An Inventory management system for an SMME
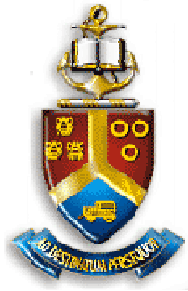
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Executive Summary

The South African economy is amongst the rapidly growing and promising economies in Africa and especially in the Southern African region as a whole. However unemployment is still amongst the biggest challenges this country faces and with the government aiming to create about 5 million job opportunities, a need is presented to focus on Small Medium and Micro Enterprises and their development thereof.

SMMEs account for about 60% of South Africa's employment and contribute 40% to the GDP, of these only 17% are registered small businesses. Unregistered micro-enterprises are typically businesses located in the rural areas and create employment for the low skilled labourer and women. M-Creations is one such type of micro business and this project aims to use vast applicable Industrial Engineering tools to facilitate optimization of this business and ultimately enable it to grow, creating opportunity for more employment.

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CHAPTER 1

1.1 Introduction and Background

1.1.1 Small medium and micro enterprises

SMMEs are a pivotal part of thriving and sound economies across the world and inarguably a great source of employment and innovation. In OECD countries alone SMEs and micro enterprises account for 95% of all firms, 60-70% of employment and 55% of GDP according to (WBCSD, 2004). In South Africa however not all of these small businesses operate within the formal market sector nor are they registered businesses recognized by SARS. This follows numerous factors that deter the rapid growth and development of South Africa's small businesses especially those located in the rural areas, to name a few; compliance to government regulations, lack of start-up capital, low-skilled labourer and absence of proper supply chain channels. The contribution of SMMEs towards sustainable growth of emerging economies across the world and South Africa is inarguably large and by far relates the importance of job creation by supporting innovative small businesses. Figure 1 below is a graphical depiction of the contribution of SMMEs to employment and GDP across varying economies in the world.
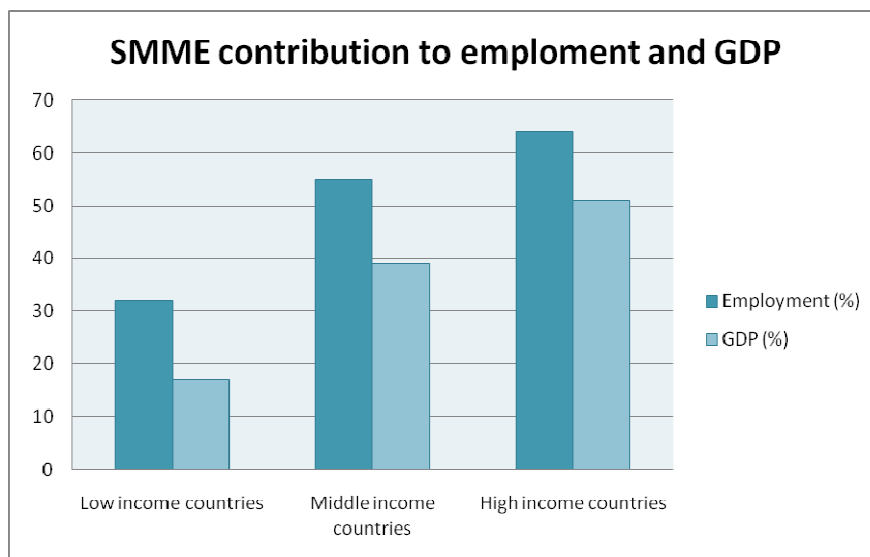
Figure 1: SMME contribution to employment and GDP

In this document we will undertake to highlight the factors that influence successful inventory management in SMMEs and what enables growth for small to medium businesses in the South African clothing industry as studies in literature indicate that these do not come

in short supply however only a small fraction will develop further. Only 1% of micro-enterprises will make the transition to a successful small enterprise employing more than 15 workers (Liedholm C, 1999).

1.2 Problem identification M-Creations

M-Creations is a small tailoring business located in a rural community of Dennilton, Mpumalanga. It was founded in the 1990s by Tryphina Mokone and her husband and provides a number of tailoring services in the community and surrounding areas. The bulk of its operations are in producing and selling school uniforms to the local primary and secondary schools in the area, these include items such as skirts, tunics, T-shirts and track suits. They are also re-sellers of items they do not produce first hand for lack of required equipment and or skill thereof, such items are identified as ties and socks and those made from wool or woven such as jerseys, cardigans and others. Dennilton also has a number of catering businesses all of whom source uniform from M-Creations. Furthermore the business caters to the needs of everyday customers with tailor made wedding outfits and matric dance gowns. To date the business employs about 12 workers and 4 assistants that work on a contractual basis depending on workload, all of whom are women with no formal tertiary education. Some of these women had to first acquire the required knowledge and skills necessary to operate the sewing machines used. Although M-Creations is an unregistered small business it has been identified as having great potential for growth and could possibly employ more people and seek to comply with regulatory provisions for registration thus enabling further expansion of its operations and customer base.
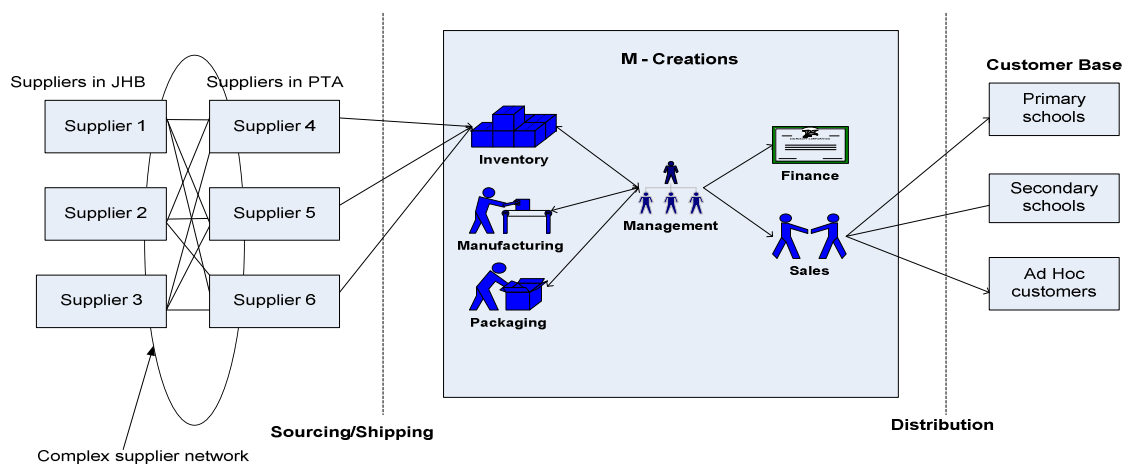
Figure 2: Operations flow at M-Creations

The figure above is a pictorial view of the basic flow of operations within the business; these typically involve the sourcing of material for producing the different school uniform items as well as those items that the business re-sells, these are sourced from different suppliers in the Johannesburg and Pretoria regions. The clothing material is kept raw in inventory until orders for set items are received; finished items are then packaged and distributed to the different schools, either by means of the business owner delivering the items at the schools or by way of individual customers collecting their orders in store.

1.3 Project Aim

The aim of this project is to ensure maximum profitability of the business by developing an inventory management policy that utilises forecasted demand to reduce inventory costs. Furthermore the project aims to identify a set of best practices for the business by identifying critical performance measures that will align demand to supply culminating to an optimal inventory management system.

1. 4 Scope

1.4.1 Project focus

Inventory management has a wide spectrum of application and involves many business considerations, for the purpose of this project however focus will be put on developing a supply chain strategy well suited to the nature of this business environment and its constraints. This will be done by aligning all related cost, demand and supply activities to determine best practices for M-Creations. Investigation and careful examination of all business processes involved from procurement of materials, production and ultimately delivery will have to be done to achieve this.

The basis of the supply strategy will be a demand forecast for better screening of future sales, inventory control, minimisation of cost at all levels of doing business, satisfying demand in a timely fashion, efficient work scheduling and optimal utilisation of resources. The stakeholders of this project are listed as:

- M-Creations
- Textile wholesalers
- Customers
- University of Pretoria

1.4.2 Obstacles

The major obstacles associated with this project will be in successfully scoping the problem to identify the best possible solution. The manager of the business and its employees have no prior understanding of the Industrial Engineering techniques that will be used in the execution of this project, communication and understanding may be hard thereof. There is no formal link or communication between the suppliers and M-Creations, nor does such a setup exist with the schools except for placement of orders.

CHAPTER 2

2.1 Literature review

The literature study conducted in this project aids in understanding the critical concepts covered in investigating the problem areas at M-Creations and how similar challenges were solved. Inventory is a business resource that serves the purpose of maximizing profit however, in practice inventory tends to be a major cash flow constraint thus making it necessary to optimize using analytical and statistical methods in an integrated approach (F. Robert Jacobs, 2009). Therefore the focus of this literature is on three main topics namely: Process mapping, demand forecasting and inventory control.

2.1.1 Process mapping

Process mapping is used to facilitate understanding of the flow of activities or tasks involved in a process that transforms some input into output with the purpose of delivering a product or service. It is aimed at aiding performance improvement efforts by bringing forth the following insight about the process of a business organization in general:

- Graphically indicates all steps involved in the entire process; from supplier to customer
- Indicates the process boundaries
- Indicates the complexity of the process and identifies non-value added activities such as rework loops and any redundancy involved
- Identifies key input variables of the process as well as resulting key output variables
- A flowchart tool is developed by adding all the process information
- Identifies areas where data collection is necessary

Types of Process Maps:

There are several different kinds of process maps however for the purpose of process analysis and optimisation at M-Creations only the following process maps are considered:

As-Is Process Map: Also known as the present state process map is a graphical representation of the current process works. This process map should to indicate how the process works in reality as far as possible as this will help indicate the shortcomings of the current process thus aiding understanding of the process that is to be achieved.

To-Be Process Map: The to-be process map shows how the future process will work after implementation of improvements. This map helps visualise the whole process and the sequence of events after improvements have been made.

2.1.2 Demand forecasting

Demand forecasting is formally defined as the activity of estimating the quantity of a product or service that customers will purchase in future. Forecasts are vital to every business organization and for every significant management decision. Production and operations personnel use forecasting to make continual decisions about production planning, scheduling and inventory (F. Robert Jacobs, 2009).

Forecasting is categorized into four basic types namely: Qualitative, Time series analysis, Causal relationships and Simulation. Table 1 below lists the different forecasting techniques and their underlying characteristics.

Forecasting technique	Model characteristics
I. QUALITIATVE	Subjective; judgemental. Based on estimates and opinions
Grass roots	Derives a forecast by compiling input from those at the end of the hierarchy who deal with what is being forecast. For example, an overall sales forecast may be derived by combining inputs from each salesperson who is closest to his or her territory.
Market research	Sets out to collect data in a variety of ways (surveys, interviews, and so on) to test hypotheses about the market. This is typically used to forecast long-range and new product sales.
Panel consensus	Free open exchange at meetings. The idea is that discussion by the group will produce better forecasts than any one individual. Participants may be executives, salespeople, or customers.
Historical analogy	Ties what is being forecast to a similar item. Important in planning new products where a forecast may be derived by using the history of a similar product.
Delphi method	Group of experts responds to questionnaire. A moderator compiles results and formulates a new questionnaire that is submitted to the group. Thus, there is a learning process for the group as it receives new information and there is no influence of group pressure or dominating individuals.
II. TIME SERIES ANALYSIS	Based on the idea that the history of occurrences over time can be used to predict the future
Simple moving average	A time period containing a number of data points is averaged by dividing the sum of the point values by the number of points. Each, therefore, has equal influence.
Weighted moving average	Specific points may be weighted more or less than the others, as seen fit by experience.
Exponential smoothing	Recent data points are weighted more with weighting declining exponentially as data become older.
Regression analysis	Fits a straight line to past data generally relating generally relating the data value to time. Most common fitting technique is least squares.
Box Jenkins technique	Very complicated but apparently the most accurate statistical technique available. Relates a class of statistical models to data and fits the model to the time series by using Bayesian

	posterior distributions.
Shiskin time series	(Also call X_{-11}) Developed by Julius Shiskin of the Census Bureau. An effective method to decompose a time series into seasonal, trends, and irregular. It needs at least three years of history. Very good in identifying turning points, for example, in company sales.
Trend projections	Fits a mathematical trend line to the data points and projects it into the future.
III. CAUSAL	Tries to understand the system underlying and surrounding the item being forecast. For example, sales may be affected by advertising, quality, and competitors.
Regression analysis	Similar to least squares method in time series but may contain multiple variables. Basis is that forecast is caused by the occurrence of other events.
Econometric models	Attempts to describe some sector of the economy by a series of interdependent equations.
Input/output models	Focuses on sales of each industry to other firms and governments. Indicates the changes in sales that a producer industry might expect because of purchasing changes by another industry.
Leading indicators	Statistics that move in the same direction as the series being forecast but move before the series, such as an increase in the price of gasoline indicating a future drop in the sale of large cars.
IV. SIMULATION MODELS	Dynamic models, usually computer-based, that allow the forecaster to make assumptions about the interval variables and external environment in the model. Depending on the variables in the model, the forecaster may ask such questions as, what would happen to my forecast if price increased by 10%? What effect would a mild national recession have on my forecast?

Table 1: Forecast techniques and Common models

2.1.2.1 Components of demand

Forecasting demand requires thorough investigation and analysis of the available demand data. The repeated observation of demand trends for a product in the order of occurrence for a pattern is known as a time series (Winston, 2004). The time series of demand comprises six components:

1. Average demand - The sum of the demand observations for each period divided by the number of periods.

2. Trend - Systematic increase or decrease in the average of the series over time.

3. Seasonal elements - The predictable increase or decrease in demand depending on the time of day, week, month, or season.

4. Cyclical elements - The less predictable increases or decreases in demand over longer periods of time.

5. Random variation – When all known causes for demand are subtracted from total demand, what remains is assumed to be random chance

6. Autocorrelation – Indicates the persistence of occurrence i.e. the expected value of demand at any point is highly correlated with its past values.

