pathologists (CAP). This method is known as the CAP

method and can be categorized under absorption costing category as it places a lot of emphasis on the workload associated with each test.

In a clinical investigation conducted to analyze hospital costs (Alex et al. 1995:1138) and another study conducted on the costs of a district hospital laboratory service in Malawi (Mundy et al. 2003:403) cost accounting techniques were applied and costs were firstly divided into variable and fixed costs and then further divided into direct and indirect costs. Statistical and data management calculations were performed on Excel, to determine key ratios, such as the cost-to-charge ratio in order to determine actual costs. The personnel cost, material cost, consumable cost, average maintenance cost and average equipment cost were calculated for each of the tests performed. The result of the study included, calculation of global expenses and the actual cost of the test performed. These results were used to determine the profitability of the Histopathology laboratory and also used in the development of a price setting strategy for the tests performed by the Histopathology laboratory.

#### **4.4 Pricing strategy**

Developing a pricing strategy for products or services is a key management decision.

Blom (2007:14) describes the objective of pricing as establishing the fees charged in order to maximize an institution's profit.

##### **4.4.1 Purpose and use of a pricing strategy**

The main goal of a pricing strategy is to price products and services accurately in order to maximise a company's profit.

##### **4.4.2 Methods, tools and techniques for a pricing strategy**

Blom (2007:14) identifies two functions which influences an institution's pricing, as the cost function and the price response function. This indicates that the cost of producing a product or delivering a service is related to the fee charged for that product or service. This is apparent in various pricing methods.

Apart from using mathematical modelling to determine a price setting strategy, various other methods exist. A well known pricing model is the cost based pricing method. This method sets prices based on an addition of the cost to provide a service or produce a product and a fixed profit

percentage. The value based pricing method can be applied which places emphasis on setting prices according to the customers' perceived value of a product or service.

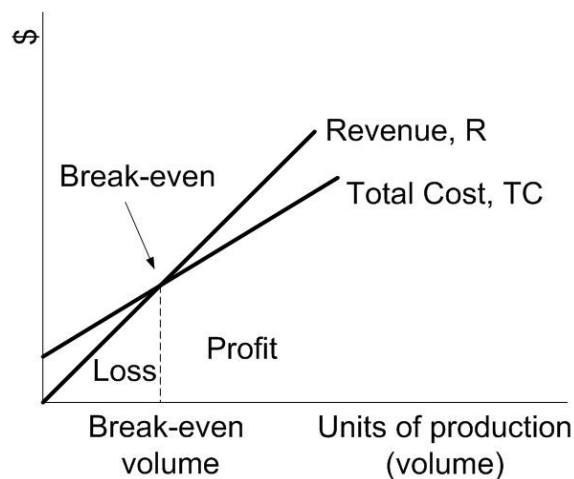
## 4.5 Break-even analysis

### 4.5.1 Purpose and use of break-even analysis

According to Whiteley (2004:33) the break-even analysis technique determines the sales capacity which should be achieved in order to cover all costs prior to making a profit. This break-even analysis technique can be adapted to either the business as a whole, or to separate departments or divisions of the corporation.

### 4.5.2 Methods, tools and techniques for break-even analysis

When doing a break even analysis it is all-important to categorize the costs as either fixed or variable. According to Adendorff and De Wit (2003:111) there are two methods to determine the break-even point, the graphical or numerical method. A graphical illustration of the break-even point is provided in Figure 3.



**Figure 3: Graphical illustration of the break-even point (copyright © Blank & Tarquin 2008).**

This chart represents an item being sold and revenue generated over a period of time. If applied to Histopathology lab this would show the performance of a specific test over a period of time. Break even analysis will be used to calculate the number of the tests the Histopathology lab have to conduct to make a profit. With regards to this project, break-even analysis will make it possible to see which tests incur a profit or a loss onto the Histopathology laboratory.

## **4.6 Spreadsheet modelling**

Spreadsheet modelling have gained in popularity as a modelling support tool, as it facilitates easy manipulation of data and reduces the time to modify models, hence today spreadsheets are a familiar tool to many people in business (Blom 2007:28).

### **4.6.1 Purpose and use of spreadsheet modelling**

Spreadsheets can be used for managerial modelling and analysis and according to Blom (2007:28) there are various reasons for using spreadsheets as a modelling tool, for instance spreadsheets are transferable, the data and results obtained from a model developed in a spreadsheet can be graphically presented (Van Sittert 2010:20).

## **5. Laboratory Services**

The Department provides an effective and efficient diagnostic pathology service, which includes macroscopic post mortem examinations and histopathological services. The Pathology Section of the department offers morphological, aetiological or differential diagnoses, based on microscopic morphology. Haematoxylin-and-Eosin (HE)-stained tissue sections from a wide variety of animals are interpreted in conjunction with information supplied by the history, macroscopic findings and results of other investigational procedures, e.g. electron microscopy , polymerase chain reaction, virus isolation, etc.

Sometimes, in order to make a diagnosis and/or ascertain causative agents in a formalin-fixed paraffin-embedded (FFPE) tissue sections and air dried smears, the pathologists make use of:

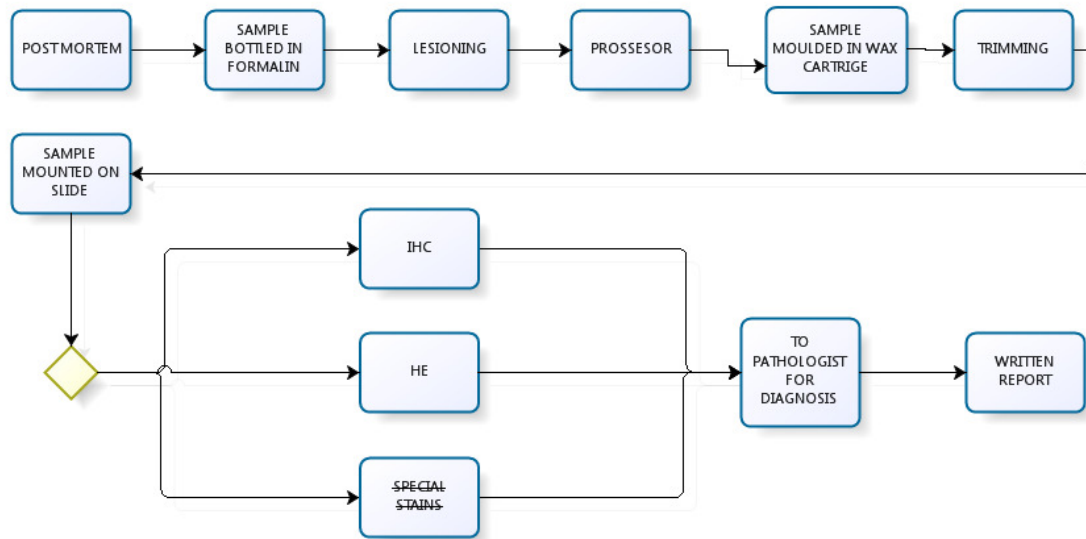
- Special stains to detect a wide variety of micro-organisms and cell deposits ( e.g. Warth-Starry stain for spirocheates and Congo Red technique(specifically in tissue sections) to demonstrate amyloid, etc.).
- Immunohistochemistry (IHC) to detect:
  - Infectious disease agents e.g. African horse sickness virus (AHSV) in specific target cells and organs/tissues
  - Specific cell markers, e.g. vimentin for cells of mesenchymal origin, or CD3 for T-lymphocytes in order to establish the histogenesis of neoplasia, and to detect micrometastases.

- Immunofluorescent antibody (IFA) test (which is part of Immunohistochemistry), usually to detect IgG on basement membranes and on desmosomes of stratified squamous epithelial cells to diagnose auto-immune skin disease.

