Design of a Forecasting Model for Brewing Raw Material Consumed Price Variance

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Executive Summary

SAB's procurement team needs to determine expected consumed price variance (CPV) values instead of purchased price variance (PPV) values in order to assess potential benefits of certain business improvement projects. In this report the problem is analysed and explained and a suggested solution is developed using Monte Carlo simulation.

The project will aim to provide SAB with a model that uses all available information to forecast CPV for (SLM) and (HFM) for an end-of-financial-year forecasting horizon if current operational trends are sustained. This will include an estimation of future logistics plans as current distribution plans are only developed for a 3 month planning horizon. The model must also be able to forecast CPV based on different strategies in order to test the potential benefit of these strategies. The model will be able to integrate with current information systems and IT resources that are used in Procurement.

Keywords: Brewing raw materials. Standard Lager Malt (SLM). Highly Fermentable Malt (HFM). Consumed price variance (CPV). Purchased price variance (PPV). Procurement. Planning. Forecast. Brewing raw materials. First-in-first-out (FIFO)

Table of Contents

1. Introduction 1
    1.1 Problem Background 1
        1.1.1 Business Improvement Initiative 1
        1.1.2 Current Situation 2
        1.1.3 Brewing Raw Materials and Price Variances 2
        1.1.4 Complexities of Malt 5
    1.2 The Problem 5
    1.3 Summary 8
2. Project Aim 8
3. Project Scope 9
4. Literature Review 9
    4.1 Definition of a Forecast 9
    4.2 Selecting a forecasting method 10
5. Summary of Available Information 12
    5.1 Supply Networks 12
    5.2 Data Sheets 14
6. Development of the Model 15
    6.1 Consolidating Data to Calculate CPV 15
    6.2 Adding Variability to the Model 21
    6.3 Summary 24
    6.4 Model Assumptions 25
7. Model Output 25

8. Model Testing 28

9. Conclusion 31

10. References 32

Appendix A: 33

South Africa Locality Map 33

Network of Possible Supply Routes 33

Appendix B 34

Data Sheets 34

DS1: Existing 3 month logistics plan 34

DS2: Weekly view on stock levels, receipts and usage. 35

DS3: Part of a Procurement sheet containing purchase prices for malt 35

DS4: Material availability and pricing on contract 36

DS5: Logistics costs obtained from Procurement 37

MS2: Modified Planning sheet used to associate costs to specific receipts (identical sheets for SLM and HFM) 38

Appendix C 39

Results of Simulation Case 1 39

Results of Simulation Case 2 40

List of Figures

Figure 1: Information Flow Between Departments 6

Figure 2: Current Supply Network for SLM........ 13

Figure 3: Supply Network for HFM 13

Figure 4: Information Flow Between Sheets 15

Figure 5: Summary of Deliveries (MS1) 17

Figure 6: Sheet Showing Consolidated Delivery Volumes and Costs per Ton (MS2)........ 18

Figure 7: Calculation Algorithm (MS3) 19

Figure 8: Illustration of Simulation Summary Data for a Single Brewery........ 20

Figure 9: Illustration of Summation of CPV per Brewery to Obtain Total CPV 21

Figure 10: Sheets Affected by Variability in Transport Lead Time 21

Figure 11: Variable Lead Time Scenario 1........ 22

Figure 12: Variable Lead Time Scenario 2........ 22

Figure 13: Sheets Affected by Variability in Logistics Costs........ 23

Figure 14: Sheets Affected by Variability in Purchase Price 23

Figure 15: Sheets Affected by Variability in Weekly Material Usage 23

Figure 16: Histogram of Simulation Output for CPV in Case 1........ 26

Figure 17: Cumulative Frequency of Simulation Output for CPV in Case 1 26

Figure 18: Histogram of Simulation Output for CPV in Case 2........ 27

Figure 19: Cumulative Frequency of Simulation Output for CPV in Case 2 27

Figure 20: Summary Statistics for Simulation Case 1 and Case 2 27

Figure 21: Mean and Standard Deviation of Transportation Lead Times 29

Figure 22: Model Test Results........ 30

1. Introduction

* Please note that for privacy reasons some specific information related to volumes and pricing has been replaced by “dummy” values or has been omitted from this report.

Beer is the alcoholic beverage of choice for millions of consumers worldwide. The South African Breweries Limited (SAB) is a subsidiary of SAB Miller plc, the second largest producer of beer in the world based on brewing volume. SAB operates seven breweries and forty depots in South Africa and produces and imports many different brands of beer and flavoured alcoholic beverages such as Carling Black Label, Castle, Hansa, Grolsch and Brutal Fruit among others.

In order to maintain the meeting of an enormous demand and brewing volume thorough supply chain planning and management is required. These activities are mainly undertaken by the planning department (Planning), dealing with activities such as demand planning and brewing plans for the seven different breweries, and the procurement department (Procurement), dealing with the identification of suppliers and negotiating supplier contracts and ensuring that any product or commodity that SAB purchases gets delivered at the right time, place, price and quantity.

1.1 Problem Background

1.1.1 Business Improvement Initiative

As from the beginning of this year Procurement has been running a major initiative to optimise the value Procurement delivers annually. A target of R220 million and a stretch target of R300 million in savings within the next year has been set. These are all savings that should result from projects relating to improvement of operations, negotiations with suppliers, cutting of unnecessary cost, innovation, i.e. from doing business more efficiently and more economically.

In order to meet such targets the benefit for every project must be reported. This implies that business benefit arising from a project must be measurable and traceable in order to compare realised benefit with original targeted benefit. More specifically benefit must be determinable relating to the following:

- Targeted benefit of the project must be proven to be realistic before a project can be approved
- Actual realised benefit must be reported during the lifetime of the project on a periodic basis
- As the project progresses and more information becomes available the expected final benefit must be adjusted accordingly
- Final benefit delivered must be accurately reported upon completion of the project.

1.1.2 Current Situation

SAB has comprehensive and effective information systems in place for reporting on past activities, mostly by means of SAP. The way future operations are predicted however depends largely on the department, the specific operation within the department or the specific project. Expected values of operational variables are mostly obtained by using and manipulating values from operational plans or values based on contracts signed with suppliers. In general, if there is a lot of variation in a variable for which a future value has to be determined or no plan exists for the timeframe within which it should be determined, no prediction is done as is the case for certain variables relating to brewing raw material usage.

1.1.3 Brewing Raw Materials and Price Variances

The Procurement team handling operations relating to brewing raw materials makes use of price variances as a means of measuring certain benefits.

According to Seal et al, in management accounting price variances are differences between actual prices and standard prices where standard prices are used to set up budgets.

Two price variances are highlighted. Variance in purchase price is referred to as purchased price variance (PPV) and is calculated as the difference between the budget for raw material purchases and actual cost of the same volume of raw material for SAB as a whole. PPV for a specific purchase of raw material is calculated as

$$\Delta PPV = PV * BR - PV * AR$$

Where

PV = Purchased Volume

BR = Budgeted Rate

AR = Actual Rate.

It then follows logically that PPV for a certain time period is calculated as

$$PPV = \sum_{Purchases\ in\ time\ period} (PV * BR - PV * AR)$$

Where T =Set including all purchases in considered time period.

It includes all material costs and logistics costs up to the point that the relevant SAB brewery takes control of the material. A system for calculating PPV based on historical operations is in place. Expected PPV is also determined very accurately as contracts are signed with suppliers for raw material shipments months ahead. The main reason for the lack of accuracy that does exist is averaging values used for logistics cost to breweries; a standard rate per ton is allocated to each brewery for inland logistics costs irrespective of the actual route the material takes. PPV is mainly used to determine benefit relating material purchases at newly negotiated prices; however it is also influenced by certain other factors such as variability in actual shipping times for imports.

Variance in the price of consumed raw materials is referred to as consumed price variance (CPV). Its calculation is similar to that of PPV, also including all logistics and storage costs up to the point where the material is delivered to the brewery. The difference is the timing of when the cost is allocated to the material. For CPV at a certain point in time (CPV_t):

$$Total\ CPV_t = Total\ PPV_t - CU_t$$

Where CU = Cost of purchased but unconsumed material.

The cost of unconsumed material includes all material that SAB has taken ownership of i.e. imports delivered to the harbour (depending on Incoterms negotiated with supplier) and material made available to SAB by local suppliers. Associated cost to unconsumed material includes material costs and logistics costs up to the point that the relevant SAB brewery takes control of the material whether or not the cost has already been incurred of will be incurred in the future.

CPV is more complex to determine due to the fact that material is used at a brewery level and needs to be computed for each brewery for each time interval (e.g. each week) before a total SAB view can be established. I.e. average values for inland logistics are not sufficient and inland logistics cost must be associated to each material delivery individually. For most raw materials however supplier and logistics networks are fairly straightforward and constant. This fact combined with the fact that purchase prices remain constant during a contract period makes it possible to obtain a high level view of such CPV values for a certain raw material for a contract period by using material usage values based on Planning's production values, material costs and logistics costs:

$$CPV = \sum_{B} (MN\ X\ BR - MN\ X\ (PP + LC))$$

Where

B = Set Containing Referring to All Breweries

MN = Material Need

PP = Purchase Price

LC = Total Inland Logistics Cost

The "Budgeted Rate" includes purchase price and logistics cost.

Although all the necessary information to calculate CPV values is recorded during several different Planning and Procurement activities, no system exists that can consolidate the information and calculate CPV values.

1.1.4 Complexities of Malt

The level of complexity rises when finding CPV for the main raw material, malt, which includes standard lager malt (SLM) and highly fermentable malt (HFM), for the following reasons:

- Both imported and locally produced malt is used and their prices differ
- There exists no fixed ratio as to what type of malt (import or local) a brewery receives.
- There exists no fixed ratio according to which imported or locally produced malt is mixed in a certain brew i.e. they are interchangeable.
- Consequently the effective price of consumed malt is not constant over a certain period and the equation above cannot be used to estimate future CPV values for malt
- Specifically relating to future or expected CPV values, distribution for malt deliveries to breweries is only planned three months in advance.

Based on the last point the current tendency to manipulate planned values to estimate future values cannot be used to find expected CPV values for more than 3 months in advance.

1.2 The Problem

Currently retrospective and expected PPV values can be calculated adequately. Procurement however wishes to start making use of CPV instead of PPV in order to measure benefits relating to certain products and certain materials. As the previous paragraphs suggest, this cannot be done with current systems.

In order to gain a better understanding of the problem to be solved it is necessary to acquire more insight on how information flows between Planning and Procurement functions. The process for malt will be discussed as it is the focus of this report (as stated under the discussion of the project scope). It is however noteworthy that the processes for other raw materials are similar to that of malt even though there may be some simplifications. Consider the flow diagram below (Figure 1).