2.1.2.2 Initializing a forecast

Quantitative forecast techniques consist of two general types: The time series approach which uses past trends to project future values. The second approach is the causal models that incorporate time series data to estimate the relationship between a dependent and independent variable(s) (Gokhan Metan, 2007). To initialize any quantitative forecast model, the following assumptions are made (F. Robert Jacobs, 2009):

- Historical sales information is available
- This information can be translated into quantifiable numerical data
- Some aspects of the data patterns indicated in historic information will continue into the future

Trend Patterns:

Trend lines are usually the starting point in developing a forecast model. These trend lines are then adjusted for seasonal effects, cyclic elements and any other factors that may influence the results of the final forecast (F. Robert Jacobs, 2009). These trend lines are used to uncover data patterns that are primary in selection of appropriate forecasting model and the most common types are illustrated in the figures below:

1. Linear trend – indicates a straight linear relationship between variables
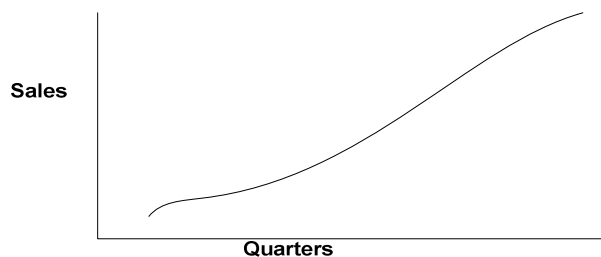
Figure 3: Linear trend graph

2. Asymptotic trend/ logarithmic trend – is indicative of a case where a business captures a new market with high levels of demand in the beginning and as time passes it stabilizes
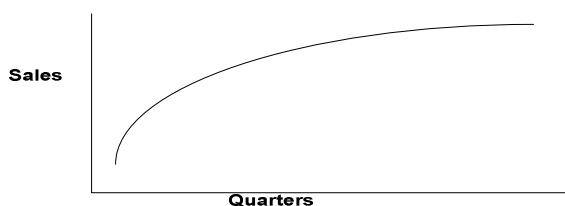
Figure 4: Logarithmic trend graph

3. Exponential trend – typical of products with explosive demand and assumes that this growth will continue into the future
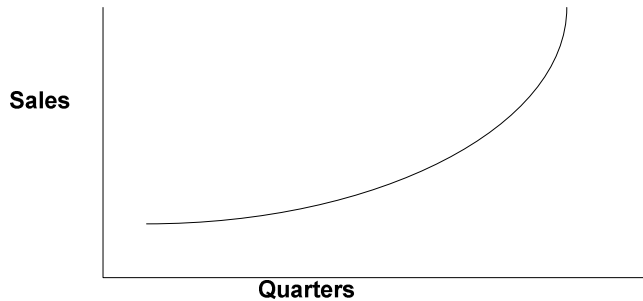
Figure 5: Exponential trend graph

2.1.2.3 Selecting the appropriate forecasting technique

Different forecasting techniques are well suited for diverse situations. The selection of the most appropriate technique should account for multiple factors such as the nature of the business, objectives, availability of data, forecast horizon, useful life of the model, expected accuracy of the forecast, time and cost constraints (Gokhan Metan, 2007).

Figure 3 below outlines the procedure to follow in selecting the best forecasting method, developed as a framework based on prior research in the field of forecasting and statistics.
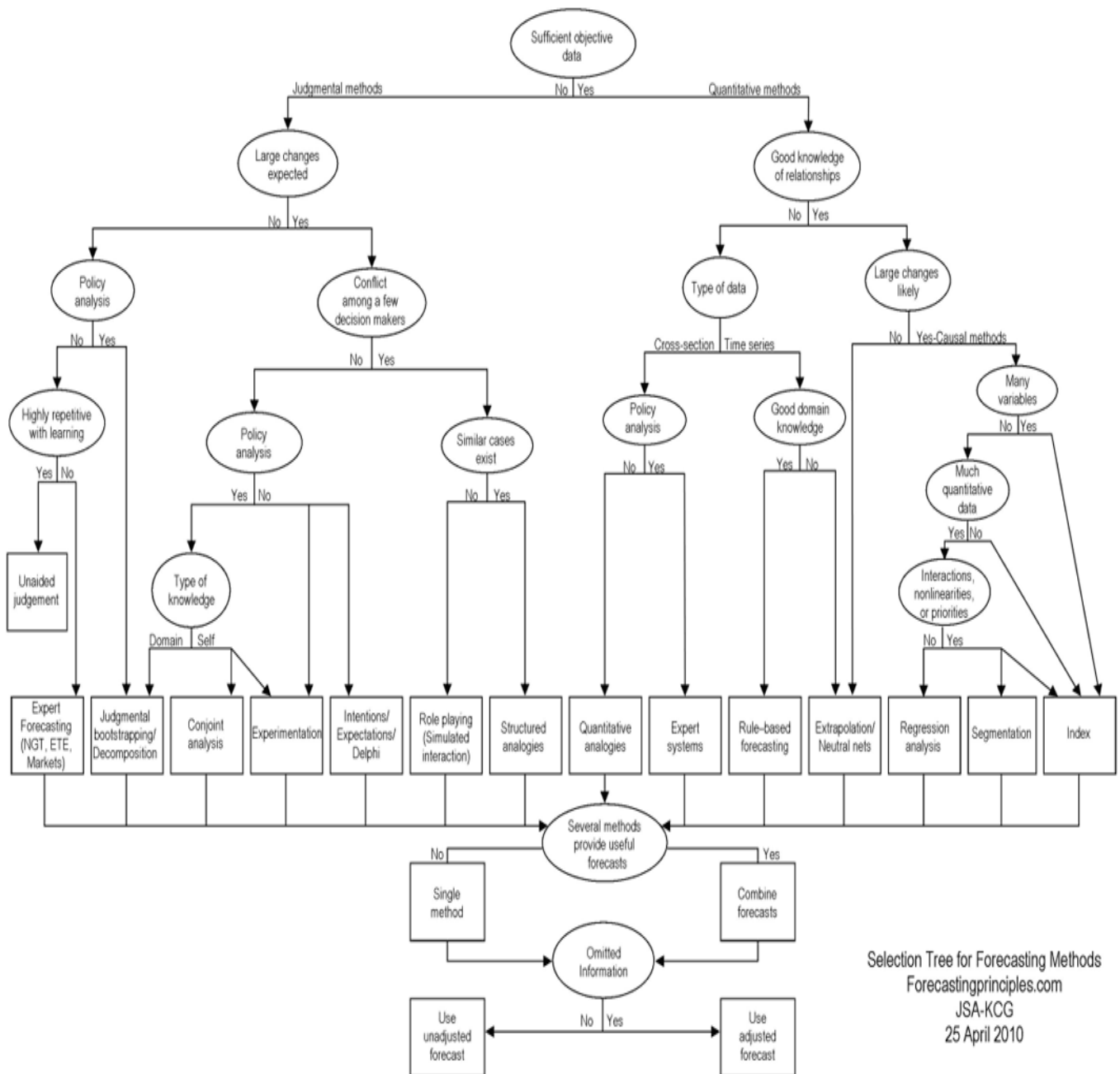
Figure 6: Selection tree for forecasting methods

Quantitative forecasting methods can further be divided into non-causal and causal methods.

Non-causal methods: Are the time-series models and work best for business types such as M-Creations where data patterns are characterized by levels, trends and seasonality elements. **Causal methods**: Are characterized by both data pattern elements and the effect of causal factors such as marketing, prices, inflation, recession and other macro economic factors.

Table 2 below lists the most common time-series or non-causal models as well as the criteria used to assess their relevancy and appropriateness.

Model Type	Most Suited Data Types	Forecast Horizon	Shelf Life of Model
Exponential Smoothing	No Trend, Varying Levels	Short	Short
Holt's Method	Varying Trends, Varying Levels, No Seasonality	Short	Short
Winter's Method	Varying Trends, Varying Levels and Seasonality	Short to Medium	Medium
ARIMA	Varying Trends, Varying Levels, Seasonality	Short to Medium	Long

Table 2: Common time-series model and criteria for selection

2.1.3 Inventory Control

2.1.3.1 Inventory

Inventory is defined as the stock of any item or resource used in an organization. An inventory system is the set of policies and controls that monitor levels of inventory and determine what cost effective levels should be maintained, when stock should be replenished and how large orders should be (F. Robert Jacobs, 2009).

2.1.3.2 Objectives of inventory control

Inventory control deals with managing all costs associated with keeping stock. It involves finding the right balance between having too much and too little inventory in order to maximize profits. Hence the objectives of inventory control are (F. Robert Jacobs, 2009):

1. To maintain independence of operations

2. To meet variation in product demand

3. Allow flexibility in production scheduling

4. Provide a buffer for variation in raw material delivery time

5. Take advantage of economic purchase order size or discounts

2.1.3.3 Inventory costs

Developing an inventory control policy requires careful consideration of the following inventory costs:

- Ordering costs - This cost refers to the cost of procurement and inbound logistical costs associated with the placement of orders.

- Holding costs - Defined as the cost to hold one unit of inventory per unit time. Inventory holding cost also includes costs of material handling, equipment, management resources, cost of capital, taxes and insurance.

- Setup costs – The cost associated with the preparation for production of an item includes the cost of labor for setting up and shutting down of production equipment.

- Shortage costs – Refers to those costs incurred by a business when there is shortage of material or stock to fulfill an order.

2.1.3.4 Deterministic Inventory models

Deterministic inventory models are used when demand over a certain time period is known in advance and there exists various EOQ inventory models that can be used when demand is deterministic, namely:

2.1.3.4.1 The Basic EOQ Model

According to WL Winston for the basic EOQ model to hold the following assumptions must be true (One year = One unit of time):

- Demand is constant and deterministic
- Lead time is zero
- Shortages are not allowed
- A set-up cost is always incurred with the placement of an order of any size
- A holding cost per time unit is incurred

2.1.3.4.2 EOQ model with non-zero Lead Times

In cases where the lead time is not zero the annual holding and ordering costs are unaffected hence the EOQ determine will still minimize inventory cost. To ensure however that no shortages occur, a replenishment order will have to be placed at a point that ensures that when the order arrives the inventory level is zero, this is called the re-order point.

2.1.3.4.3 EOQ model when Quantity discounts are allowed

The annual purchasing cost is effectively influenced by the size of order in this regard where for a certain order quantity a discount is given. WL Winston (2004) suggests that the model that minimizes inventory costs where price breaks are present can be solved by using the following approach:

Let q be the quantity ordered, b_k the price break point and p_k the purchase cost associated with q

- EOQ_k is allowed if $b_{k-1} < EOQ_k < b_k$

- EOQ_k is the order quantity that minimizes total annual cost for p_k

2.1.3.4.4 Continuous rate EOQ model

The continuous rate model assumes that an item can be produced at a rate r units per time period usually stated in units per year. This model behaves exactly the same way as the Basic EOQ model except in this case rate at which an item is produced annually has to be factored in. if D is the annual demand the $r \geq D$ must hold to ensure that no shortages occur and inventory increases at a rate of $r - D$.

2.1.3.4.5 EOQ model with Back Orders Allowed

Demand is not always met is most realistic situations and shortages occur, when this happens a shortage cost s is incurred. In this case it is assumed that demand is backlogged and there are no lost sales as a result. WL Winston defines the following parameters to adjust the EOQ model to allow for shortages:

- q = Order quantity

- $q - M$ = Maximum shortage that occurs

Hence in a situation where zero lead time exists there will always be q-M units short every time an order is placed.

2.1.3.5 Probabilistic Inventory models

Probabilistic inventory models address inventory problems where the demand over a period of time is uncertain or random. There are different types of probabilistic inventory models however the EOQ with uncertain demand model is more relevant to M-Creations and hence the literature covered in this section shall be limited to this model.

2.1.3.5.1 The EOQ with uncertain demand: The (r, q) and (s, S) models

WL Winston (2004, p 147) describes the EOQ model with uncertain demand as the modified version of the basic EOQ model where lead time is assumed to be non-zero and the demand during each lead time is random. The following assumptions are made:

- All demand can be backlogged

- A continuous review model is assumed to allow the placement of orders at any time

The following variables are defined for the EOQ model with uncertain demand:

- K = Ordering cost

- h = Holding cost/unit/year

- L = Lead time for each order (which is assumed to be known exactly)

- q = Quantity to be ordered

- D = Random variable that represent the demand with mean E(D), variance var D, and standard deviation σ_D

- c_B = Cost incurred for each unit short

- $OHI(t)$ = Amount of stock on hand at time t

- $B(t)$ = Number of outstanding orders at time t

- $I(t)$ = Inventory level at time t = $OHI(t) – B(t)$

- r = Inventory level at which a replenishment order is placed

- X = Continuous random variable with density function f(x) that represents the demand during lead time and has mean E(X), variance var X, standard deviation σ_X

M-Creations follows a policy that all demand must be met and no lost sales may occur, this is also referred to as the back-ordered case by WL Winston (2004, pg 148).

2.1.3.6 Inventory control policies

Inventory control policies primarily address two questions regarding inventory; (1) what is the optimal order quantity? And (2) when should a replenishment order be placed? To answer the above questions two inventory policies are considered:

2.1.3.6.1 Continuous review system

A continuous review policy suggests that q units be ordered each time the inventory level depletes up to the re-order point level r. For this ordering policy the EOQ units to be ordered is always fixed however the cycle time between orders may vary. As a general rule some level of inventory will be kept on hand before the replenishment order is received known as the safety stock. This is done to serve as a buffer against possible stock-outs where unusually high levels of demand occur or replenishment lead times take longer than anticipated. Figure 4 below is graphical representation of the inventory balances in a continuous review system:
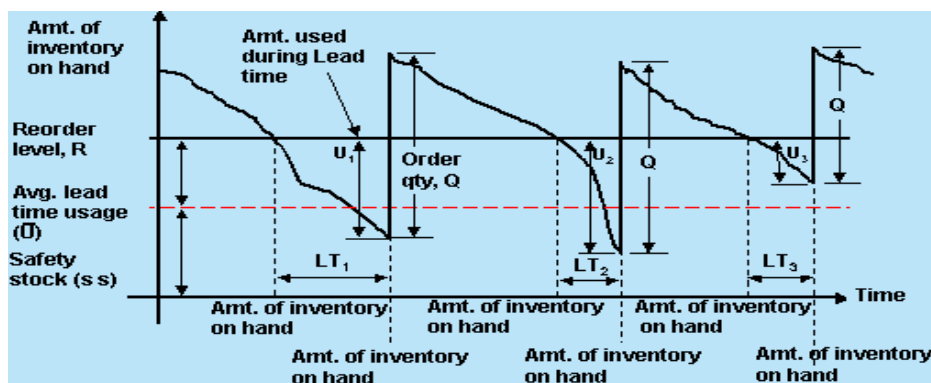
Figure 7: Inventory balances in a Continuous review system (Q, r)

2.1.3.6.2 Periodic review system

In this review system a fixed review period is set wherein orders are placed after this period has elapsed up to a predetermined inventory level (Winston, 2004).The order quantity is allowed to vary in relation to demand, the cycle time however is fixed. The figure below is a graphical illustration of the inventory balances in the periodic review system:
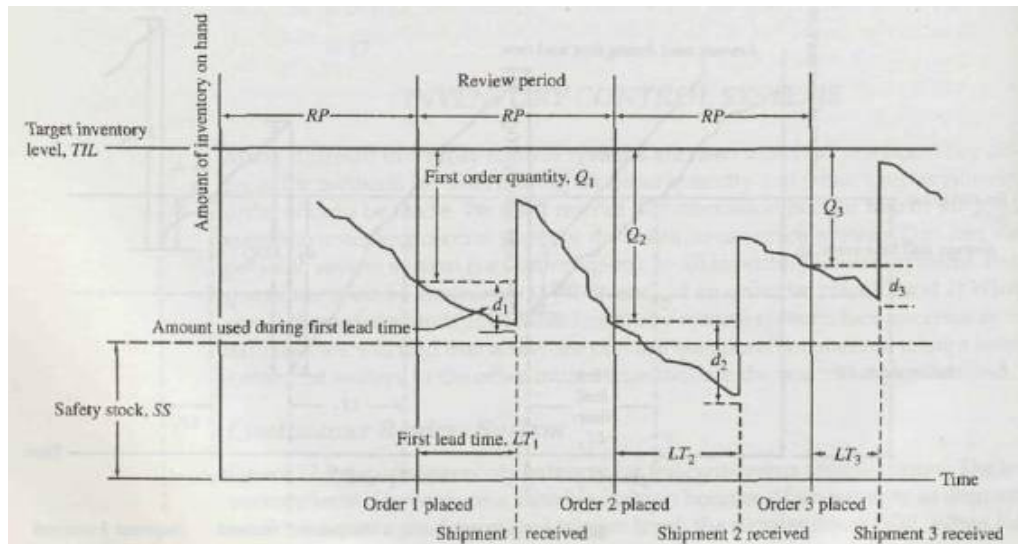
Figure 8: Inventory balances in a periodic review system (R, S)

2.1.4 Forecast based inventory modelling

The continual development of inventory theory that relays more realistic assumptions about demand is pivotal (Graves, 1999). In practice demand is highly uncertain and unpredictable making it harder to forecast, hence inventory managers rely on forecasts based on a time-series of past data to model an optimal inventory model.