From these three different tests, two of the tests were identified as major contributors to the running cost of the laboratory. Tests identified are: Immunohistochemistry (IHC) and Haematoxylin-and-Eosin (HE). (It is recommended that Special stains are priced in a separate project, as it has multiple variables and only contributes to a small part of work done).

## 6. Process

**Figure 4: Process map of the laboratory's processes**



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### 6.1 Introduction

The process starts when a client submits a carcass for a post mortem to determine the cause of death. The animals are dissected in a sterile post mortem hall. Samples are taken of various body parts and intestines. Most tissues are fixed in Formalin before they are examined microscopically. It follows that fixation is the foundation for the subsequent stages in the preparation, through to the making of diagnosis. An appropriate fixative must be used to facilitate any further studies. A

formaldehyde based chemical compound is used to fix these tissues. This compound is prepared by the staff in the laboratory and is a unique mixture of chemicals that comes from years of research and experience.

The fixed tissues that arrive at the laboratory are allocated a unique number which will accompany the sample block throughout the process. The first stage of processing is done in an automatic processing machine. The stage of automatic tissue processing is;

- Dehydrating the tissue of fixative and water and replacing it with dehydrating fluid like ethanol.
- Replacing the dehydrating fluid with a clearing agent (eg Xylene) that is miscible with both the dehydrating fluid and the embedding medium.
- Impregnating the embedding agent to replace the clearing agent.
- Embedding the tissue in paraffin wax to support the tissue to give it sufficient rigidity to enable thin sections to be cut by a microtome blade.

The thin sections is cut by a machine and put onto a slide. This slide is then classified and taken to different parts of the laboratory. It can be classified into Immunohistochemistry (IHC), Haematoxylin and Eosin (HE) or Special Stains. This classification determines which type of process will follow next. For the purpose of this project the focus will only be on IHC and HE staining. Although information have been provided relating to the process of Special stains, the frequency of use of this test is negligible and therefore it was decided in agreement with the Head of the Laboratory to focus our study on the IHC and HE test cases.



**Figure 5: Pictures of sample in formalin.**



**Figure 6: Picture of samples embedded in wax.**

## **6.2 Immunohistochemistry (IHC)**

Immunohistochemistry is one of the pillars of modern diagnostic pathology and a fundamental research tool in pathology. IHC combines anatomical, immunological and biochemical techniques to identify cell or tissue antigens ranging from amino acids and proteins to infectious agents and specific cellular populations, most commonly in formalin-fixed paraffin-embedded tissues (FFPE). By the interaction of target antigens with specific antibodies tagged with a visible label, IHC makes it possible to visualize the distribution and localization of selected antigens within cells and in the proper tissue context. Its popularity as a research and diagnostic tool no doubt stems from the fact that the technique is sensitive yet robust, reliable, easily available, generally inexpensive and can be automated for labelling, image acquisition and scoring.

Immunohistochemistry makes use of Antigen demasking agents, primary and secondary antibodies, tumor markers and staining kits to detect;

- Infectious disease agents e.g. African horse sickness virus (AHSV) in specific target cells and organs/tissues
- Specific cell markers, e.g. vimentin for cells of mesenchymal origin, or CD3 for T-lymphocytes in order to establish the histogenesis of neoplasia, and to detect micrometastases.

Immunofluorescent antibody (IFA) test, usually to detect IgG on basement membranes and on desmosomes of stratified squamous epithelial cells to diagnose auto-immune skin disease.

The following figures illustrate the two methods of IHC staining.

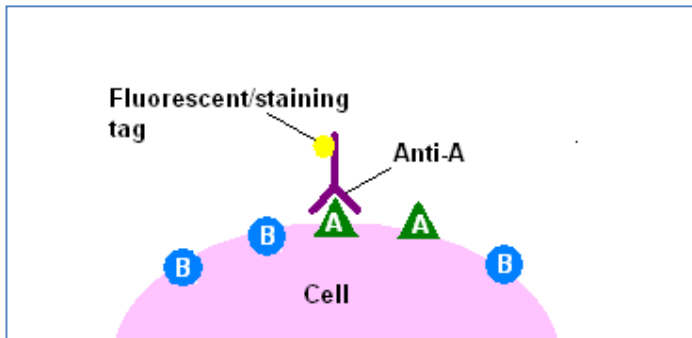


Figure 7: The direct method of immunohistochemical staining uses one labelled antibody, which binds directly to the antigen being stained for.

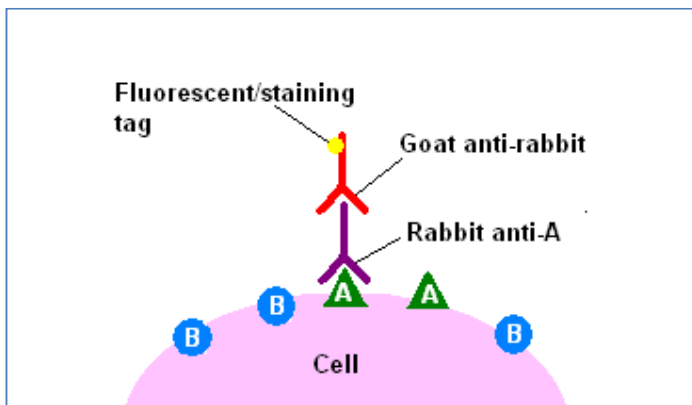


Figure 8: The indirect method of immunohistochemical staining uses one antibody against the antigen being probed for, and a second, labelled, antibody against the first.



Figure 9: Some of the kits used in the IHC process. From left to right. Novacastra polymer kit, AB Complex kit, LSAB+ kit.

### 6.3 Haematoxylin & Eosin (HE)

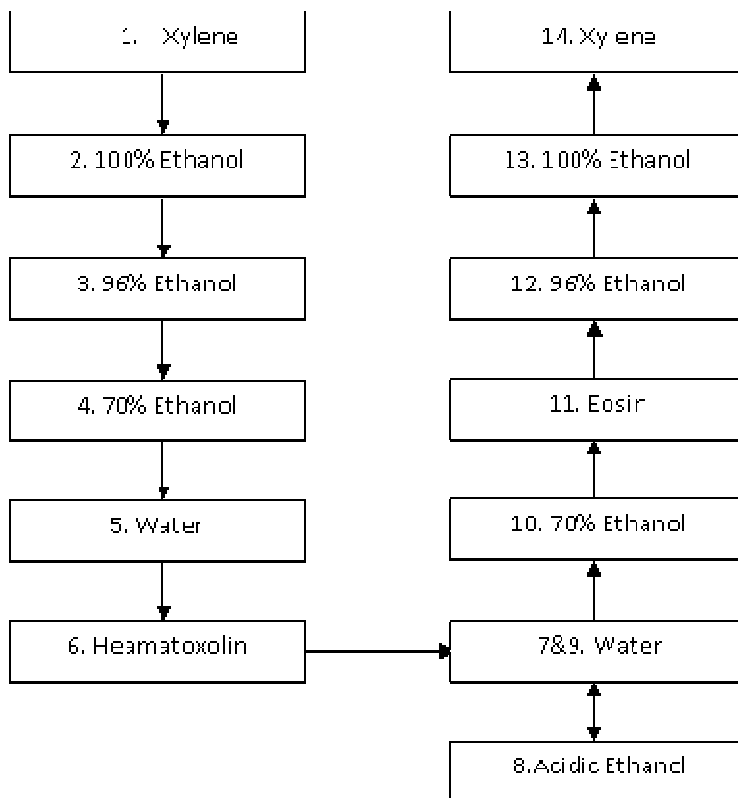
Haematoxylin and Eosin staining is the most common of all tests. In this test slides are taken through a staining process that only uses the colourants Haematoxylin & Eosin, Xylene, Distilled Water and various percentages of Ethanol. A five litre Haematoxylin mix is made of;

- 25g of Haematoxylin
- 250g of Aluminium Ammonium Sulphate Dodecahydrate
- 1.5L of Glycerol
- 100ml Glacial Acetic Acid
- 2.5g Sodium Iodate
- Distilled Water

A five litre Eosin mix is made of;

- 25g Eosin
- 3,6L 96% Ethanol
- 1,4L Distilled Water

In figure 10 and in section 6.3.1 the process of HE staining is explained.



