# Cost differential between two similar manufacturing operations in South African and the Czech Republic

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**A consultancy report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Business Administration**

**Johannesburg, [2018]**

# DECLARATION

I, Euclid Convence Nkuna, declare that this consultancy report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration in the Graduate School of Business Administration, University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Euclid Convence Nkuna

Signed at ……………………………………………………

On the …………………………….. day of ………………………… 2018

# DEDICATION

I would like to dedicate this Master’s degree research work – my first – to my father and mother who continue to lead by example. With multiple post graduate degrees behind them, I could not have received better encouragement to pursue this.

# ACKNOWLEDGEMENTS

I would like to acknowledge, most importantly, my supervisor who steered me in the right direction. I would also like to acknowledge the organization's employees – the Director of South African plant especially, who afforded me the opportunity to be its consultant for this insightful business gap. I thank all of the interviewees for taking part and the level of depth to which they each contributed. Lastly, but not least, my father for the fuelling informal chats about research work which kept me going.

# SUPPLEMENTARY INFORMATION

Supervisor: Mrs. Cosmore Pariola

Word count †: 14 998

Supplementary files: Data Collection Instrument: Cover Letter

Data Collection Instrument: Interview Questionnaire

Process Flow Diagrams – Direct and Direct Inter-Company Material Sourcing

Other Appendices

† Includes Executive Summary and References

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# EXECUTIVE SUMMARY

A quest to establish the source of cost differences between two manufacturing plants with similar policies, methods and procedures, product ranges and process, as well as senior management is the focus of this paper. A South African (ZA) plant has been losing business to its Czech Republic (CZ) counterpart on internal bids to supply the Automotive Industry with various components.

The corporation ("the Group") to which the plants belong, is found to have a uniform product costing model ("iCOST") backed by guidelines on what business costs to consider. However, there are no mathematical, scientific or economic methods defined and documented for determining most of the inputs.

Underpinning the study are Accounting Management theories of Management and Cost accounting. In Section 3, various costing methods and techniques are explored – primarily to form basis for the paper but also to give an overview to the reader with little or no knowledge on this specialized field and/or these management theories. Each sub-section concludes with critical questions that eventually form the foundation for data collection.

The data collected – primarily by means of interviews, but also through the use of a reference case study, SAP (the organization's Enterprise Resource Planning system) and various reports including Global Capacity Planning Reports – is presented in Section 4, followed by critical analysis and contrasts with literature in Section 5.

Data reveals how various managers use traditional budgeting methods for departmental budgets which are used for various overheads (OH) costs. Their accuracy levels remain unclear, despite their significance to product cost calculation in the ZA plant where they contribute approximately 20% of the overall manufacturing cost evident on the reference case presented. Between the managers is also a vast difference on the basic knowledge of cost accounting – or even more relevant to them, the cost components used in the organization's iCOST.

Revealed further by the data is how the age of equipment and lack of newer technologies at the ZA plant constrain its productivity by increasing reliance on the human resources operating; and those maintaining the equipment. Furthermore, lack of automation at the ZA plant leads to the need for simulations of manufacturing processes during quotations. Done for cycle time estimations, these simulations arguably result in less accurate values – typically reportedly higher for fear of under-quoting.

The use of replacement values for some categories of machinery for quotation, presents an unintended consequence. A Plant matches this high equipment cost with existing slower manufacturing time, typically from aged machinery, with little or no new technologies, slow and high reliance on human effort. These factors, along with electricity costs (60% higher in ZA than CZ) result in high direct machine costs; which form over 11% of manufacturing costs at the ZA plant.

Due to its location, the CZ plant benefits from economies of scale unlike its ZA counterpart.

Recommendations include equipping managers with basic costing and Better Budgeting knowledge; correct matching of manufacturing times with quoted equipment values and capabilities; and, strategic partnerships to boost economies of scale benefits.

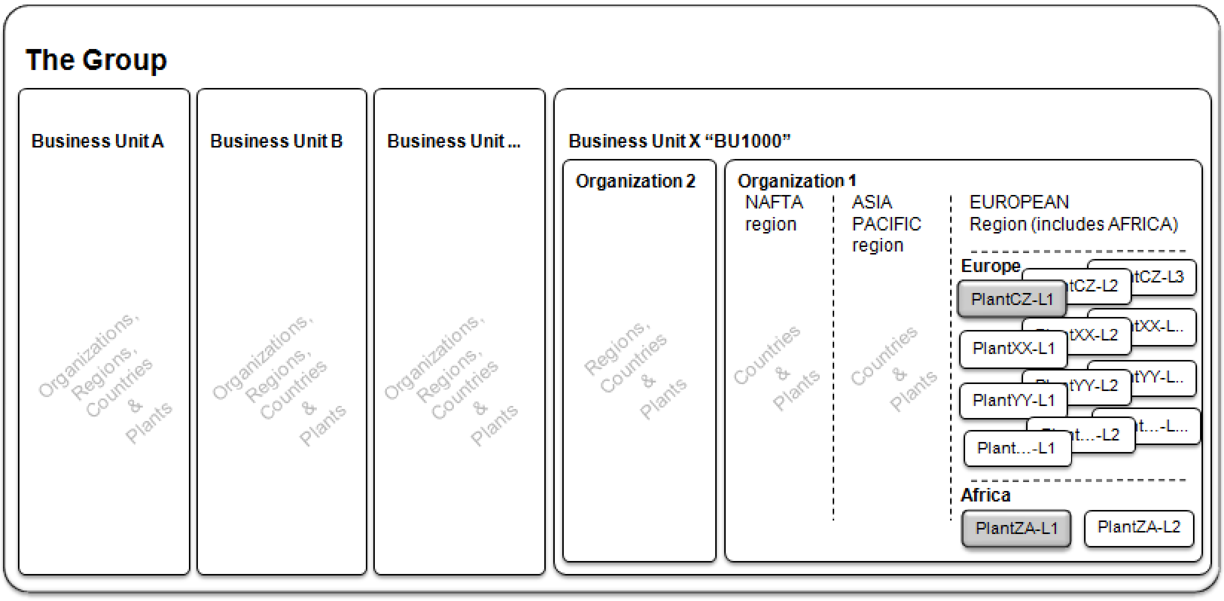
Keywords: Cost Comparison, South Africa versus Czech Republic, Manufacturing Costs, Automotive Industry Manufacturing Costs, 1st versus 3rd World Manufacturing Costs.

# 1 INTRODUCTION

## 1.1 Context

This corporation (the Group – Figure 1) is one of the leading component manufacturers for the automotive industry world-wide. It employs under 90000 employees across a majority of the world's 7 continents (The Group, 2005 - 2017a). It has a world-wide footprint of over 150 production locations backed by more than 10 major research and development centres. These are organized in a number of business units, the X$^{th}$ of which (henceforth referred to as BU1000) houses the plants this paper is about.

**Figure 1:** Structure - the Group

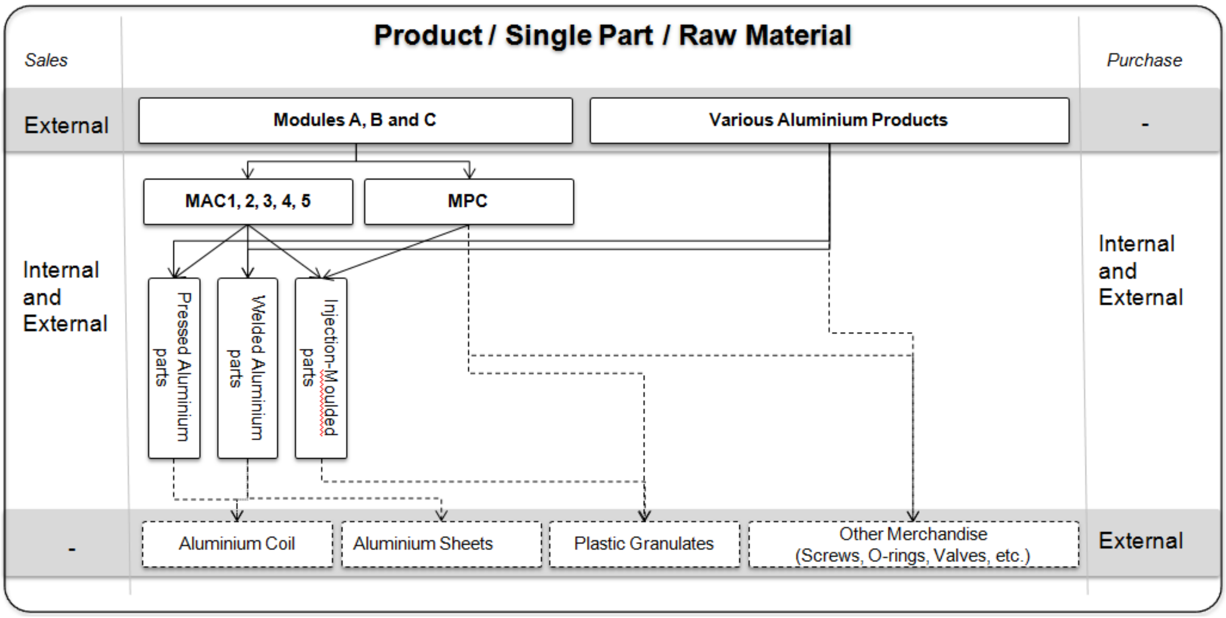



BU1000 consists of two of the Group's recent acquisitions; Organization1 and Organization2; acquired within the past 5 years (TheGroup, 2005 - 2017b). Organization1 operates in 3 regions. Its European region includes Europe and Africa. Africa has two manufacturing plants in South Africa (ZA). We shall call them PlantZA-L1 and PlantZA-L2. Of focus in Europe is only PlantCZ-L1 – one of the 3 plants in the Czech Republic and many more in Europe.

Organization1 produces and supplies three modules (Modules A, B and C) and various aluminium products to the automotive industry.

Modules are made from what will be referred to as Module Aluminium Components (MACs) and Module Plastic Components (MPCs). There are 5 types of MACs. Module A uses MAC1 and MAC5, Module B uses MAC2, MAC3 and MAC4, while Module C only uses MAC4. Most modern passenger cars and all commercial vehicles use Modules A and B.

**Figure 2:** Structure - Product, Single Part & Raw Material




PlantZA-L1 specializes in MAC manufacturing, but is now in the final stages of industrializing its first Module manufacturing, while PlantZA-L2 specializes in Module manufacturing.

The MACs can be traded between the Group's plants; the MAC-producing plants and the Module-producing plants, a competitor's Module-producing plant, or directly with a motor vehicle Original Equipment Manufacturer (OEM).

For every MAC traded as described above, two costing milestones exist within the Group; Acquisition (Quotation) costing and Serial Production costing. Software packages Facton and SAP are used for the former and latter respectively. While their costing models are relatively similar, some of the assumptions used are different.

## 1.2 The Problem and, or, the Opportunity

There is a consistent MAC1 manufacturing cost difference between the two competing plants - PlantZA-L1 and PlantCZ-L1. This difference is approximately €3, -. The difference may be due to cost calculation differences, or manufacturing efficiency differences between the two plants. A combination of the two is also a possibility.