This inventory optimization approach uses mathematical models to derive demand patterns and or distribution that will be used to develop forecasts. The forecasted demand is then used as input into an inventory model that will in turn be used to derive an ordering policy that minimizes total inventory costs.

CHAPTER 3

3.1 Methodology

3.1.1 As-Is Process map

 M-Creations is a small business and does not posses a predetermined supplier network and the sourcing of material thereof is done on an ad hoc basis or as and when needed. This result in multiple inventory problems such as over stocking of material used to produce uniforms, possible stock-outs and unjustified inventory costs. In this section we begin by assessing the complete work process flow at M-Creations and map the movement of inventory from the point where a customer places an order to the point where material is sourced from available suppliers. The following as-is process map was drawn in order to identify the point at which problem areas arise in respect to inventory:
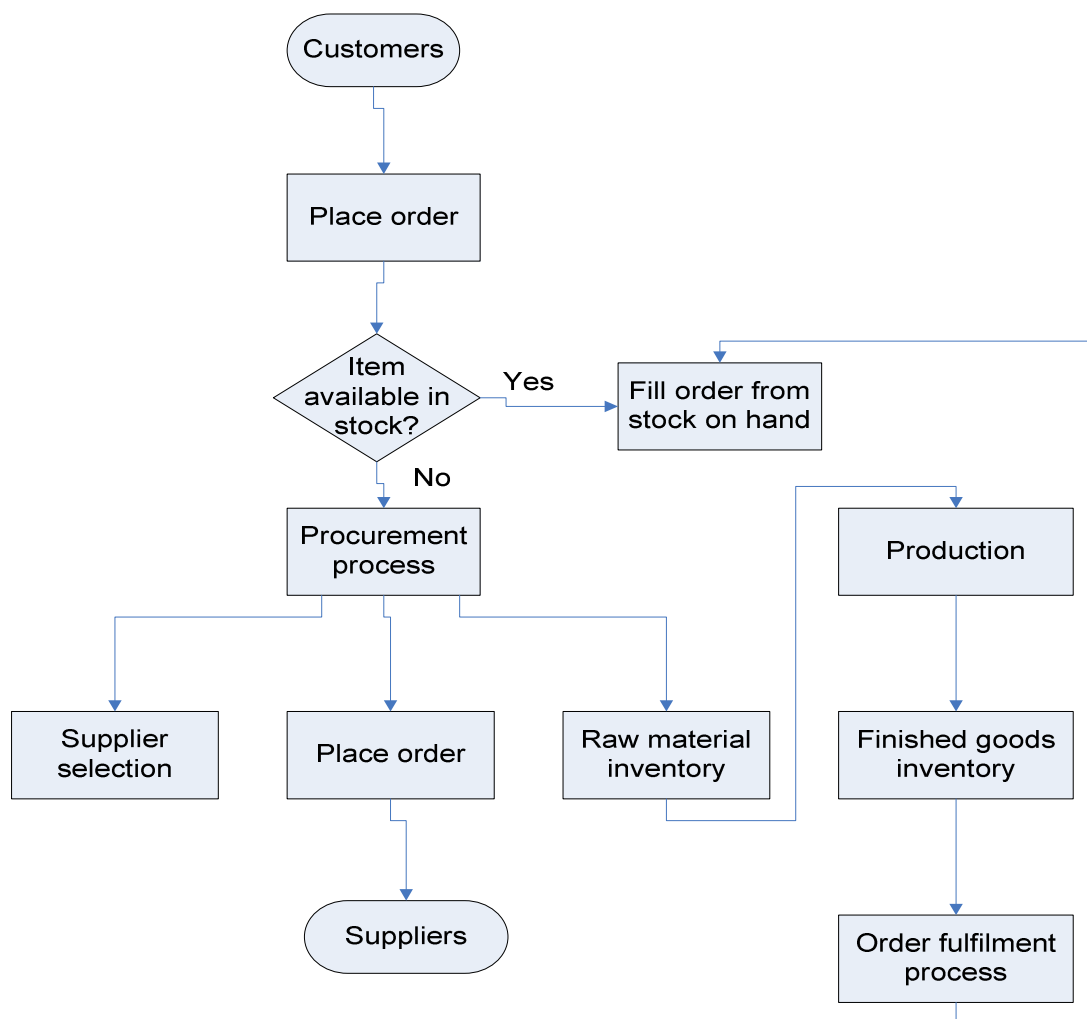
Figure 9: M-Creations internal business process

The solution approach following the study of the above business process will attempt to solve the following problems regarding management of inventory at M-Creations:

- Develop an inventory policy to aid optimal order quantities and defer from over stocking
- Minimize all associated costs of inventory and procurement
- Develop a benchmark or set of best practices to ensure continual improvement and performance of the business

3.2 Data gathering and analysis

3.2.1 Sales data

M-Creations currently utilize no automated or electronic tool to store sales data, orders are captured manually in a book according to year, month, school, item description, item size and price. Orders at the end of each month are then summed up and tabulated for each school and intuitively used to decide how much of each material will be need in future for each uniform item and for each school.

For the purpose of obtaining more usable sales data for the forecast model, this raw data was first captured in excel and organized according to quarterly sales per item per school, refer to Appendix A.

The figures below illustrate the demand data pattern for M-Creations, from the first graph which plots the demand for one of the items (skirts) it is clear that the bulk of sales made on uniforms for each year lie in the first quarter of every year. A decision was taken in conjunction with M-Creations to place focus on this part of the sales period and develop a forecast that will predict future demand during this high peak period of sales. The second graph illustrates the best fit for the data:

Assumption: The demand patterns for all other uniform items depict the same trends as can be seen in the Forecasted vs. Actual sales plots for each uniform item in inventory included in Appendix B.
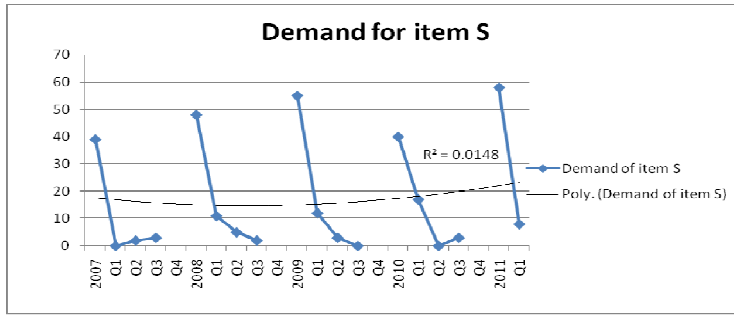
Figure 10: Plot of Annual demand data for item S
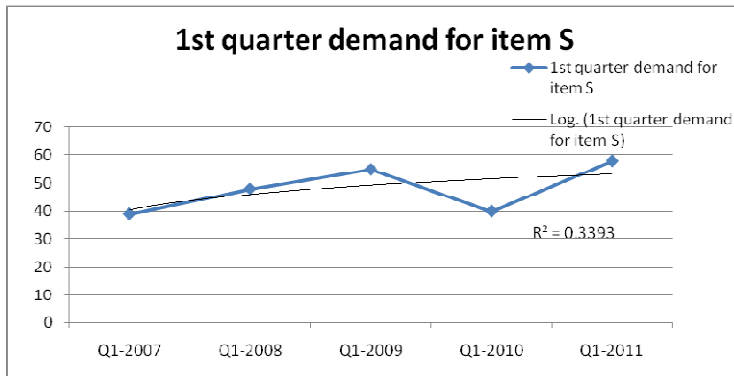
Figure 11: Plot for 1st quarterly demand for item S

3.2.2 Cost data

The costs associated with procurement of material, costs of producing each item of uniform and costs of holding material in stock were also captured in excel refer to Appendix C. These costs were directly obtained from M-Creations and used to determine the related inventory costs for each item in inventory.

3.3 Methods and Tool selection

The study of the historic sales data for uniform items is highly seasonal and follows the same trend for each year hence Winter's forecasting technique will be used. To ensure maximum forecast accuracy a Mean Absolute Percentage Error of over 10% will not be accepted, hence all smoothing forecast parameters are adjusted accordingly to ensure the least possible MAPE for each forecast. Furthermore the Basic EOQ model will be used to determine optimal order quantities of material required to produce the various items of uniform sold.

CHAPTER 4

4.1 Proposed solution

4.1.1 Forecast Model specifications and assumptions

Due to the nature of demand and sales behaviour at M-Creations, focus was placed on the high demand sales periods in developing the model. This was done because for every year the bulk of uniform orders are received in the first quarter of the year. The sales data indicates both trend and high levels of seasonality hence the Winter's forecasting technique was chosen as the best method for developing a forecast for demand yielding the lowest Mean Absolute Percentage Error (MAPE).

The inventory model will use the average forecast demand as input to determine relevant inventory parameters. The forecast model will assume the following specifications:

1. The model will be based on a quarterly sales period for each year
2. The model will estimate future demand for quarterly sales for the next 2 years
3. The model will forecast demand for each item in inventory
4. A graph will be drawn to compare the forecasted demand against actual sales to ensure accuracy

4.1.2 Model formulation

4.1.2.1 Winter's method

The parameter values for this forecast technique that had to be determined are the level, trend and seasonality smoothing constants. These were also determined using the excel solver to ensure the lowest MAPE. Refer to Appendix B for the forecast model for each item of uniform per school.

4.2 Inventory policy

4.2.1 EOQ model

The basic EOQ model was chosen to develop an inventory model for M-Creations for the following implications that apply at M-Creations:

WL Winston (2004) states the following assumptions for the Basic EOQ Model

1. Demand is deterministic and occurs at constant rate (Demand is known from forecast model)
2. Any order of any size placed incurs a set-up cost **K**
3. The lead time for each order is zero (Material is sourced directly from suppliers and hence no lead time is incurred)
4. M-Creations works on a "No shortages allowed" policy
5. The cost per unit-year of holding inventory is **h**

Appendix C contains the spreadsheet model of the EOQ with related figures for demand, purchasing costs, ordering costs, holding costs and total inventory costs for each uniform item per school. The optimal order quantities for the different demand situation are also reflected in this sheet.

4.2.2 Continuous review with forecast based policy updating

The inventory policy proposed for M-Creations given the nature of the business operations and constraints is the continuous review model that will be updated using the forecasted demand. This is done because the demand of school uniform is variable across the year and for each year. This policy will indicate how much material to stock for each uniform item per school and how many orders will have to be placed annually to achieve optimality and reduce inventory costs.

4.3 Testing and validation

For the best model output ensuring minimization of costs, a testing and validation phase for the forecast model will have to be implemented to ensure accuracy and track the improvements brought about by the implementation of the proposed inventory policy.

CHAPTER 5

5.1 Results

5.1.1 Interpretation of model results
The table below gives a summary of the solution computed in Excel using the Basic EOQ model. For each uniform item the demand is determined using a forecast model and the associated EOQ listed in column 5.

For illustrative purpose; M-Creations will order 28metres of Tetrex material to produce skirts for Ramokhutlwane primary school this will yield an annual total cost of R 2558.0 and 3 orders will have to be placed annually to fulfil demand.

The model is flexible and can be adjusted to compute the optimal quantity to order for any level of demand, should there be changes thereof.

School	Item	Material required	Demand	EOQ	Ordering cost	Purchasing cost	Holding cost	Total cost	Orders/year
Ramokhutlwane	Skirt	Tetrex	71	27.50	29.70	R 2 485.00	R 43.31	R 2 558.00	3
	Tunic	Tetrex	42	21.55	37.81	R 3 360.00	R 77.57	R 3 475.38	2
	T-shirt	Lacosta	55	14.10	39.01	R 3 382.50	R 39.01	R 3 460.53	4
	Track suit	Quantex	20	9.61	55.14	R 2 550.00	R 55.14	R 2 660.29	2
Supatsela	Skirt	Tetrex	64	21.62	34.05	R 2 240.00	R 34.05	R 2 308.09	3
	Tunic	Tetrex	42	15.04	54.16	R 3 360.00	R 54.16	R 3 468.32	3
	T-shirt	Lacosta	106	19.57	54.16	R 6 519.00	R 54.16	R 6 627.32	5
	Track suit	Quantex	32	12.16	69.75	R 4 080.00	R 69.75	R 4 219.50	3
Nkadimeng	Skirt	Tetrex	62	21.28	R 33.51	R 2 170.00	R 33.51	R 2 237.02	3
	Tunic	Tetrex	57	17.53	R 63.09	R 4 560.00	R 63.09	R 4 686.19	3
	T-shirt	Lacosta	78	16.79	R 46.46	R 4 797.00	R 46.46	R 4 889.92	5
	Track suit	Wool material	20	10.93	R 43.02	R 1 750.00	R 43.02	R 1 836.04	2
Motlhako	Skirt	Minimet	73	27.88	R 30.11	R 1 752.00	R 30.11	R 1 812.22	3
	Tunic	Minimet	64	26.60	R 46.68	R 2 496.00	R 46.68	R 2 589.36	2
	Track suit	Wool material	32	13.82	R 54.42	R 2 800.00	R 54.42	R 2 908.83	2
Machipe	Skirt	Minimet	42	21.15	R 22.84	R 1 008.00	R 22.84	R 1 053.68	2
	Tunic	Minimet	26	16.95	R 29.75	R 1 014.00	R 29.75	R 1 073.51	2
	Track suit	Wool material	25	10.12	R 58.06	R 2 187.50	R 39.84	R 2 285.40	2
Dibathuto	Skirt	Minimet	91	31.20	R 33.69	R 2 193.53	R 33.69	R 2 260.91	3
	Tunic	Minimet	96	32.58	R 57.19	R 3 746.02	R 57.19	R 3 860.39	3
Tlhako	Skirt	Minimet	120	35.80	R 38.67	R 2 889.35	R 38.67	R 2 966.68	3
	Tunic	Minimet	75	28.88	R 50.68	R 2 942.41	R 50.68	R 3 043.78	3
St Joseph	Skirt	Minimet	49	22.91	R 24.74	R 1 182.81	R 24.74	R 1 232.29	2
	Tunic	Minimet	40	21.08	R 36.99	R 1 567.20	R 36.99	R 1 641.17	2
Thejane	Skirt	Minimet	86	30.32	R 32.74	R 2 071.71	R 32.74	R 2 137.19	3
	Tunic	Minimet	32	18.68	R 32.78	R 1 230.79	R 32.78	R 1 296.35	2
	T-shirt	Lacosta	89	17.96	R 49.69	R 5 487.58	R 49.69	R 5 586.96	5
Segolokwane	Skirt	Tetrex	102	27.35	R 43.08	R 3 586.06	R 43.08	R 3 672.22	4
	Tunic	Tetrex	97	22.83	R 82.19	R 7 737.88	R 82.19	R 7 902.26	4
	T-shirt	Lacosta	159	23.99	R 66.40	R 9 798.22	R 66.40	R 9 931.03	7

Table 3: Summary table of the EOQ model

5.2 Deriving a Supply strategy from proposed solution

To bring M-Creations to full optimality where cost minimization and profitability is realised, all cost elements that are unnecessary or negatively affect the bargaining of the business need to be identified as well as a business strategy to eradicate these cost elements.