**Figure 10: Haematoxylin & Eosin process.**

### 6.3.1 Method

(Times are standard sections that is four micron thick)

1. De-wax the slide in Xylene for 5min
2. Rinse in 100% Ethanol for 1min
3. Rinse in 96% Ethanol for 1 min
4. Rinse in 70% Ethanol for 1 min
5. Bring to distilled water
6. Stain in Haematoxylin for 10min
7. Rinse in tap water
8. Differentiate the slides in Acid Alcohol with only one dip
9. Blue in running tap water for 10min
10. Rinse in 70% Ethanol for 3 min
11. Counter stain the slides in Eosin for 2 ½ min
12. Differentiate and dehydrate in 96% Ethanol for 3 min
13. Dehydrate 100% Ethanol for 3 min
14. Clear in Xylene and mount in Entellan

### **6.3.2 Expected results for HE test**

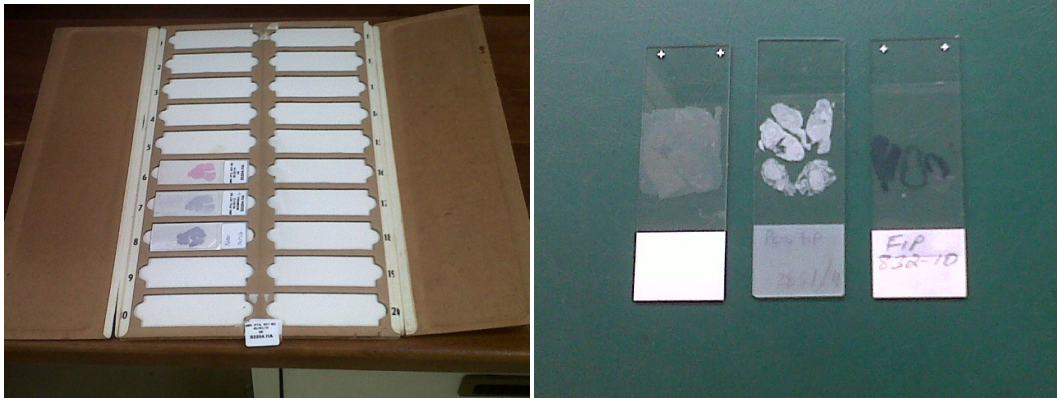
The Nuclei of the cell is expected to turn blue.

The Cytoplasm of the cell is expected to turn pink

**This section is adapted from Bancroft (2003:130)**

## **6.4 Report**

The final product is a clear and concise, generally standardized report that contains all the information that is necessary to trace them back to the specimen submitted and to the person responsible for the report. Where a written report is provided with a statement that further tests/examination will be performed, the report is identified as a "Preliminary Report". The "Final Report" is identified as such and contains all the information of the preliminary report and additional data.



**Figure 11: Pictures of finished slides ready for diagnosis.**

## **7. Data**

### **7.1 Data Collection**

In order to arrive at an end result of a calculated price per slide and per case, the project was started with intensive data collection and an understanding of the detailed workings of the Lab.

In the first instance four years of purchase data was collected from the Laboratory's purchasing records. These records were kept in hard copy on file and a manual exercise was required to capture this data. Purchases were divided into several categories for eg. Maintenance, equipment bought, consumables, office equipment, external tests, incinerations, travel and accommodation and literature. This data collection took approximately two weeks.

In respect of this information collected, only maintenance and equipment costs were relevant to the pricing that of the IHC and HE tests. The other costs could not be attributed to the direct cost of sales of these two processes.

Secondly, time was spent in the Laboratories and Post mortem hall to get a understanding for how the process is running. Time spent in the post mortem hall gave an idea of how some equipment and consumables are applied in the process.

Thirdly, most of the time was spent to understand the workings of the Laboratory itself. Some research was done on Histopathology and Histology to simplify the task of understanding complex biological terms. The Laboratory is split up into two major sections, the Immunohistochemical Laboratory and the Chemical Laboratory. This are where most of the consumables are used and therefore was an important area of focus for the for the purpose of this project the data collection

phase. With the help of Mrs. M Smit (Head of the Laboratory), products from the consumables lists to products in the two Laboratories were identified.

The fourth step was to construct a questionnaire; due to the huge quantity of products used by both Laboratories it would be impossible to identify all the products with short visits to Onderstepoort. The questionnaire constructed was left with Mrs. Smit until completion and was the main source of data.

Data was collected from the intranet of the Department of Paraclinical Sciences. This data documents the number of cases that have been handled in period of three tests namely, Haematoxylin & Eosin, Immunohistochemistry (IHC) and Special Stains.

Although data have initially been collected in relation to Special Stains, it was decided to exclude this test from the study due to the low frequency of use and the uniqueness of this test from one case to the next. Ideally, Special Stains tests should be priced on an individual basis and does not fit well into an Excel based pricing framework. The exclusion of Special Stains was agreed with by the DPS.

During the process of putting all the various sets of data together, a number of discrepancies and gaps were identified. A number of fields were queried and requeryed to ensure that all data available was included in the pricing model to make it as accurate as reasonably possible. Specifically, the data queries related to the prices of various products, the volume of product per price, how products are diluted and how much of the diluted solutions are used per slide, per case and per week.

It is important to note that some products are used per week eg Formic acid – 0.25L used per week, and this meant that the cost of 0.25L of Formic acid needed to be distributed between the average number of cases and slides handled per week. It was therefore incredibly important to understand exactly how products were used in the laboratory as well as within a testing process.

In conclusion, the data collection process was time consuming and form the basis of the pricing mode, hence the saying - "Garbage in, Garbage out."

## **7.2 Calculating the average Equipment and Maintenance Cost per slide**

Information relating to the equipment and maintenance cost purchases from 2007 to 2010 had been provided by the Laboratory. This information was used to derive an estimate of the fixed costs that should be costed in when calculating the proposed price per slide.

The difficulty associated with adding this cost is that the study is focused on two types of tests only. Many other tests and processes are conducted in the Laboratory and fixed costs should therefore be shared between all income generating processes.

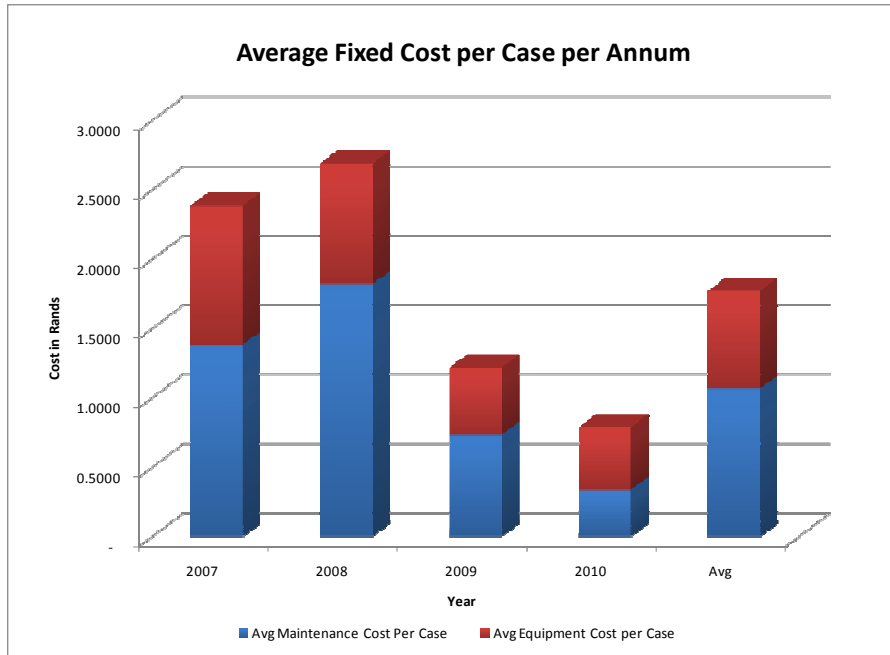
However, a basic approach was taken on calculating the average equipment and maintenance costs over the last four years. This cost has been allocated to the average cost per slide in our pricing model, which is believed to be a conservative average of the costs. Details of calculations are provided in section 7.2.1.