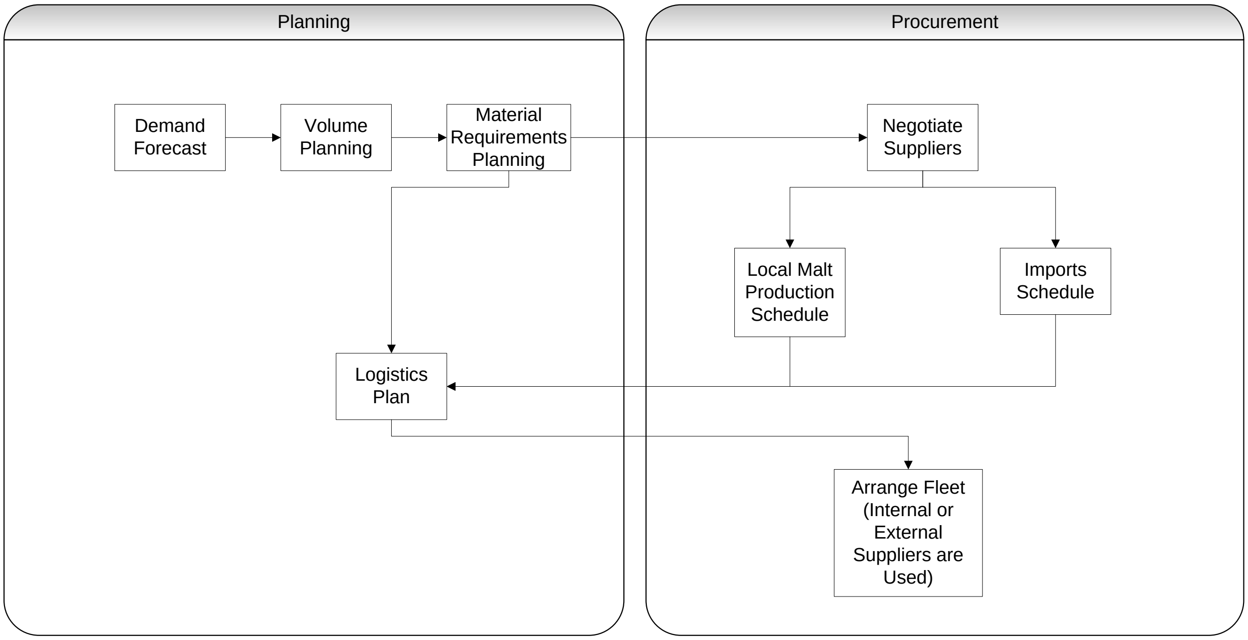

Figure 1: Information Flow Between Departments

- At the end of a financial year Planning forecasts demand for all brands for 3 years in advance.
- Based on this forecast brewing planning or volume planning is done: Weekly brewing plans are formulated for the period until the end of the next financial year for all 7 breweries.
- Based on each brand's malt requirements and brewing volumes overall malt requirements are determined.
- Procurement sources malt from local and international malt producers.
- As a result of Procurement's negotiations with suppliers a schedule of available malt from local suppliers and imported malt to arrive at the harbour is created. This shows availability on a weekly basis.
- Planning uses the knowledge on malt availability and production plans for breweries in conjunction with feedback from breweries on available storage space to prepare a logistics plan. The logistics plan is fixed for the following month's malt transport and a tentative plan is prepared for the next two months in advance.

- Procurement arranges fleets to accommodate the logistics plan.
- Malt is transported to the breweries where the malt is consumed.

It is clear that Procurement is responsible for the large cost incurring activities of SAB which relate to materials, such as raw material purchases or arrangement with logistics contractors. Which costs to assign to specific volumes of material existing in different phases of the supply chain are however influenced by information from both departments. Due to the level at which SAB calculates PPV, it is possible for Procurement to calculate PPV using information that they primarily govern. CPV however is dependant on the specific logistical route a specific volume of material takes before being consumed at a specific brewery. This means that cost information from Procurement, logistics information from Planning and brewery specific volume information from Planning is necessary for calculating CPV. This means that a large part the problem is scattered information which needs to be consolidated before CPV can be calculated.

This however raises the question on whether it is an information management problem, or whether it is indeed also a forecasting problem. It is evident that Planning's original demand forecast is an input to volume plans, which determines the volumes that Procurement sources, both which influence logistics. The last three aspects mentioned all in turn influence CPV, in fact, if costing aspects are included the aforementioned list it includes all the primary inputs that influence CPV. Hence a forecast of a financial year's CPV would indirectly be driven by the first forecast of demand. If the relevant information based on the first forecast is available and can be processed in such a way as to obtain the expected CPV, is the expected CPV a forecast in its own right? Linking back to the briefly discussed aspect of variability in future variables, would the expected CPV calculation be a forecast in its own right if it takes into account possible variability on the relevant information? At this point it becomes necessary to consult the literature.

1.3 Summary

SAB's Procurement team in charge of brewing raw materials cannot verify savings opportunities relating to the price of consumed raw materials as no forecast for CPV exists and consequently the potential effect of improvement initiatives relating thereto cannot be forecasted. A forecast using currently implemented methods and systems cannot be done due to the following facts:

- Necessary information is scattered between departments and needs to be consolidated in some way.
- No current systems can take into account possible variability of future variables when determining expected values.
- A distribution plan for the required forecasting horizon does not exist.

2. Project Aim

The aim of this project is to design a model that can consolidate the available information from the relevant departments (inputs) and process it to deliver an expected CPV value, based on current operational trends, for the forecasting horizon (output) using available information. It must also be able to take different operational variables based on different strategies as input and forecast CPV based on these strategies in order to test them. The model will be compatible with current information systems that are used – mainly meaning that it must not be necessary to purchase new software. An estimation of logistics plans for an end-of-financial year planning horizon will be generated and input to the model that will extend the forecasting horizon. The logistics plan must be approved by planning in order to ensure that it will resemble actual future distribution as accurately as possible. The model will account for variability in planned values in order to provide the most accurately achievable output.

3. Project Scope

Based on Procurement needs from the model as expressed by its representative's and available time for project completion, the following boundaries have been established

- As HMF and SLM are the main raw materials used, the project will include a distribution plan and forecasts of CPV for only both major types of malt, SLM and HFM, for all 7 breweries for the next 12 months. The model may be adapted or simplified to accommodate other raw materials at a later stage.
- It will not include planning of demand or planning of production but rather assume that available plans are satisfactory and take it as input to the model.

4. Literature Review

4.1 Definition of a Forecast

The question on whether the determining of future CPV values is a forecast by its own right needs to be addressed.

Many different opinions exist in the literature regarding the strict definition of a forecast, especially when it is compared to another concept referred to as a prediction. (Freeman et al. 1979, p. 114). Some use the terms interchangeably or make no precise distinctions (Zarnowitz, 1968: 425) or (Theil, 1971). Others regard forecasts and predictions as distinct activities, but differ on the nature of the distinction, e.g. for one forecasts would be a subset of predictions and for another it would be the other way around. (Schuessler 1968: 418), (Choucri 1974: 63). Another opinion is that a forecast is a weaker activity due to a prediction being deductive and a forecast being inductive in nature, making a forecast less reliable (Hempel, 1965). Freeman et al (1979, p.117) attempts to clarify this in the following way: It is suggested that forecasts and predictions have 3 aspects in common namely that in general a relationship exists between certain outcomes under certain conditions, a claim that these conditions will exist at a certain future time, and a statement on the probability of certain outcomes happening at said future time under said conditions. If the statement on the probability of certain outcomes is based on the generalization of the relationship between the outcomes and certain conditions and the claim that the conditions will definitely occur, Freeman et al classifies it as a prediction. If the statement on probabilities is however based on generalization of the relationship between the outcomes and certain conditions and the claim that the conditions will occur based on some stated probability, then it is classified as a forecast.

The calculation of expected CPV adheres to the 3 aspects that are common to predictions and forecasts, however certain inputs such as material usage (discussed under the Method section), define certain circumstances with certain probability distributions. This implies that according to the suggested classification by Freeman et al the determining of future CPV values is in this case a forecast, which implies that it is a forecast by its own right.

4.2 Selecting a forecasting method

This project requires forecasting of raw material usage and raw material prices to forecast consumed price variance. Gentry et al. (2006, p56) suggested a way to classify forecasting methods based on two main factors, judgemental methods and empirical evaluated ideas, and naive and causal forecasting. The result was classification of methods as correlations, models, predictions and scripts. Correlations are forecasts based on performance of another factor, without making any causal assumptions and include methods such as extrapolation, analogies, and neural networks. Models are forecasts based on specific causal assumptions that can be described by mathematics and include methods such as expert systems, econometric models, and structural models. Predictions, as the name suggests, are speculated outcomes based on no specific causal assumptions and includes the Delphi method, conjoint analysis, and expert opinion. Scripts are speculative forecasts based on specific causal assumptions and include methods such as role playing, scenarios and traditional writings.

This forecast is based on causal assumptions such as a raw material distribution plan that will greatly influence when malt will be delivered and used at breweries. For this reason Predictions and Correlations as defined by Gentry can be ruled out.

Under the Models class expert systems use rules that experts use to make a forecast (Armstrong, 2001). Although certain expert opinions influence the inputs to the model, many calculations are needed that account for variability, ruling out expert systems. According to Gentry (p12) econometric models usually refer to regression models, which is also not a fit. Structural models "simulate the impact of important causal factors". Forrester (1958). Gentry's summary of Forrester does however not explicitly state whether this will provide the needed quantitative analysis.

Under the Scripts class role-playing makes use of subjects acting in certain roles in order to predict behaviour which is irrelevant in this case. Traditional writings aren't a match for self-explanatory reasons. According to Bright (1978) scenarios describe all possible future events in detail and use them to decide on what actions to take. This does not provide the qualitative output that is required.

Another option does however exist in the world of risk analysis. According to Evans (2010, p349) risk is the probability of occurrence of an undesirable outcome. Risk analysis techniques consider certain risks which by definition are events that have a probability of happening in the future. Inherent to risk analysis then is the making of predictions or forecast on the risk events on which risk managing decisions can be made. These techniques can be applied to other outcomes that may or may not be risk events in order to make predictions or forecasts thereon. As an example Evans explicitly refers to the output of a Monte Carlo simulation (which is a risk analysis technique) as forecasts. (Evans, 2010, p357). Also on p349; "Monte Carlo simulation is the process of repeatedly generating inputs to a decision model based on sampling from their assumed probability distributions, calculating the outputs and analyzing the results. Of particular interest are the distributions of the output variables, which characterize the likelihood that certain output values will be achieved." This technique can be tailored to take assumed distributions of model inputs such as logistics plan's delivery dates, raw material usage or prices, apply the model to the inputs and generate probability distributions for the outputs. This method can fall under the Models category of Gentry's classification grid due to it producing a forecast by taking certain explicitly defined causal assumptions that can be described mathematically as input and processes it to produce a forecast as output. Monte Carlo simulation also adheres to the aims of the model for use in with the project namely that it can produce a forecast, it can be modelled with readily available software such as spreadsheets and it can take into account a lot of variability. For these reasons it will be the method of choice for this project.

5. Summary of Available Information

5.1 Supply Networks

The first piece of relevant information to discuss is the supply networks used to transport malt from suppliers to breweries as the cost elements that relate to it summarises to one of the primary factors that makes the required CPV values more complex to calculate than the current PPV values. It also supports the understanding of the gathered input data that is to follow and how distribution planning is done. A map showing different site's approximate geographical positions in South Africa has been added in Appendix A in order to aid in the visualisation of the supply networks. This would also help clarify certain practical issues and constraints that drive supply networks. A diagram illustrating all optional supply routes, all that have been used in the past, has also been added in Appendix A.

Below are two diagrams illustrating currently used supply networks, one describing SLM supply and the other describing HFM supply. These describe routes and transport modes that are currently used and will be used for the foreseeable future. Each route and associated transport mode has a cost associated with its usage.

Note that currently all SLM is locally sourced and all HFM is imported. It is also worthy to mention that the intermediate storage capacity of Premier is avoided as it incurs extra cost. Also noteworthy is that both "bulk" and "containers" are imported by ship and transported inland by either rail or road depending on the specific link hence a single rate is used for each link.