These plants compete due to their relatively similar production capabilities and product ranges. They are both within BU1000 and produce MACs for passenger and commercial vehicles. They also have their own single parts – those used to produce MACs – production facilities (Injection Moulded, Pressed Aluminium, and Welded Aluminium single parts).

The focus of this paper is only on these two internal (within BU1000) competitors. No external competitors (within the Industry) will be considered.

## 1.3 Objectives of this Research Project

The objectives of this project are therefore as follows:

1. Establish the sources of the cost difference between these two plants for the production of MAC1s.
2. Identify opportunities and recommend steps to be taken in order to close the gap(s). PlantZA-L1's MAC1 manufacturing cost reduction by €3, - is the target, which is the more expensive of the two plants.

## 1.4 The Need to Solve the Problem

### 1.4.1 *Employment Opportunities – direct and indirect staff*

MAC1s contribute about half of the MAC production capacity of PlantZA-L1. Of this plant's total production staff of 350, 30% is dedicated to MAC1 production – either directly or indirectly. Loss of this business would disturb the continuous employment of this direct staff. If this loss of business repeats itself frequent enough, some indirect staff members' employment may become unjustifiable, and may be lost.

The above would be tragic, because South Africa suffers from high unemployment rate: 26.7% at the time of writing this report (TradingEconomics, 2018). Moreover, this could result either in employment retrenchments – the 7th highest reason for strikes in South Africa in 2015 and 2016, or unsatisfactory remuneration – the highest cause of labour unrest in the country (Chief Directorate of Communication, 2016).

### 1.4.2 ***Revenue Losses for PlantZA-L1***

If PlantZA-L1 continues to be more expensive and keeps losing the MAC1 business to PlantCZ-L1, it will eventually need to stop producing the product. Assets will be relocated to more cost efficient plants. MAC1s sell for an average price of R460 or €31.23 each. With an annual volume of 200,000, this would result in a revenue loss of R92 million or €6.25 million on an annual basis. This would consequently result in corporate tax revenue losses for the South African government thereby affecting its economic performance.

## 1.5 Breakdown of the problem

Production costs are calculated with 3 main inputs. These are material-related costs, direct resource-related costs, and other costs which include overheads and extra costs. The approach to be adopted is to break these down and understand their elementary building blocks and the assumptions made. There is a need to understand how each of the two plants interpret and make the assumptions.

1. Material related Costs
    a. Direct Material Costs
    b. Material Overheads
    c. Inbound Freight
2. Direct Resource Costs
    a. Direct Labour & Direct Machine Costs
    b. Direct Labour Overheads
    c. Setup Costs
3. Other Costs
    a. Plant Overhead Costs
    b. Extra costs

## 1.6 Limitations and Un-intended Consequences

The limitations lie in the primary data collection method – Interviews. Challenges expected include undetectable information filtering from interviewees. Another limitation is the limited access to crucial documents like financial statements due to this being a private company.

To limit the impact of these, attainable (secondary and tertiary) sources of data will be used for triangulation. These will include presentations, reports and business systems' data.

Further, interviewees will be notified upfront, of the anonymity of their responses, and how they would not be used for performance evaluation and/or incentivising.

Un-intended consequences could be a possible breach of the local and international competition laws by disclosing sensitive information that may compromise competitive behaviour. For this, the organization's legal department will be contacted for clarity and assistance.

# 2 LITERATURE REVIEW

## 2.1 The review approach

Theory on the relevant topics will be explored, drawing on what has been written about them in the public domain. Topics and sub-topics, where relevant, will end with a critical question for the plants under study. These will then form the foundation for the investigations done for this paper.

## 2.2 Introduction

The theoretical foundations of this research are the Management and Cost Accounting sub-branches of the accounting discipline (Accounting For Management, 2012 - 2017). However, great emphasis and in-depth analysis will be on the latter, due to the nature of the problem; it is primarily a manufactured product costing problem.

Within Cost Accounting, different costing theories will be explored with the aim of ultimately settling on those utilized by the case organisation. The depths of the ones utilized will be critically researched in order to understand the extremes of their application within a product manufacturing context.

## 2.3 The Topic and its Background

This research shall be titled:

"*Cost differential between two similar manufacturing operations in South African and the Czech Republic*".

## 2.4 Management Theories: Management and Cost Accounting

### 2.4.1 *Management Accounting*

Management Accounting is a branch of accounting that is concerned with providing information for management, i.e. planning, controlling and making decisions, of an organization (Lal & Srivastava, 2009). Under management accounting is a wide scope of accounting system according to, among many, Lal and Srivastava (2009) and Debarshi (2011). *Financial Accounting, Cost Accounting, Forecasting and Budgeting, Statistical Tools,* as well as *Financial Analysis and Interpretation* are some of the accounting systems included within Management accounting further attest the authors.

### 2.4.2 ***Cost Accounting***

In Management Accounting, Cost Accounting is primarily responsible for providing information on *product costing* and *performance* (Khan & Jain, 2000). Drury (2008) defines it as cost accumulation with the aim to establish and report the value of inventory externally, and to measure profit internally. The two definitions above are very much in line with each other and will be adopted for this study. In essence, they are both understood to refer to the *planning, collection, storage* and *analysis* of costs accumulated as a result of business activities, for internal and external reporting.

## 2.5 Manufactured Product Costing

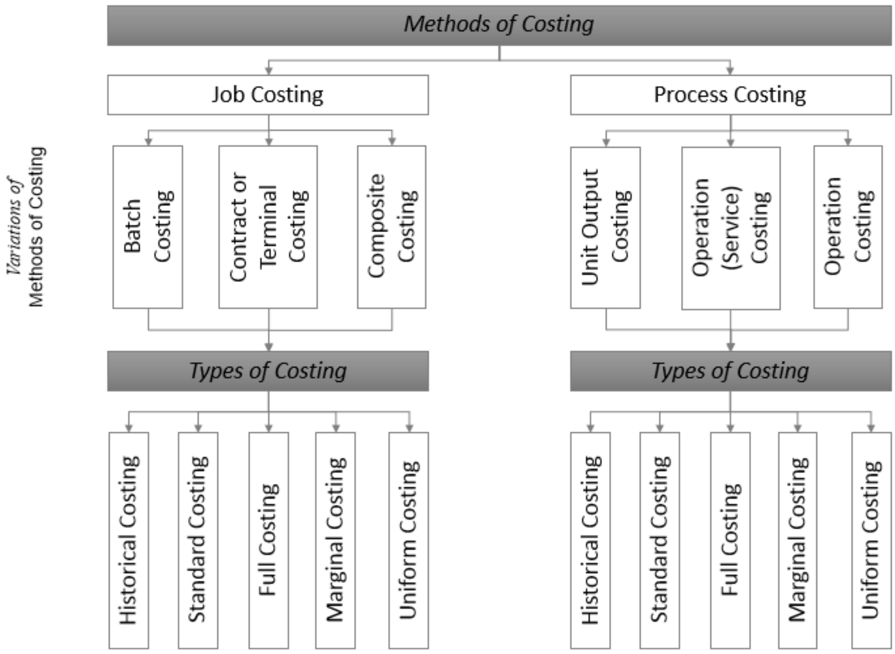
The sub-section above gave context to what part of business this study focuses on. This sub-section delves further into that sub-section of cost accounting as it relates to manufactured product costing.

Lal and Srivastava (2009) clarify the word '*costing*' by defining it as techniques and processes of establishing costs incurred by rendering a service or producing a product. These authors affirm, along with Murthy (1964) and Drury (2008), that products can be costed in different ways; but they bring some clarity to the environment of the intermingled and somewhat intimidating terms associated with the word '*costing*' in cost accounting.

Firstly, they define *Methods of Costing* and *Types or Techniques of Costing* before illustrating their relationship. There are two *Methods of Costing*, and at least five *Types of Costing*. The former are merely methods of ascertaining costs to a product or a service, while the latter bring to light the techniques of cost ascertainment used under the selected specific method. It is further denoted that the methods mentioned above have several variations (Murthy, 1964; Drury, 2008; Lal & Srivastava,2009).

Figure 3 below shows these two distinctions – *Methods* versus *Types (Techniques) of Costing* – as well as their relationship. Also depicted on the figure are the three variations that each method can have (Lal & Srivastava, 2009).

**Figure 3:** Method and Types of Costing according to Lal and Srivastava (2009, pp. 13-15)




While the authors above bring a clear structure, there is a wide mention of other concepts associated with the word costing. These include Activity Based Costing, Target Costing and Parametric Costing to mention a few.

### 2.5.1 ***Methods of Costing***

#### ***2.5.1.1 Job Costing***

Job costing is utilized when products are made to order. This can be for immediate sale, stored finished products, or work in progress. According to Drury (2008), direct costs and overhead costs are allocated to the individual units, adding that this is done because costs of the units produced normally require different amounts of labour, material and overheads. Below are the variations of this method (Khan & Jain, 2000; Drury, 2008; Lal & Srivastava, 2009)

**Batch Costing**

This variant is applied when a group of similar products are produced on the same process. The cost is expressed per group of products produced (batch), not a single product.

**Contract Costing**

This variant is normally used for a big project or contract, which normally extends over a long period of time. All direct costs are booked to the contract account, while the overheads are apportioned to the contract accordingly before being booked to the account.

**Composite Costing**

Lal and Srivastava (2009) and Bhar (2008) express that this variant is one where the product is of relatively higher complexity. Individual components are costed separately and the cost sums are composed together to form the final complex product's.

#### *2.5.1.2 Process Costing*

This is for mass and continuous flow production where costs are determined by averaging all steps' costs as they are untraceable to a single unit.

The following are its variants as widely explained by Khan and Jain (2000), Bhar (2008), Drury (2008) and Lal and Srivastava (2009)

**Unit Output Costing**

The total cost of a product or service is a whole of identical, homogenous units. This cost, attained by taking an average of a series of production processes costs, is divided by the number of the single, identical homogenous units in order to arrive to the final single unit cost.

**Service Costing**

This is used in service industries where no physical products are produced. The total cost is calculated by finding the quotient of the total cost incurred and the desired costing unit's (e.g. hour, minute, kilometre, etc.) quantity.

**Operation Costing**

In Operation costing, the final product/service – the output – is normally attained through a series of interconnected but different operations. Here, the cost of each operation is of interest, as opposed to the cost of a process.

> **Critical Question:**
>
> *Exactly which of the two methods and variations do PlantZA and PlantCZ use? If they use same method and variations, then do the cost-calculating employees understand and apply them the same way?*

### 2.5.2 *Types (Techniques) of Costing*

#### *2.5.2.1 Historical Costing*

When costs of a product or service are determined after they have happened, the technique is called Historical Costing (Debarshi, 2011).

#### *2.5.2.2 Standard Costing*

In some instances, it is found to be necessary to establish standard costs based on the most efficient process and optimal utilization of resources (Khan & Jain, 2000). Actual costs are then measured against these standard costs, and management then uses this information to initiate appropriate steps (Lal & Srivastava, 2009).

#### *2.5.2.3 Full Costing*

Also referred to as absorption costing, this is used for external reporting under the Generally Accepted Accounting Principles (Weygandt, Kimmel, & Kieso, 2009). Here, all costs are charged to the saleable units of the organization. The costs include both variable and fixed costs according to Khan and Jain (2000), Bhar (2008), and Lal and Srivastava (2009).