### **7.2.1 Data Analysis**

The graph below details the average calculated equipment and maintenance cost per Case – calculated by taking the total costs per year and dividing it by the number of cases handled in that specific period.

Technically, fixed costs can be amortised over a number of years, but due to the small size of the overall margin added to the price of a slide, it was decided to simplistically calculate the average cost per case. The approach is conservative and are therefore not at risk of underestimating the required price per slide.

Secondly, as indicated above, it was assumed that the IHC and HE test cases will be the only contributors to covering fixed costs – another conservative assumption, as Special Stains tests are not covered.



**Figure 12: Taking the average fixed cost over the four year period of R1.06 and R0.70 per Case was allocated in our pricing model as Maintenance and Equipment costs respectively.**

## 8. Developing of pricing model

### 8.1 Introduction

The intension with the Excel pricing model is to provide the lab with a tool that can be used every time they have to calculate the cost of an IHC or HE test that has been conducted. Therefore, the model needs to take into account the following:

- The cost of actual products used during the entire test process (eg Xylene)
- The cost of any other consumables used during the test (eg glass pipettes)
- The cost of any consumables that are not specifically linked to an individual case or test (eg gloves)
- The marginal cost associated with purchasing equipment
- The marginal cost associated with maintenance of the lab

At this stage, the cost of rent or monthly salaries has not been taken into account as the DSP could not provide such detail.

## 8.2 Microsoft Excel Functions

It was decided to construct the required model in Excel as this is a well-known platform that will be easily available to anyone utilising the model. A number of Excel functions used include:

1. The Nested IF statement – this statement was incredibly valuable in designing a dynamic tool that can automatically provide results for IHC or HE, depending on selections made by the user.
2. The V-Lookup Function – this function allow the user to easily transfer data from one sheet to another by “looking up” the product name. This function was used to help program the part of the model in section 8.3.4 of this report, which details all the products and consumables used in the pricing model.
3. List Boxes – List boxes were used to allow the user to choose the products that they have used in conducting the test. These selections where in turn used to calculate the cost of handling each case and each slide
4. Macros – A macro was recorded to allow the user to clear its previous selections and to price a new case.
5. “Clear All” Button – The macro was used to create a “Clear All” button so that the user can easily delete the information from the case that was priced before. This will ensure that unnecessary errors can be avoided as all input boxed needs to be populated before a price can be provided.

## 8.3 Structure of the Model

### 8.3.1 Identification of cells

The various cells in the model can be identified the following:

| Type of Cell   | Colour coding |
|--|---------------|
| Input Cell (can be changed)                                | Light Blue    |
| Assumption Cell (can be changed)                           | Light Green   |
| Calculation and Output Cell (protected, cannot be changed) | Light Yellow  |
| Cells containing only information                          | White         |

**Table 1: Identification of cells in the spread sheet model**

A number of sheets in the model were created, each of which is discussed in more detail below.

### **8.3.2 Input Data**

The model is constructed as a database with most fields closed for editing by the end user. However, certain fields displayed in green are editable. These unlocked fields include all product related input data (description, dilution details and price per unit information), the input assumptions as well as the quoting sheet drop down fields.

Data is divided into three main groups; HE, IHC and process. The HE group is composed of consumed products in the HE process such as Xylene and different concentrations of Ethanol and the various chemicals used to make the haematoxylin and eosin mixture respectively. The IHC group is comprised of antibodies, immunoflorescent antibodies, secondary antibodies, serums, antigen demasking agents and various kits. The process part of the input sheet is consumables that are used by HE and IHC test procedures. Products like formalin, types of slides used, paraffin wax, cassettes for wax embedding, trimming blades and accu-edge blades.

### **8.3.3 Input assumptions**

Some assumptions are made in the spread sheet model. These assumptions are input variables in the workings of the model and detail on how these assumptions were set are provided in a separate section. These assumptions can be changed if the dynamics of the Histopathology laboratories services changes going in the future. The input assumptions include the number of HE and IHC cases handled per week, the average maintenance and equipment cost to take into account per case, the average monthly salaries to be covered by the tests as well as the profit margins to be taken into account when calculating the external price of the two selected tests.

The profit margins used is calculated by using the current as-is margin between the internal and external price.

| External Assumptions applied in the Pricing Model |                   |
|---|-------------------|
| Number of IHC Cases per week                      | 55                |
| Number of HEs Cases per week                      | 660               |
| Avg Equipment Cost per Case                       | 0.7 rands         |
| Avg Maintenance Cost per Case                     | 1.06 rands        |
| Avg IHC Salaries per month                        | 32829.25 rands    |
| Avg HE Salaries per month                         | 131,317 rands     |
| Profit Margin on IHC Tests                        | 43.48% percentage |
| Profit Margin on HE Tests                         | 75.00% percentage |


**Figure 13: External assumptions applied in the pricing model**

### 8.3.4 Quote sheet

The quote sheet is the interface that will be used by the end user. In this sheet the user will input information and the sheet will do calculations according to the information. Before the user inserts any information it will be necessary to clear all the fields. A macro called “clear all” was created to assist the user with this function.

The user should choose from the first dropdown box what type of test is to be conducted as shown in figure 14.

## Diagnostic Pathology - Price Calculator



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YUNIBESITHI YA PRETORIA

1. Test to be conducted


▼

2. Select Antigen Demasking Agent

**Figure 14: Screenshot 1 of quote sheet**

If IHC is chosen a range of fields will require completion to accommodate the many elements associated with this test. Figure 14 shows the range of choices in the IHC testing process.

## Diagnostic Pathology - Price Calculator



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1. Test to be conducted

2. Select Antigen Demasking Agent

3. Select Primary Antibody

4. Select Secondary Antibody

5. Select Serum

6. Select Kit

7. Will you use the NovaRed Kit?

8. How Many Slides will be used in this Case?

9. Select Type of Slide

**Calculated Break-even Cost per Slide (incl Vat)**

**Calculated Break-even Cost for this Case (incl Vat)**

**Calculated External Cost per Slide (incl Vat)**

**Calculated External Cost per for this Case (incl Vat)**

Clear All

**Figure 15: Screenshot 2 of quote sheet**

Options give in the dropdown boxes when IHC is the chosen test is listed below;

2. Select antigen demasking agent:

- Antigen Retrieval pH6
- Antigen Retrieval pH9
- Protease

3. Select Primary Antibody

- CD3
- Adenovirus
- African Horse Sickness
- African Swine Fever
- Blue Tongue Virus
- Bovine Herpes Virus
- Bovine Papilloma Virus
- BVD
- Calcitonin
- CD 20