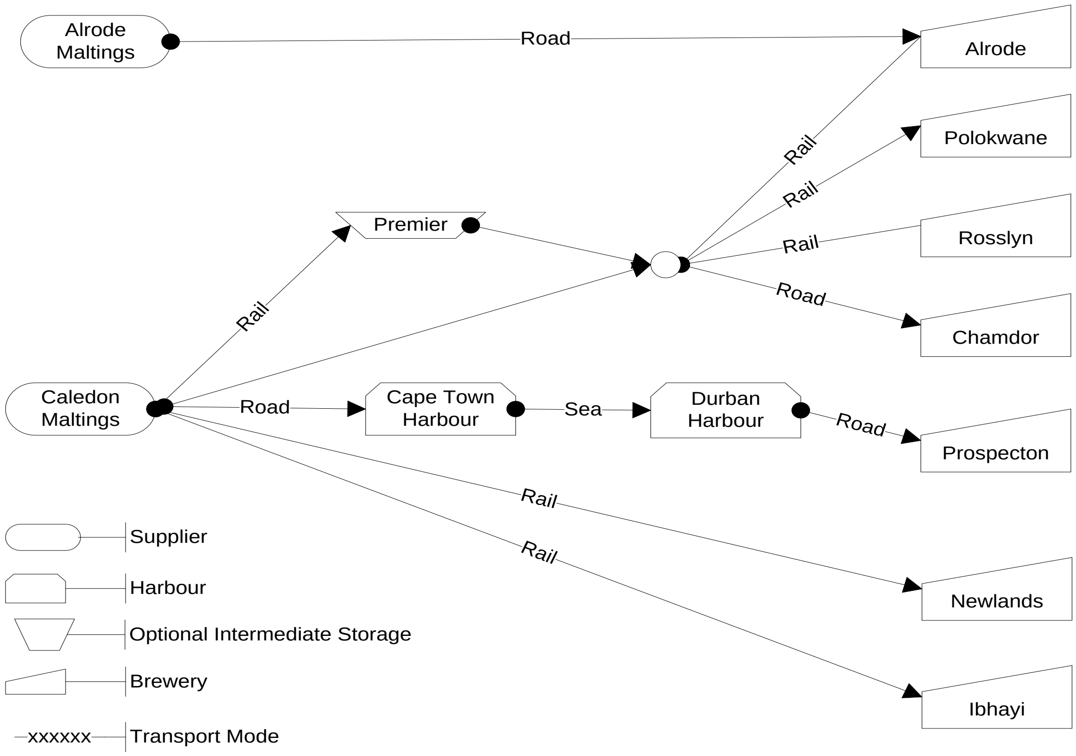

Figure 2: Current Supply Network for SLM

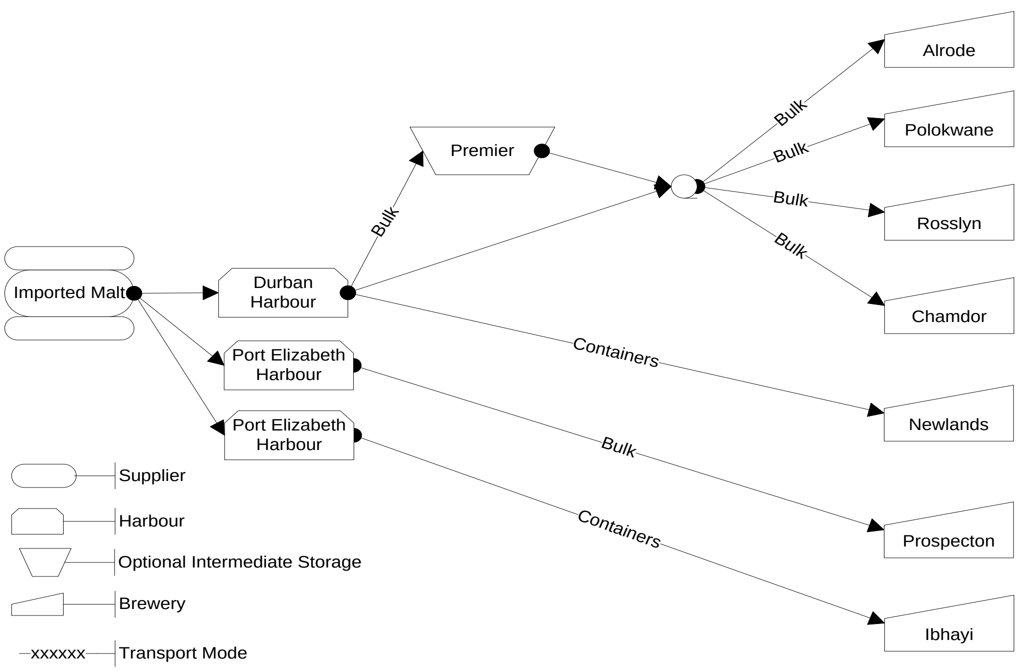

Figure 3: Supply Network for HFM

5.2 Data Sheets

Examples of actual sheets maintained by Planning and Procurement persons have been added Appendix B. In summary they include:

DS1: Existing 3 month logistics plan. This sheet contains the logistics plan that has been discussed earlier in this report. Planned dispatches of SLM from local producers (Caledon and Alrode) are tabulated under the SLM heading for each brewery. Note that Premier's storage is only used for imported malt in cases where problems occur and is as a rule not currently used. Planned imports to each brewery are given under the HFM heading and a colour code system is used to indicate transport mode. Imports dispatches for Newlands, Prospecton and Ibhayi will always be directly from the closest harbour. Import dispatches to the other four breweries will mostly be from premier. This is due to the fact that malt is imported in very large volumes to enable negotiating of a better price. In some cases imports do however get transported directly from Durban harbour to one of the aforementioned four the breweries. The specific link used is indicated on the Planning sheet using a "note" (see DS1) and inland logistics costs need to be allocated accordingly.

DS2: Weekly view on stock levels, receipts and usage. This sheet contains planned malt usages that have already been calculated based on Planning's weekly production schedule. It also contains the sum of each specific week's planned receipts at breweries based on the logistics plan, manually entered by Planning.

DS3: Part of a Procurement sheet containing purchase prices for malt. Sheet added for illustrative purposes.

DS4: Material availability and pricing on contract. This contains Planning's version of the schedule of available materials for purchases. DS4 shows the modified version of this sheet that the model uses to accommodate related purchase prices explained in the next section.

DS5: Logistics costs obtained from Procurement. This sheet contains contracted costs of moving malt through different links in the supply network.

6. Development of the Model

In order to solve Procurement's problem, the aforementioned data must be consolidated and used to forecast CPV. The data is available in Excel sheets and as Excel can be used quite effectively to generate random numbers used in Monte Carlo simulations. Based on the latter and the fact that part of the aim of the project is to develop a model that is compatible with currently used systems, Excel will be used to implement the model.

6.1 Consolidating Data to Calculate CPV

Consider the diagram below depicting information flow between data sheets and the model (which will also be built in Excel sheets as discussed).

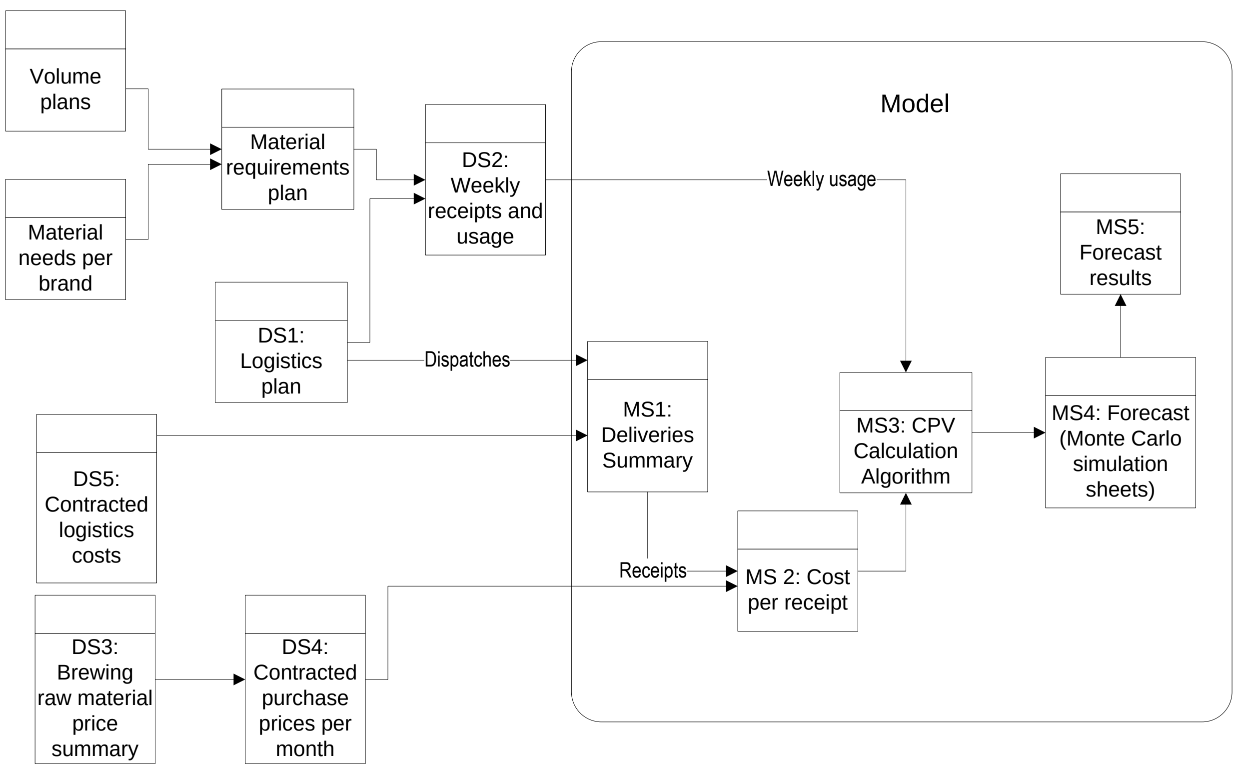

Figure 4: Information Flow Between Sheets

For the sake of clarity on where planned usage values originates from the flow from volume planning and material needs per brand into a material requirements plan which flows into DS2 has been indicated. This is however a piece of work that is already done by Planning for the desired forecasting horizon and will not be repeated in this project.

- DS1-DS2: It is however worth mentioning that the logistics plans from DS1 determine the receipts of DS2: The lead time needs to be added to the dispatch date according to the logistics plans in order to obtain the receipt date. The sums of all resulting receipts per week are documented in DS2. The implication of the fact that the sums of receipts are entered is that it is not possible to associate costs to the receipts accurately. It is needed to observe each delivery to each brewery and its associated cost individually in order to track costs accurately and compute CPV. Note that the way in which the information is presented in this sheet using colour codes and notes makes it difficult to pull through to different sheets using simple cell references.
- (DS1 and DS5)-MS1: The first model sheet, Deliveries Summary, is made necessary by the manual means by which logistics plans are generated and entered into worksheets. It is necessary to process this information manually in order to make it more usable in Excel and make the rest of the model more user-friendly. MS1 Contains a summary of all dispatches times, dispatch volumes, lead times, expected receipt dates, transport routes and resulting logistics costs for every expected receipt. This sheet is then used to view individual receipts and allocate costs to them as discussed above. The bit of work around adding lead times to dispatch times to obtain receipt times is already done by planning in order to compile its stock summary in DS2, it is simply not noted down. It follows logically that if MS1's receipts are summated over each week, it should equal the receipts of DS2. This can be used to test MS1's values against planning's values before variability is analysed (see discussion on adding variability to the model).

Disp Date	Disp Week	Material	Imp/Loc	From	To	Transport Mode	Lead Time	Expected Del Date	Del Week/Mo	Vol (t)	Tpt Rate
2011/09/05	week 22	SLM	Local	Caledon	Alrode	Rail	14	2011/09/19	week 24	xxx	R xxxx.xx
2011/09/06	week 22	SLM	Local	Caledon	Alrode	Rail	14	2011/09/20	week 24	xxx	R xxxx.xx
2011/10/05	week 26	SLM	Local	Caledon	Alrode	Rail	14	2011/10/19	week 28	xxx	R xxxx.xx
2011/10/11	week 27	SLM	Local	Caledon	Alrode	Rail	14	2011/10/25	week 28	xxx	R xxxx.xx
2011/10/12	week 27	SLM	Local	Caledon	Alrode	Rail	14	2011/10/26	week 29	xxx	R xxxx.xx

Figure 5: Summary of Deliveries (MS1)

- DS3-DS4: The modified sheet referred to as DS4 is used to summarise contracted purchase price information on a monthly basis which are obtained from Procurement's pricing sheets, part of which is illustrated in DS3. This information is entered manually when supplier contracts are negotiated and confirmed when contracts are confirmed.
- (DS4 and MS1)-MS2: MS2 is used to summarize all incurred costs relating each specific receipt. Thanks to the bit of work done in MS1, MS2 automatically pulls the individual receipts and their costs into sheets that can be used to as input to a CPV calculation.
- MS2 – Individual Receipts and Costs: Modified Planning sheet used to associate costs to specific receipts (identical sheets for SLM and HFM). Used for data consolidation, specifically adding material costs and logistics costs for each receipt.