#### 2.5.2.4 Marginal Costing

Also referred to as *Variable Costing* and as implied in this alternative name, this only considers variable costs. Weygandt, Kimmel, and Kieso (2009) explain that fixed manufacturing overheads are considered period costs or expenses, unlike on full or absorption costing where they are considered product costs.

#### 2.5.2.5 Uniform Costing

Lal and Srivastava (2009) argue that this is not a costing technique, but an attempt to use a similar costing methodology across the organization. Khan and Jain (2000) add that this standardisation includes which accounting standards, costing, and cost centre overhead allocation methods employ.

#### 2.5.2.6 Direct Costing & Activity Based Costing (ABC)

According to Khan and Jain (2000) and Bhar (2008), Direct Costing apportions only the direct costs to the products and services sold by an organization. All indirect costs are allocated to the Profit and Loss account.

ABC is a fairly new type of costing technique (Turney, 2010). It allocates costs to products using cost drivers and this is done by examining the benefit linked to various activities – indirect activities specifically (Bhar, 2008).

> **Critical Question:**
>
> *With all of these costing techniques, some constituting more cost components than others; do PlantZA and PlantCZ use the same techniques? If affirmative, then, are the components well understood and applied the same way? Is the existence of iCOST enough to assume 100% uniformity?*

### 2.5.3 Elements / Components of Cost

Drury (2008) distinguishes cost components into *Direct Material*, *Direct Labour*, *Prime Cost* and *Manufacturing Overhead*. While Lal and Srivastava (2009) add, *Selling*, *Distribution* and *Administrative Overheads* to these, Drury (2008) argues that they are all dependent on the cost objective. On the same note, we see Khan and Jain (2000) limiting it to only three: omitting *Prime Costs* and classifying *Sales and Distribution* as charges under *Overheads*. There is clearly a large scope for classifying and interpreting the components of costing. Let us gain deeper understanding of each:

#### *2.5.3.1 Direct Material Cost*

According to these authors, these are the costs that can be directly attributable to being part of a product. Indirect material costs form part of manufacturing overheads.

#### *2.5.3.2 Direct Labour Cost*

This is the labour that is directly attributable to the manufacture of the product. This does not include any support functions' labour. Indirect labour costs form part of manufacturing overheads according to the authors above.

#### *2.5.3.3 Prime Costs*

These are the costs incurred to manufacture a specific product, but are neither direct nor indirect materials, neither direct nor indirect labour.

#### *2.5.3.4 Manufacturing Overhead Costs*

These are combinations of all indirect costs in the manufacturing plant – both material and labour, as well as the costs of all other non-production related activities if the organization. Khan and Jain (2000) add Sales and Distribution charges to this component.

#### *2.5.3.5 Sales, Distribution and Administrative Overheads*

These are the expenses that are incurred post the manufacturing; where the factory cost cease to increase (Lal & Srivastava, 2009). The authors add that the administrative costs include aspects like rental, board of Director's fees, etc.

> **Critical question:**
>
> *How do the case Plants' employees select these, evaluate them and put a cost against them? Do they do these in a uniform way or is there any variation? If there are variations, then to what extent?*

The overheads seem to be quite varied from author to author. Below, we explore this topic more.

#### 2.5.4 ***Manufacturing Overhead Cost***

Overheads are predetermined and are always based on estimations (Weygandt, Kimmel, & Kieso, 2009). According to these authors, the predetermined overhead rate is based on estimated annual overhead cost and expected annual activity.

Categorized into *Blanket (Single) overhead* and *Multiple overhead rates*, Bhar (2008) argues that the latter is a more accurate way of ascertaining cost to products. He explains that the former looks at the whole plant and is better and acceptable for smaller organizations where a single product is produced, while the latter looks at multiple departments in a larger organization, and therefore allows for better accuracy. Along with Turney (2010), Bhar (2008) advocates for the use of ABC to more accurately calculate overheads.

In his work, Bhar (2008) further discusses how overheads can have different absorption rates based on different merits.

> **Critical Question:**
> *With all of these possible variations or merits, is there likelihood that different Plants interpret and ascertain costs differently?*

## 2.6 Prior Research

A similar research to this has been conducted before, covering the fast-growing economies of India and China. A paper about manufacturing cost competitiveness in China and India by Van Ark, Erumban, Chen, and Kumar (2008), outlines the comparison of productivity, labour cost and industry level competitiveness between the two (2) countries.

Although quite expansive on the sectors covered, it is relatively narrow on its focus being *labour cost and productivity*. Its major finding is that despite higher levels of productivity, higher compensation rates left China in a less competitive state than India. Another significant finding was the levelling out (becoming similar) of unit labour rates over time between the two (2) countries.

With that in mind, it is noted that, between 1997 and 2017, South Africa has had a faster increasing rate of remuneration compared to Czech Republic. By March 2017, it had reached 145.3 index points up 105.6 from 39.7 in 1997 (TradingEconomics, 2017a). Czech Republic had only increased by 47.93 index points to 113.13 from 65.2 over the same period (TradingEconomics, 2017b).

> **Critical Question:**
>
> *Could these higher index points in South Africa be linked to the less cost competitiveness of PlantZA-L1 from a costing point of view? Could South Africa, therefore on a macro level, be becoming more expensive?*

Another similar research is one done by Hoste (2017), about Pig production cost comparison internationally. It established that the Netherlands was more expensive compared to its Western European counterparts by between €0.15 and €0.20 per unit output. This reportedly worsening position of the Netherlands over the years was due to input costs such as labour, manure disposal services, and sow performance – all of which were increasing. It was reported, however, that it maintained a relatively more favourable cost position for piglet production compared to many countries, although less so with Germany.

More importantly for this paper, the report outlined the difficulty of conducting an international cost comparison owing to differences in many things including calculation methods.

In another study, Hinze (1998) highlights one of these problems related to international labour cost comparisons. He highlights how in national currencies of the countries under study, the labour rates show certain trends while when converted to one currency, the trends could be completely different.

> **Critical Questions:**
>
> *For the case Plants, could there be some differences not yet understood between their costing methods/calculation since they are found in different countries in line with the finding by Hoste* (2017)*?*
>
> *Based on Hinze* (1998) *should the study choose one currency – EURO or ZAR – to get a consistent comparison?*

# 3 DATA COLLECTION AND ANALYSIS PLAN

## 3.1 Paradigm and Methodological Approach

The nature of the study is a comparison – the first case being PlantZA-L1 and the second one being PlantCZ-L1.

Organization1 has a common and standardised costing model called iCOST (The Group, n.d.). This model is utilized across all plants. Secondly, the fact that software packages are used for the costing exercises, it is expected that either the inputs into the software packages are different, or that there is a lack of common understanding of the inputs into the software by the responsible personnel.

The approach taken for this study will therefore largely be a qualitative analysis, but may, to some extent, may include some quantitative analysis.

## 3.2 Data Collection Instrument

The most effective way to collect data will be interviews with various personnel that have some form of contribution to the inputs of the costing model. Research reveals a number of potential pitfalls for doing interviews, and below are some of them as presented by Boyce and Neale (2006), and how their impact will be minimized for this paper.

Interviews are *prone to interviewee bias* depending on their relationship with the topic. To limit this, examples for responses given will be requested for in order to ensure veracity. Secondly, the authors report that interviews *can be time consuming.* To limit this, interviewees will be sent questionnaires upfront. Another limitation is the *lack of generalizing ability* of the results. That is not the aim of this research and is therefore not a concern. Finally, the authors highlight that the *interviewer must be appropriately trained*. They must avoid leading questions for example, and keep the interviewee interested.  I am trained as an interviewer and have, in my leadership roles, conducted several interviews. This minimizes this pitfall.

## 3.3 Data Collection at Case Sites

The interviewee list will consist of only Organization1 employees working at the case plants. This is because of the conjecture that possibly the inputs into iCOST are different, and/or that these users could be using it differently. Between the two plants iCOST itself is uniform.

## 3.4 Schedule of Interviewees

This is a dual-case study, solving a specific problem, within a specific organization. The interviewees will be the departmental decision makers and employees responsible for, or closely supporting the costing process.

The interviewees will primarily include the Acquisition, Finance and Controlling departmental personnel. For supporting information, the Plant Managers (being key decision makers) and supporting departmental personnel may be interviewed if necessary. Such departments will include Logistics, Purchasing, Maintenance, Industrialization and Human Resources.

**Table 1:** Schedule of Data Collection Interviewees: Primary and Secondary

| Case Sites | Interviewees' Departments | Possible Interviewees | Interviewee Count per Plant |
|---|---|---|---|
| **PlantZA-L1 & PlantCZ-L2** | Finance and Controlling Department | Departmental Head | 1 |
| | | Departmental Employees | 1-2 |
| | Acquisition Department | Departmental Head | 1 |
| | | Departmental Employees | 1-2 |
| | Plant Managers | Plant Manager | 1 |
| | Other (Supporting) Departments | Purchasing Department | 1 |
| | | Logistics Department | 1 |
| | | Maintenance Department | 1 |
| | | Human Resources Department | 1 |
| | | Industrialization Department | 1 |

## 3.5 Participation from Interviewees at Case Sites

PlantZA-L1 is the initiator of this study. Little effort to convince its employees to participate and answer the questions as truthfully as possible will be required. The interviewees will be made to understand the urgency and the need to have this study done and concluded as accurately as possible. A letter (appendix A1) will be used to get the PlantZA-L1employees to participate.

For PlantCZ-L1's employees, more effort may be required. Their plant benefits from the current situation and the success of this study may compromise their plant's competitive position. For this reason, a need to get the two (2) sites' directors to speak first and gain common understanding of the situation presents itself. Secondly, these directors are to relay the message to their plant managers and eventually to the departments in which personnel to be interviewed work.

Questions will be sent to them well in advance of the interviews. First priority would have been to interview them face to face in Czech Republic in order to optimize engagement, build rapport and maximize interviewee buy-in. However, most research works show that the telephonic mode of interview chosen returns similar results. Sturges and Hanrahan (2004) demonstrated this on their study.

Since the interviews with PlantZA-L1 participants will be face-to-face, this mode will be the preferred one for PlantCZ-L1 participants' as well. If not possible, then telephonic interviews, probably with video, will be used, but with strategies proposed by Farooq and De Villers (2017) for successful telephonic interviews.

Some positives in using telephone interviews are mentioned to include better time and monetary resource utilization (Sturges & Hanrahan, 2004). Farooq (2015) argued that despite conventional thinking, this mode could suitably create rapport and help maintain power balance and reduce bias between the interviewer and interviewee.

## 3.6 Reliability and Validity

In order to ensure both reliability and validity of the data collected, the following steps will be taken:

### 3.6.1 ***External Validity***

With this being a consultancy case study, limitations to qualify the external validity generally exist. The results will only be specific to the scope of this project, and within the Organization.

### 3.6.2 ***Internal Validity***

#### ***3.6.2.1 Content of Face Validity***

In order to ensure face validity, the entire scope of manufactured product costing will be explored. This will cover the same scope as the literature review above.