- CD79A
- Chromogranin A
- Clamidia AC-1
- Cytoceritin MNF116
- Cytoceritin AE1/AE3
- BVDV MOAB
- Desmin
- Distemper
- Equine Encephalitis Virus
- Equine Herpes Virus
- EstogenReseptor
- Feline Corona Virus
- Feline Leukaemia Virus
- Glial Fibrillary Acidic Acid
- Hart Water
- Hog Colera
- IgG Canine
- IgG Equine
- IgG Feline
- Lenti Virus
- Leptospira
- Lumpy Skin Disease
- CD31
- Vimentin Clone
- MAC387 Mycliod/Histiocytic Antigen
- Melanin A
- Myoglobin
- Neospora
- Neurofilament Protein Clone
- Newcastle Disease
- Parvovirus
- Polyclonal Von Willebrand Factor 8
- Porcine Circo Virus

- CD117
- Rabies
- Rift Valley Fever
- S100
- Somtostatin
- Toxoplasma
- Wesselsbron

4. Select Secondary Antibody

- Goat AntiRabbit
- Rabbit AntiGoat
- Rabbit AntiMouse
- Or blank if no secondary antibody is required

5. Select Serum

- Normal Horse Serum
- Goat Serum
- Or blank if no serum is required

6. Select Kit

- LSAB+ Kit
- AB Complex
- Novacastra Polymer Kit

7. Will you use the NovaRed kit?

- Yes/No

8. How many slides in this case?

- Select 1-20

9. Select type of slide

- Menzel cut edge slides
- Superfrost plus slides

When calculating the cost of the HE tests only a few fields of information have to be entered.

Illustrated

in

figure

16

**Diagnostic Pathology - Price Calculator**

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1. Test to be conducted

2. Not Applicable

3. Not Applicable

4. Not Applicable

5. Not Applicable

6. Not Applicable

7. Not Applicable

8. How Many Slides will be used in this Case?

9. Select Type of Slide

**Calculated Break-even Cost per Slide (incl Vat)**  
**Calculated Break-even Cost for this Case (incl Vat)**

**Calculated External Cost per Slide (incl Vat)**  
**Calculated External Cost per for this Case (incl Vat)**

**Figure 16: Screenshot 3 of quote sheet**

Only two fields are to be entered when HE is selected because HE is a standardized test. The questions asked is the same as the last two questions asked when IHC is selected.

### **8.3.5 Calculation Sheet**

The Calculation sheets' input is all the consumables used in the lab. Products used are either priced per slide, per sample or per week. The price per week is divided into the assumed number of tests that have been calculated in section 8.3.3. The price per sample is costs that are divided into the total slides in the case. Some consumable are used for a week and can be priced accordingly per week. The calculation sheet is shown in figure 16 with only the essential columns shown.

| Test                      | Product                                | Price per slide | Price per sample | Price per week |
|---------------------------|--|-----------------|------------------|----------------|
| HEAMATOXILIN & EOSIN (HE) | ETHANOL 96.5                           | #DIV/0!         | 0.0272           | 17.9550        |
| HEAMATOXILIN & EOSIN (HE) | ETHANOL 99.9                           | #DIV/0!         | 0.6255           | 412.8000       |
| HEAMATOXILIN & EOSIN (HE) | XYLENE                                 | #DIV/0!         | 0.0032           | 2.1250         |
| HEAMATOXILIN & EOSIN (HE) | EOSIN YELLOW IKG                       | #DIV/0!         | 0.0097           | 6.4125         |
| HEAMATOXILIN & EOSIN (HE) | 210L ETHANOL 96.5                      | #DIV/0!         | 0.0114           | 7.5160         |
| HEAMATOXILIN & EOSIN (HE) | HAEMATOXALIN                           | #DIV/0!         | 0.1192           | 78.6600        |
| HEAMATOXILIN & EOSIN (HE) | 25LGLYCEROL                            | #DIV/0!         | 0.0046           | 3.0204         |
| HEAMATOXILIN & EOSIN (HE) | GLACIAL ACEDIC ACID                    | #DIV/0!         | 0.0015           | 1.0126         |
| HEAMATOXILIN & EOSIN (HE) | SODIUM IODATE                          | #DIV/0!         | 0.0032           | 2.1076         |
| HEAMATOXILIN & EOSIN (HE) | ALUMINUM AMMONUIM                      | #DIV/0!         | 0.0527           | 34.7985        |
| IMMUNOHISTOLOGY(IMP)      | A0452 CD3 1ML                          | 1.8417          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | ADENOVIRUS                             | 0.7335          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | AFRICAN HORSE SICKNESS                 | 0.3131          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | AFRICAN SWINE FEVER                    | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | BLUE TONGUE VIRUS                      | 2.3383          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | BOVINE HERPES VIRUS                    | 0.2349          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | BOVINE PAPILLOMA VIRUS                 | 1.8240          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | BVD MONO CL AB                         | 0.3401          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | CALCITONIN 6ML                         | 14.8333         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | CD20                                   | 28.8333         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | CD79A 1ML                              | 34.5484         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | CHROMOGRANIN A                         | 7.5647          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | CLAMIDIA AC-1 AB                       | 5.2935          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | CYTOCERITIN MNF116                     | 5.0822          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | CYTOKERATIN AE1/AE3 1ML                | 8.6255          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | D89-1 BVDV MOAB 1ML                    | 0.4018          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | DESMIN                                 | 4.6109          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | DISTEMPER                              | 5.8025          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | EQUINE ENCEPHALITIS VIRUS              | 0.0783          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | EQUINE HERPES VIRUS                    | 1.9950          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | ESTOGEN RESEPTOR                       | 16.2857         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | FELINE CORONA VIRUS                    | 0.9165          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | FELINE LECUMIA VIRUS                   | 0.9165          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | GLIAL FIBRILLARY ACIDIC PROTEIN        | 1.5472          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | HART WATER                             | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | HOG COLERA                             | 5.8025          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | IgG CANINE                             | 0.4615          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | IgG EQUINE                             | 1.0293          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | IgG FELINE                             | 0.4070          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | LENTIVIRUS                             | 42.7273         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | LEPTOSPIRA                             | 0.6374          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | LUMPY SKIN DISEASE                     | 0.3131          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | M0823 CD31 0.2ML                       | 22.1762         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | M702001 VIMENTIN CLONE VIM 3B4         | 11.8725         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | MAC387 MYCLIOD/HISTIOCYTIC ANTIGEN     | 14.4923         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | MELANIN A                              | 30.4462         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | MYOGLOBIN                              | 2.3383          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | NEOSPORA                               | 0.4695          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | NEUROFILAMENT PROTEIN CLONE 0.2ML      | 18.6373         | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | NEW CASTLE DISEASE                     | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | PARVOVIRUS                             | 1.2209          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | POLYCLONAL VON WILLEBRAND FACTOR 8.2ML | 2.8474          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | PORCINE CIRCO VIRUS                    | 0.1879          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | PRIMARY CD117 0.2ML                    | 3.8591          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | RABIES                                 | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | RIFT VALLEY FEVER                      | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | S100                                   | 0.4741          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | SARCOCYSTIS                            | 0.4695          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | SOMTOSTATIN                            | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | TOXOPLASMA                             | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | WESSELSBRON                            | 0.9381          | n/a              | n/a            |
| IMMUNOHISTOLOGY(IMP)      | 5GR PROTEASEE                          | #DIV/0!         | 10.1431          | n/a            |
| IMMUNOHISTOLOGY(IMP)      | ANTIGEN RETRIEVAL PH6                  | #DIV/0!         | 0.1150           | n/a            |
| IMMUNOHISTOLOGY(IMP)      | ANTIGEN RETRIEVAL PH9                  | #DIV/0!         | 0.3708           | n/a            |