Reciepts (tons)		week 23	week 24	week 25	week 26	week 27	week 28	week 29	week 30	week 31	week 32
		10-Sep-11	17-Sep-11	24-Sep-11	01-Oct-11	08-Oct-11	15-Oct-11	22-Oct-11	29-Oct-11	05-Nov-11	12-Nov-11
ALR	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										
	Reciept 4										
	Reciept 5										
CHA	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										
	Reciept 4										
	Reciept 5										
ROS	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										
	Reciept 4										
	Reciept 5										
POL	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										

Reciepts (R/t)		week 23	week 24	week 25	week 26	week 27	week 28	week 29	week 30	week 31	week 32
		10-Sep-11	17-Sep-11	24-Sep-11	01-Oct-11	08-Oct-11	15-Oct-11	22-Oct-11	29-Oct-11	05-Nov-11	12-Nov-11
ALR	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										
	Reciept 4										
	Reciept 5										
CHA	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										
	Reciept 4										
	Reciept 5										
ROS	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										
	Reciept 4										
	Reciept 5										
POL	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										

Figure 6: Sheet Showing Consolidated Delivery Volumes and Costs per Ton (MS2)

- MS3 – CPV Calculation Algorithm: DS2 and MS2 now contain necessary data on usage, receipts and costs packaged in such a way that it can be combined. Consider Figure 5 showing consolidated data for 2 weeks for one brewery for SLM. Note that the actual model consolidates weekly data for a 3 month forecasting horizon and further monthly data for an end-of-financial year forecasting horizon for each brewery for both SLM and HFM each with its own sheet, hence 14 MS3 sheets are used.

week 22

Intermediate Stock

-	Price	-	Price	Mix 1	Price	LOC1	Price	-	Price	LOC2	Price	ALD2	Price	LOC3
0.00	0.00	0.00	0.00	49.00	50.00	29.00	50.00	0.00	0.00	70.00	50.00	70.00	50.00	40.00

							Deliveries				Total Usage
Price	ALD3	Price	-	Price	ALD4	Price	LOC5	Price	ALD5	Price	
50.00	70.00	50.00	0.00	0.00	70.00	50.00	70.00	50.00	60.00	50.00	130.00

FIFO Usage								Forecast Cost								
Mix 1	LOC1	-	LOC2	ALD2	LOC3	ALD3	-	Mix 1	LOC1	-	LOC2	ALD2	LOC3	ALD3	-	
49.00	29.00	0.00	52.00	0.00	0.00	0.00	0.00	2450.00	1450.00	0.00	2600.00	0.00	0.00	0.00	0.00	

week 23

Intermediate Stock

Mix 1	Price	LOC1	Price	-	Price	LOC2	Price	ALD2	Price	LOC3	Price	ALD3	Price	-
0.00	50.00	0.00	50.00	0.00	0.00	18.00	50.00	70.00	50.00	40.00	50.00	70.00	50.00	0.00

							Deliveries				Total Usage
Price	ALD4	Price	LOC5	Price	ALD5	Price	LOC6	Price	ALD6	Price	
0.00	70.00	50.00	70.00	50.00	60.00	50.00	50.00	50.00	50.00	50.00	120.00

FIFO Usage								Forecast Cost								
-	LOC2	ALD2	LOC3	ALD3	-	ALD4	LOC5	-	LOC2	ALD2	LOC3	ALD3	-	ALD4	LOC5	
0.00	18.00	70.00	32.00	0.00	0.00	0.00	0.00	0.00	900.00	3500.00	1600.00	0.00	0.00	0.00	0.00	

Figure 7: Calculation Algorithm (MS3)

This sheet automatically pulls information from DS2 and MS2 for each week (or month) into the highlighted cells. To the left of the highlighted cells it shows the opening stock for the week (and consequently closing stock for the previous week) in order of original delivery. To the right of the highlighted cells it shows the results of the model's calculation on how the material will be used in a first-in-first-out basis (see model assumptions). To the right of "FIFO Usage" it uses the prices pulled from MS2 to calculate the forecasted cost of consumed material. Note that the size of the sheet i.e. the number of receipts in opening stock and number of new deliveries it tracks is dependent on the specific brewery and material.

This sheet consequently not only consolidates data, but also generates a possible future scenario. It can therefore also used to impose probability distributions any of the variables it contains, such as "Total usage", or "Price" if the specific price has not been fixed by a contract yet. (See discussion on adding variability to the model)

- MS4: In the forecasting part of the model a Monte Carlo simulation is done on each of the 14 "consolidation sheets"; Excel's "What If Analysis" (more on this when under section discussing variability) is used to generate many possible scenarios giving many possible CPV values, the summarising statistics of which gives the forecast price of consumed material. It also effectively gives a probability distribution for the CPV value which can be used in decision making when alternative strategies are considered.

Note that each simulation is run in a separate Excel workbook that pulls the information on usage and distributions from the MS3 sheets. This is done in order to have a level of control over when certain computations are done by the computer to avoid crashing – a single workbook containing a simulation can be opened, updated and closed again before the next is opened.

- MS5: Each of the aforementioned workbooks summarises simulation data and calculates weekly CPV as illustrated in Figure 6. Note that standard costs are pulled from Procurement's "Standard Costs" sheet.

	Forecast Cost	Forecast Usage	Forecast Cost/t	Std Cost/t	Tot Std Cost	CPV	Cumulative CPV
Week 22	1710.76	74.52	22.96	25.7415103	1918.135402	207.37	207.37
Week 23	1925.93	90.06	21.38	28.0903124	2529.947627	604.02	811.39
Week 24	2002.49	75.28	26.60	37.156052	2796.942477	794.45	1605.85
Week 25	1735.84	81.36	21.34	21.5468008	1753.070793	17.23	1623.07
Week 26	2045.79	110.28	18.55	23.6456588	2607.601086	561.81	2184.88
Week 27	1710.20	78.16	21.88	32.205378	2517.024207	806.82	2991.71
Week 28	2388.09	106.78	22.36	28.9933545	3095.89938	707.81	3699.52
Week 29	1985.39	75.59	26.27	24.4611929	1848.970631	-136.42	3563.10
Week 30	2033.70	70.42	28.88	23.5503195	1658.307457	-375.40	3187.70
Week 31	1597.12	65.44	24.40	24.3986722	1596.736541	-0.38	3187.32
Week 32	1610.14	103.65	15.53	29.1472543	3021.057345	1410.92	4598.23
Week 33	2252.69	70.29	32.05	38.321661	2693.441049	440.75	5038.98
Week 34	1410.61	65.52	21.53	29.6410009	1941.988278	531.38	5570.37

Figure 8: Illustration of Simulation Summary Data for a Single Brewery

Summary data from the 14 simulation workbooks get pulled back to the original workbook where total CPV is calculated. See Figure 7.

	Alrode	Chamdor	Prospecton	Newlands	Polokwane	Ibhayi	Rosslyn	Total SAB per week
week 22	-45.30	40.91	197.04	184.31	16.60315044	176.16	257.8783283	872.89
week 23	205.55	83.67	133.88	144.21	53.73275515	-165.58895	-98.0469516	151.85
week 24	-134.78	-28.97	-107.86	283.16	153.2585024	-171.713138	43.27020643	171.16
week 25	-72.64	-14.65	218.98	-132.01	224.345011	193.386629	-107.27834	382.78
week 26	181.96	-10.46	-129.63	-14.20	207.2389662	-8.94947578	-168.986618	-124.98
week 27	232.92	-27.82	66.87	-87.42	235.434637	-31.8603028	103.6879942	258.89
week 28	135.30	180.57	163.16	230.92	-3.885054647	261.670706	-12.3282845	820.11
week 29	190.89	233.29	1.19	61.68	-176.866443	180.905461	-73.220672	226.98
week 30	92.45	179.45	118.63	-109.67	109.2168411	-198.200872	270.1706374	369.61
week 31	172.07	124.22	-36.67	173.81	-33.95169008	-123.855611	-106.577548	-3.02
week 32	-58.97	286.46	100.07	1.59	-132.7586726	-128.482854	-100.308005	26.56
week 33	-107.16	255.27	123.41	30.40	129.3019403	-83.1686469	200.7959865	656.00
week 34	282.09	-19.31	-60.82	66.04	-0.910154185	68.8093236	158.4520373	212.26
Total	1074.37	1282.63	788.26	832.81	780.76	-30.89	367.51	4021.08

Figure 9: Illustration of Summation of CPV per Brewery to Obtain Total CPV

6.2 Adding Variability to the Model

Note that the above sheets as described only calculate a possible scenario of weekly CPV values based on expected or planned values. The advantage however of having Excel automatically read and calculate values from input sheets is that should a value in an input cell be replaced with a random number that excel generates, the dependent cells in the subsequent sheets automatically reads the newly generated value and recalculates its own value. If such a random value generated by Excel is used for certain inputs the effect is that the model calculates a new possible scenario of CPV values each time new random values are generated. The model specifically enables adding variability to the following:

Transport Lead Times (MS1)

For the sake of aiding in the visualisation of how values would change in sheets an example using screenshots focussing on changing values is given for transport lead times.

Consider the diagrams below illustrating two scenarios based on random numbers generated for lead times and the effect it has on the rest of the model.