#### ***3.6.2.2 Predictive Validity***

The result of this work will be applied to at least one (1) other product produced by both plants in order to qualify its Predictive validity.

### 3.6.3 ***Reliability***

A similar interview method will be used, ideally face to face, with questionnaires as an alternative. A pilot study (test interview) will be done with at least one (1) employee from two (2) of the relevant departments.

# 4 DATA COLLECTION RESULTS

Critical analysis and contrasts with theory and/or best practice, as well as discussions, significance and implications of significant findings will be discussed in for Section 5. This Section will *only* present the findings of the interviews, starting with the interviewee demographics on table 2 below.

**Table 2:** Interviewee Demographics

<table>
<tr><th>Case Sites</th><th>Interviewees' Departments</th><th>Possible Interviewees</th><th>Years Current Job</th><th>Years Similar Job</th><th>Formal Costing Education</th><th>Informal Costing Education</th></tr>
<tr><td rowspan="8">MBZA-DU & MBCZ-O</td><td rowspan="2">Finance & Controlling Dept.</td><td>Departmental Head</td><td>4</td><td>4</td><td>Yes</td><td>Yes</td></tr>
<tr><td>Departmental Employees*</td><td>4</td><td>1</td><td>Yes</td><td>Yes</td></tr>
<tr><td rowspan="2">Acquisition Department</td><td>Departmental Head</td><td>5</td><td>6</td><td>No</td><td>Yes</td></tr>
<tr><td>Departmental Employees*</td><td>5</td><td>2</td><td>No</td><td>Yes</td></tr>
<tr><td rowspan="4">Other (Supporting) Departments</td><td>Purchasing Department*</td><td>3</td><td>6</td><td>No</td><td>Yes</td></tr>
<tr><td>Logistics Department*</td><td>9</td><td>20</td><td>No</td><td>No</td></tr>
<tr><td>Maintenance Department*</td><td>11</td><td>15</td><td>No</td><td>No</td></tr>
<tr><td>Industrialization Department*</td><td>3</td><td>2</td><td>No</td><td>Yes</td></tr>
</table>

*Average

## 4.1 Product Costing at Organization1's Plants

Organization1 uses its own in-house developed costing model called iCOST (The Group, n.d.). In this model, the costing method variant used is *Batch Costing*. While the technique (type) used is *Standard Costing*. Costs are calculated based on best expected purchase prices for material, and the most efficient manufacturing times. On a monthly basis thereafter, actual costs are compared to the set standard costs. Further, the Organization uses *Multiple Overheads*. Table 3 below shows various cost components of the iCOST model.

**Table 3:** iCOST Manufacturing Cost Components

| Direct Costs |
|---|
| Direct Material |
| Direct Material IC |
| Direct Labour |
| Direct Machine |
| **Overhead (OH) Costs** |
| Direct Material OH |
| Direct Labour OH |
| Plant OH |
| **Other Costs** |
| Inbound Freight |
| Direct Setup |
| Extra Costs |

Although these cost components are standard and ought to be adhered to by all BU1000 plants, there is no prescription on formulae to be used to quantify each. Existing is a limited and interpretive guide on what business costs are to be allocated under each cost component.

These guideline are documented in two documents – the Guideline for Product Calculations (The Group, personal communication, January 2018) and the Management Accounting Guidelines (The Group, personal communication, January 2018).

## 4.2 Direct Material Costs

### 4.2.1 *PlantZA-L1*

Every product's *direct material* costing process starts at its quotation (a.k.a. Project Acquisition) phase. Spearheading it is a representative of the purchasing department – the Project Buyer. Refer to appendix B.

#### *4.2.1.1 Data Gathering*

The first step is the collection of all relevant data about the product being costed. A bill of material (BOM) is the basis for this exercise. It disintegrates the final product into its building blocks; *subassemblies*, *single parts* and *raw materials* (Monahan, 1995). In addition, it specifies quantities of each of those building blocks, as well as their assembly relationships.

Organization1 sources its *raw materials* externally – that is, from outside the Group. There is typically nothing more than just quantifying their required amounts post identification in the BOM. The buyer merely records these required amounts and keeps the list aside for usage later.

*Single parts* from the BOM generally require a little bit more scrutiny than *raw materials*. This is because PlantZA-L1 has capability to produce some of them. Examples of these are plastic injection-moulded parts, welded- and pressed aluminium parts. For this list of *single parts* therefore, the buyer is required to perform a "Make-

Or-Buy" decision. If PlantZA-L1 is not able to produce the particular *single part* in-house – either due to limited resource capacity or due to the limitations on its capabilities – the buyer makes a decision to buy. However, if the plant subsumes both capability and capacity, the buyer and the quotation leader trigger the process to establish costs of making the *single part* in-house.

On the other hand, whether PlantZA-L1 is able to make the part in-house or not, the buyer adds the *single part* to the list of parts to send Request for Quotations (RFQs) for.

The *subassemblies* get an even more intense scrutiny. This starts with a "Make-or-Buy" decision. If the quotation team is of the view that the *subassembly* can possibly be made in-house, both capacity and capability are checked. However, since *subassemblies* are made typically from any combination of *single parts* and *raw materials,* a decision to make them in-house requires that they be broken down into their building blocks. The resulting *single parts* and *raw materials* are then treated as described above.

If, however, a decision is taken for the *subassembly* to be purchased – resulting typically from the knowledge that PlantZA-L1 is either incapable or lacks the capacity to make it in-house, the *subassembly* in question is then entered into the list for RFQ.

Finally, depending on the timeframe within which to handover the costs, the buyer decides, for all items in the RFQ list, whether to request for official quotations from suppliers or to estimate the costs on their behalf. The first three (3) of the four (4) sub-sections below explain the former case, while the last explains the latter.

#### *4.2.1.2 The Request for and Receipt of Quotations*

*Pool4Tool* is a web-based platform used to request for quotations from the suppliers. Suppliers each receive a notification when a new request for quotation is loaded. The information entered on *Pool4Tool* as part of the RFQ includes

> Project Start and End dates
> Project Exchange Rate (for imported materials)
> Contract volumes/quantities of goods concerned

> Technical specification for the material

The suppliers respond by filling in a cost breakdown (CBD) sheet, which ultimately becomes the quotes submitted back to PlantZA-L1. PlantZA-L1 then receives a notification once the quotations are ready for viewing on *Pool4Tool*.

#### *4.2.1.3 Review of the quotation*

On receipt of the quotation, PlantZA-L1's buyer reviews it, verifying that all information provided has been correctly captured.
During this process, the buyer also performs a crucial step; A critical evaluation of the extent to which the quoted prices are realistic. This benchmarking exercise as it is know within PlantZA-L1 requires the buyer to:

> Compare previous quotations of a similar material by the same supplier,
> Critically analyse and compare cost components from all suppliers:
- quoting on similar material against each other,
- against internally-computed costs for materials that PlantZA-L1 has similar capability (but lacks the capacity) to make in-house,

> Check for any "*muda or waste*" built into the quotations.

In the cases where the buyer finds some aspect of the quotation to be incorrect, inaccurate, unreasonable, etc., the quoting party is contacted and a request for rectification is requested. This step is repeated until satisfactory results are received. PlantZA-L1 also engages in deep negotiations with the target quotation reduction of *3*%.

#### *4.2.1.4 Submission of quotations for Product Costing*

The buyer supplies the final and best quoted prices to the product cost-calculating department. The prices are submitted as finally agreed with the supplier without modification.

#### *4.2.1.5 Estimating the material costs*

When the costing timeframe does not allow for the lengthy official RFQ process detailed in the three sub-sections above, the buyer resorts to material purchase prices estimation.

Having established the requirements for the materials already, the buyer completes the CBD sheets on behalf of the suppliers. The buyer then submits the estimated prices to the product cost-calculating department.

#### *4.2.1.6 Key Notes – Direct Material*

> The lower the volume, the higher the quoted price.
> Negotiations are sometimes not possible if the material is already supplied to another plant within BU1000.

### 4.2.2 *PlantCZ-L1*

Similar to PlantZA-L1, the Project Buyer takes over the role of sourcing the material for manufacturing the product.

The process flow followed is largely the same in both plants. Starting with data gathering, the BOM is disintegrated, analyzed and Make-or-Buy decisions are made.

*Pool4Tool* is also utilized for the requests and receipts of quotations. The quotations are scrutinized for opportunities for quoted-price-improvement and a decision is taken which supplier to go with.

At this plant, however, the interviewee reported no need for the estimation of quotes due to the lack of time. It was explained that the turnaround time for quotations was about 24 hours at most. The significance of this is scrutinized in Section 5.

Once complete, the buyer supplies the final and best quoted prices to the product cost-calculating department.

## 4.3 Direct Inter Company Material Costs

For this section, please use appendix C for reference.

### 4.3.1 *PlantZA-L1*

This is the type of material that is sourced from within the Group – predominantly from within BU1000 for PlantZA-L1. This becomes the case when capability elsewhere within the Group to manufacture the material required exists; or when another plant already sources the material and PlantZA-L1 can, for one (1) or many reasons, get it cheaper inter-company than directly from the external supplier.

This process starts with a number of critical questions. If the answers to those critical questions end up in favour of the material being sourced inter-company, then that is the way PlantZA-L1 precedes.

#### *4.3.1.1 Critical questions prevailing to the decision to source inter company*

The first critical question asked is whether the project being purchased for is a transfer project from another BU1000 plant (to PlantZA-L1) or not. If it is not, PlantZA-L1 simply initiates the process of sourcing the component inter-company. This is presumably because the assets utilized for the manufacture of the material are already/still under obligation for other products to other customers from the plant which PlantZA-L1 will source. However, in the case where the project is being transferred, the next critical question is asked.

This next (second) critical question is if the remaining volume for the project is enough to justify a transfer of the asset(s) that produces the material or not. The volume threshold is not defined in the Group’s policies according to the interviewee, but very much depends on whether those units can absorb the cost of asset transfer without compromising the desired profitability. If the remaining quantities are not enough, then, again, the PlantZA-L1 team simply initiates the process of inter-company sourcing. However, if the quantities are enough and a payback is possible without affecting profitability, then the next critical question follows.

The third critical question asked is if the asset – predominantly a tool, but at times also a machine – is under obligation to fulfil other orders other than the ones of the transfer project PlantZA-L1 is costing for. If affirmative, then PlantZA-L1 culls the process of investigating feasibility to import the asset and initiates the process of inter-company sourcing. If not affirmative, however, the last critical question is asked.

The last critical question seeks to establish if PlantZA-L1 has both the capacity and the capability to utilize the asset for manufacturing the material required. If it lacks both, it is immediately investigated if the capacity or capability - whichever it lacks - can be created within an acceptable amount of time – that is, enough to meet the required start of production date milestone.

Uniquely for this last critical question, whether the answer is in the affirmative or not, the process of inter-company pricing is initiated.

If the outcome is in the affirmative – meaning that PlantZA-L1 posses both capacity and capability or can, within an acceptable timeframe, create what it falls short on – then costing for the manufacture of the part within PlantZA-L1 starts straight away. Kept aside, the results of this are later compared with the quotation of sourcing the part inter-company.