Cost elements:

- High levels of material kept in inventory
- Transportation costs involved with sourcing material
- Waste of resources such as electricity, idle time of workers that is still billed
- Loss of customers due to unfulfilled or late orders

Strategy:

A detailed business and operational strategy needs to be developed in part with the owner of the business and this is still to be conducted as best practices following the implementation of the forecast model still need to be identified. Generic methods that can be implemented however are identified as follows:

- Keep as very little inventory as possible as indicated by the proposed inventory policy
- Establish communication lines between the business and the school for efficient and effective demand planning.
- Determine the closest and most reliable suppliers in both Johannesburg and Pretoria and weigh them against costs of sourcing i.e. material prices, transportation costs and material availability to minimise lead times.
- Opt for more contractual workers instead of permanent employees especially during the times when demand is highest.

5.3 Cost saving potential
The implementation of the proposed inventory policy will yield the following cost savings:

- Reduced inventory carrying costs
- Improved lead times to customers
- Reduced procurement and internal logistical costs

CHAPTER 6

6.1 Recommendations and conclusion

M-Creations shows significant areas for growth and improvement like most SMMEs in the rural areas. The implementation of a forecast based inventory policy should enable the business management to better plan for how much stock and keep in inventory and furthermore how to schedule work and reduce cost associated with sourcing of material. This should ultimately enable the business to fulfil orders in a timely manner and improving business performance by eliminating unjustified cost elements. Furthermore the business will be able to acquire an even bigger customer base hence ensuring growth for the business.

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Appendices

Appendix A: Actual sales data

1. Actual sales history for quarterly sales of uniform items for primary schools

Primary Schools

Year	Period	Ramokhutlwane Skirts (S)	Tunics (T1)	T-shirts (T2)	Track suits (T3)	Supatsela Skirts (S)	Tunics (T1)	T-shirts (T2)	Track suits (T3)	Nkadimeng Skirts (S)	Tunics (T1)	T-shirts (T2)	Track suits (T3)	Motlhako* Skirts (S)	Tunics (T1)	Track suits (T3)	Machipe* Skirts (S)	Tunics (T1)	Track suits (T3)
2007	Q1	39	20	28	10	32	10	56	7	40	15	38	12	28	30	14	20	12	5
	Q2	20	13	10	3	12	7	27	7	12	4	13	4	11	20	10	5	6	3
	Q3	2	1	2	0	5	1	12	5	5	1	5	2	5	4	6	5	2	0
	Q4	3	0	1	0	2	0	8	0	2	1	0	0	0	2	0	1	0	0
2008	Q1	37	14	30	9	31	15	50	10	33	20	47	10	26	33	8	22	11	7
	Q2	11	5	12	4	13	10	20	6	17	8	20	3	15	25	15	10	3	6
	Q3	1	2	1	0	2	2	10	6	3	0	4	3	7	10	6	3	1	0
	Q4	2	0	1	0	1	2	2	1	1	2	3	0	2	1	0	2	1	0
2009	Q1	39	22	32	12	30	18	58	10	37	28	35	13	33	32	10	20	15	11
	Q2	12	15	14	2	11	11	20	4	10	15	11	6	17	23	12	8	8	10
	Q3	1	1	2	0	4	3	11	3	5	1	6	2	3	8	0	0	2	3
	Q4	0	0	1	0	0	5	3	0	2	1	3	0	4	2	0	1	0	0
2010	Q1	40	25	36	14	44	23	64	14	40	29	49	16	37	40	17	25	19	14
	Q2	17	18	10	3	18	14	33	7	11	18	17	4	19	22	10	13	2	6
	Q3	3	2	2	0	2	6	5	7	2	3	4	0	5	4	2	2	2	2
	Q4	3	0	2	0	1	1	2	1	2	1	5	0	2	1	0	0	1	0
2011	Q1	58	30	40	16	24	25	60	17	43	37	41	18	41	44	18	27	22	17
	Q2	14	15	12	8	10	9	22	8	16	17	20	8	18	20	6	11	7	9

2. Actual sales history for quarterly sales of uniform items for primary schools

Secondary schools

Year	Period	Dibathuto Skirts (S)	Tunics (T1)	Tlhako Skirts (S)	Tunics (T1)	St Joseoh Skirts (S)	Tunics (T1)	Thejane Skirts (S)	Tunics (T1)	T-shirts (T2)	Segolokwane Skirts (S)	Tunics (T1)	T-shirts (T2)
2007	Q1	40	37	48	40	20	15	31	15	33	40	39	56
	Q2	22	28	26	20	9	8	22	8	21	33	28	44
	Q3	18	6	16	5	1	1	12	1	3	10	8	18
	Q4	6	2	8	2	0	0	5	0	0	2	1	5
2008	Q1	44	38	51	39	19	16	29	17	32	42	41	61
	Q2	19	29	21	13	12	6	19	10	24	28	30	39
	Q3	10	8	10	3	3	2	11	3	5	5	4	16
	Q4	4	1	2	1	1	0	2	3	2	1	0	1
2009	Q1	47	38	55	45	25	18	33	15	38	48	45	66
	Q2	23	33	30	16	15	11	24	11	28	29	27	48
	Q3	12	9	13	7	0	4	14	4	9	4	4	16
	Q4	7	1	1	2	0	1	5	1	0	1	2	3
2010	Q1	51	40	63	47	28	17	37	18	36	53	44	68
	Q2	28	36	33	21	12	9	27	12	22	34	36	49
	Q3	11	12	12	4	5	2	16	6	6	3	7	18
	Q4	3	2	4	1	1	2	4	0	1	0	1	7
2011	Q1	60	44	68	50	27	20	40	19	41	58	48	71
	Q2	30	29	36	27	17	11	31	9	25	38	39	50

Appendix B: Forecast model

Forecast model output for the 10 schools:

1. Forecast model for Ramokhutlwane

Ramokhutlwane										

Item: Skirts (s)

Forecast parameters values:

							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4
2010	40	17	3	3	63	15.75	2.54	1.08	0.19	0.19
2009	39	12	1	0	52	13	3.00	0.92	0.08	0.00
2008	37	11	1	2	51	12.75	2.90	0.86	0.08	0.16
						AVG St	**2.81**	**0.96**	**0.12**	**0.12**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0 = 0.69

Estimate of trend at beginning of quarter 1 L_0 = 16.78

Smoothing constants: alpha = 0.2 beta= 0.1 gamma= 0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.81		
Q-2				0.96		
Q-1				0.12		
Q0				0.12		
Q1- 2007	39.00	16.75	0.62	2.76		
Q2	20.00	18.06	0.69	1.07	16.67	3.33
Q3	2.00	18.33	0.64	0.13	2.25	0.25
Q4	3.00	20.18	0.76	0.13	2.28	0.72
Q1-2008	37.00	19.43	0.61	2.95	57.84	20.84
Q2	11.00	18.09	0.42	1.13	21.46	10.46
Q3	1.00	16.34	0.20	0.14	2.42	1.42
Q4	2.00	16.19	0.17	0.15	2.23	0.23
Q1-2009	39.00	15.73	0.10	3.20	48.30	9.30
Q2	12.00	14.79	0.00	1.21	17.92	5.92
Q3	1.00	13.29	-0.15	0.14	2.03	1.03
Q4	0.00	10.51	-0.41	0.15	1.93	1.93
Q1-2010	40.00	10.58	-0.37	3.58	32.31	7.69
Q2	17.00	10.97	-0.29	1.37	12.38	4.62
Q3	3.00	12.70	-0.09	0.17	1.54	1.46
Q4	3.00	14.16	0.07	0.17	1.86	1.14
Q1-2011	58.00	14.63	0.11	3.97	50.92	7.08
Q2	14.00	13.83	0.02	1.47	20.15	6.15
Q3					1.90	MAPE
Q4					2.04	4.92
Q1-2012					44.32	
Q2					16.80	
Q3					2.00	
Q4					2.04	
Q1-2013					49.56	
Q2					18.94	Average annual demand= 71.11
Q3					2.33	
Q4					2.33	

Forecast vs Actual demand (skirts)

Legend: Actual demand, Forecast demand, Linear (Forecast demand)

Item: Tunics (T1)						Seasonal factor					
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4	
2010	25	18	2	0	45.00	11.25	2.22	1.60	0.18	0.00	
2009	22	15	1	0	38.00	9.5	2.32	1.58	0.11	0.00	
2008	14	5	2	0	21.00	5.25	2.67	0.95	0.38	0.00	

Assumption: Quarter 4 is an outlier and is omitted from calculations, hence M-Creations can expect no sales for Tunics in the last quarter of every year

						AVG S_t	**2.40**	**1.38**	**0.22**	**0.00**	

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.44	
Estimate of trend at beginning of quarter 1 L_0			11.91	
Smoothing constants:		**alpha =**	0.2 **beta=**	0.1 **gamma=**	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.4		
Q-2				1.38		
Q-1				0.22		
Q1- 2007	20	11.54	0.36	2.33		
Q2	13	11.40	0.31	1.36	16.42	3.42
Q3	1	10.28	0.16	0.21	2.58	1.58
Q1-2008	14	9.55	0.08	2.25	24.36	10.36
Q2	5	8.44	-0.04	1.28	13.06	8.06
Q3	2	8.64	-0.02	0.21	1.74	0.26
Q1-2009	22	8.86	0.00	2.27	19.38	2.62
Q2	15	9.44	0.06	1.31	11.34	3.66
Q3	1	8.55	-0.03	0.20	2.00	1.00
Q1-2010	25	9.02	0.02	2.32	19.33	5.67
Q2	18	9.97	0.11	1.36	11.84	6.16
Q3	2	10.06	0.11	0.20	2.02	0.02
Q1-2011	30	10.72	0.16	2.37	23.59	6.41
Q2	15	10.91	0.17	1.36	14.80	0.20
Q3					2.33	**MAPE**
Q1-2012					25.15	3.80
Q2					14.52	
Q3					2.22	
Q1-2013					25.71	
Q2					15.07	
Q3					2.22	

Forecast vs. Actual demand (Tunics)

					Average annual demand=	41.88	

Item: T-Shirts (T2)										
Forecast parameters values:										
							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4
2010	36	10	2	2	50	12.50	2.88	0.80	0.16	0.16
2009	32	14	2	1	49	12.25	2.61	1.14	0.16	0.08
2008	30	12	1	1	44	11.00	2.73	1.09	0.09	0.09
						AVG St	**2.74**	**1.01**	**0.14**	**0.11**
Initialization of forecast:										
Estimate of trend at beginning of quarter 1 To					0.06					
Estimate of trend at beginning of quarter 1 Lo					12.59					
Smoothing constants:		alpha =	0.2	beta=	0.1	gamma=	0.1			
Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error				

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.74		
Q-2				1.01		
Q-1				0.14		
Q0				0.11		
Q1- 2007	28	12.17	0.01	2.70		
Q2	10	11.73	-0.03	0.99	12.30	2.30
Q3	2	12.21	0.02	0.14	1.64	0.36
Q4	1	11.60	-0.04	0.11	1.35	0.35
Q1-2008	30	11.47	-0.05	2.69	31.17	1.17
Q2	12	11.55	-0.04	1.00	11.36	0.64
Q3	1	10.62	-0.13	0.14	1.64	0.64
Q4	1	10.25	-0.15	0.11	1.13	0.13
Q1-2009	32	10.46	-0.12	2.73	27.14	4.86
Q2	14	11.08	-0.04	1.03	10.33	3.67
Q3	2	11.74	0.03	0.14	1.52	0.48
Q4	1	11.29	-0.02	0.10	1.25	0.25
Q1-2010	36	11.65	0.02	2.76	30.70	5.30
Q2	10	11.29	-0.02	1.01	11.97	1.97
Q3	2	11.86	0.04	0.14	1.59	0.41
Q4	2	13.33	0.18	0.11	1.25	0.75
Q1-2011	40	13.71	0.20	2.78	37.32	2.68
Q2	12	13.50	0.16	1.00	14.07	2.07
Q3					1.88	MAPE
Q4					1.46	1.65
Q1-2012					37.23	
Q2					14.01	
Q3					1.92	
Q4					1.43	
Q1-2013					37.73	
Q2					13.82	
Q3					1.96	Average annual demand= 54.78
Q4					1.49	
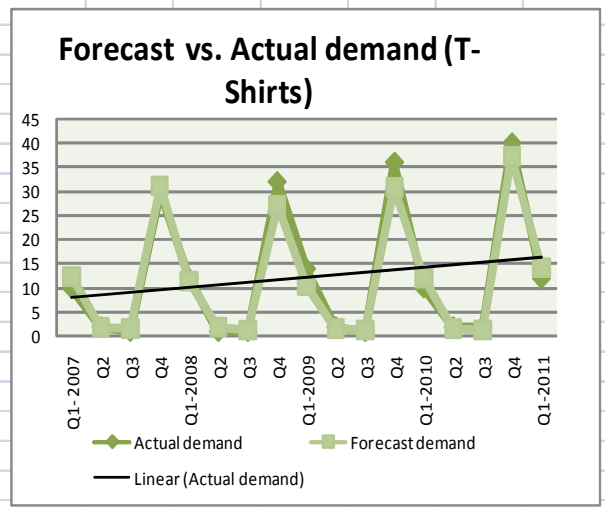
Forecast vs. Actual demand (T-Shirts)

Item: Track suits (T3)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010	14	3	0	0	17	4.25	3.29	0.71	0.00	0.00
2009	12	2	0	0	14	3.5	3.43	0.57	0.00	0.00
2008	9	4	0	0	13	3.25	2.77	1.23	0.00	0.00

Assumption: Quarters 3 and 4 are regarded as outliers and omitted from calculations, M-Creations can expect no sales for Track suit items in these periods

					AVG St	**3.16**	**0.84**	**0.00**	**0.00**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.19				
Estimate of trend at beginning of quarter 1 L_0			4.53				
Smoothing constants:		alpha =	0.2	beta=	0.1	gamma=	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				3.16		
Q-2				0.84		
Q1-2007	10	4.41	0.16	3.07		
Q2	3	4.37	0.14	0.82	3.83	0.83
Q1-2008	9	4.19	0.11	2.98	13.83	4.83
Q2	4	4.40	0.12	0.83	3.54	0.46
Q1-2009	12	4.42	0.11	2.95	13.47	1.47
Q2	2	4.10	0.06	0.80	3.77	1.77
Q1-2010	14	4.28	0.08	2.98	12.30	1.70
Q2	3	4.24	0.06	0.79	3.48	0.48
Q1-2011	16	4.51	0.08	3.04	12.83	3.17
Q2	8	5.70	0.20	0.85	3.63	4.37
Q1-2012					17.42	**MAPE**
Q2					4.71	**2.12**
Q1-2013					17.61	
Q2					4.66	Average annual demand= 20.29