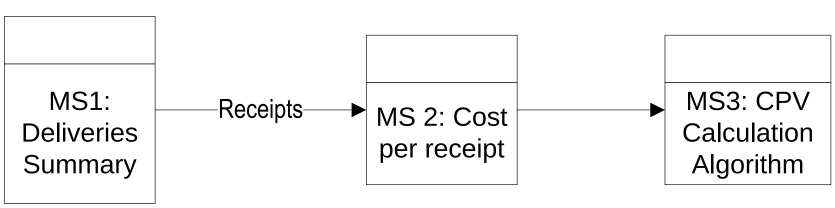

Figure 10: Sheets Affected by Variability in Transport Lead Time

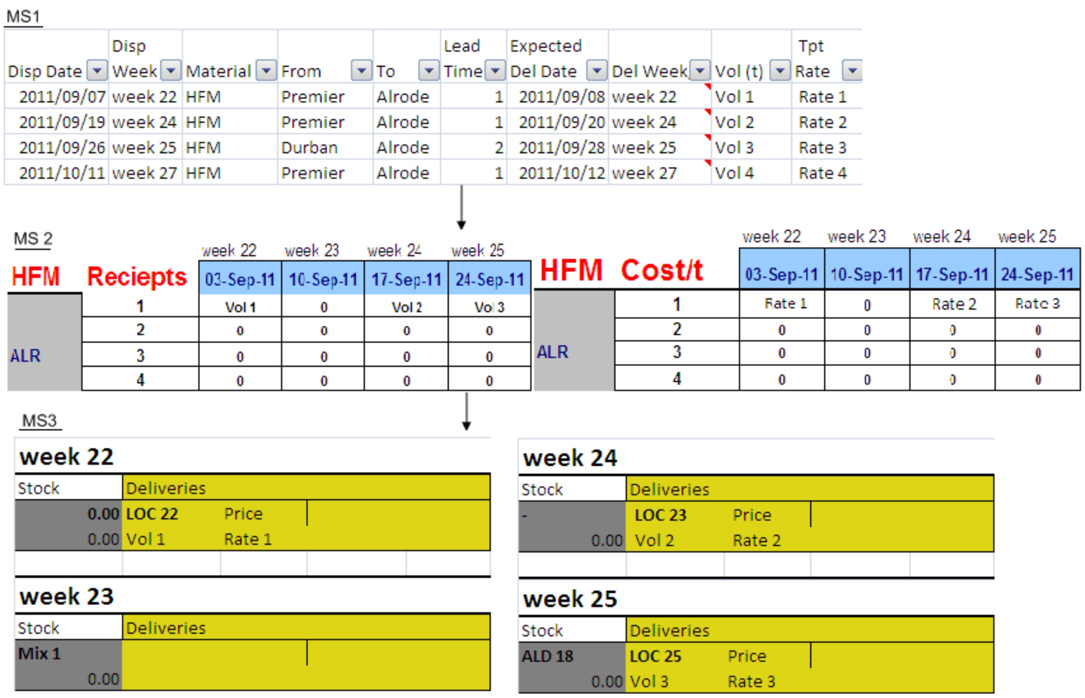

Figure 11: Variable Lead Time Scenario 1

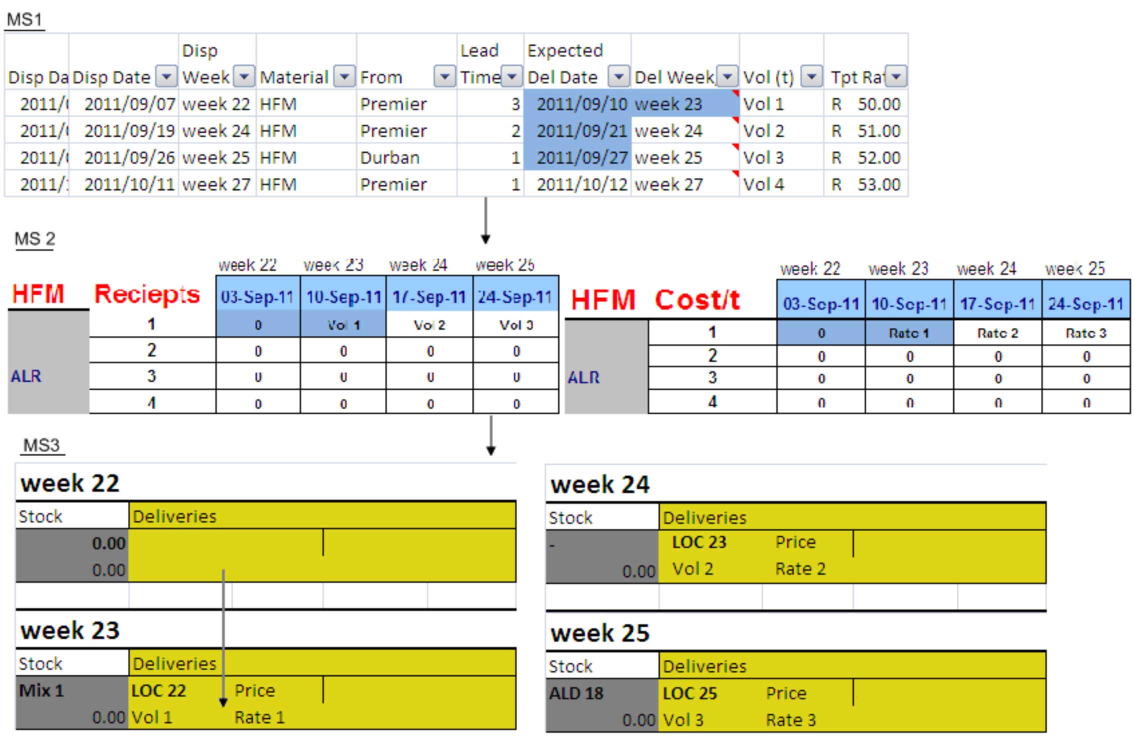

Figure 12: Variable Lead Time Scenario 2

Logistics Cost Rate

When transport rates for a specific delivery hasn't been fixed on contract or if it is uncertain which route or transport mode a certain delivery will take it, then it is uncertain what the related logistics costs will be and it may be desirable to assign a probability distribution to this value.

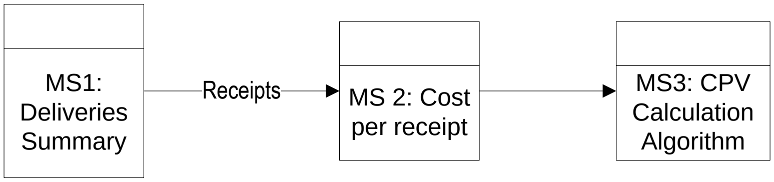

Figure 13: Sheets Affected by Variability in Logistics Costs

Purchase Prices

When a forecast with a forecasting horizon for which purchase prices have been contracted is being done, then these values will be constant. For a forecasting horizon beyond that of a contract period these values will be assigned probability distributions influenced by economic forecasts and expert opinion. Sheets affected by variability in Purchase prices are as such:

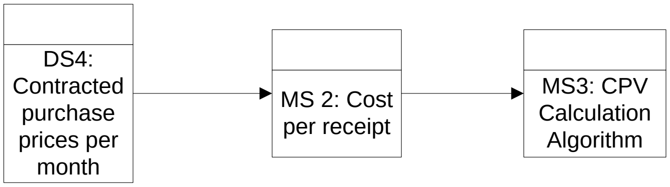

Figure 14: Sheets Affected by Variability in Purchase Price

Weekly Material Usage

Probability distributions for material usage can be imposed directly onto the copy of Planning's DS2 sheet. If it is undesirable to edit this, however, it can also be imposed directly onto the calculation sheets of MS3 keeping in mind that the latter will take longer is it requires input to 14 sheets instead of 1.

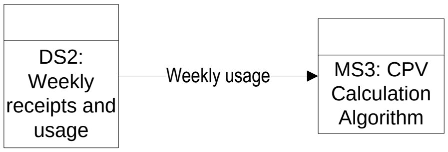

Figure 15: Sheets Affected by Variability in Weekly Material Usage

Business or Process Rules

It is necessary to note at this point that not only variability in inputs can be imposed on these sheets, but also business rules affecting model values. The summation of stock items and the adjustment of planned usage values according variation between actual and planned usage (see model assumptions) are examples of such rules.

Summarising Many Generated Scenarios

It is now clear that the model can generate a possible scenario for values contributing to CPV based on expected values. It can also generate many more possible scenarios based on variable inputs, created by assigning values generated from probability distributions to the variables. However, it would be impractical to manually command Excel to generate new scenarios and manually note down these values for summarising.

Excel provides a practical solution that it calls "What-If Analysis". When using this function, one selects a cell in a worksheet for Excel to analyse. Excel takes into account all other formulae and cells that influences the selected cell's value and automatically generates as many different possible values for this cell as it is commanded to. For this model the total cost of consumed material or "Consumed Price" is used, however, it should be noted that it can be used to analyse consumed prices for any or all weeks, for usage values, stock levels etc.

6.3 Summary

The largest bit of manual work when using the model is the completion of MS1. The rest simply includes addition of material prices (and pricing probability distributions) in MS2, copying Planning's DS2 sheet into the model (and imposing probability distributions if necessary) and then the model automatically runs Monte Carlo simulations on the sheets of MS4 when the are opened and closed and results are summarised in MS5.

Currently results are total CPV values for September 2011 to March 2012, but model can be adapted to give different information if necessary.

6.4 Model Assumptions

Based on available information and certain business rules applied at SAB the following assumptions are imposed on the model:

1. The model will assume that the demand forecast and subsequent planning variables is satisfactory and use it as an input.
2. Stocks are used on a first-in-first-out basis.
3. Each brewery has its own tailored number of deliveries to be carried over as stock between weeks. If too little space is kept in the calculation sheet (MS3) the model uses the total volume and weighted average price to create a new imaginary "mixed" delivery. The model however tracks enough deliveries that this will occur very rarely and that the CPV forecast would not be influenced significantly.
4. If the usage for a certain week differs from the planned value by too great a margin, defined for each brewery based on manager's opinion, then the next week's planned production volume would be adjusted accordingly.
5. Prices for contracted periods are fixed. Prices for forecasting horizons further into the future than contract periods will have a probability distribution.

7. Model Output

In order to illustrate the model's output two hypothetical cases will be demonstrated for Alrode Brewery's CPV calculation for SLM.

In the first case all values are kept static accept for weekly material usage. Each week's material usage is quantified with a normal distribution with mean equal to its planned value and standard deviation equal to 3.5% of the planned value. Model assumption 1 has also been applied. Results for Total CPV for the period of September 2011 to March 2012 are obtained. Results of generating 500 possible scenarios has been added in Appendix C.

In the second case material purchase prices are also varied based on a hypothetical forecast of next year's prices, i.e. this year's prices are constant, but January to March will have a slightly higher expected value and will be defined by a probability distribution. Delivery lead times are varied. Variable weekly usage and assumption 4 is imposed as in the first case. Results of generating 500 possible scenarios has been added in Appendix C.

Results are summarised as follows.