|                      |                                      |         |        |          |
|----------------------|--------------------------------------|---------|--------|----------|
| IMMUNOHISTOLOGY(IMP) | DISPOSIBLE GLASS PIPETTES            | #DIV/0! | 0.5828 | n/a      |
| IMMUNOHISTOLOGY(IMP) | PH4 BUFFER                           | #DIV/0! | 0.0084 | 0.4600   |
| IMMUNOHISTOLOGY(IMP) | PH7 BUFFER                           | #DIV/0! | 0.0084 | 0.4600   |
| IMMUNOHISTOLOGY(IMP) | ABCOMPLEX+ KIT                       | 47.3024 | n/a    | n/a      |
| IMMUNOHISTOLOGY(IMP) | LSAB +                               | 47.1504 | n/a    | n/a      |
| IMMUNOHISTOLOGY(IMP) | NOVACAstra RE7150-K POLYMER KIT      | 72.0100 | n/a    | n/a      |
| IMMUNOHISTOLOGY(IMP) | NOVA RED KIT                         | 12.7376 | n/a    | n/a      |
| IMMUNOHISTOLOGY(IMP) | GOAT X RABBIT 1ML (GXR)              | 1.1377  | n/a    | n/a      |
| IMMUNOHISTOLOGY(IMP) | RABBIT ANTI GOAT (RXG)               | 0.9381  | n/a    | n/a      |
| IMMUNOHISTOLOGY(IMP) | RABBIT ANTI MOUSE (RXM)              | 0.5177  | n/a    | n/a      |
| IMMUNOHISTOLOGY(IMP) | 10ML HORSE SERUM - 50 ML             | #DIV/0! | 1.6755 | n/a      |
| IMMUNOHISTOLOGY(IMP) | GOAT SERUM 10ML                      | 2.3338  | n/a    | n/a      |
| FORMALIN             | 25L FORMALDEHYDE 40%                 | #DIV/0! | 0.0000 | 0.0178   |
| FORMALIN             | SODIUM DIHYD ORTHOPHOSPHATE 25KG     | #DIV/0! | 0.0151 | 10.7730  |
| FORMALIN             | NaOH                                 | #DIV/0! | 0.0032 | 2.3237   |
| FORMALIN             | ALUMINUM AMMONIUM SULPHATE DODECAHYD | #DIV/0! | 0.1428 | 102.0996 |
| FORMALIN             | GLUCOSE @R10/KG                      | #DIV/0! | 0.0008 | 0.5952   |
| PROCESSES            | 25L METHANOL                         | #DIV/0! | 0.0279 | 19.9728  |
| PROCESSES            | ACCU EDGE PROFILE BLADES             | 2.6600  | n/a    | n/a      |
| PROCESSES            | ALL COLOUR CASSETTES                 | #DIV/0! | 0.4332 | n/a      |
| PROCESSES            | BLOTTING PAPER                       | #DIV/0! | 0.1057 | 75.6000  |
| PROCESSES            | ENTELLAN                             | 0.0347  | n/a    | n/a      |
| PROCESSES            | EXTRAN AP 21                         | #DIV/0! | 0.0268 | 19.1862  |
| PROCESSES            | FORMIC ACID 2.5L                     | #DIV/0! | 0.0011 | 0.7665   |
| PROCESSES            | NO7 GLOVES                           | #DIV/0! | 0.0037 | 2.6200   |
| PROCESSES            | PARAFIN WAX 25KG                     | #DIV/0! | 0.2198 | 157.1630 |
| PROCESSES            | PARAFIN WAX 25KG                     | #DIV/0! | 0.4401 | n/a      |
| PROCESSES            | TRIMMING BLADES                      | #DIV/0! | 0.1231 | 88.0080  |
| PROCESSES            | WHITE THERMAL DIRECT LABELS          | 0.7598  | n/a    | n/a      |
| PROCESSES            | MENZEL COVER SLIP                    | 0.3956  | n/a    | n/a      |
| PROCESSES            | MENZEL CUT EDGE SLIDES               | 0.4765  | n/a    | n/a      |
| PROCESSES            | SUPERFROST PLUS SLIDES               | 2.7075  | n/a    | n/a      |

**Figure 17: Screenshot of calculation sheet**

### 8.3.6 Test results

A printable quote is generated as a report from the quote sheet; this sheet is called “detail of quote”. Details of each consumable used and its break-even and proposed external price are quoted. Random test inputs were used as illustration in figure 18.

## Test Quoting Results



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|   |                                 | Cost Per Slide (incl Vat) |
|---|---------------------------------|---------------------------|
|   |                                 | (Rands)                   |
| <b>Test Conducted:</b>                    | IMMUNOHISTOCHEMISTRY (IHC)      |                           |
| <b>Test Details:</b>                      |                                 |                           |
| ANTIGEN DEMASKER                          | 5GR PROTEASEE                   | 0.77                      |
| ANTIBODY                                  | DITEMPER                        | 6.61                      |
| SECONDARY ANTIBODY                        | RABBIT ANTI MOUSE (RXM)         | 0.59                      |
| SERUM                                     | 10ML HORSE SERUM - 50 ML        | 0.13                      |
| KIT                                       | NOVACAstra RE7150-K POLYMER KIT | 82.09                     |
| NOVARED KIT                               | No                              | -                         |
| <b>Slide Details:</b>                     |                                 |                           |
| NR OF SLIDES                              | 15                              |                           |
| TYPE OF SLIDE                             | MENZEL CUT EDGE SLIDES          | 0.54                      |
| <b>Additional Cost items - per slide:</b> |                                 |                           |
| PROCESS COST                              |                                 | 0.05                      |
| CONSUMABLES                               |                                 | 4.06                      |
| SLIDE COVER                               |                                 | 0.45                      |
| STAFF SALARIES                            |                                 | 7.60                      |
| MAINTENANCE COST                          |                                 | 0.08                      |
| EQUIPEMENT COST                           |                                 | 0.05                      |
| <b>Break-even Cost per Slide</b>          |                                 | <b>103.02</b>             |
| <b>Break-even Cost per Case</b>           |                                 | <b>1,545.35</b>           |
| <b>External Cost per Slide</b>            |                                 | <b>147.82</b>             |
| <b>External Cost per Case</b>             |                                 | <b>2,217.24</b>           |

Figure 18: Test quoting results

### 8.3.7 Workings sheet

This sheet just acts as the bridge between the Input Data and the Quoting Sheet. In this sheet, the selections from the initial quoting sheet questions are used to set up the correct questions to ask in the remainder of the quoting sheet.

## 9. Results

### 9.1 As-Is Pricelist

Table 2 is a representation of the as-is price quoted for the laboratory's services.