Forecast vs. ACtual demand (Track suits)

Legend: Actual demand, Forecast demand, Linear (Actual demand)
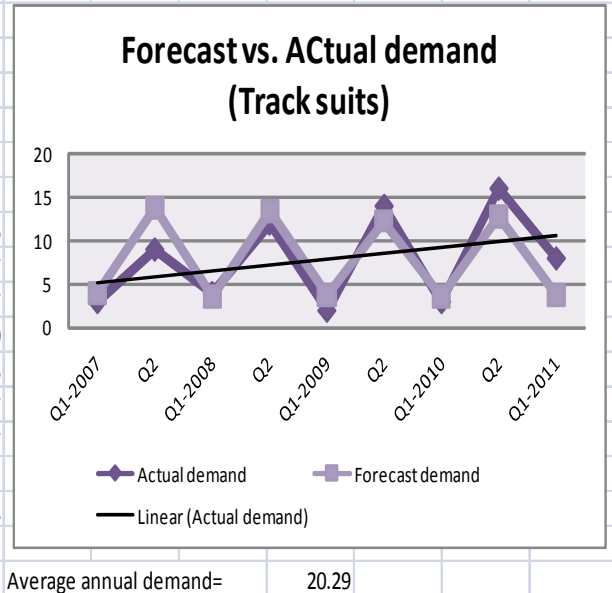
2. Forecast model for Supatsela

Supatsela										

Item: Skirts (s)

Forecast parameters values:

							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010	44	18	2	1	65.00	16.25	2.71	1.11	0.12	0.06
2009	30	11	4	0	45.00	11.25	2.67	0.98	0.36	0.00
2008	31	18	2	1	52.00	13.00	2.38	1.38	0.15	0.08
						AVG St	**2.59**	**1.16**	**0.21**	**0.05**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0				1.25		
Estimate of trend at beginning of quarter 1 L_0				18.13		
Smoothing constants:		alpha =	0.1	beta=	0.1	gamma= 0.6

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.59		
Q-2				1.16		
Q-1				0.21		
Q0				0.05		
Q1- 2007	32	18.67	1.18	2.06		
Q2	12	18.90	1.08	0.84	23.03	11.03
Q3	5	20.37	1.12	0.23	4.20	0.80
Q4	2	23.34	1.31	0.07	1.07	0.93
Q1-2008	31	23.69	1.21	1.61	50.88	19.88
Q2	18	24.54	1.18	0.78	21.04	3.04
Q3	2	24.01	1.01	0.14	5.95	3.95
Q4	1	23.91	0.89	0.05	1.79	0.79
Q1-2009	30	24.19	0.83	1.39	39.96	9.96
Q2	11	23.93	0.72	0.59	19.47	8.47
Q3	4	25.00	0.76	0.15	3.51	0.49
Q4	0	23.18	0.50	0.02	1.38	1.38
Q1-2010	44	24.48	0.58	1.63	32.88	11.12
Q2	18	25.62	0.64	0.66	14.71	3.29
Q3	2	24.94	0.51	0.11	4.02	2.02
Q4	1	27.56	0.72	0.03	0.55	0.45
Q1-2011	24	26.92	0.58	1.19	46.20	22.20
Q2	10	26.27	0.46	0.49	18.05	8.05
Q3					3.81	**MAPE**
Q4					1.43	6.34
Q1-2012					37.12	
Q2					15.69	
Q3					4.09	
Q4					0.57	
Q1-2013					43.67	
Q2					17.54	
Q3					2.92	Average annual demand= R 63.97
Q4					0.81	

Forecast vs. Actual demand (Skirts)

Legend: Actual demand — Forecast demand — Linear (Actual demand)

Item: Tunics (T1)							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010	23	14	6	1	44.00	11.00	2.09	1.27	0.55	0.09
2009	18	11	3	5	37.00	9.25	1.95	1.19	0.32	0.54
2008	15	10	2	2	29.00	7.25	2.07	1.38	0.28	0.28
						AVG St	**2.04**	**1.28**	**0.38**	**0.30**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.44	
Estimate of trend at beginning of quarter 1 L_0			11.66	
Smoothing constants:		**alpha =**	0.20 **beta=**	0.10 **gamma=** 0.10

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.04		
Q-2				1.28		
Q-1				0.38		
Q0				0.30		
Q1- 2007	10	10.66	0.29	1.93		
Q2	7	9.85	0.18	1.22	14.01	7.01
Q3	1	8.56	0.04	0.35	3.81	2.81
Q4	0	6.87	-0.14	0.27	2.58	2.58
Q1-2008	15	6.94	-0.12	1.95	13.00	2.00
Q2	10	7.10	-0.09	1.24	8.35	1.65
Q3	2	6.74	-0.12	0.35	2.48	0.48
Q4	2	6.78	-0.10	0.27	1.79	0.21
Q1-2009	18	7.19	-0.05	2.01	13.05	4.95
Q2	11	7.48	-0.01	1.26	8.86	2.14
Q3	3	7.70	0.01	0.35	2.60	0.40
Q4	5	9.84	0.22	0.30	2.10	2.90
Q1-2010	23	10.34	0.25	2.03	20.19	2.81
Q2	14	10.68	0.26	1.27	13.39	0.61
Q3	6	12.16	0.38	0.37	3.85	2.15
Q4	1	10.71	0.20	0.28	3.71	2.71
Q1-2011	25	11.19	0.23	2.05	22.14	2.86
Q2	9	10.55	0.14	1.23	14.49	5.49
Q3					3.72	**MAPE**
Q4					2.91	2.57
Q1-2012					21.46	
Q2					13.52	
Q3					3.76	
Q4					3.16	
Q1-2013					21.70	
Q2					13.57	
Q3					3.92	Average annual demand= 42.43
Q4					2.95	
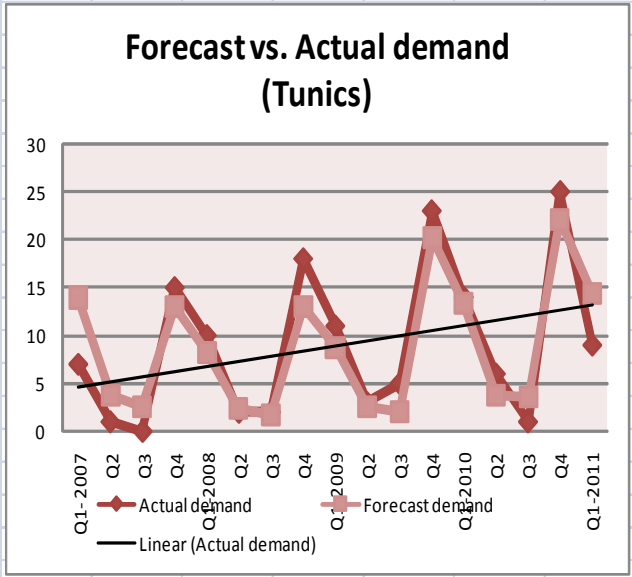
Forecast vs. Actual demand (Tunics)

Item: T-Shirts (T2)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010.00	64	33	5	2	104.00	26.00	2.46	1.27	0.19	0.08
2009.00	58	20	11	3	92.00	23.00	2.52	0.87	0.48	0.13
2008.00	50	20	10	2	82.00	20.50	2.44	0.98	0.49	0.10
						AVG St	2.47	1.04	0.39	0.10

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0 — 0.75

Estimate of trend at beginning of quarter 1 L_0 — 27.13

Smoothing constants: alpha = 0.1 beta= 0 gamma= 0.9

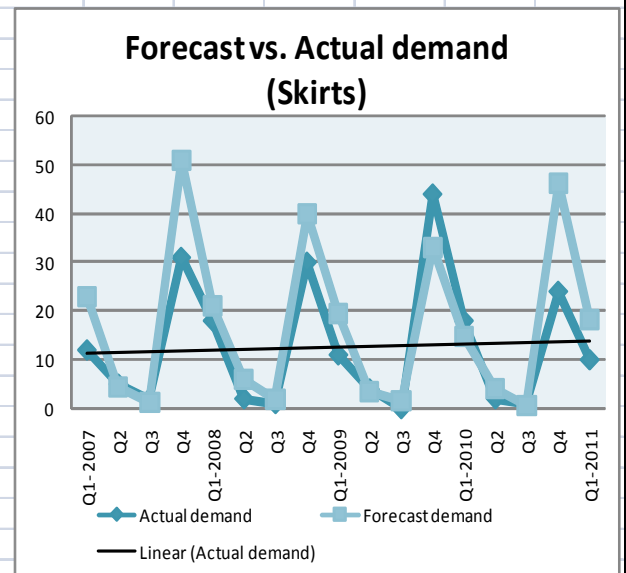| Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error	
Q-3				2.47			
Q-2				1.04			
Q-1				0.39			
Q0				0.10			
Q1- 2007	56	27.35	0.75	2.09			
Q2	27	27.89	0.75	0.98	29.23	2.23	
Q3	12	28.85	0.75	0.41	11.17	0.83	
Q4	8	34.64	0.75	0.22	2.96	5.04	
Q1-2008	50	34.25	0.75	1.52	73.95	23.95	
Q2	20	33.55	0.75	0.63	34.13	14.13	
Q3	10	33.29	0.75	0.31	14.18	4.18	
Q4	2	31.55	0.75	0.08	7.41	5.41	
Q1-2009	58	32.88	0.75	1.74	49.19	8.81	
Q2	20	33.42	0.75	0.60	21.32	1.32	
Q3	11	34.28	0.75	0.32	10.65	0.35	
Q4	3	35.34	0.75	0.08	2.76	0.24	
Q1-2010	64	36.16	0.75	1.77	62.78	1.22	
Q2	33	38.70	0.75	0.83	22.22	10.78	
Q3	5	37.06	0.75	0.15	12.62	7.62	
Q4	2	36.41	0.75	0.06	3.19	1.19	
Q1-2011	60	36.84	0.75	1.64	65.66	5.66	
Q2	22	36.48	0.75	0.63	31.11	9.11	
Q3					11.61	**MAPE**	
Q4					2.94	6.00	
Q1-2012					64.78		
Q2					22.41		
Q3					11.91		
Q4					3.14		
Q1-2013					65.80		
Q2					30.82		
Q3					5.71	Average annual demand=	106.02
Q4					2.15		
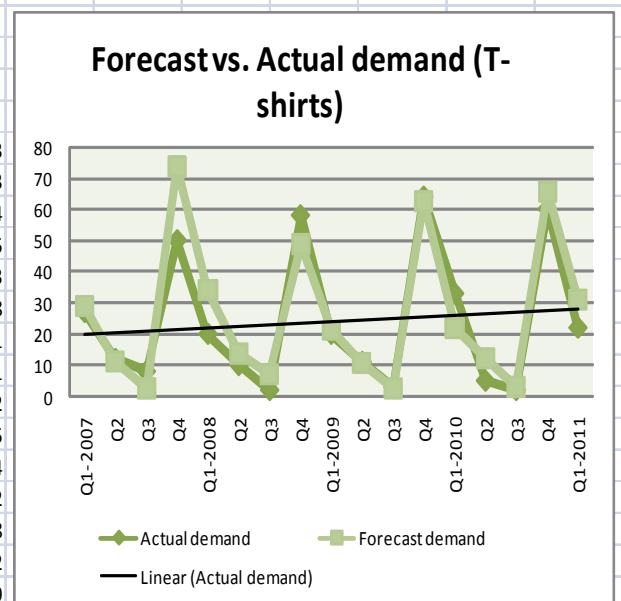
Forecast vs. Actual demand (T-shirts)

Legend: Actual demand · Forecast demand · Linear (Actual demand)

Item: Track suits (T3)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010	14	7	7	1	29.00	7.25	1.93	0.97	0.97	0.14
2009	10	4	3	0	17.00	4.25	2.35	0.94	0.71	0.00
2008	10	6	6	1	23.00	5.75	1.74	1.04	1.04	0.17
						AVG St	**2.01**	**0.98**	**0.90**	**0.10**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0	0.75	
Estimate of trend at beginning of quarter 1 L_0	8.38	
Smoothing constants:	**alpha =** 0.2	**beta=** 0.1 **gamma=** 0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.01		
Q-2				0.98		
Q-1				0.90		
Q0				0.10		
Q1- 2007	7	8.00	0.64	1.90		
Q2	7	8.34	0.61	0.97	8.46	1.46
Q3	5	8.27	0.54	0.87	8.05	3.05
Q4	0	7.04	0.36	0.09	0.88	0.88
Q1-2008	10	6.98	0.32	1.85	14.05	4.05
Q2	6	7.08	0.30	0.95	7.05	1.05
Q3	6	7.28	0.29	0.87	6.43	0.43
Q4	1	8.28	0.36	0.09	0.68	0.32
Q1-2009	10	7.99	0.30	1.79	15.99	5.99
Q2	4	7.47	0.21	0.91	7.91	3.91
Q3	3	6.84	0.13	0.82	6.65	3.65
Q4	0	5.57	-0.01	0.08	0.65	0.65
Q1-2010	14	6.02	0.03	1.84	9.96	4.04
Q2	7	6.37	0.07	0.93	5.52	1.48
Q3	7	6.85	0.11	0.84	5.30	1.70
Q4	1	7.96	0.21	0.09	0.58	0.42
Q1-2011	17	8.38	0.23	1.86	15.06	1.94
Q2	8	8.60	0.23	0.93	8.01	0.01
Q3					7.65	**MAPE**
Q4					0.82	2.06
Q1-2012					15.81	
Q2					8.06	
Q3					7.27	
Q4					0.74	
Q1-2013					16.29	
Q2					8.22	
Q3					7.44	Average annual demand= 32.05
Q4					0.78	

Forecast vs. Actual demand (Track suits)

Actual demand — Forecast demand — Linear (Actual demand)

3. Forecast model for Nkadimeng

Nkadimeng										

Item: Skirts (s)

Forecast parameters values:

							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010	40	11	2	2	55.00	13.75	2.91	0.80	0.15	0.15
2009	37	10	5	1	53.00	13.25	2.79	0.75	0.38	0.08
2008	33	12	3	1	49.00	12.25	2.69	0.98	0.24	0.08
						AVG St	**2.80**	**0.84**	**0.26**	**0.10**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0				0.13	
Estimate of trend at beginning of quarter 1 L_0				13.94	
Smoothing constants:		alpha =	0.2	beta=	0.1	gamma=	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.8		
Q-2				0.84		
Q-1				0.26		
Q0				0.1		
Q1- 2007	40	14.11	0.13	2.80		
Q2	12	14.25	0.13	0.84	11.96	0.04
Q3	5	15.35	0.23	0.27	3.74	1.26
Q4	2	16.46	0.32	0.10	1.56	0.44
Q1-2008	33	15.78	0.22	2.73	47.03	14.03
Q2	17	16.84	0.30	0.86	13.44	3.56
Q3	3	15.96	0.18	0.26	4.57	1.57
Q4	1	14.87	0.06	0.10	1.65	0.65
Q1-2009	37	14.65	0.03	2.71	40.80	3.80
Q2	10	14.08	-0.03	0.84	12.58	2.58
Q3	5	15.10	0.07	0.27	3.63	1.37
Q4	2	16.19	0.18	0.10	1.50	0.50
Q1-2010	40	16.05	0.14	2.69	44.39	4.39
Q2	11	15.56	0.08	0.83	13.64	2.64
Q3	2	14.02	-0.08	0.25	4.16	2.16
Q4	2	15.10	0.03	0.10	1.41	0.59
Q1-2011	43	15.31	0.05	2.70	40.72	2.28
Q2	16	16.15	0.13	0.85	12.73	3.27
Q3					4.21	**MAPE**
Q4					1.61	2.66
Q1-2012					44.14	
Q2					13.71	
Q3					4.33	
Q4					1.65	
Q1-2013					43.79	
Q2					13.49	
Q3					4.13	Average annual demand=	62.07
Q4					1.70	

Forecast vs. Actual demand (skirts)

Legend: Actual demand, Forecast demand, Linear (Forecast demand)

Item: Tunics (T1)						Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010	29	18	3	1	51.00	12.75	2.27	1.41	0.24	0.08
2009	28	15	1	1	45.00	11.25	2.49	1.33	0.09	0.09
2008	20	8	0	2	30.00	7.50	2.67	1.07	0.00	0.27
						AVG St	**2.48**	**1.27**	**0.11**	**0.14**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.38		
Estimate of trend at beginning of quarter 1 L_0			13.31		
Smoothing constants:		**alpha =**	0.20	**beta=**	0.10 **gamma=** 0.10

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.48		
Q-2				1.27		
Q-1				0.11		
Q0				0.14		
Q1- 2007	15	12.16	0.22	2.36		
Q2	4	10.54	0.04	1.18	15.73	11.73
Q3	1	10.28	0.01	0.11	1.16	0.16
Q4	1	9.66	-0.05	0.14	1.44	0.44
Q1-2008	20	9.38	-0.08	2.33	22.61	2.61
Q2	8	8.80	-0.13	1.15	10.99	2.99
Q3	0	6.94	-0.30	0.10	0.94	0.94
Q4	2	8.24	-0.14	0.15	0.90	1.10
Q1-2009	28	8.88	-0.06	2.42	18.90	9.10
Q2	15	9.65	0.02	1.19	10.17	4.83
Q3	1	9.78	0.03	0.10	0.95	0.05
Q4	1	9.21	-0.03	0.14	1.44	0.44
Q1-2010	29	9.75	0.03	2.47	22.18	6.82
Q2	18	10.84	0.13	1.24	11.67	6.33
Q3	3	14.88	0.53	0.11	1.08	1.92
Q4	1	13.72	0.36	0.14	2.21	1.21
Q1-2011	37	14.26	0.37	2.48	34.79	2.21
Q2	17	14.45	0.36	1.23	18.15	1.15
Q3					1.45	**MAPE**
Q4					2.18	3.18
Q1-2012					35.75	
Q2					17.67	
Q3					1.46	
Q4					2.12	
Q1-2013					36.58	
Q2					18.36	
Q3					1.61	Average annual demand= 57.38
Q4					2.02	
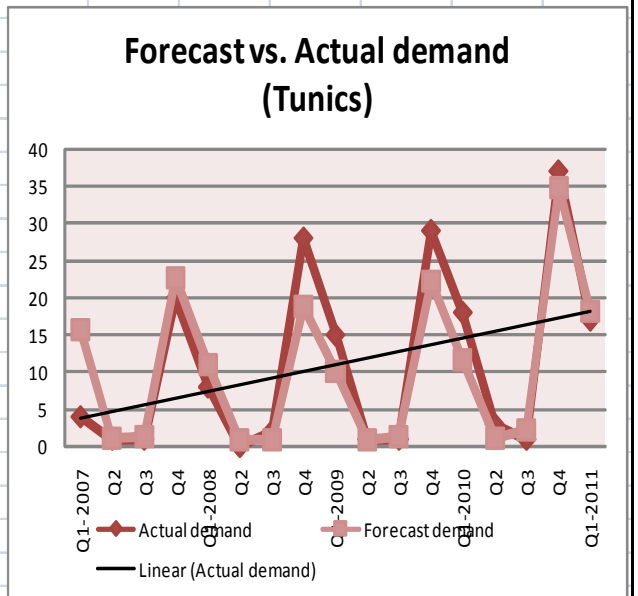
Forecast vs. Actual demand (Tunics)

Item: T-Shirts (T2)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Seasonal factor Q1	Q2	Q3	Q4
2010.00	49	17	4	5	75.00	18.75	2.61	0.91	0.21	0.27
2009.00	35	11	6	3	55.00	13.75	2.55	0.80	0.44	0.22
2008.00	47	20	4	3	74.00	18.50	2.54	1.08	0.22	0.16
						AVG St	**2.57**	**0.93**	**0.29**	**0.22**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T$_0$	1.25
Estimate of trend at beginning of quarter 1 L$_0$	20.63
Smoothing constants:	alpha = 0.2 beta= 0.1 g

Period	Actual sales(X$_t$)	L$_t$	T$_t$	S$_t$	Forecast	Error
Q-3				2.57		
Q-2				0.93		
Q-1				0.29		
Q0				0.22		
Q1- 2007	38	20.46	1.11	2.50		
Q2	13	20.05	0.96	0.90	20.06	7.06
Q3	5	20.25	0.88	0.29	6.09	1.09
Q4	0	16.91	0.46	0.20	4.65	4.65
Q1-2008	47	17.65	0.49	2.52	43.39	3.61
Q2	20	18.95	0.57	0.92	16.36	3.64
Q3	4	18.41	0.46	0.28	5.58	1.58
Q4	3	18.13	0.38	0.19	3.74	0.74
Q1-2009	35	17.59	0.29	2.46	46.56	11.56
Q2	11	16.71	0.17	0.89	16.40	5.40
Q3	6	17.81	0.27	0.28	4.71	1.29
Q4	3	17.54	0.21	0.19	3.52	0.52
Q1-2010	49	18.18	0.26	2.49	43.72	5.28
Q2	17	18.56	0.27	0.89	16.43	0.57
Q3	4	17.88	0.17	0.28	5.36	1.36
Q4	5	19.64	0.33	0.20	3.47	1.53
Q1-2011	41	19.27	0.26	2.45	49.64	8.64
Q2	20	20.11	0.32	0.90	17.46	2.54
Q3					5.70	MAPE
Q4					3.98	3.59
Q1-2012					50.30	
Q2					18.21	
Q3					5.81	
Q4					3.93	
Q1-2013					50.77	
Q2					18.25	
Q3					5.69	Average annual demand= 77.93
Q4					4.06	
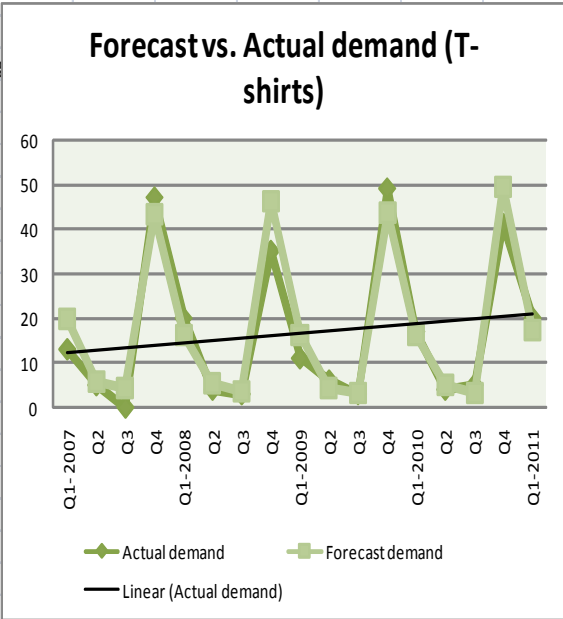
Forecast vs. Actual demand (T-shirts)

Item: Track suits (T3)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010	16	4	0	0	20.00	5.00	3.20	0.80	0.00	0.00
2009	13	6	2	0	21.00	5.25	2.48	1.14	0.38	0.00
2008	10	3	3	0	16.00	4.00	2.50	0.75	0.75	0.00

Assumption: Quarter 4 is an outlier and is omitted from calculations, hence M-Creations can expect no sales for Track suit items in the last quarter of every year

						AVG St	**2.73**	**0.90**	**0.38**	**0.00**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			-0.06	
Estimate of trend at beginning of quarter 1 L_0			4.91	
Smoothing constants:		alpha =	0.2	beta=	0.1	gamma=	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.73		
Q-2				0.90		
Q-1				0.38		
Q1- 2007	12	4.75	-0.07	2.71		
Q2	4	4.64	-0.08	0.90	4.21	0.21
Q3	2	4.70	-0.06	0.38	1.73	0.27
Q1-2008	10	4.45	-0.08	2.66	12.56	2.56
Q2	3	4.16	-0.10	0.88	3.91	0.91
Q3	3	4.81	-0.03	0.41	1.56	1.44
Q1-2009	13	4.80	-0.02	2.67	12.74	0.26
Q2	6	5.19	0.02	0.91	4.20	1.80
Q3	2	5.14	0.01	0.41	2.13	0.13
Q1-2010	16	5.32	0.03	2.70	13.75	2.25
Q2	4	5.16	0.01	0.89	4.85	0.85
Q3	0	4.14	-0.10	0.37	2.10	2.10
Q1-2011	18	4.57	-0.04	2.83	10.92	7.08
Q2	8	5.41	0.05	0.95	4.04	3.96
Q3					2.23	**MAPE**
Q1-2012					14.55	1.83
Q2					4.95	
Q3					2.22	
Q1-2013					14.74	
Q2					4.87	
Q3					2.00	Average annual demand= 20.17

Forecast vs. Actual demand (Track suits)

— Actual demand — Forecast demand — Linear (Actual demand)
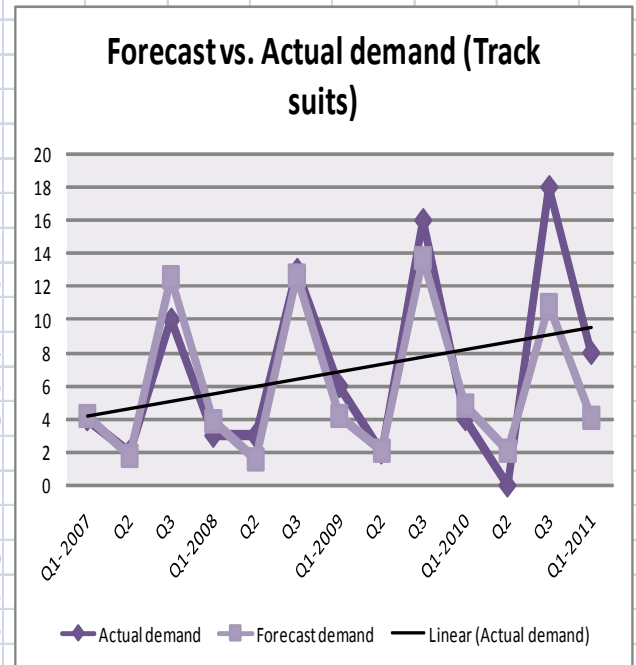
4. Forecast model for Motlhako

Mothlako												
Item: Skirts (s)												
Forecast parameters values:												
								Seasonal factor				
Year	Q1	Q2	Q3	Q4	Annual Sales	Average		Q1	Q2	Q3	Q4	
2010	37	19	5	2	63.00	15.75		2.35	1.21	0.32	0.13	
2009	33	17	3	4	57.00	14.25		2.32	1.19	0.21	0.28	
2008	26	15	7	2	50.00	12.50		2.08	1.20	0.56	0.16	
						AVG St		**2.25**	**1.20**	**0.36**	**0.19**	
Initialization of forecast:												
Estimate of trend at beginning of quarter 1 T_0					0.38							
Estimate of trend at beginning of quarter 1 L_0					16.31							
Smoothing constants:		alpha =	0.2	beta=	0.1	gamma=	0.1					

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.25		
Q-2				1.2		
Q-1				0.36		
Q0				0.1		
Q1- 2007	28	15.84	0.29	2.20		
Q2	11	14.74	0.15	1.15	19.35	8.35
Q3	5	14.69	0.13	0.36	5.36	0.36
Q4	0	11.85	-0.17	0.09	1.48	1.48
Q1-2008	26	11.71	-0.16	2.20	25.74	0.26
Q2	15	11.84	-0.13	1.17	13.34	1.66
Q3	7	13.27	0.02	0.37	4.19	2.81
Q4	2	15.08	0.20	0.09	1.20	0.80
Q1-2009	33	15.22	0.20	2.20	33.68	0.68
Q2	17	15.25	0.18	1.16	17.97	0.97
Q3	3	13.94	0.03	0.36	5.78	2.78
Q4	4	19.66	0.60	0.11	1.32	2.68
Q1-2010	37	19.57	0.53	2.17	44.58	7.58
Q2	19	19.36	0.46	1.14	23.34	4.34
Q3	5	18.64	0.34	0.35	7.11	2.11
Q4	2	18.98	0.34	0.11	2.00	0.00
Q1-2011	41	19.24	0.33	2.17	41.91	0.91
Q2	18	18.80	0.25	1.12	22.36	4.36
Q3					7.15	**MAPE**
Q4					1.80	2.48
Q1-2012					41.93	
Q2					22.12	
Q3					6.84	
Q4					2.00	
Q1-2013					41.34	
Q2					21.78	
Q3					6.67	Average annual demand= 72.63
Q4					2.00	

Forecast vs. Actual demand (Skirts)

Item: Tunics (T1)							Seasonal factor					
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4		
2010	40	22	4	1	67.00	16.75	2.39	1.31	0.24	0.06		
2009	32	23	8	2	65.00	16.25	1.97	1.42	0.49	0.12		
2008	33	25	10	1	69.00	17.25	1.91	1.45	0.58	0.06		
						AVG St	**2.09**	**1.39**	**0.44**	**0.08**		

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.13				
Estimate of trend at beginning of quarter 1 L_0			16.94				
Smoothing constants:		**alpha =**	0.20	**beta=**	0.10	**gamma=**	0.10