#### *4.3.1.2 The Request for and Receipt of Quotations*

Post the series of critical questions above, the buyer takes over from the point of requesting for quotes from the supplying plant. An RFQ is issued via *Pool4Tool* and within a predefined timeframe – typically a week – this quoting plant returns with a quote.

The quoted amount, according to the Groups' inter-company quoting policy is always the cost of manufacturing the material inflated by a pre-defined percentage. This percentage is standard across all BU1000 plants when they trade with each other, and we shall simply call it IC%. Over and above this inter-company price, the receiving plant (PlantZA-L1) has to factor in the cost of packaging and shipment. Although, as will be seen in one of the sub-sections below, these packaging and shipment costs are not supplied to the acquisition department for costing, they are necessary to include at this point to attain the true cost of souring the material inter-company versus getting it from an external supplier.

#### *4.3.1.3 Review of the quotation and decision*

Post receiving the quote, what follows is a critical review of the same in order to ascertain that all quotation criteria have been adequately satisfied. "There is very little room for negotiation on this type of quotation for PlantZA-L1." Once all rectifications are done, the following are added to the costs received from the inter company supplier:

> Packaging costs (from industrial engineering)
> Freight costs (from logistics)
> Duties and taxes, if applicable (from the finance department)

The acquisition team then sits and compares the quotation results to the PlantZA-L1 in-house manufacturing option (if applicable). It concludes by accepting the more cost effective option as the way forward.

In the case that the PlantZA-L1 team chooses that the material be manufactured in-house, it immediately initiates the process of transferring the asset as well as building capacity and/or capability if applicable. However, if the team chooses rather to source the material inter-company, it notifies the supplying plant of the decision to award the business to it.

#### *4.3.1.4 Submission to Acquisition for usage in product costing*

If the team decides to go with the inter-company-sourced material option, then the purchasing responsible person submits the value that is to be used in product costing. This value is as described in the sub-section above, but without the logistics costs. The reason for this is that the team treats all logistics costs for bringing all material in from any supplier as overheads named *inbound freight*. Inbound freight has a section dedicated to it because it is a major component of the iCOST model, and will be discussed as a sub-section of its own in this chapter.

### 4.3.2 ***PlantCZ-L1***

This process is also quite similar to the PlantZA-L1 way of doing things. This is because the process is standardized in order to ensure that material is primarily sourced from within the business unit (or the group) before any external supplier is considered, but only if it is economically beneficial for Organization1.

Rather different from PlantZA-L1 however is the presence of a higher proportion of material sourced inter-company compared to those sourced from an external supplier. Section 5 explores the significance of this further.

## 4.4 Direct Labour Costs

### 4.4.1 *PlantZA-L1*

Direct labour cost is a very simple calculation. It is a product of two items – the total *labour time* it takes to manufacture a product, and the *labour rate*.

#### *4.4.1.1 Labour time calculation*

The *labour time* is a number extracted from the routing of the product whose product cost is being calculated. This differs per product – even when products are produced within the same manufacturing line.

*Labour time* is a measure of the amount of human time required to manufacture the product. This study is performed by a specific discipline – Industrial Engineering – within PlantZA-L1.

At product acquisition / quotation stage, the industrial engineering team members use various means to arrive to the labour time. Typically, they:

- Either use a similar existing product's labour time (usually already in SAP)
- Or perform time studies on a simulation of a proposed process to be industrialized for the manufacture of the product and its required in-house-produced material if applicable.

The team performs time studies using one of two methods – *Observation & Stopwatch Timing Method* or *Method Time Measurement* (MTM). Competency at PlantZA-L1 is for either the former solely, or both.

#### *4.4.1.2 Labour Rate calculation*

Briefly, this is calculated by taking the weighted average of hourly labour rates of all employees within each manufacturing area. These hourly rates are received from the payroll department. Depending on the time of the year they are received, they may or may not have the annual increases already built in. In the case that they do not, the person responsible for calculating the labour rate inflates all hourly rates received by the planned annual increases before calculating the weighted averages.

The weighted averages for all manufacturing areas are then averaged, and the result used as the labour rate for product costing at a quotation stage.

### 4.4.2 *PlantCZ-L1*

Just as in the case at PlantZA-L1, the inputs for this calculation are also *labour time* and *labour rate*. However, the interviewee/s provided information that direct labour did not include only internal employees, but externally sourced labour.

The split between the two (2) was reported to be 1:3. or 33% external to 66% internal labour. The planning of the 66% labour is done at head office by the central planning department, and the 33% managed at the plant.

The labour rate used in the product cost calculation is not distinguished between internal and external employees according to the interviewee/s.

#### *4.4.2.1 Labour time calculation*

There are however, some subtle differences when it comes to quantifying the amount of *labour times* during the acquisition phase. PlantCZ-L1 has quite a wide customer base for each type of MAC it produces. For this very reason, it usually has an existing product model similar to the one being quoted for. This makes the estimation of production times less cumbersome and much more accurate. There is hardly any simulation ever necessary.

Moreover, the amount of *labour time* required for workers to interact with the machine is hardly dependent on the characteristics of the product specification. This is because of the higher level of automation on the majority of its machinery. Workers are mostly required for the minimal tasks of loading material onto the machine and removal of the manufactured component. Another common task is merely starting a cycle for the machine to manufacture something.

#### *4.4.2.2 Labour Rate calculation*

The calculation of this rate is similar in both plant – owing to the process being centrally specified by head office and its inputs being straight forward.

## 4.5 Direct Machine Costs

### 4.5.1 ***PlantZA-L1***

Direct machine costs are also straightforward at a glance. They are simply a product of two inputs – *machine time* and *machine rate*. However, the latter is slightly more cumbersome to arrive at. Below we explore each of them in depth.

#### ***4.5.1.1 Machine time calculation***

This input is the cycle time of a product through a manufacturing line. The manufacturing line may consist of multiple machines and the product may require different amounts of time on each as it goes through the various steps of manufacturing. However, none of that is considered. Only the cycle time though the manufacturing line is used as the machine time.

At acquisition stage, the industrial engineering team uses various methods to arrive at the cycle time, depending on the information at hand. These methods have different levels of accuracy. Below are the methods used presented in order of their accuracy and preference:

> Use of similar existing product's machine times (usually already in SAP).
> Time studies execution on a simulation of a proposed process to build the product, through MTM or stop watch time studies.

#### ***4.5.1.2 Machine Rate Calculation***

The calculation of *machine rate* has a somewhat higher level of complexity. To get the overall machine rate, a number of inputs associated with the manufacturing line concerned are entered into the machine rate function. These inputs are sourced from different departments of the organization. While the actual formula of the *machine rate* will not be disclosed, some of the most important inputs will be discussed below.

##### 4.5.1.2.1 Depreciation

One of the major inputs on the *machine rate* function is depreciation of the assets used in the manufacturing line of concern. PlantZA-L1 depreciates assets using the straight-line method over the useful life of the asset. Factored into the calculation are all depreciable assets already within, and those planned to be introduced to the manufacturing line within the period the calculation will be valid for.

The useful life periods of the assets vary depending on the asset type but the general range can be up to a factor of two (2) between the shortest and the longest life. Depending on a range of other criteria, an even shorter or much longer useful life period can be used. For example, if the plant purchases a unique asset for a once-off project, the useful life will depend on the duration of that unique project. This ensures that by the time the asset has fully met its obligation as initially agreed with the customer, its entire costs have been fully recovered. The longer the unique project lasts, the lower the annual depreciation amount. The converse also holds – the lower the period of the project, the higher the costs.

Whether the asset is used in an existing manufacturing line (with existing products) or in a new and unique manufacturing line where it produces its unique product, its depreciation value contributes to the overall *machine rate* of the cost centre.

The asset value used in the calculation depends on the intended use of the depreciation value. For product quotation calculation, the replacement value of the asset is used. This replacement value is converted from a foreign currency to the local currency using the Organization1's strategic plan forecast rate of exchange. For serial production cost calculation, the actual purchase price of the asset is used.

The *machine rate* is directly proportional to depreciation of capitalized equipment.

#### 4.5.1.2.2 Imputed Interest

Put quite simply; PlantZA-L1 would have earned this interest had it invested the amount used to purchase the asset in an interest-bearing account. The department responsible for its calculation multiplies a fraction of the replacement value of the asset by an interest rate provided by head office. For the PlantZA-L1 plant, we shall call this fraction $f_{DU}$ and the interest rate $i_{DU}$.

Although the calculation of this interest rate $i_{DU}$ happens at head office, it is unique to the region and plant depending on its country's macroeconomics.
This usage of the replacement value is only true for new product quotations.

#### 4.5.1.2.3 Floor Space

To arrive to this input of the *machine rate* function, two things are considered; namely, the *machine rate cost per square meter* and the total *square meters* of the manufacturing line.

While the latter component is merely the area size of the manufacturing line for which the *machine rate* is being calculated, the calculation of the former component is slightly more complex. It is done by adding the space rental costs of all production-related areas; which are all manufacturing line areas and the areas around them (aisles, areas for tools, jigs and fixture storage, etc.), and dividing them by the sum of only the manufacturing lines' total floor space (without the areas around them).

Multiplied by each other, these two components yield the manufacturing line's floor space.

#### 4.5.1.2.4 Electricity

There are three (3) components, which make up this *machine rate* input. They are the *power consumption rates* of all assets within the manufacturing line, *power cost per unit* from the municipality and the *total amount of time* the manufacturing line will be manufacturing something.

The first component, *power consumption rate* per asset, is part of the information handed over and recorded in the asset register following purchase and industrialization of an asset. The source of this information is typically the engineering department's employees – but it can also be from the production or maintenance departments' employees.

The second component, *power cost per unit*, is sourced from the maintenance department. It is a number published by the municipality on an annual basis to its commercial users.

The third and final component – the *number of hours* the manufacturing line runs per annum – is calculated and provided by the industrial engineering department. For each assembly manufactured on a particular manufacturing line, the product of its cycle time and its annual volume is computed. All of the results are added together to give the total amount of time the manufacturing line runs in a year.

These three (3) components are then handed over to the *machine rate*-calculating department for use in computing the electricity costs.

#### 4.5.1.2.5 Gases and Water

Various *gases* are used at PlantZA-L1, but not all manufacturing lines use them. The *gases* used include Liquid Petroleum Gas (LPG), Helium (He) and Nitrogen (N). The *water* used is De-ionised water. Based on the expected volumes to be produced on every manufacturing line that uses any of these, and on historical consumption rates, the departments that use these fluids estimate the requirements of each of them.

There are neither mathematical nor scientific methods used to establish these estimations according to one (1) of the departments that provide these costs. The bases for estimations are experience historical and future information. These departmental personnel are of the opinion that their "estimations are satisfactorily accurate." On the other hand, one other departmental personnel claims that they estimate using first principles. When asked to elaborate, the interviewee responded that they used first principles because LPG, for example, did not necessarily escalate by the prevailing inflation rate, but by a special rate. The application of the special rate was considered first principles.

These departments submit these estimated costs to the *machine rate*-calculating department for insertion into the *machine rate* formula.

#### 4.5.1.2.6 Maintenance

*Maintenance costs* are also handed over per manufacturing line. They are also an estimate based on experience, historical information and expected annual volumes of products to be manufactured on the respective manufacturing line during the period being budgeted for.