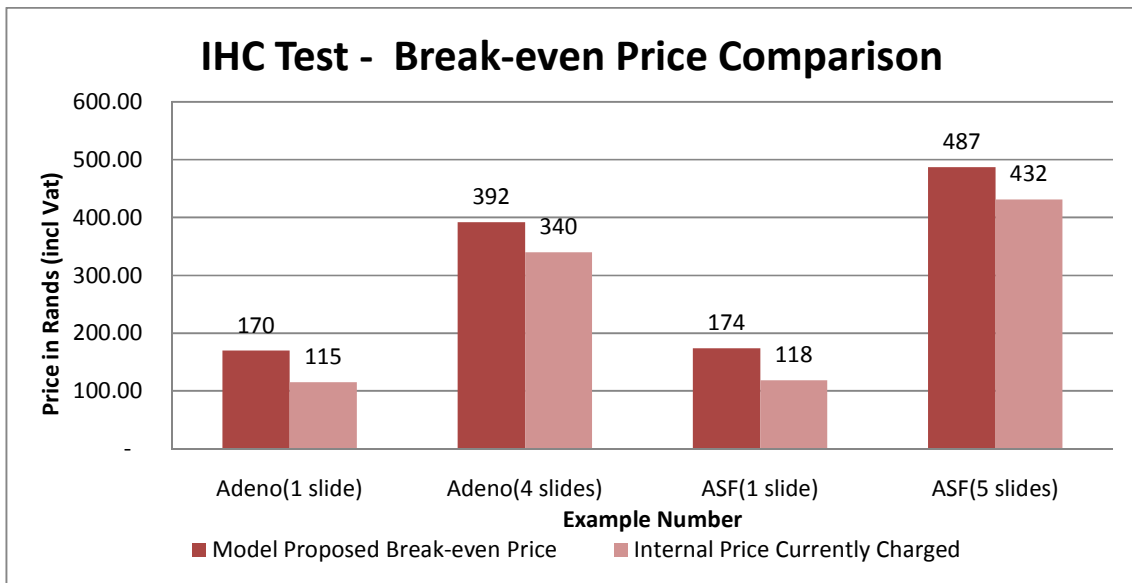
| As-Is Pricelist                                |          |          |                       |
|--|----------|----------|-----------------------|
|  | Internal | External | Current Profit margin |
| IHC-First section immunoperoxidase             | 115      | 165      | 0.43                  |
| IHC-for every additional section(same antigen) | 75       | 125      | 0.67                  |
| HE stained sections                            | 22       | 38.5     | 0.75                  |

**Table 2: As-Is price list**

Result of two IHC tests are tabled in table 3 and graphed figure19 and figure 20.

| IMMUNOHISTOCHEMISTRY(IHC)        | AdenoVirus     |                 | African Swine Fever |               |
|----------------------------------|----------------|-----------------|---------------------|---------------|
|                                  | Adeno(1 slide) | Adeno(4 slides) | ASF(1 slide)        | ASF(5 slides) |
| Model Proposed Break-even Price  | 169.69         | 391.81          | 173.94              | 487.09        |
| Internal Price Currently Charged | 115.00         | 340.00          | 118.30              | 431.50        |
| Model Proposed External Price    | 243.47         | 562.17          | 249.56              | 698.87        |
| External Price Currently Charged | 165.00         | 540.00          | 168.30              | 681.50        |

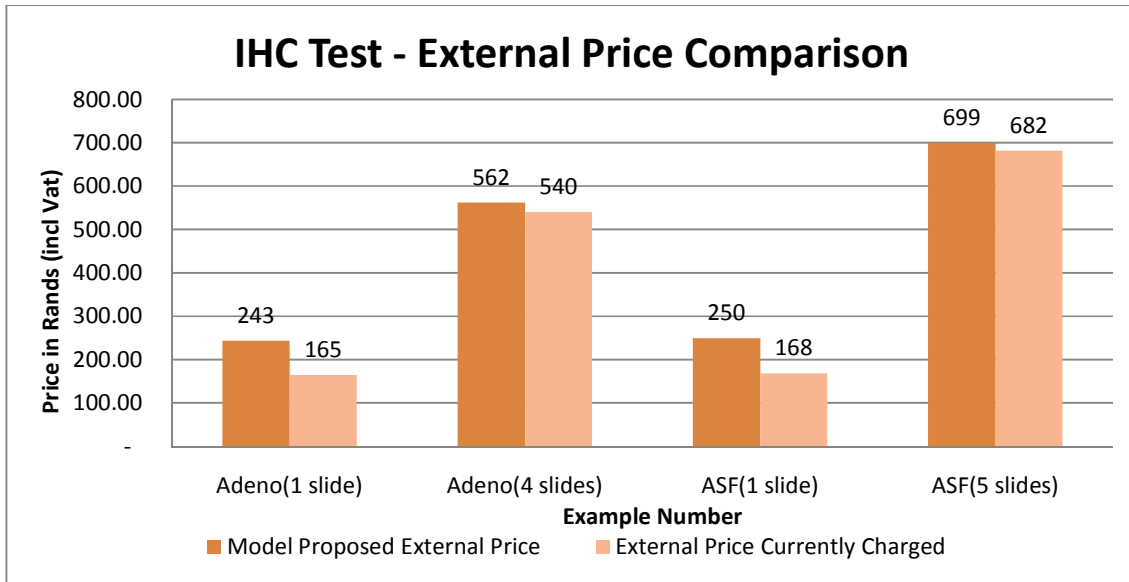
**Table 3: Immunohistochemistry results**



**Figure 19: Break-even price comparison for Adenovirus (Adeno) and African Swine Fever(ASF)**

When examining the break-even cost compared to internal costs calculated by the Model it is evident that the cost charged for the first slide is too low in both instances.

When more slides are added to a case the percentage deviation between the break-even and the internal costs are smaller, but the internal price is still 10-20 percent underpriced.



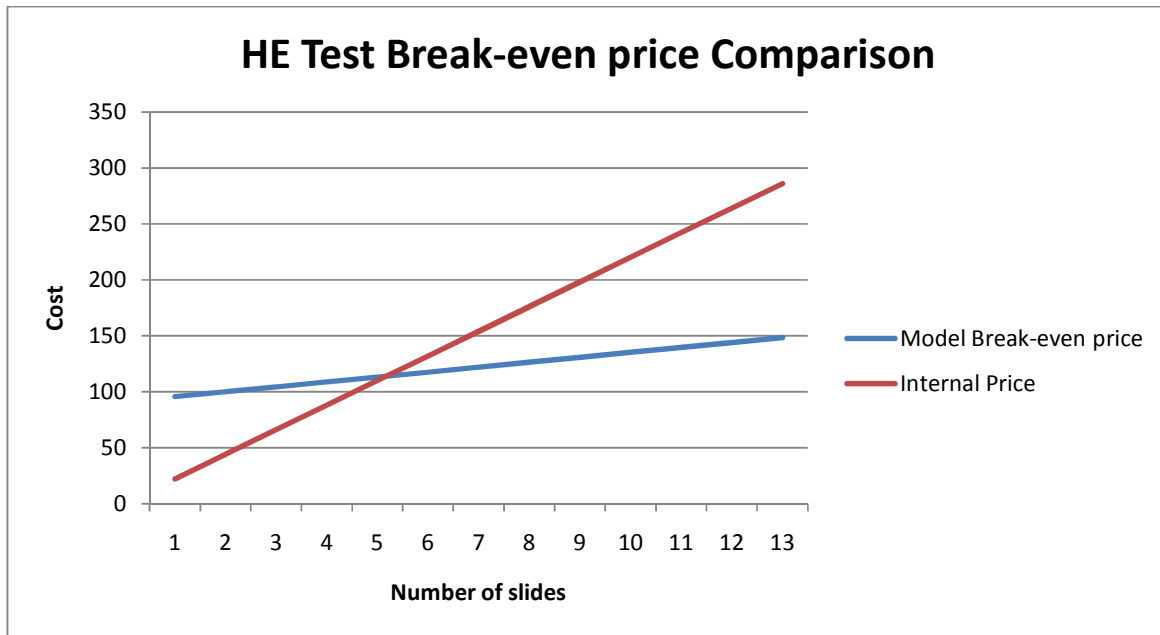
**Figure 20: External price comparison for Adenovirus(Adeno) and African Swine Fever(ASF)**

The external price charged is lower than the proposed price. However, when more slides are added per case the compared prices are more equal.