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error	
Q-3				2.09			
Q-2				1.39			
Q-1				0.44			
Q0				0.08			
Q1- 2007	30	16.52	0.07	2.06			
Q2	20	16.15	0.03	1.37	23.06	3.06	
Q3	4	14.76	-0.11	0.42	7.12	3.12	
Q4	2	16.72	0.09	0.08	1.17	0.83	
Q1-2008	33	16.65	0.08	2.05	34.67	1.67	
Q2	25	17.01	0.11	1.38	22.99	2.01	
Q3	10	18.42	0.24	0.44	7.24	2.76	
Q4	1	17.31	0.10	0.08	1.57	0.57	
Q1-2009	32	17.04	0.06	2.04	35.77	3.77	
Q2	23	17.01	0.05	1.38	23.68	0.68	
Q3	8	17.33	0.08	0.44	7.42	0.58	
Q4	2	18.84	0.22	0.08	1.42	0.58	
Q1-2010	40	19.18	0.24	2.04	38.84	1.16	
Q2	22	18.72	0.17	1.36	26.82	4.82	
Q3	4	16.94	-0.03	0.42	8.27	4.27	
Q4	1	15.91	-0.13	0.08	1.42	0.42	
Q1-2011	44	16.94	-0.01	2.10	32.22	11.78	
Q2	20	16.48	-0.06	1.35	23.02	3.02	
Q3					7.14	**MAPE**	
Q4					1.34	2.65	
Q1-2012					33.45		
Q2					22.68		
Q3					7.19		
Q4					1.38		
Q1-2013					33.53		
Q2					22.34		
Q3					6.86	Average annual demand=	64.16
Q4					1.34		
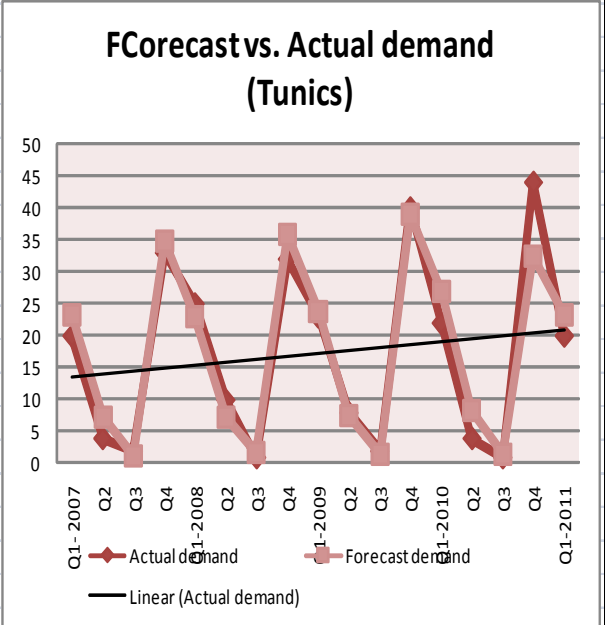
FCorecast vs. Actual demand (Tunics)

Item: Track suits (T3)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010.00	17.00	10.00	2.00	0.00	29.00	7.25	2.34	1.38	0.28	0.00
2009.00	10.00	12.00	0.00	0.00	22.00	5.50	1.82	2.18	0.00	0.00
2008.00	8.00	15.00	6.00	0.00	29.00	7.25	1.10	2.07	0.83	0.00

Assumption: Quarter 4 is an outlier and is omitted from calculations, hence M-Creations can expect no sales for Track suit items in the last quarter of every year

						AVG St	**1.76**	**1.88**	**0.37**	**0.00**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0		0.44
Estimate of trend at beginning of quarter 1 L_0		7.91
Smoothing constants:	**alpha =** 0.1	**beta=** 0.1	**gamma=** 0.8

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				1.76		
Q-2				1.88		
Q-1				0.37		
Q1- 2007	14	8.30	0.43	1.70		
Q2	10	8.40	0.40	1.33	16.43	6.43
Q3	6	9.54	0.47	0.58	3.25	2.75
Q1-2008	8	9.48	0.42	1.02	17.03	9.03
Q2	15	10.04	0.43	1.46	13.16	1.84
Q3	6	10.47	0.43	0.57	6.05	0.05
Q1-2009	10	10.80	0.42	0.94	11.07	1.07
Q2	12	10.92	0.39	1.17	16.39	4.39
Q3	0	10.18	0.28	0.11	6.49	6.49
Q1-2010	17	11.21	0.36	1.40	9.88	7.12
Q2	10	11.27	0.33	0.94	13.55	3.55
Q3	2	12.17	0.38	0.15	1.33	0.67
Q1-2011	18	12.59	0.39	1.42	17.60	0.40
Q2	6	12.31	0.32	0.58	12.25	6.25
Q3					7.25	**MAPE**
Q1-2012					11.92	3.85
Q2					14.80	
Q3					1.45	
Q1-2013					17.70	
Q2					11.93	
Q3					1.95	Average annual demand= 32.28

Forecast vs. Actual demand (Track suits)
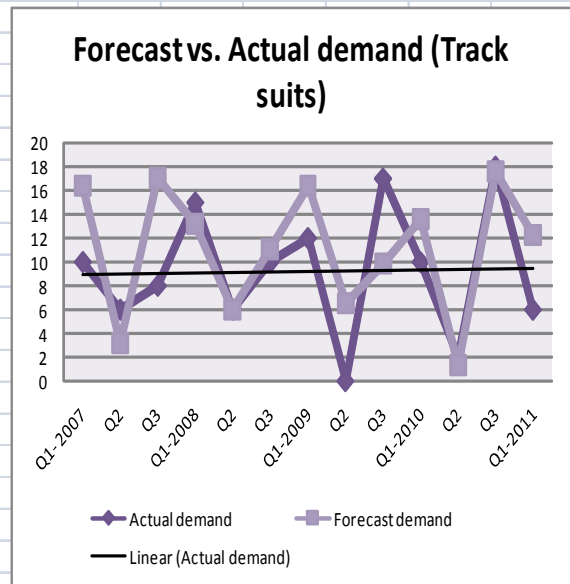
5. Forecast model for Machipe

Machipe										

Item: Skirts (s)

Forecast parameters values:

							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010	25	13	2	0	40	10	2.50	1.30	0.20	0.00
2009	20	8	0	1	29	7.25	2.76	1.10	0.00	0.14
2008	22	10	3	2	37	9.25	2.38	1.08	0.32	0.22
						AVG S_t	**2.55**	**1.16**	**0.17**	**0.12**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0				0.69	
Estimate of trend at beginning of quarter 1 L_0				11.03	
Smoothing constants:		alpha =	0.1	beta=	0.1	gamma=	0.7

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.55		
Q-2				1.16		
Q-1				0.17		
Q0				0.12		
Q1- 2007	20	11.33	0.65	2.00		
Q2	5	11.21	0.57	0.66	13.90	8.90
Q3	5	13.55	0.75	0.31	2.00	3.00
Q4	1	13.70	0.69	0.09	1.72	0.72
Q1-2008	22	14.05	0.65	1.70	28.78	6.78
Q2	10	14.75	0.66	0.67	9.71	0.29
Q3	3	14.84	0.60	0.23	4.77	1.77
Q4	2	16.19	0.68	0.11	1.34	0.66
Q1-2009	20	16.36	0.63	1.36	28.61	8.61
Q2	8	16.48	0.58	0.54	11.43	3.43
Q3	0	15.35	0.41	0.07	4.00	4.00
Q4	1	15.07	0.34	0.08	1.77	0.77
Q1-2010	25	15.69	0.37	1.52	21.02	3.98
Q2	13	16.85	0.44	0.70	8.70	4.30
Q3	2	18.41	0.56	0.10	1.22	0.78
Q4	0	17.07	0.37	0.02	1.52	1.52
Q1-2011	27	17.47	0.37	1.54	26.59	0.41
Q2	11	17.62	0.35	0.65	12.53	1.53
Q3					4.21	**MAPE**
Q4					2.02	3.03
Q1-2012					24.52	
Q2					9.73	
Q3					1.26	
Q4					1.44	
Q1-2013					27.39	
Q2					12.62	
Q3					1.74	Average annual demand=	41.50
Q4					0.43	

Forecast vs. Actual demand (Skirts)
— Actual demand
— Forecast demand
— Linear (Actual demand)

Item: Tunics (T1)							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010	19	2	2	1	24	6	3.17	0.33	0.33	0.17
2009	15	8	2	0	25	6.25	2.40	1.28	0.32	0.00
2008	11	3	1	1	16	4	2.75	0.75	0.25	0.25
						AVG St	**2.77**	**0.79**	**0.30**	**0.14**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			-0.06	
Estimate of trend at beginning of quarter 1 L_0			5.91	
Smoothing constants:		alpha =	0.20 **beta=**	0.10 **gamma=** 0.10

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.77		
Q-2				0.79		
Q-1				0.30		
Q0				0.14		
Q1- 2007	12	5.54	-0.09	2.71		
Q2	6	5.88	-0.05	0.81	4.30	1.70
Q3	2	6.00	-0.03	0.30	1.75	0.25
Q4	0	4.77	-0.15	0.13	0.83	0.83
Q1-2008	11	4.51	-0.16	2.68	12.51	1.51
Q2	3	4.21	-0.18	0.80	3.53	0.53
Q3	1	3.89	-0.19	0.30	1.22	0.22
Q4	1	4.54	-0.11	0.14	0.47	0.53
Q1-2009	15	4.67	-0.08	2.74	11.91	3.09
Q2	8	5.66	0.02	0.86	3.68	4.32
Q3	2	5.89	0.04	0.30	1.70	0.30
Q4	0	4.74	-0.07	0.12	0.80	0.80
Q1-2010	19	5.13	-0.03	2.83	12.78	6.22
Q2	2	4.54	-0.08	0.82	4.40	2.40
Q3	2	4.89	-0.04	0.31	1.35	0.65
Q4	1	5.52	0.03	0.13	0.59	0.41
Q1-2011	22	5.99	0.07	2.92	15.70	6.30
Q2	7	6.55	0.12	0.85	4.98	2.02
Q3					1.99	**MAPE**
Q4					0.90	1.89
Q1-2012					18.24	
Q2					5.76	
Q3					2.02	
Q4					0.81	
Q1-2013					18.89	
Q2					5.48	
Q3					2.09	Average annual demand= 25.91
Q4					0.85	
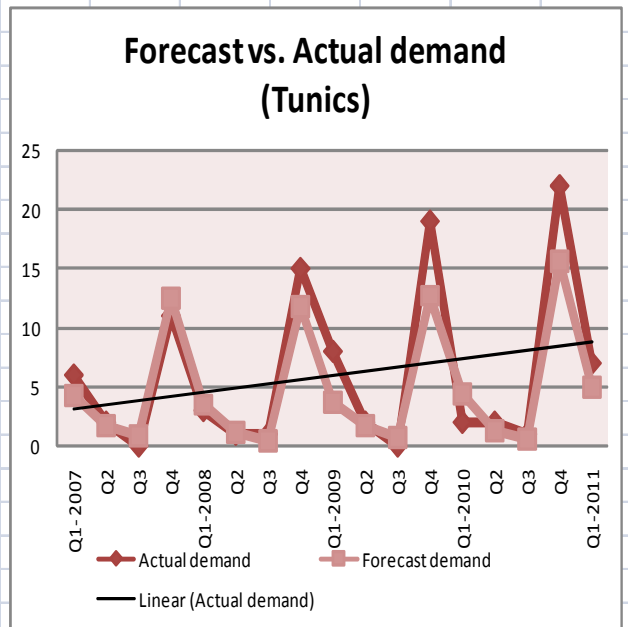
Forecast vs. Actual demand (Tunics)

Item: Track suits (T3)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010.00	14.00	6.00	2.00	0.00	22.00	5.50	2.55	1.09	0.36	0.00
2009.00	11.00	10.00	3.00	0.00	24.00	6.00	1.83	1.67	0.50	0.00
2008.00	7.00	6.00	0.00	0.00	13.00	3.25	2.15	1.85	0.00	0.00

Assumption: Quarter 4 is an outlier and is omitted from calculations, hence M-Creations can expect no sales for Track suit items in the last quarter of every year

						AVG St	**2.18**	**1.53**	**0.29**	**0.00**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			-0.13	
Estimate of trend at beginning of quarter 1 L_0			5.31	
Smoothing constants:	**alpha =**	0.20 **beta=**	0.10 **gamma=**	0.10

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.18		
Q-2				1.53		
Q-1				0.29		
Q1- 2007	5	4.61	-0.18	2.07		
Q2	3	3.93	-0.23	1.45	6.77	3.77
Q3	0	2.96	-0.31	0.26	1.07	1.07
Q1-2008	7	2.80	-0.29	2.11	5.50	1.50
Q2	6	2.83	-0.26	1.52	3.64	2.36
Q3	0	2.06	-0.31	0.23	0.67	0.67
Q1-2009	11	2.44	-0.24	2.35	3.69	7.31
Q2	10	3.07	-0.15	1.69	3.34	6.66
Q3	3	4.89	0.04	0.27	0.69	2.31
Q1-2010	14	5.14	0.06	2.39	11.61	2.39
Q2	6	4.87	0.03	1.65	8.80	2.80
Q3	2	5.39	0.08	0.28	1.34	0.66
Q1-2011	17	5.79	0.11	2.44	13.06	3.94
Q2	9	5.82	0.10	1.64	9.73	**MAPE**
Q3					1.39	2.95
Q1-2012					13.93	
Q2					10.02	
Q3					1.61	
Q1-2013					14.15	
Q2					9.75	
Q3					1.67	Average annual demand=

Average annual demand= 25.11

Forecast vs. Actual demand (Track suits)
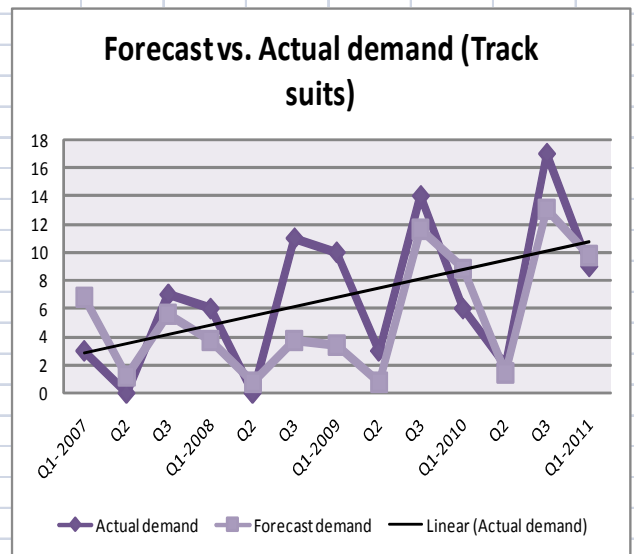
6. Forecast model for Dibathuto

Dibathuto										

Item: Skirts (s)

Forecast parameters values:

							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4
2010.00	51.00	28.00	11.00	3.00	93.00	23.25	2.19	1.20	0.47	0.13
2009.00	47.00	23.00	12.00	7.00	89.00	22.25	2.11	1.03	0.54	0.31
2008.00	44.00	19.00	10.00	4.00	77.00	19.25	2.29	0.99	0.52	0.21
						AVG St	**2.20**	**1.08**	**0.51**	**0.22**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T₀ — 0.25