#### 4.5.1.2.7 Consumables

There are consumable items used in general across the majority, if not all manufacturing lines. Their consumption cannot be directly attributable to any manufacturing line or the products it runs. The consumables, include items like health and safety equipment (HSE) or personal protective equipment (PPE), various lubricants, various cleaning agents, etc.

The costs of these are estimated – also based on historical and future information. Experience and expert judgment is also used. Neither is there any mathematical, scientific nor economic method used to estimate these costs at PlantZA-L1.

#### 4.5.1.2.8 Insurance

The calculations of *insurance* costs are performed using the annual *depreciation* values of the assets and an *insurance rate* calculated and issued from head office. This *interest rate*, despite being issued from head office, is specific to the country.

### 4.5.2 ***PlantCZ-L1***

Specified centrally, the calculation of this is similar to the process explained above for PlantZA-L1. The inputs are the same as above, however, they need to be discussed slightly below due to some subtle differences.

#### *4.5.2.1 Machine time calculation*

As mentioned on the preceding sub-section, the machinery in this plant's level of automation is much higher. Quantifying manufacturing *cycle times* are more accurately doable due to minimal interaction with humans, who typically bring process variation. Calculations are almost always possible. Simulations for estimations are hardly required. If, however, estimations of *machine times* are ever required, the wide product range makes the exercise simple. This is because there is usually an existing product with specifications close enough to the one requiring estimations.

#### 4.5.2.2 Machine Rate Calculation

*Machine rate* calculations are done the same was as at PlantZA-L1. This process is as specified globally. However, details on the actual inputs could not be attained. On the other hand, however, the fact that most inputs here are dependent on factors external to the company (interest rates, electricity costs, etc.), it will be possible to make inferences and general analysis in the analysis chapter.

## 4.6 Direct Setup Costs

### 4.6.1 *PlantZA-L1*

The *direct setup* cost input of product costing at PlantZA-L1 constitutes five (5) components - *machine setup time*, *direct labour setup time*, *machine rate*, *direct labour rate* and the *economic batch quantity*. The *machine* and *direct labour rates* are discussed on sections of their own on this report. Below we briefly look at the other components.

#### 4.6.1.1 Machine setup time

The Industrial engineering team personnel provide this component to the costing department. It is the amount of time that a machine does not run due to setup activities. It is typically an average of times recorded by means of a time study done repeatedly over a period. The average setup time at PlantZA-L1 was found to be 59 minutes per batch of MAC1s for example.

#### 4.6.1.2 Direct labour setup time

Similarly, this is an average of several time study results observed on the line, as is the case with machine setup time. This, however, is the time a direct operator takes to help with setting the line for manufacturing. For MAC1s, this was found to be 6 minutes per batch on average.

#### 4.6.1.3 Economic batch size

Also known as the costing lot size, this is the amount of assemblies manufactured per setup performed, such that the organization realizes the best possible gain economically. It is a number calculated and provided by the Production Planning department and stored on SAP. The average economic batch size was found to be 307 components per batch for PlantZA-L1's MAC1s.

### 4.6.2 *PlantCZ-L1*

The components used to calculate this input at this plant are 100% the same as at PlantZA-L1. When discussed on their subsection, it was noted that some of these components – *direct machine* and *direct labour rate* for example, were different.

Below the focus is on the non-common components. Similarly, averages on SAP were calculated as in the case for PlantZA-L1, and these are the results.

#### *4.6.2.1 Machine setup time*

At PlantCZ-L1, *machine setup times* are also arrived to the same way as at PlantZA-L1. They were, however, on average found to be 80 minutes per batch of MAC1s.

#### *4.6.2.2 Direct labour setup time*

On average, *direct labour setup time* at PlantCZ-L1 was calculated to be 7 minutes per batch of MAC1s.

#### *4.6.2.3 Economic batch size*

For the first time, a major difference between PlantZA-L1 and PlantCZ-L1 is found, and it is the economic batch size. It is found to be an average of 496 components per setup for PlantCZ-L1. This is 62% higher than PlantZA-L1 at 306 components per setup. Section 5 explores this further.

## 4.7 Material Overhead Costs

### 4.7.1 *PlantZA-L1*

*Material overhead* covers all costs incurred from all parts of the plant responsible for the sourcing, storage and assurance of the availability of materials for manufacturing. *Inbound Material Purchasing*, *Inbound Logistics*, and *Inbound Quality* portions of the Purchasing, Plant Logistics and Quality Management departments are respectively the affected parts of the plant.

These *departmental-portion's costs*, along with the *total cost* of all plant materials purchased, are inputs of this overhead's function. Below, we look at how these input costs are arrived to.

#### *4.7.1.1 Inbound Material Purchasers*

The two (2) sub-section included on this category are Production Materials Purchasing (PMP) and Supplier Quality Assurance (SQA). All costs within these departments, which, among many, include basic salaries, general office supplies, travel, training and development costs, are included in this category.

#### *4.7.1.2 Inbound Logistics*

The inbound logistics costs include two (2) sub-sections of the Logistics department – Materials Management (MM) and Warehouse Management (WM). Costs included here are similar to those in 4.7.1.1 above.

Further discussions with the interviewees revealed, however, that all logistics handling equipment / machinery costs are booked under inbound logistics as well. These include the annual costs for the hire and operation of forklifts, reach trucks and tow motors. If capitalized, then the annual depreciation values thereof are booked here. These handling equipment are not, however, exclusively used for handling inbound material only, but also for internal and outbound finished goods.

Further, it is understood from the interviewee that sub-contracting within the Logistics department is also booked to this overhead – irrespective of whether or not it is linked to incoming material. There is evidently a false cost allocation – making business management cumbersome as explored further in Section 5.

Another important cost budgeted for here is the expected overtime cost of the staff members within this departmental portion. In general, a 10% overtime value is included as a quick estimation due to the lack of a more precise method.

#### *4.7.1.3 Inbound Quality – Quality Management Department*

The inbound quality portion of the Quality Management department includes only the Supplier Quality Plant (SQP) sub-section. All costs within this department are similar to the previous two (2) departmental-portions'.

The budgeted overtime cost is also estimated to be 10% of total staff remuneration. The staff members considered are only those legible to claim compensation for overtime worked. The increment on all other expenses is the prevailing consumer price index (CPI) rate.

Further, the responsible manager performs a survey of new equipment that will be required in the following year. A provision for it is included in the budget if required. If sourced from abroad, a strategic plan exchange rate is used for conversion to local currency.

Another important cost budgeted for here is an annual auditing fee, which the manager equally spreads among the four (4) portions within the Quality Management department. The interviewee expressed that, although the fees were easy to establish since they are quotation based, there was no method used to quantify what the split should be. A four-way-equal-split was the best option.

### 4.7.2 ***PlantCZ-L1***

In accordance with the organizational guidelines, the material overhead covers all costs incurred by the three sub-departments as is the case for PlantZA-L1 above. No deviations from the standard were reported.

All future (budget) costs are also attained by looking at past costs and factoring in utilization increase for the following year. Most fees are similar, with the exception of audit fees which are slightly higher in PlantCZ-L1.

## 4.8 Inbound Freight Overhead Costs

### 4.8.1 *PlantZA-L1*

This includes all *normal logistics costs* from PlantZA-L1's suppliers to its inbound material warehouses. These *normal logistics costs* include collection, transportation (*sea* and *road freight*) and delivery to the warehouse from the ports (if imported).

This cost is calculated every 3 to 4 years for the plant. The resulting 'per product family' values are derived by splitting this overall cost into volumes per product family.

### 4.8.2 *PlantCZ-L1*

Just as at PlantZA-L1 this overhead includes all costs incurred between the suppliers and the plant. The largest cost in this overhead for this PlantCZ-L1 is customs cost. Freight, warehousing, inspection and insurances are the other costs included on this overhead.

With these costs forming the numerator, and the total costs of imported material making up the denominator, the quotient is the overhead rate.

## 4.9 Direct Labour Overhead Costs

### 4.9.1 *PlantZA-L1*

Used to calculate the *direct labour overhead costs*, the *direct labour overhead rate* constitutes total *working-hour direct labour costs* and 13 other inputs at this plant. The latter includes *annual bonuses, overtime allowances, social costs allowances* and *various leave allowances*. Below we look at how they are calculated.

#### *4.9.1.1 Total Working-Hour Direct Labour Cost*

This is simply the expected total cost related to a direct worker required to fulfil all customer orders during normal working hours. Normal working hours at PlantZA-L1 range between 06:00 to 22:00 on Monday to Friday, and 06:00 to 14:00 on a Saturday.

Moreover, the normal working time per person per day is only 8 hours. Any amount of time above this is considered overtime – even if it falls within the periods mentioned above.

#### *4.9.1.2 Allowances (Overtime Only)*

Here, the plant direct workers are remunerated in excess of the normal wage rate for any non-normal working hour time worked. For Monday to Saturday overtime is remunerated at 50% more than normal pay rate, while on Sunday, this increases to 100%. These 50% and 100% excess payments are referred to as remuneration premiums.

The amount of overtime budgeted is generally an estimate by the various production departmental managers. Depending on the amount of work expected on a particular manufacturing line per day, either the next shift is planned for, or overtime is planned and budgeted for (table 4).

**Table 4:** Planned Shifts versus Budgeted Overtime - Direct Labour

| Shifts Required / Manufacturing Line | Planned Shifts | Budgeted Overtime |
|---|---|---|
| Up to 1 | 1 | 0 hours |
| Between 1.0 and 1.5 (Exclusive) | 1 | 4 hours (0.5 shifts) |
| Between 1.5 and 2.0 (Inclusive) | 2 | 0 hours |
| Between 2.0 and 2.5 (Exclusive) | 2 | 4 hours (0.5 shifts) |
| Between 2.5 and 3.0 (Inclusive) | 2 | 8 hours (1.0 shift) |

#### *4.9.1.3 Balance of the 13 other Inputs*

The percentages for these remaining contributors to the *labour overhead cost* are standard across the organization for all direct employees. These include, for example, annual bonus payments and leave allowances. The same percentages are applied by the plant administration department.

### 4.9.2 *PlantCZ-L1*

At this plant, these overhead rates are also based on multiple inputs. These, just like at PlantZA-L1, include leave allowances, night shift allowances and social insurance costs.

It was, however, mentioned that this overhead in this plant – PlantCZ-L1 – is utilization-dependant and has remained relatively constant over the past 5 years at minimum. This is the length of time the interviewee has been working at PlantCZ-L1.

It was also mentioned that despite the above, financial recoveries on these overheads are tracked on a monthly basis and that in existence is a possibility to amend them if required. However, this had not been necessary.

## 4.10 Plant Overhead Cost

### 4.10.1 *PlantZA-L1*

This overhead consists of quite a number of cost categories as inputs. They, however, exclude costs within the plant that contribute to other *overhead* categories and those that contribute to the *Sales, General and Administration* (SG&A) expense accounts of the organization.

These cost categories include the personnel costs and associated allowances (bonuses, leave payments, etc.), office supplies (furniture, stationery, etc), kitchen consumables (tea, coffee, etc.), training & development expenses (professional membership fees, employee training, etc.), Safety wear (Shoes, Overalls, etc.) among a multitude of other costs.