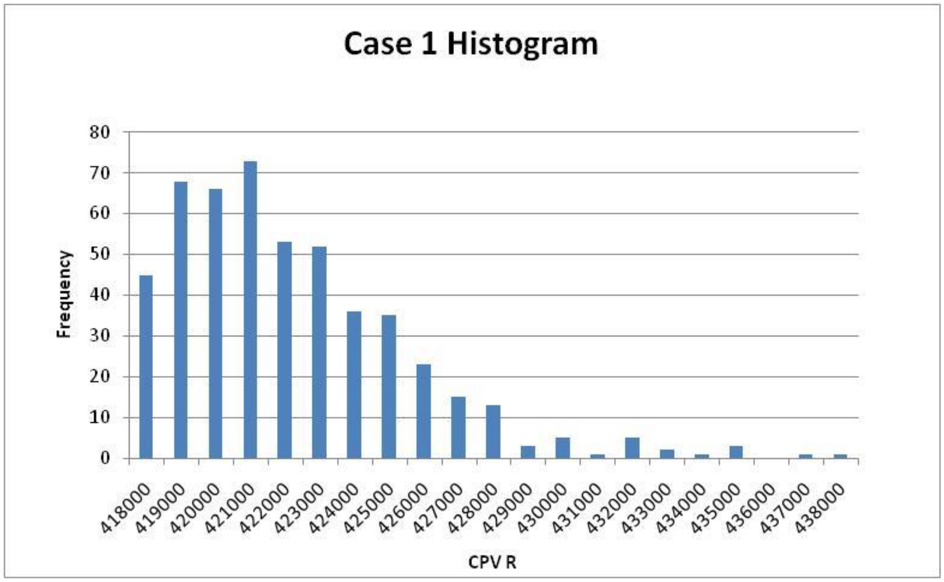

Figure 16: Histogram of Simulation Output for CPV in Case 1

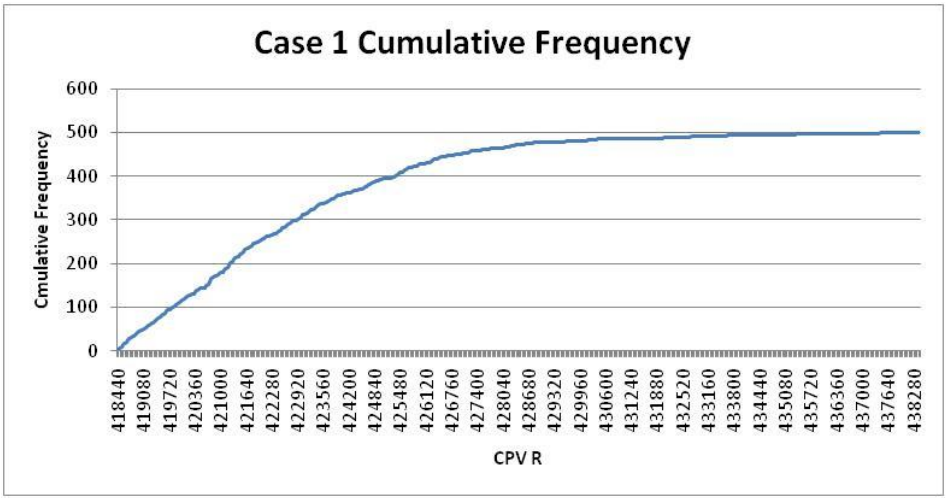

Figure 17: Cumulative Frequency of Simulation Output for CPV in Case 1

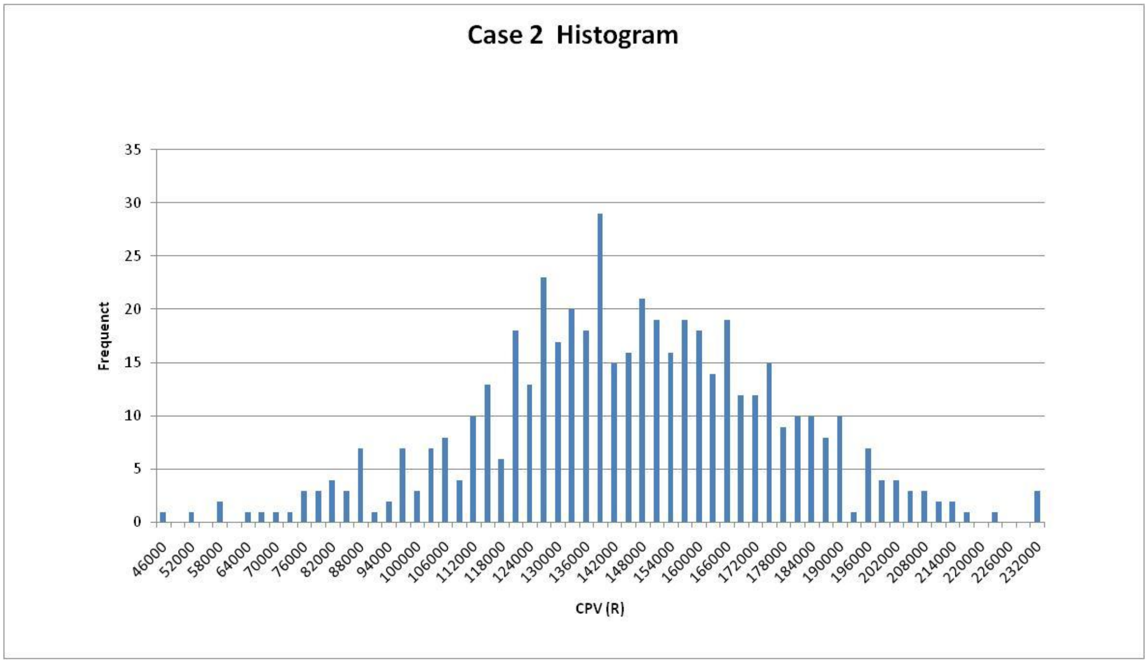

Figure 18: Histogram of Simulation Output for CPV in Case 2

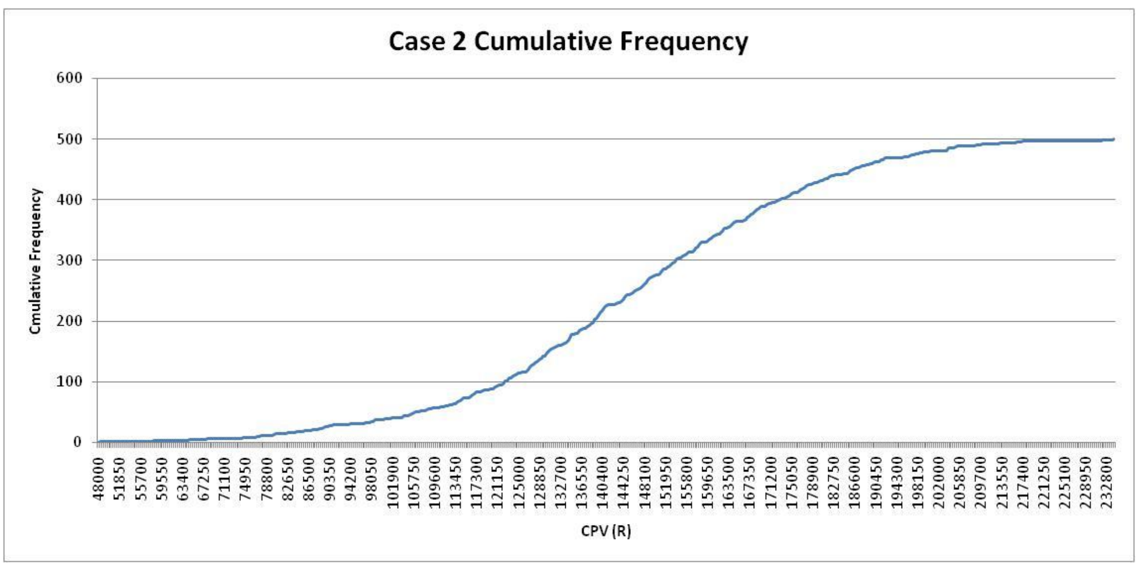

Figure 19: Cumulative Frequency of Simulation Output for CPV in Case 2

	Case 1		Case 2	
Minimum	R	418,455.93	R	48,387.22
Mean	R	422,570.09	R	146,641.54
Maximum	R	438,449.45	R	234,547.55
Standard Deviation	R	3,269.25	R	31,573.20

Figure 20: Summary Statistics for Simulation Case 1 and Case 2

Case 1 shows that the total CPV for the forecasting period would be between R 418 455.93 and R 438 449.45 with an expected value of R 422 570.09. The small range implies that the model does not describe a lot of variability and CPV can be forecasted very accurately. This is due to the fact that in case 1 only usage is variable whereas in reality other inputs would also be variable. The business rule that adapts a week's planned usage values according to the variation in the previous week's usage also causes total usage for the forecasting period to lean towards the planned value and this reduces variability further. The value is also very optimistic because it doesn't take into account possible price changes in 2012.

Case 2 shows an expected total CPV of R 146 641.54, but indicates that it can still be expected that the actual value will fall between R 48 387.22 and R 234 547.20. The wider range indicates the larger uncertainty that arises due to the fact the variability in purchase price is taken into account. The smaller expected value is caused by the fact that possible price increases is considered when the probability distribution of 2012 purchase prices are determined.

Depending on the decisions to be made, other analysis can also be done with the data such as the probability that CPV would be larger or smaller than a critical value or the probability that it would fall between certain critical values.

8. Model Testing

The information that the model can process and the variability that it can take into account when making a forecast has been discussed. Before using the model's output to base real decisions on it is necessary to test its validity. This has been done in the following way - Please note that although the model currently has the capability to forecast CPV for all breweries, not all input data is currently available as different breweries keep different records. Due to availability of data Alrode is used to test the model: Input data as described above exists for historical operations as from beginning April 2011 to end August 2011. This information was used as input to the model and a Total CPV forecast for the period April 2011 to August 2011 was generated. More specifically:

- Logistics plans with dispatch dates: Latest versions of each month's logistics plans were used.
- Transport lead times: Normal distributions with mean lead times and standard deviations based on figure 21, used by Planning, were implemented when running the simulation. For transportation links where no information is available static values were used.
- Logistics cost rate: Contracts for the relevant period were fixed. Logistics cost values were however scaled according to the lead time of a generated scenario to account for costs incurred (or saved) by long or short lead times.
- Purchase prices: Contracts for the relevant period were fixed and static values were used in the simulation.
- Weekly material usage: Varied according to Alrode's operations manager's analysis of variation between planned and actual production. Model assumption 4 was imposed.

Transportation Lead Time						
	Durban (Road Rail Combo)	Cape Town	Port Elizabeth	Caledon	Alrode	Premier (Trucks)
Alrode	2	-	-	14	0	1
Rosslyn	2	-	-	16	-	1
Chamdor	2	-	-	2	-	1
Polokwane	2	-	-	15	-	1
Prospecton	1	-	-	14	-	1
Ibhayi		3	1	5	-	2
Newlands		1	4	2	-	1

Transportation Lead Time Std Deviation						
	Durban (Road Rail Combo)	Cape Town	Port Elizabeth	Caledon	Alrode	Premier (Trucks)
Alrode	0.5	5	2	5	-	0
Rosslyn	2	3	4	8	0	0
Chamdor	2	3	4	9	-	0
Polokwane	2	3	4	8	-	0
Prospecton	2	3	0.5	5	-	0
Ibhayi	4	5	6	4	-	0
Newlands	20	2	3	7	-	0

Figure 21: Mean and Standard Deviation of Transportation Lead Times

Actual values:

- Actual production values for April to August, drawn from SAP, is multiplied by the standard rate for Alrode to obtain each month's standard cost.

- Actual material cost values for April to August, also drawn from SAP, is subtracted from each month's standard cost in order to obtain actual CPV for April to August.

The relation between forecast CPV and actual CPV is used to test the model's validity.

As actual volume and cost values can't be included in this report the percentage difference between each month's actual and forecast values used in this analysis:

	% Difference
April	14.11
May	6.42
June	1.31
July	12.47
August	10.43
	8.95

Figure 22: Model Test Results

According to this analysis one can expect that, for any month, the forecast would be within 14.11% of the actual CPV and for a total CPV with a 5 month forecasting horizon one can expect the forecast CPV to be about 9% accurate. It is necessary to note that this analysis was done using actual logistics plans from Planning which were available as historical values were used; hence the estimation of logistics plans for a beyond-3 month forecasting horizon was not necessary as it would be for an actual forecast. One can thus expect that the results from this analysis would apply to a forecast with a 3-month forecasting horizon and that forecasts for the successive months will be less accurate.

9. Conclusion

Procurement needs a CPV forecast in order to determine potential benefits of certain projects.

The literature has been consulted and it has been established that it is possible to solve. A model has been developed that consolidates information influencing CPV values and applied Monte Carlo simulation to forecast these values.

The model can also accommodate many different inputs and can apply variability to all values it describes and for this reason it can be used to forecast CPV for many different strategies based on many different assumptions (as partly illustrated in the model output section).

With only slight modifications, the model cab analyse other aspects such as stock levels based on given inputs and assumptions. More specifically it numerically defines probability distributions for all these outputs. This can aid in decision making when considering different strategies.

When applying the model to the current trends it is expected to give 9% accurate forecasts for a forecasting horizon smaller than three months, but less accurate for a longer forecasting horizon. This is due to the uncertainty caused by the fact the logistics plans are only generated for a three month planning horizon.

It can be recommended that a joint initiative between Planning and Procurement be started to lengthen the logistics planning horizon in order to be able to generate better forecasts for longer forecasting horizons. This can be included in the strategies that the model will test.

The next step would be to use the actual model to test strategies such as using different transport modes or routes, using more or less intermediate storage or keeping more or less stock.

An interesting addition to the model would be to take into account holding cost of stock at breweries and revisit current and optional strategies.