Result of HE tests are tabled in table 4 and graphed in figure 21

| Haematoxin & Eosin |                |                        |            |
|--------------------|----------------|------------------------|------------|
| Number of slides   | Internal Price | Model Break-even price | Difference |
| 1                  | 22.00          | 95.50                  | -73.50     |
| 2                  | 44.00          | 99.89                  | -55.89     |
| 3                  | 66.00          | 104.27                 | -38.27     |
| 4                  | 88.00          | 108.66                 | -20.66     |
| 5                  | 110.00         | 113.05                 | -3.05      |
| 6                  | 132.00         | 117.44                 | 14.56      |
| 7                  | 154.00         | 121.83                 | 32.17      |
| 8                  | 176.00         | 126.22                 | 49.78      |
| 9                  | 198.00         | 130.61                 | 67.39      |
| 10                 | 220.00         | 135.00                 | 85.00      |
| 11                 | 242.00         | 139.39                 | 102.61     |
| 12                 | 264.00         | 143.78                 | 120.22     |
| 13                 | 286.00         | 148.16                 | 137.84     |

**Table 4: Haematoxylin and Eosin Internal cost comparison**

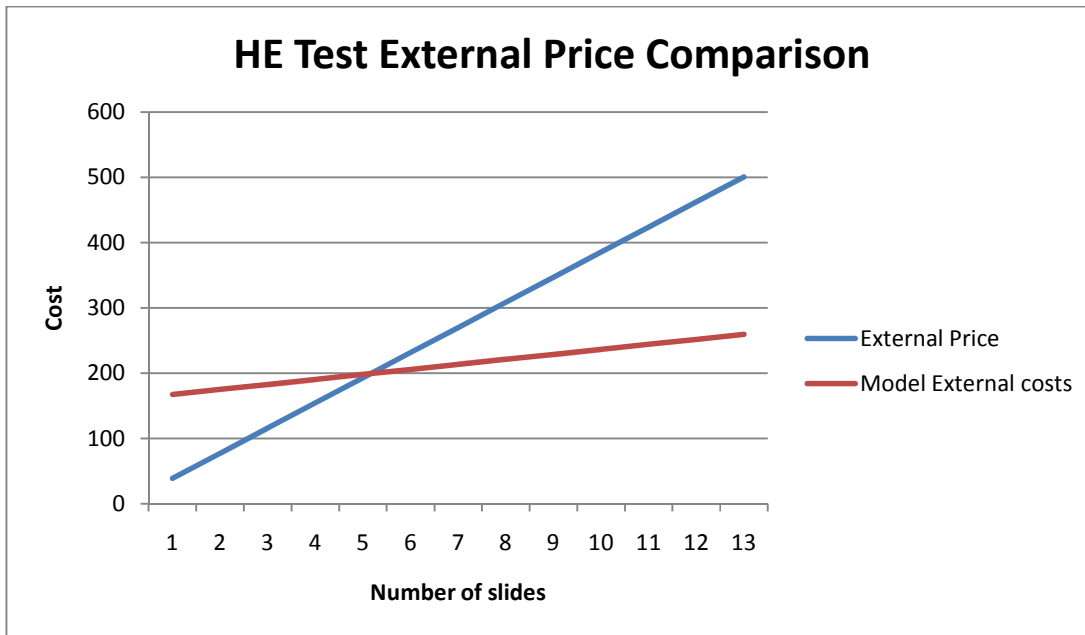


**Figure 21: Break-even price comparison for HE tests.**

The price of the first slide in this comparison differs by quite some margin. The reason for this is the fixed costs that are associated with the HE staining process. As the slides per case increase the current internal price grows steeply but the model break-even price grows with a smaller slope.

| Haematoxilin & Eosin |                |                      |            |
|----------------------|----------------|----------------------|------------|
| Number of slides     | External Price | Model External price | Difference |
| 1                    | 38.50          | 167.12               | -128.62    |
| 2                    | 77.00          | 174.80               | -97.80     |
| 3                    | 115.50         | 182.48               | -66.98     |
| 4                    | 154.00         | 190.16               | -36.16     |
| 5                    | 192.50         | 197.84               | -5.34      |
| 6                    | 231.00         | 205.52               | 25.48      |
| 7                    | 269.50         | 213.20               | 56.30      |
| 8                    | 308.00         | 220.88               | 87.12      |
| 9                    | 346.50         | 228.57               | 117.93     |
| 10                   | 385.00         | 236.25               | 148.75     |
| 11                   | 423.50         | 243.93               | 179.57     |
| 12                   | 462.00         | 251.61               | 210.39     |
| 13                   | 500.50         | 259.29               | 241.21     |

**Table 5: Haematoxylin & Eosin External cost comparison**



**Figure 22: External price comparison for HE tests.**

External price comparison behaves in the same way as the break-even price comparison.

## **10. Conclusion**

Whilst compiling this report, some problems at the Histopathology laboratory were analysed as recognised by Department of Paraclinical Sciences of the Faculty of Veterinary Science at Onderstepoort. The main focus of this project was to address the problem of no current price setting strategy. This strategy will aim to help the Histopathology laboratory with its financial state, whether a profit or loss are made.

A literature review was conducted with the aim of solving the proposed problem. Appropriate Industrial Engineering methods, tools and techniques were considered and researched. The focus of this literature was put on Economic, Human and Research Sciences. The project report also addresses the process of data gathering and analysis of this data. A fully integrated financial model was created to solve the primary problem of this project. This model was constructed in MS Excel and was provided to the Department of Paraclinical Science to help with future management decisions such as the price setting and budgeting.

By using the financial model the Department of Paraclinical Sciences will benefit greatly. It will now be possible to charge mathematically correct price for services rendered which will allow the Histopathology laboratory can now be run as a sustainable and profitable diagnostic laboratory and is therefore recommend that this project is implemented at the Histopatology laboratory.

## 11. Bibliography

Adendorff, SA and de Witt, PWC 1999. 'Productions and operations management', *A South African perspective*, 2<sup>nd</sup> Edition, Oxford University Press, South Africa.

Alex, MD and Terry, S and Dunn, MD and Brian, BA and McDonald, MD 1995, '*Analysis of Hospital Costs and Charges for Inpatient Surgical Care*', *Anesthesiology*, vol. 83, no. 6, pp1138-1144.

Blank, LT and Tarquin, AJ 2008. '*Engineering Economy*', 5<sup>th</sup> Edition, McGraw-Hill, USA.

Blom, L 2007, '*Development of a revenue management and pricing model for Avis South Africa*', Project Report, Department of Industrial and Systems Engineering, University of Pretoria.

Brezmes, MF 2002, '*Cost Analysis in a Clinical Microbiology Laboratory*', *European Journal of Clinical Microbiology & Infectious Diseases*, vol. 21, no. 8, pp582-588.

Dearden, J 1978, '*Cost accounting comes to service industries*', vol. 56, no.5, pp132-140.

Garrison,RH and Seal,W and Noreen,EW 2009, '*Management Accounting*',3<sup>rd</sup> Edition

Hernandez, S 2003, '*Cost-Effectiveness of Laboratory Testing*', *Journal of Pathology & Laboratory medicine*, vol. 127. No. 4 , pp440-445.

Jacobs, FR and Chase, RB and Aquilano, NJ 2009,'*Operations & Supply Management*',12<sup>th</sup> Edition , McGraw-Hill International, New York.

Kaye, G 1994 , '*Financial Planning Models*', *Construction and use*, 1<sup>st</sup> edition, Academic Press Ltd, London.

Schwarz, E.C and Hall, S.A and Shibli, S 2010,'*Sport Facility Operations Management*',1<sup>st</sup> Edition

Van Sittert, B 2010, '*Financial modelling and price setting strategy for the department of veterinary tropical diseases at the faculty of veterinary science at Onderstepoort.*', Project Report, Department of Industrial and Systems Engineering, University of Pretoria.

Whiteley, J 2004, *Mastering Financial Management*, 1<sup>st</sup> Edition, Palgrave MacMillan, New York.

Wood, S 1985, '*Cost Analysis, Cost Recovery, Marketing, and Fee-Based Services*', *A Guide for the Health Sciences Librarian*, vol. 4, The Haworth Press Inc., New York.