Departmental managers which contribute to this overhead submit budgets to the plant overhead-calculating department. The calculated plant overhead is then split into three (3) categories before being applied to products. The categories are *High, Medium* and *Low* volume product categories. Let us explore.

#### *4.10.1.1 Determination of budget costs*

Departmental managers arrive to these values in very similar ways at PlantZA-L1.

During the budgeting period, they typically take their year-to-date departmental costs according to their cost tracking systems, and annualize them. Inflation, typically 6%, is then added. Also factored are planned or expected changes in the departmental expense bill according to their best knowledge at the time.

#### *4.10.1.2 High, Medium & Low Volume overhead split*

The split between *high, medium* and *low* volume overhead categories is to achieve better accuracy of cost allocation. This is achieved by setting cut-off points, based on annual volumes, between these three categories.

The two (2) critical outputs of this exercise are the *count* of the number of *products* produced per category, and the *sum* of all *volumes* per category. The former is a measure of the *product variation* within the plant. This is because every product produced is unique and requires a certain level of effort to manage. The latter – *volume* – is the magnitude of each category. The table below illustrates this exercise's results, assuming that the *total plant volume* is $V_{tot,}$ and the *count of products/parts* produced is $P_{tot}$.

**Table 5:** Product Count (variation) vs.Total Volume (magnitude)

| Category / Output | High Volume | Medium Volume | Low Volume |
|---|---|---|---|
| Product Count | x%$P_{tot}$ | y%$P_{tot}$ | z%$P_{tot}$ |
| Total Volume | p%$V_{tot}$ | q%$V_{tot}$ | r%$V_{tot}$ |

*where* x, y, p, q and r are positive real numbers;
*and* x+y+z = 100;
*and* p+q+r = 100.

Next, for every department that contributes to this overhead, the amount of 'effort' required to manage this product variation (*count*) is expressed, alongside the amount of 'effort' required to manage the associated magnitude (*volume*). With the former expressed as $PC_{eff\,n}$%, the latter as $TV_{eff\,n}$%, and the departmental budget expenditure as $DBEx_n$, table 6 below illustrates this effort split.

**Table 6:** Dept. Expenditure Effort Split for Count and Volume

| Category / Output | Dept. Budget Expenditure | Effort on Product Count | Effort on Total Volume |
|---|---|---|---|
| Department 1 | $DBEx_1$ | $PC_{eff1}$% | $TV_{eff1}$% |
| Department 2 | $DBEx_2$ | $PC_{eff2}$% | $TV_{eff2}$% |
| ... | ... | ... | ... |
| Department $n$ | $DBEx_n$ | $PC_{eff.n}$ % | $TV_{eff\,n}$ % |

*Where,* per department, $PC_{eff\,n}$, and $TV_{eff\,n}$ are positive numbers;
*and* $PC_{eff\,n} + TV_{eff\,n} = 100$

Finally, the estimated expenditure portions (splits) per volume category for every departmental budget are calculated as;

$$HV_{port\_dept\ n} = DBEx_{n}\ [\ (x\%P_{tot})(\ PC_{eff\ n}\ \%) + (p\%V_{tot})(TV_{eff\ n}\ \%)\ ]$$
$$MV_{port\_dept\ n} = DBEx_{n}\ [\ (y\%P_{tot})(\ PC_{eff\ n}\ \%) + (q\%V_{tot})(TV_{eff\ n}\ \%)\ ]$$
$$LV_{port\_dept\ n} = DBEx_{n}\ [\ (z\%P_{tot})(\ PC_{eff\ n}\ \%) + (r\%V_{tot})(TV_{eff\ n}\ \%)\ ]$$

Tabulated and summed up for *n* departments, the results look like this:

**Table 7:** Plant Summation of High, Medium and Low Vol. Expenditure Splits

| **Category** / **Output** | High Volume | Medium Volume | Low Volume |
|---|---|---|---|
| Department 1 | $HV_{port\_dept1}$ | $MV_{port\_dept1}$ | $LV_{port\_dept1}$ |
| Department 2 | $HV_{port\_dept2}$ | $MV_{port\_dept2}$ | $LV_{port\_dept2}$ |
| ... | ... | ... | ... |
| Department $_{n}$ | $HV_{port\_dept.\ n}$ | $MV_{port\_dept\ n}$ | $LV_{port\_dept\ n}$ |
| **Plant Totals** | $\sum_{n} HVport\_dept_{n}$ | $\sum_{n} MVport\_dept_{n}$ | $\sum_{n} LVport\_dept_{n}$ |

$$And, typically, \quad \sum_{n} LV_{port-dept_{n}} > \sum_{n} MV_{port-dept_{n}} > \sum_{n} HV_{port-dept_{n}}$$

### 4.10.2 *PlantCZ-L1*

Quite similar to PlantZA-L1, the contributing departments to this plant overhead are those that neither contribute to any other overhead category nor to the SG&A expense accounts.

The cost categories included from those departments are also personnel and associated costs, office supplies, training and development, safety equipment, etc.

This overhead is applied to all products in the plant. It is never split into categories.

#### *4.10.2.1 Determination of budget costs*

Costs are determined from cost collectors of different parts of the organization – only those contributing to this overhead. The OH% remains relatively unchanged at around 23%.

## 4.11 Extra Costs

### 4.11.1 *PlantZA-L1*

This category at PlantZA-L1 includes all *cost of poor product quality* (COPPQ) that the plant expects to incur for the period being budgeted for. Included in COPPQ are costs of warrantee claims, replacement of scrapped parts costs, costs for shipment of products with poor quality for inspection and/or rework, costs for the replacement of such as well.

However, the way these costs are arrived at is quite detailed as reported by the interviewee. For every line item of the COPPQ, detailed analysis is done to establish the level of risk that each carries into the period being budgeted for. Once that is established, other activities within the organization that might have an impact on each line item are analyzed and their expected possible impacts incorporated into the respective risk profiles. The result of this is then, along with the annualized current year-to-date costs of the line item, used to estimate the following period's expenditure budget.

All line items' budgets are summed up to get the overall COPPQ cost. These costs are then spread among all products in direct proportion to their production costs (fixed rate) as extra costs.

### 4.11.2 *PlantCZ-L1*

The costs included in this plant are 100% identical to PlantZa-L1. Any difference is purely due to activity differences between the plants.

## 4.12 Reference Case: A MAC1 Cost Calculation from both plants

An interviewee handed over a calculation recently performed and shared between the two (2) plants during data collection. The calculation shows the various cost components of the product costing in accordance with the Organization1's costing model. For overheads, however, not only does it show the costs, but the percentages used to get to the numbers. Presented in table 8 below is the reference case for a MAC1 cost breakdown.

Its various cost components are as per sections 4.2 to 4.11 above.

**Table 8:** Reference Case: A MAC1 Cost Breakdown

| Cost Breadown | PlantCZ-L1 Costing | OH% | PlantZA-L1 Costing | OH% |
|---|---|---|---|---|
| Direct Material | € 2.61 | | € 16.98 | |
| Direct Material IC | € 16.53 | | € 0.00 | |
| Direct Labour | € 0.83 | | € 2.36 | |
| Direct Machine Cost | € 2.07 | | € 3.46 | |
| **TOTAL DIRECT COSTS** | **€ 22.03** | | **€ 22.79** | |
| Material OH | € 0.36 | 1.46% | € 0.78 | 4.57% |
| Direct Labour OH | € 0.71 | 85.71% | € 0.97 | 41.34% |
| Plant OH | € 0.97 | 25.69% | € 3.82 | 54.41% |
| **TOTAL OH COSTS** | **€ 2.04** | | **€ 5.57** | |
| Inbound Freight | € 0.68 | 2.80% | € 0.21 | 1.24% |
| Set-up Cost | € 0.18 | | € 0.22 | |
| Extra Cost | € 0.63 | 2.09% | € 0.76 | 2.65% |
| **TOTAL OTHER COSTS** | **€ 1.50** | | **€ 1.20** | |
| | | | | |
| **TOTAL PRODUCTION** | **€ 25.57** | | **€ 29.56** | |

# 5 CRITICAL ANALYSIS

## 5.1 Direct- and Direct Inter-Company Material Costs

Both plants follow a very similar and detailed process to obtain prices for their manufacturing materials. The process seems to afford the buyers an opportunity to escape with the best price when all steps are adhered to.

There are, however, niches of opportunities where each plant seems to thrive, which ultimately results in differences to the overall cost of direct material purchased.

### 5.1.1 *Plants' Physical Locations*

According to the organizational structure, both plants fall under the BU1000's European region. PlantCZ-L1 is also physically in Europe, where a majority of other BU1000 plants are. PlantZA-L1 is in Africa, where only one (1) other sister plant exists. PlantCZ-L1 is also, within its country, surrounded by several other sister plants with similar products. The only other plant in South Africa does not produce similar products to PlantZA-L1.

A report circulated by a central capacity-planning department for all plants within the European region revealed that PlantCZ-L1's injection moulded part demand would be 7 times higher than PlantZA-L1's for 2018. On another report, it was revealed that in the same year, PlantCZ-L1 would produce 20 times more MACs compared to PlantZA-L1.

It appears PlantCZ-L1 benefits from this situation in the following manner:

> Most material is sourced inter-company from a number of the other plants within the Czech Republic and Europe. This results in less material being sourced from external suppliers – which is a preference for the organization. This results in lower direct material costs for PlantCZ-L1.

> The above also implies *economies of scale* benefits – because; instead of raw material being supplied to various smaller external companies to produce and supply each of these BU1000 sister plants, one (1) sister plant buys,

manufactures and suppliers the material inter-company to the sister companies instead (more on this in section 5.2).

These result in PlantCZ-L1 having much less on its *Direct Material Cost* component. The reference case study confirms this.

### 5.1.2 *Material Purchase Floor Price: Hard-To-Negotiate Prices*

When another plant already sources some material from a certain external supplier and PlantZA-L1 tries to source it from the same, it becomes almost impossible for PlantZA-L1 to successfully negotiate a better price. The supplier normally reports that an extra set-up would be required for PlantZA-L1 and that its smaller demand would result in a higher cost. At best, the other plant's agreed price with the supplier becomes the best price PlantZA-L1 can purchase the material for, which ultimately increases due to associated packaging and shipment costs.

### 5.1.3 *PlantZA-L1's freedom to source externally*

While PlantCZ-L1 is able to reduce its externally-sourced *Direct Material Cost* component as per above, the costs do not disappear because they eventually fall under *Direct Inter-Company Material*. PlantZA-L1, however, escapes the above challenges – lack of benefit from *economies of scale*, the floor price debacle, and packaging and shipment costs – by eventually finding a cheaper external supplier. This external supplier is often local (within South Africa) due to the benefits linked to it:

> Close proximity
> Government Incentives on locally sourced material (Black & Mitchell, 2002)

This alone, as evident on the case study, results in PlantZA-L1 often having very little or no material sourced inter-company. PlantZA-L1 therefore seems to be in a better position than PlantCZ-L1 when it comes to *overall material* costs.

But, they contribute 57% of the total manufacturing costs and are critical to reduce. To boost economies of scale, PlantZA-L1 could look at forming or becoming part of a buyer group. A powerful one can be formed with other users of the same raw and standard parts it uses (Porter, 1979; Porter, 2006). No need exists to do this with a sister plant.