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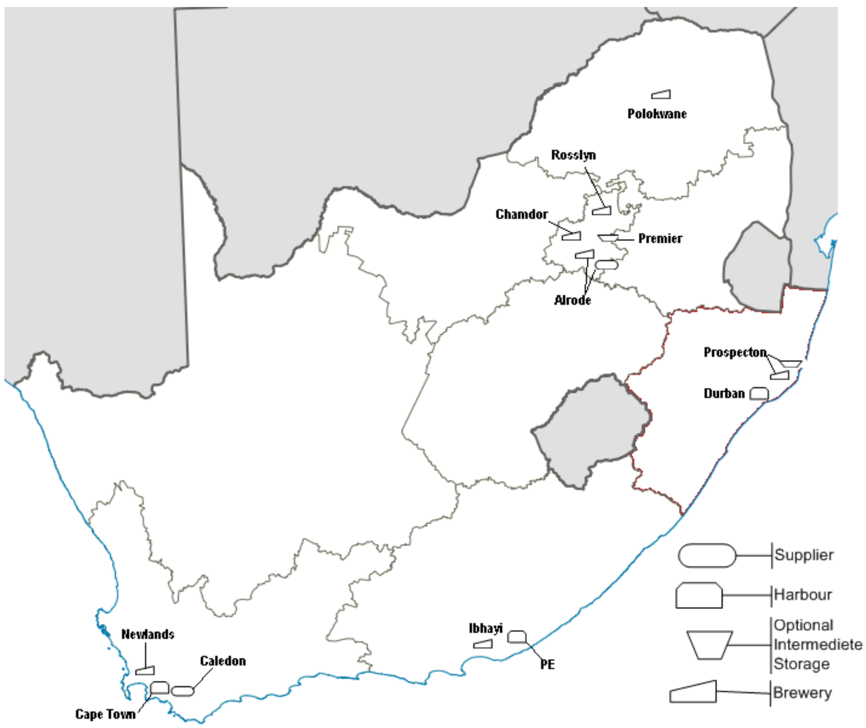
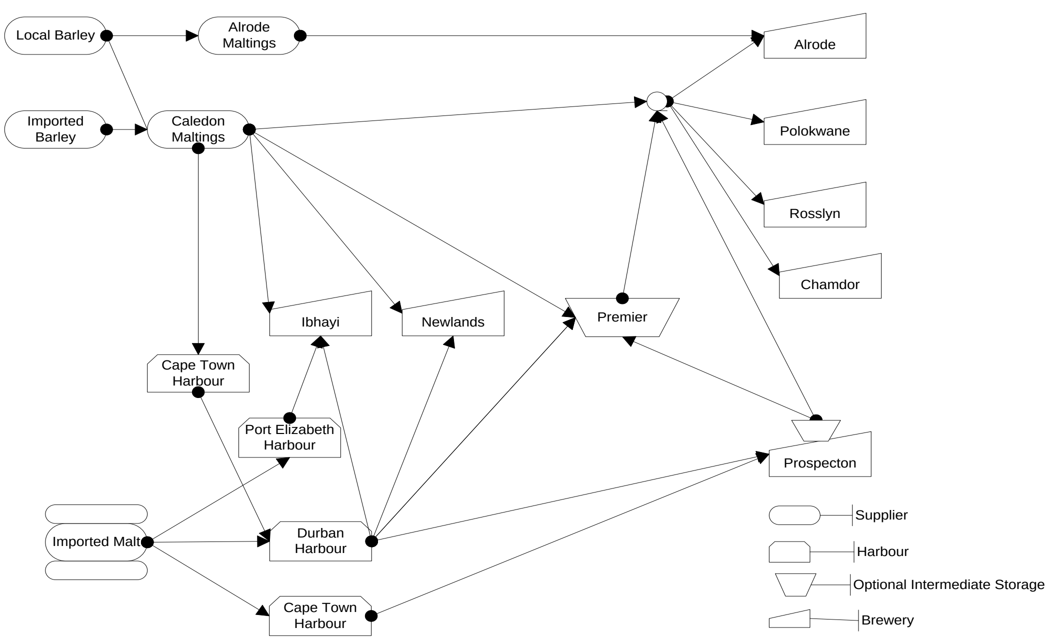
Appendix A:

South Africa Locality Map



Network of Possible Supply Routes



Appendix B

Data Sheets

DS1: Existing 3 month logistics plan

Apply for permit | Transportation TBD

SAB September Logistics Plan

Month **September 2011**

Rail | Road | Sea | Bulk Imports | Container Imports

		ALRODE						CHAMDOR						IBHAYI					
		Caledon		Imports				Caledon		Imports				Caledon		Imports			
Date	Day	HFM	SLM	HFM	SLM	Other	Total	HFM	SLM	HFM	SLM	Other	Total	HFM	SLM	HFM	SLM	Other	Total
2011/09/05	Mon		x				0						0			x			0
2011/09/06	Tue		x	x (From Premier)			0						0						0
2011/09/07	Wed		x				0						0		x				0
2011/09/08	Thu						0						0						0
2011/09/09	Fri						0						0						0
2011/09/10	Sat						0						0						0
2011/09/11	Sun						0						0						0
2011/09/12	Mon						0						0			x			0
2011/09/13	Tue						0						0						0
2011/09/14	Wed						0						0						0
2011/09/15	Thu						0						0						0
2011/09/16	Fri						0						0		x				0
2011/09/17	Sat						0						0						0
2011/09/18	Sun						0						0						0
2011/09/19	Mon			x (From Premier)			0		x				0			x			0
2011/09/20	Tue						0						0		x				0
2011/09/21	Wed						0						0						0
2011/09/22	Thu						0						0						0
2011/09/23	Fri						0						0						0
2011/09/24	Sat						0						0						0
2011/09/25	Sun						0						0						0
2011/09/26	Mon			x (Direct from port)			0						0			x			0
Total		**0**	**0**			**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
PO tonnage [+10%]		0	0			0	0	0	0	0	0	0	0	0	0	0	0	0	0

DS2: Weekly view on stock levels, receipts and usage. (Identical sheets for SLM and HFM)

SLM		10-Sep-11	17-Sep-11	24-Sep-11	01-Oct-11	08-Oct-11	15-Oct-11	22-Oct-11	29-Oct-11	05-Nov-11	12-Nov-11
ALR	OS										
	Usage										
	Receipts										
	Closing stocks										
	WOC										
CHA	OS										
	Usage										
	Receipts										
	Closing stocks										
	WOC										
ROS	OS										
	Usage										
	Receipts										
	Closing stocks										
	WOC										
POL	OS										
	Usage										
	Receipts										
	Closing stocks										
	WOC										
IBH	OS										
	Usage										
	Receipts										
	Closing stocks										
	WOC										
PRO	OS										
	Usage										
	Receipts										
	Closing stocks										
	WOC										
NEW	OS										
	Usage										
	Receipts										
	Closing stocks										
	WOC										
SAM ALR	OS										
	Output 21 days										
	Receipts										
	Despatch										
	Closing stocks										

DS3: Part of a Procurement sheet containing purchase prices for malt

Brewing Raw Material Price Summary 2011

Malt Actual Prices			2011	
SLM Type B - SAM Local Dryland	R / Tonne			A weighted average price is used for the sake of simplicity
SLM Type B - SAM Local Irrigated	R / Tonne		xxx	
SLM Type B - SAM (Imported Barley)	R / Tonne			
SLM Type B - Import	R / Tonne	xxx		
HFM Type A - SAM Import	R / Tonne	xxx		
HFM Type A - Import	R / Tonne	xxx		

DS4: Material availability and pricing on contract

SLM	AUG		SEP		OCT		NOV		DEC	
	tons	Price	tons	Price	tons	Price	tons	Price	tons	Price
Opening Stock OPS										
SAB Usage OPS										
Receipts Imports										
Caledon Output (14 days)										
ALRM Output (21 days)										
Total Receipts (tons|Rands)										
Closing Stock										
WOC										
Target										

HFM	AUG		SEP		OCT		NOV		DEC	
	tons	Price	tons	Price	tons	Price	tons	Price	tons	Price
Opening Stock										
SAB USAGE										
Bulk Import										
Container Import										
Caledon Output (14 days)										
ALRM Output (21 days)										
Total Reciepts (tons|Rands)										
Closing Stock										
WOC										
Target										

DS5: Logistics costs obtained from Procurement

Contracted Costs: Logistics

MALT STORAGE

Ensign	Comment	F11		F12		
Imported Malt		Storage	Handling out	Storage	Handling out	Total
6000mts	Fixed					
Overflow	Variable					

Prospecton	Comment	F11		F12			
Imported Malt		Storage	Handling out	Storage	Handling out	Tons/other	Total
mts	Fixed						
Overtime	Variable						
						Total	**R 0**

Premier	Comment	F11		F12			
Local Malt		Storage	Handling out	Storage	Handling out	Tons/other	Total
	Fixed						
Overtime	Variable						

MALT TRANSPORT

Caledon to Prospecton	Container Capacity tons	F11				F12 Rate/ton	
		incl insurance	Fuel Surcharge	Cost per ton	F12 Budgeted increase (Ave CPI & PPI)	Rate/ton	Rate per container
Containers							

MALT TRANSPORT (RAIL)

Caledon to breweries	F11	Proposed F12 Increase	Proposed F12 Energy Levy	F12 Rate/ton		F12 Budgeted volume	F12 Budgeted Split by Region
Regions	Rate/ton			Rate/ton	Rate per wagon		
Chamdor							
Premier							
Rosslyn							
Polokwane							
Prospecton							
Newlands							
Ibhayi							
Alrode							
					Totals	-	**1.00**

MALT TRANSPORT (ROAD)

Caledon to breweries	F11	Proposed F12	F12 Rate/ton		F12 Budgeted volume	F12 Budgeted Split by Region	F12 Estimated Spend
Regions	Rate/ton		Rate/ton	Rate per load			
Chamdor							
Premier							
Rosslyn							
Polokwane							
Prospecton							
Newlands							
Ibhayi							
Alrode							
				Totals			**R 0.00**

IMPORTED MALT DISTRIBUTION - PRIMARY

	F12 Planned tons	F11 Rate/ton	F12 Budgeted Increase	F12 Rate per ton	F12 Estimate Spend
Prospecton					
Ensign					
				Total	**R** -

MALT FROM PROSPECTON - SECONDARY

	F12 Planned tons	F12 Budgeted split by Region	F11 Rate/ton	F12 Budgeted Increase	F12 Rate per ton	F12 Estimate Spend
Alrode						
Chamdor						
Rosslyn						
Polokwane						
Premier						
				Totals		**R** -

MALT FROM PREMIER TO BREWERIES

MS2: Modified Planning sheet used to associate costs to specific receipts (identical sheets for SLM and HFM)

		week 23	week 24	week 25	week 26	week 27	week 28	week 29	week 30	week 31	week 32
Reciepts (tons)		10-Sep-11	17-Sep-11	24-Sep-11	01-Oct-11	08-Oct-11	15-Oct-11	22-Oct-11	29-Oct-11	05-Nov-11	12-Nov-11
ALR	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										
	Reciept 4										
	Reciept 5										
CHA	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										
	Reciept 4										
	Reciept 5										
ROS	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										
	Reciept 4										
	Reciept 5										
POL	Reciept 1		x	x	x	x	x	x	x	x	x
	Reciept 2			x		x		x			
	Reciept 3										

		week 23	week 24	week 25	week 26	week 27	week 28	week 29	week 30	week 31	week 32
Reciepts (R/t)		10-Sep-11	17-Sep-11	24-Sep-11	01-Oct-11	08-Oct-11	15-Oct-11	22-Oct-11	29-Oct-11	05-Nov-11	12-Nov-11
ALR	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										
	Reciept 4										
	Reciept 5										
CHA	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										
	Reciept 4										
	Reciept 5										
ROS	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										
	Reciept 4										
	Reciept 5										
POL	Reciept 1		Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx	Rx
	Reciept 2			Rx			Rx		Rx		
	Reciept 3										

Appendix C

Results of Simulation Case 1

R	422,287.23	R	429,133.97	R	426,009.51	R	422,778.10	R	419,437.26	R	418,505.01	R	421,852.54
R	422,452.84	R	422,393.36	R	419,063.25	R	420,952.94	R	420,260.87	R	419,339.11	R	423,574.38
R	424,101.06	R	420,464.79	R	421,780.73	R	419,089.54	R	423,461.61	R	419,086.25	R	419,142.96
R	418,963.83	R	421,825.28	R	419,278.37	R	424,990.35	R	418,854.30	R	420,687.06	R	418,551.71
R	422,561.60	R	431,266.39	R	429,108.52	R	418,730.76	R	421,892.16	R	424,298.40	R	419,398.00
R	420,268.74	R	421,296.66	R	421,027.18	R	421,758.71	R	421,250.57	R	418,590.62	R	423,195.97
R	419,595.44	R	418,882.42	R	421,803.15	R	421,597.22	R	418,494.74	R	423,767.78	R	419,297.40
R	420,870.42	R	426,907.27	R	430,096.50	R	426,522.20	R	419,062.35	R	421,281.22	R	421,715.34
R	432,088.63	R	426,128.54	R	420,352.56	R	422,333.11	R	419,499.60	R	420,648.00	R	418,581.62
R	430,266.77	R	433,529.19	R	419,295.77	R	423,114.41	R	426,087.93	R	426,410.64	R	422,795.43
R	423,128.92	R	422,221.31	R	422,433.78	R	426,065.67	R	418,675.77	R	419,737.05	R	419,633.75
R	421,644.77	R	424,638.23	R	424,589.27	R	418,869.13	R	419,200.69	R	424,081.69	R	419,257.26
R	418,660.88	R	427,416.10	R	420,251.49	R	419,324.50	R	421,400.41	R	430,750.81	R	423,105.93
R	420,268.54	R	425,570.99	R	420,530.01	R	421,822.17	R	419,782.60	R	421,969.26	R	427,190.37
R	420,269.48	R	425,344.67	R	420,322.24	R	418,780.27	R	422,551.48	R	419,100.71	R	424,593.93
R	419,174.50	R	426,294.94	R	418,690.86	R	420,831.25	R	419,190.96	R	419,420.39	R	420,916.81
R	419,970.76	R	418,782.58	R	423,594.38	R	420,462.01	R	425,881.55	R	418,662.05	R	428,271.19
R	420,036.47	R	424,378.29	R	431,483.90	R	425,502.49	R	422,786.31	R	421,019.72	R	424,408.81
R	425,516.53	R	418,987.35	R	420,863.65	R	420,557.66	R	421,738.23	R	419,825.29	R	420,047.23
R	420,817.66	R	421,414.82	R	420,709.10	R	421,056.34	R	420,793.81	R	428,108.19	R	418,703.02
R	423,377.91	R	422,770.65	R	420,343.51	R	418,562.71	R	421,127.48	R	419,595.90	R	419,375.74
R	418,807.76	R	421,208.45	R	421,977.29	R	423,093.84	R	429,922.18	R	422,905.44	R	423,714.35
R	423,893.71	R	426,168.87	R	428,658.93	R	421,764.32	R	422,233.45	R	426,463.91	R	423,919.13
R	420,971.27	R	419,824.94	R	426,301.91	R	423,999.05	R	420,100.43	R	422,037.94	R	420,629.35
R	423,759.58	R	425,489.66	R	423,824.28	R	424,438.33	R	420,699.74	R	423,389.27	R	423,994.96
R	420,593.21	R	419,596.91	R	427,210.27	R	423,344.25	R	418,456.53	R	423,246.60	R	420,253.62
R	432,711.69	R	425,095.10	R	420,960.39	R	419,783.79	R	422,648.85	R	418,781.34	R	420,059.46
R	423,000.13	R	430,628.53	R	420,905.50	R	428,726.15	R	418,706.78	R	421,815.74	R	425,812.06
R	419,635.51	R	422,797.87	R	418,906.51	R	420,684.30	R	423,593.80	R	428,362.08	R	421,427.84
R	423,899.21	R	422,261.44	R	420,926.41	R	423,681.46	R	418,590.70	R	428,533.12	R	421,087.59
R	419,046.50	R	418,504.06	R	428,507.07	R	427,220.48	R	421,175.10	R	424,252.76	R	419,691.81
R	422,461.57	R	421,078.82	R	421,741.35	R	425,232.89	R	430,311.46	R	422,440.03	R	421,660.82
R	420,235.44	R	429,179.36	R	421,827.61	R	419,731.10	R	434,840.29	R	420,548.96	R	428,136.83
R	421,011.13	R	420,692.37	R	421,355.27	R	423,012.20	R	419,603.44	R	420,771.13	R	419,775.15
R	422,671.84	R	419,306.21	R	426,100.03	R	418,966.08	R	422,049.18	R	420,742.72	R	420,145.14
R	423,096.13	R	424,102.70	R	423,803.21	R	419,955.48	R	425,200.43	R	420,419.50	R	432,934.85
R	422,206.12	R	422,567.54	R	419,996.71	R	425,678.85	R	425,611.19	R	422,359.81	R	426,575.69
R	424,598.79	R	423,886.44	R	429,601.44	R	418,957.56	R	425,482.11	R	421,703.49	R	427,579.22
R	425,789.47	R	423,935.18	R	423,015.24	R	418,769.45	R	419,431.39	R	425,148.73	R	420,144.29
R	428,832.25	R	422,869.45	R	422,303.47	R	424,730.19	R	420,716.77	R	420,826.19	R	419,065.77
R	422,280.25	R	418,842.49	R	419,954.39	R	422,115.63	R	422,077.10	R	424,163.15	R	423,365.09
R	424,249.49	R	421,969.99	R	424,501.29	R	423,916.66	R	418,479.96	R	420,231.73	R	425,447.56
R	425,294.33	R	420,000.70	R	421,854.71	R	419,125.13	R	418,988.72	R	419,166.15	R	428,677.24
R	420,324.77	R	419,153.27	R	420,771.53	R	419,381.62	R	428,845.27	R	421,337.20	R	421,899.46
R	422,103.86	R	422,201.89	R	425,798.71	R	420,862.37	R	423,966.20	R	426,894.88	R	422,404.87
R	419,621.72	R	425,079.48	R	421,732.82	R	423,124.72	R	423,712.18				

Results of Simulation Case 2

R	148,884.34	R	140,423.57	R	133,140.47	R	133,095.33	R	190,225.07	R	158,587.11	R	184,804.20
R	201,227.94	R	210,302.07	R	168,337.82	R	134,595.12	R	147,378.72	R	135,030.54	R	128,512.01
R	138,916.63	R	122,355.28	R	170,528.06	R	127,739.37	R	159,841.18	R	144,844.25	R	147,132.61
R	139,328.34	R	114,189.64	R	189,497.27	R	167,002.42	R	185,991.17	R	79,029.80	R	113,802.20
R	144,990.57	R	110,761.54	R	115,063.92	R	169,398.70	R	134,025.46	R	149,033.47	R	155,605.82
R	94,335.82	R	105,317.27	R	189,409.00	R	170,666.30	R	130,556.03	R	154,050.80	R	158,481.31
R	99,036.39	R	144,723.32	R	138,505.82	R	68,216.40	R	100,880.07	R	188,288.77	R	180,079.56
R	130,738.23	R	177,054.79	R	203,997.24	R	160,945.84	R	116,881.88	R	234,457.16	R	203,853.70
R	152,660.03	R	180,052.87	R	140,234.26	R	147,721.97	R	138,555.11	R	149,489.60	R	133,588.78
R	124,312.79	R	131,896.15	R	120,879.06	R	186,857.64	R	232,152.42	R	167,660.47	R	124,320.17
R	168,874.37	R	155,843.19	R	121,180.32	R	90,569.52	R	127,151.76	R	164,715.82	R	179,450.12
R	151,486.88	R	106,099.57	R	86,873.52	R	129,785.28	R	138,196.83	R	161,001.54	R	144,578.24
R	80,502.87	R	163,548.61	R	115,771.62	R	128,379.33	R	121,228.43	R	175,556.23	R	157,595.17
R	145,243.74	R	104,175.95	R	122,767.47	R	178,721.38	R	123,860.21	R	164,395.18	R	139,063.97
R	126,929.07	R	176,548.98	R	140,386.72	R	196,841.14	R	134,372.77	R	166,394.18	R	163,906.95
R	58,434.65	R	150,928.13	R	174,422.18	R	148,733.82	R	116,399.98	R	164,283.10	R	122,308.81
R	177,308.03	R	158,040.15	R	137,293.91	R	141,639.23	R	177,800.41	R	117,554.55	R	83,050.79
R	166,938.20	R	139,752.25	R	172,895.31	R	195,923.38	R	151,405.72	R	171,430.68	R	121,081.90
R	128,843.02	R	177,942.66	R	124,172.79	R	147,990.42	R	144,903.49	R	175,555.08	R	190,570.73
R	177,860.43	R	134,178.12	R	168,482.94	R	145,971.67	R	182,121.90	R	87,286.69	R	156,365.64
R	149,488.34	R	182,099.54	R	134,811.30	R	174,925.51	R	187,227.79	R	100,692.21	R	89,720.09
R	200,650.93	R	121,016.15	R	91,187.61	R	213,462.82	R	140,008.16	R	150,049.55	R	128,330.44
R	184,870.36	R	144,190.00	R	182,658.85	R	94,418.89	R	196,773.33	R	205,323.45	R	161,139.50
R	129,900.45	R	216,597.55	R	119,000.47	R	199,291.05	R	132,573.85	R	138,039.44	R	155,062.43
R	142,862.52	R	149,029.78	R	98,988.06	R	140,754.83	R	140,389.69	R	149,644.10	R	166,731.08
R	160,450.00	R	141,209.53	R	175,218.42	R	186,400.35	R	188,924.71	R	130,783.71	R	188,370.54
R	127,813.66	R	168,503.88	R	124,132.25	R	125,763.47	R	124,851.41	R	155,199.69	R	157,996.01
R	145,153.04	R	136,868.41	R	138,991.11	R	127,643.26	R	182,654.93	R	125,490.89	R	139,306.05
R	131,361.90	R	74,833.88	R	165,168.33	R	110,215.99	R	187,762.72	R	172,952.92	R	131,032.07
R	234,547.55	R	170,645.39	R	129,620.43	R	168,208.51	R	132,041.44	R	216,044.58	R	174,207.48
R	134,839.06	R	48,387.22	R	162,646.52	R	169,533.87	R	203,936.86	R	159,964.11	R	123,429.56
R	186,473.34	R	114,387.38	R	117,071.98	R	167,030.05	R	178,214.07	R	129,140.31	R	165,001.21
R	181,856.36	R	122,866.56	R	141,284.58	R	149,746.93	R	168,689.48	R	123,275.91	R	144,353.78
R	82,822.98	R	129,568.05	R	152,483.18	R	185,832.74	R	191,716.02	R	161,641.72	R	162,113.86
R	147,007.38	R	117,238.99	R	160,151.34	R	178,153.58	R	148,684.21	R	84,651.79	R	135,373.03
R	137,723.52	R	197,312.74	R	127,270.06	R	153,074.16	R	127,221.23	R	129,092.96	R	169,219.58
R	148,810.21	R	108,902.87	R	133,543.25	R	131,836.35	R	185,884.54	R	144,364.47	R	175,387.34
R	130,254.29	R	167,850.67	R	77,395.94	R	107,295.58	R	139,164.21	R	174,505.37	R	128,088.01
R	164,203.62	R	181,393.24	R	170,957.40	R	163,065.24	R	142,946.97	R	168,242.31	R	157,260.34
R	128,705.26	R	150,695.33	R	106,163.41	R	123,568.05	R	52,457.80	R	177,071.93	R	148,260.59
R	129,396.36	R	172,602.73	R	121,532.53	R	136,392.73	R	191,041.44	R	104,037.08	R	186,773.18
R	134,931.78	R	133,909.28	R	162,623.40	R	140,988.47	R	112,802.51	R	171,713.85	R	130,736.14
R	192,404.31	R	198,756.44	R	177,204.37	R	109,325.25	R	155,824.67	R	140,541.09	R	104,078.80
R	72,218.23	R	118,554.29	R	137,690.46	R	148,213.58	R	151,556.68	R	198,029.67	R	108,486.30
R	144,810.86	R	153,513.19	R	162,557.39	R	146,471.61	R	131,282.48	R	135,105.95	R	136,267.69
R	157,790.14	R	115,091.89	R	106,228.84	R	168,779.09	R	118,505.27				