## 5.2 Direct Labour & Direct Machine Costs

### 5.2.1 *Machine and Labour Times*

#### *5.2.1.1 Automation Benefits: Doing More with Less*

Sections 4.4 and 4.5 revealed that PlantCZ-L1’s equipment was more automated than PlantZA-L1’s.

Due to that level of automation, minimal labour time is often required per job. At PlantCZ-L1, one (1) operator can simultaneously operate an Injection Moulding cell of up to four (4) machines. Robots and conveyors, for example, do most of the work while a human being does only what is not programmable. This is not the case at PlantZA-L1 where one (1) operator per machine is required. There are neither robots, nor conveyors.

This means that for injection moulding as an example, PlantZA-L1 typically requires up to four (4) times the amount of labour resource for an equivalent job.

#### *5.2.1.2 Automation Benefits: Doing Things Faster*

The higher automation at PlantCZ-L1 also implies another critical point: that the equipment is possibly newer than that at PlantZA-L1. Evidence of this was found on a capacity planning report where the ages of 66% of its Injection Moulders, for example, were between 0 and 4 years, while 100% of PlantZA-L1’s averaged at 5 years. These injection moulders, at PlantZA-L1, are the most recently purchased of the equipment with the exception of two (2) other machines.

If they are newer, then they more likely work faster. Exactly how much faster is not clear. SAP revealed that a MAC1 production cycle time was 72% slower at PlantZA-L1 on average.

#### *5.2.1.3 Automation Benefits: Higher Accuracy*

Section 4.4 also revealed how PlantZA-L1 often resorts to usage of various labour time estimation methods. PlantCZ-L1 does not. This is because it has capability to more accurately calculate required labour times owing to the higher level of automation. Cycles are more repeatable and consistent than in the case where human interaction is higher.

Finally, the points above suggest less *machine* and *labour times* at PlantCZ-L1 compared to PlantZA-L1. The less labour time is further validated by a 40% less plant labour reduction target at PlantCZ-L1 compared to PlantZA-L1 for the year 2017. These targets are set annually by head office for all plants within BU1000.

Yusuf, Chek and Hashmi (2005) cite a number of authors on the benefits of automation as including better cost effectiveness, quality and delivery to market speed for Small and Medium Enterprises (SMEs). Meredith (1987) argues such benefits are not linked to an organization's size. With this in mind, irrespective whether PlantZA-L1 is seen as an isolated SME or a large business, it stands to benefit from automation. Sheridan (2002), however, cautions on the difficulty to integrate humans with automation. Socio-economic issues in ZA, including low levels of education and high poverty (Taylor, Van der Berg, & Burger, 2011) could negatively affect such initiative.

### 5.2.2 *Machine and Labour Rates*

#### *5.2.2.1 Labour Rate*

Converted to Euros and compared, the minimum monthly wage rates in the manufacturing industries for South Africa and the Czech Republic had a difference of only 8.4%. The former is the lower of the two at €428.83 per employee while the latter is €464.99 (TradingEconomics, 2018a; TradingEconomics, 2018b). This difference is minimal, compared to the required labour time differences established in section 5.2.1.1.

This comes as no surprise because it is in accordance with the case study presented where the labour costs are higher in the South African quotation.

A ZA industry-specific minimum wage law impact study returned evidence of increase in wages in the formal sector (Millea, Rezek, Shoup, & Pitts, 2017). This will narrow the gap in the wage gap between ZA and CZ when it hits the automotive industry, further necessitating automation to remain/become competitive.

#### *5.2.2.2 Machine Rate*

Presented in section 4.5 was how, for product costing for quotation, the replacement value of the equipment is used. This gives a common solid base for comparison as it implies brand new machines. Some inputs of the machine rate can already be eliminated in this comparison as they would most likely be the same, since the replacement machine is the same. These are *Depreciation*, *Maintenance* and *Insurance costs*.

Of the remaining 5 inputs, it is believed that only 3 will result in a noticeable difference in the machine rate. They are *Imputed Interest*, *Electricity* and *Floor Space Rental costs*.

##### 5.2.2.2.1 Imputed Interest

The deposit interest rates for South Africa and Czech Republic are 7.17% and 0.05% respectively (TradingEconomics, 2018c; TradingEconomics, 2018d). This means that PlantZA-L1 has an opportunity cost 143 times higher than its counterpart if everything else is kept the same. PlantZA-L1 is clearly at a disadvantage.

##### 5.2.2.2.2 Electricity Costs

While the power consumption is the same, the charges for the electricity are different. In 2017, electricity for business use was €0.13/kWh in Durban (Ethekwini Electricity, 2016), while it was only €0.083/kWh in Czech Republic (Dos Santos, 2018). PlantZA-L1 is worse off by a factor of 1.6.

##### 5.2.2.2.3 Floor Space Rental Costs

While in 2016 5,000m$^2$ industrial properties rented at an average of €3.07/m$^2$ in Durban according to RODE as quoted by Mundy and Makhoka (2017), the effective rental rates for a property between 5,000m$^2$ and 10,000m$^2$ in Czech costed €3.20-

€3.75/$m^2$ according to CBRE's 2016 research results as quoted by CzechTrade (1997-2018). Assuming €3.20/$m^2$ was for a 5,000$m^2$ in Ostrava, Durban would be better off by a factor of 0.96.

With the points above, it is safe to conclude that the *machine rate* at PlantZA-L1 would be higher than at PlantCZ-L1. The case study affirms this conclusion, where PlantZA-L1's machine costs are 1.68 times higher than PlantCZ-L1's.

Finally, PlantZA-L1's situation is worsened by how it costs its products at slower cycle times based on its low-tech and older machines, while PlantCZ-L1 quotes with faster cycle times for the same equipment replacement value.

## 5.3 Direct Setup Costs

### 5.3.1 *Setup Times and Economic Batch Quantities*

According to SAP, PlantZA-L1's average setup time per batch for MAC1's is 59 minutes. With an average economic batch quantity of 307 units/setup, the average setup time is 11.53 seconds/MAC1. A similar exercise for PlantCZ-L1 results in 9.92 seconds/MAC1 from 82 minutes/batch and 496 units/setup.

These results, along with the machine rate comparisons in section 5.2, signify how PlantCZ-L1 could possibly have lower setup costs compared to PlantZA-L1. The case study validates this finding as well.

This has insignificant impact on overall cost and will not be discussed further.

## 5.4 The Various Overhead Costs

While PlantCZ-L1's proper method(s) of establishing the costs of the overheads remain unknown, there is one major finding valid across all of PlantZA-L1's overhead costs that needs discussion. Discussed also below are other minor findings.

### 5.4.1 ***Major OH Finding: Departmental Budget Creation and Tracking Methods***

Neither of the departmental managers at PlantZA-L1 presented a properly defined method of budgeting departmental costs. Essentially, each simply took the annualized costs of the current year and applied the prevailing CPI and factored in the production quantities changes. There is no clearly defined method of how this was done. Worsening this is the lack tracking of financial recoveries on overheads.

Wienhold (2015) gives alternatives of budgeting methods in place of traditional ones. These include Activity Based Budgeting – which emanates from Activity Based Costing – and would be a great short term solution as advocated by Bhar (2008).

However, judging on how we live in the information and data analytics ages, it is advocated that budgeting should be gotten rid of entirely (Goode & Malik, 2011; Neely, Bourne, & Adams, n.d) as have some Scandanavian companies already.

Either of the above would lessen the 20% contribution as costs would be more realistic. We learnt earlier that managers often over-estimate costs to avoid under-budgeting.

### 5.4.2 ***Minor OH Findings***

There is evidence of misaligned understanding on what costs are allocated where. For example, non-inbound material handling equipment costs were allocated to *material overheads*. Another example was a departmental manager reporting that customer-rejected material shipment costs were booked under the *inbound freight overhead*, while they were, in fact, booked under *extra costs*.

Another arguably minor finding is how neither of the managers reported allocation of budget towards strategic departmental activities and/or alignment with the organizational strategy. All budgeted amounts were only for the following year's operational activities!

Although the above would not necessarily result in a lower product costs at PlantZA-L1, allocating them properly would aid better business management.

# 6 RECOMMENDATIONS

## 6.1 Consultancy Project Recommendations

**Direct- and Direct Inter-company Material**

> Direct material sourced from external suppliers is the largest cost contributor to manufacturing cost; PlantZA-L1 should formulate strategies on how to lower this component to remain competitive post government incentives.

One such could be forming or joining a purchaser/buyer group to create economies of scale benefits. This group membership should be based on material purchased, not industry, organization, etc. However, care should be taken not to infringe competitive laws by sharing sensitive information.

**Direct Labour and Direct Machine Costs**

> PlantZA-L1 should refrain from using slower cycle times based on older technology and slower equipment for quotations. Cycle times should match the quoted machinery.

Doing the above will increase PlantZA-L1's competitiveness, and will result in more business being won. This will require it to increase capacity by acquiring more equipment. When this happens, PlantZA-L1 should therefore acquire new assets equivalent to those quoted – faster and newer technology.

**Direct Setup Costs**

> PlantZA-L1 is competitive when it comes to setup times, but the batch sizes work against it. Wining more business (by doing the above) and maintaining or improving on its setup times will improve the overall cost competitiveness on setup activities.

**Various Overheads**

> PlantZA-L1's budgeting process requires structure and definition. Budgeting for incremental costs - evident from the chronic use of previous year's values plus CPI needs to cease. Two (2) Better Budgeting Methods could be employed:

The plant could adopt the Activity Based Budgeting (ABB) method. This will bring structure, help managers focus on the right areas, and free them from dependence on CPI. The literature-reported high costs on ABC/ABB implementation could be averted by requesting managers to start small, on a spreadsheet or so and slowly build an integrated system over time.

External Benchmarking (EB) could also be adopted. When used within the Organization1 or even wider within BU1000, this could bring richness to this process as the plants would learn from each other.

> Managers should also be educated on the iCOST model – at least on the components they have an impact on or contribute to.

This awareness may possibly positively influence the budgeting process and result in an effort to optimize where possible. However, this should be bundled with an *overhead budget vs. actual* KPI and tracking. Therefore, an employment of change management tool such as Kotter's Eight-Stage Process (Kotter, 1996) would be highly recommended.

## 6.2 Future Related Research Recommendations

Future research work could concentrate more on the strategies of forming purchasing/buyer groups without infringing competition laws. The study could hone not only on purchase bargaining power, but also potential savings on centralised logistics management and purchasing efforts through shared resources.

Another study could investigate the most effective ways of implementing 1$^{st}$ world technology in 3$^{rd}$ world and underdeveloped economies – especially those stricken by low literacy levels and high poverty rates.

A low willingness to participate from PlantCZ-L1 was a major struggle for this paper, despite foresight and prior preparation thereof. A possible future study could look into strategies to secure buy-in from multiple facets of the *same* organization for a study as crucial as this. Without this, the EB budgeting method could prove a nightmare to adopt.

Lastly, a future study could concentrate on putting together a cost-benefit analysis of the recommendations made in 6.1. This is expected to be a complex and lengthy exercise.

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