Estimate of trend at beginning of quarter 1 L₀ — 23.63

Smoothing constants: alpha = 0.20   beta= 0.1

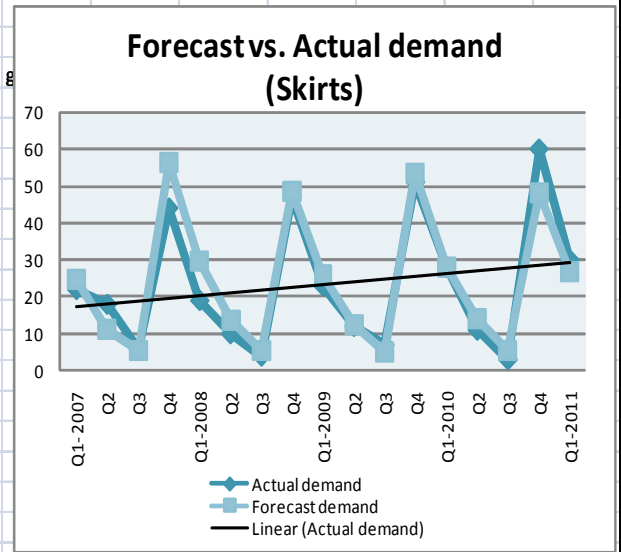| Period	Actual sales(Xt)	Lt	Tt	St	Forecast	Error
Q-3				2.20		
Q-2				1.08		
Q-1				0.51		
Q0				0.22		
Q1- 2007	40	22.74	0.14	2.16		
Q2	22	22.37	0.09	1.18	24.70	2.70
Q3	18	25.03	0.34	0.58	11.45	6.55
Q4	6	25.75	0.38	0.24	5.58	0.42
Q1-2008	44	24.99	0.27	2.33	56.33	12.33
Q2	19	23.43	0.08	1.26	29.76	10.76
Q3	10	22.25	-0.04	0.63	13.68	3.68
Q4	4	21.05	-0.16	0.26	5.40	1.40
Q1-2009	47	20.74	-0.17	2.56	48.72	1.72
Q2	23	20.11	-0.22	1.37	25.91	2.91
Q3	12	19.74	-0.23	0.69	12.47	0.47
Q4	7	20.94	-0.09	0.30	5.12	1.88
Q1-2010	51	20.67	-0.11	2.81	53.36	2.36
Q2	28	20.52	-0.11	1.51	28.25	0.25
Q3	11	19.53	-0.20	0.74	14.04	3.04
Q4	3	17.49	-0.38	0.31	5.72	2.72
Q1-2011	60	17.96	-0.30	3.14	47.99	12.01
Q2	30	18.10	-0.25	1.68	26.68	3.32
Q3					11.19	**MAPE**
Q4					4.68	4.03
Q1-2012					45.67	
Q2					24.52	
Q3					12.28	
Q4					5.28	
Q1-2013					50.08	
Q2					26.96	
Q3					13.28	Average annual demand= 91.40
Q4					5.58	

Forecast vs. Actual demand (Skirts)

Legend: Actual demand, Forecast demand, Linear (Actual demand)

Item: Tunics (T1)							Seasonal factor				
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4	
2010.00	40.00	36.00	12.00	2.00	90.00	22.50	1.78	1.78	0.53	0.09	
2009.00	38.00	33.00	9.00	1.00	81.00	20.25	1.88	1.88	0.44	0.05	
2008.00	38.00	29.00	8.00	1.00	76.00	19.00	2.00	2.00	0.42	0.05	
						AVG St	1.88	1.88	0.47	0.06	
Initialization of forecast:											
Estimate of trend at beginning of quarter 1 T_0			0.56								
Estimate of trend at beginning of quarter 1 L_0			23.34								
Smoothing constants:		alpha =	0.20	beta=	0.1	gamma=	0.1				

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				1.88		
Q-2				1.88		
Q-1				0.47		
Q0				0.06		
Q1- 2007	37	23.06	0.48	1.85		
Q2	28	21.81	0.31	1.82	44.25	16.25
Q3	6	20.25	0.12	0.45	10.39	4.39
Q4	2	22.96	0.38	0.06	1.22	0.78
Q1-2008	38	22.77	0.32	1.83	43.23	5.23
Q2	29	21.66	0.18	1.77	42.04	13.04
Q3	8	21.00	0.09	0.45	9.88	1.88
Q4	1	20.07	-0.01	0.06	1.32	0.32
Q1-2009	38	20.19	0.00	1.84	36.79	1.21
Q2	33	19.88	-0.03	1.76	35.79	2.79
Q3	9	19.92	-0.02	0.45	8.84	0.16
Q4	1	19.18	-0.09	0.06	1.22	0.22
Q1-2010	40	19.62	-0.04	1.86	35.10	4.90
Q2	36	19.75	-0.02	1.77	34.48	1.52
Q3	12	21.17	0.12	0.46	8.80	3.20
Q4	2	23.64	0.36	0.06	1.29	0.71
Q1-2011	44	23.93	0.35	1.86	44.61	0.61
Q2	29	22.71	0.19	1.72	42.91	13.91
Q3					10.20	MAPE
Q4					1.41	4.18
Q1-2012					42.11	
Q2					40.33	
Q3					10.22	
Q4					1.39	
Q1-2013					42.57	
Q2					40.47	
Q3					10.49	Average annual demand=	96.05
Q4					1.44	

Forecast vs. Actual demand (Tunics)
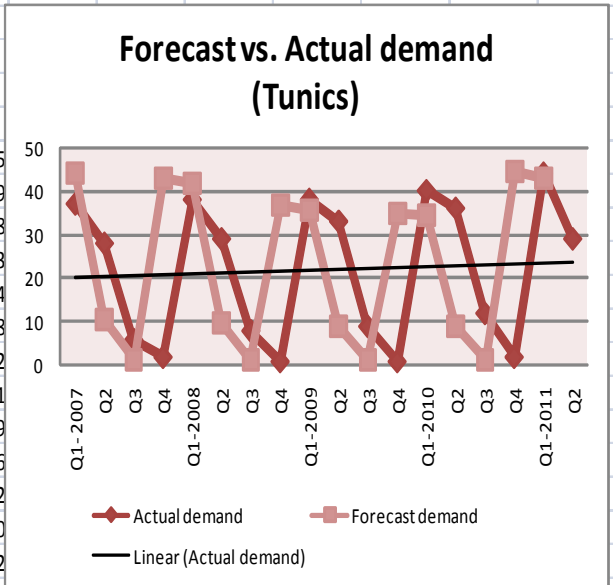
7. Forecast model for Tlhako

Tlhako										

Item: **Skirts (s)**										
Forecast parameters values:										
							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4
2010.00	63.00	33.00	12.00	4.00	112.00	28.00	2.25	1.18	0.43	0.14
2009.00	55.00	30.00	13.00	1.00	99.00	24.75	2.22	1.21	0.53	0.04
2008.00	51.00	21.00	10.00	2.00	84.00	21.00	2.43	1.00	0.48	0.10
						AVG St	**2.30**	**1.13**	**0.48**	**0.09**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0 — 0.81

Estimate of trend at beginning of quarter 1 L_0 — 29.22

Smoothing constants: **alpha =** 0.20 **beta=** 0.1 **gamma=** 0.001

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.30		
Q-2				1.13		
Q-1				0.48		
Q0				0.09		
Q1- 2007	48	28.20	0.63	2.30		
Q2	26	27.66	0.51	1.13	32.58	6.58
Q3	16	29.21	0.62	0.48	13.53	2.47
Q4	8	41.64	1.80	0.09	2.68	5.32
Q1-2008	51	39.18	1.37	2.30	99.87	48.87
Q2	21	36.16	0.93	1.13	45.87	24.87
Q3	10	33.83	0.61	0.48	17.82	7.82
Q4	2	31.99	0.36	0.09	3.11	1.11
Q1-2009	55	30.66	0.19	2.30	74.43	19.43
Q2	30	29.99	0.11	1.13	34.91	4.91
Q3	13	29.48	0.04	0.48	14.47	1.47
Q4	1	25.84	-0.32	0.09	2.66	1.66
Q1-2010	63	25.88	-0.29	2.30	58.74	4.26
Q2	33	26.30	-0.22	1.13	28.99	4.01
Q3	12	25.86	-0.24	0.48	12.56	0.56
Q4	4	29.35	0.13	0.09	2.31	1.69
Q1-2011	68	29.49	0.13	2.31	67.97	0.03
Q2	36	30.05	0.18	1.13	33.59	2.41
Q3					14.53	MAPE
Q4					2.73	8.09
Q1-2012					69.60	
Q2					34.23	
Q3					14.55	
Q4					2.73	
Q1-2013					69.67	
Q2					34.27	
Q3					14.56	Average annual demand= 120.39
Q4					2.73	

Forecast vs. Actual demand (Skirts)

52
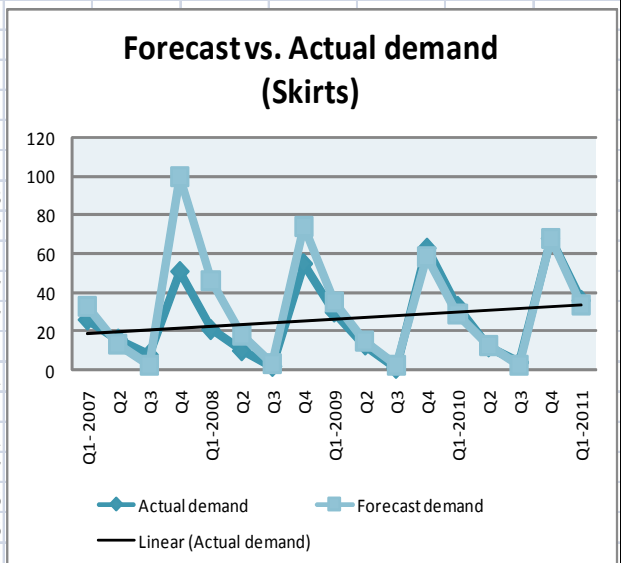
Item: Tunics (T1)							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sales	Average	Q1	Q2	Q3	Q4
2010.00	47.00	21.00	4.00	1.00	73.00	18.25	2.58	1.15	0.22	0.05
2009.00	45.00	16.00	7.00	2.00	70.00	17.50	2.57	0.91	0.40	0.11
2008.00	39.00	13.00	3.00	1.00	56.00	14.00	2.79	0.93	0.21	0.07
						AVG St	2.64	1.00	0.28	0.08

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.19	
Estimate of trend at beginning of quarter 1 L_0			18.53	
Smoothing constants:	alpha =	0.20	beta=	0.1	gamma=	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.64		
Q-2				1.00		
Q-1				0.28		
Q0				0.08		
Q1- 2007	40	18.01	0.12	2.60		
Q2	20	18.50	0.15	1.01	18.12	1.88
Q3	5	18.49	0.14	0.28	5.22	0.22
Q4	2	19.90	0.27	0.08	1.49	0.51
Q1-2008	39	19.14	0.16	2.54	52.40	13.40
Q2	13	18.02	0.03	0.98	19.46	6.46
Q3	3	16.59	-0.11	0.27	5.04	2.04
Q4	1	15.62	-0.20	0.08	1.35	0.35
Q1-2009	45	15.88	-0.15	2.57	39.21	5.79
Q2	16	15.85	-0.14	0.98	15.40	0.60
Q3	7	17.77	0.07	0.28	4.23	2.77
Q4	2	19.25	0.21	0.08	1.43	0.57
Q1-2010	47	19.22	0.18	2.56	50.03	3.03
Q2	21	19.80	0.22	0.99	19.07	1.93
Q3	4	18.86	0.11	0.27	5.64	1.64
Q4	1	17.59	-0.03	0.08	1.57	0.57
Q1-2011	50	17.96	0.01	2.58	44.94	5.06
Q2	27	19.83	0.20	1.03	17.79	9.21
Q3					5.39	**MAPE**
Q4					1.61	3.30
Q1-2012					51.48	
Q2					19.67	
Q3					5.64	
Q4					1.65	
Q1-2013					51.23	
Q2					19.83	
Q3					5.50	Average annual demand=	75.45
Q4					1.60	

Forecast vs. Actual demand (Tunics)

53
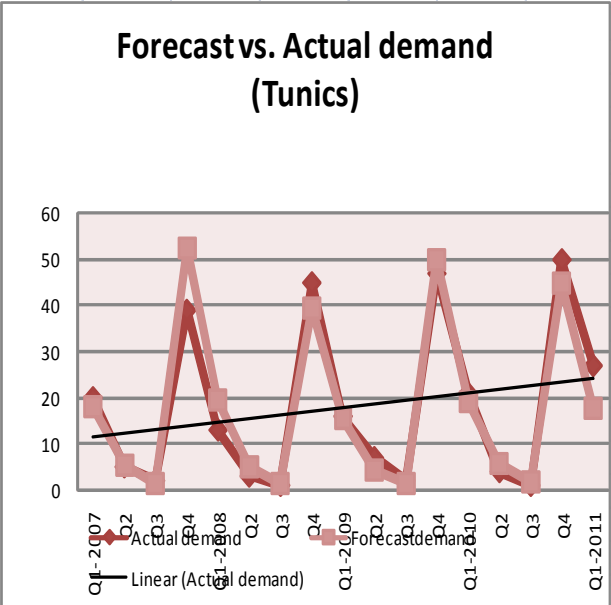
8. Forecast model St Joseph

St Joseph										
Item: Skirts (s)										
Forecast parameters values:										
							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010.00	28.00	12.00	5.00	1.00	46.00	11.50	2.43	1.04	0.43	0.09
2009.00	25.00	15.00	0.00	0.00	40.00	10.00	2.50	1.50	0.00	0.00
2008.00	19.00	12.00	3.00	1.00	35.00	8.75	2.17	1.37	0.34	0.11
						AVG St	**2.37**	**1.30**	**0.26**	**0.07**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.38	
Estimate of trend at beginning of quarter 1 L_0			12.06	
Smoothing constants:	**alpha =**	0.20	**beta=**	0.1	gamma=	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.37		
Q-2				1.30		
Q-1				0.26		
Q0				0.07		
Q1- 2007	20	11.64	0.30	2.30		
Q2	9	10.93	0.19	1.38	15.51	6.51
Q3	1	9.67	0.05	0.27	2.89	1.89
Q4	0	7.78	-0.15	0.07	0.68	0.68
Q1-2008	19	7.75	-0.13	2.55	17.59	1.41
Q2	12	7.83	-0.11	1.54	10.53	1.47
Q3	3	8.40	-0.04	0.31	2.09	0.91
Q4	1	9.54	0.07	0.08	0.58	0.42
Q1-2009	25	9.65	0.08	2.81	24.51	0.49
Q2	15	9.74	0.08	1.69	14.94	0.06
Q3	0	7.85	-0.12	0.31	3.00	3.00
Q4	0	6.19	-0.27	0.08	0.62	0.62
Q1-2010	28	6.73	-0.19	3.23	16.62	11.38
Q2	12	6.65	-0.18	1.87	11.04	0.96
Q3	5	8.44	0.02	0.37	1.98	3.02
Q4	1	9.25	0.10	0.09	0.68	0.32
Q1-2011	27	9.15	0.08	3.52	30.16	3.16
Q2	17	9.20	0.07	2.05	17.27	0.27
Q3					2.84	**MAPE**
Q4					0.75	2.15
Q1-2012					26.06	
Q2					15.68	
Q3					2.84	
Q4					0.75	
Q1-2013					29.93	
Q2					17.35	
Q3					3.39	Average annual demand=	49.28
Q4					0.85	

Forecast vs. Actual demand (Skirts)

Item: Tunics (T1)							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010.00	17.00	9.00	2.00	2.00	30.00	7.50	2.27	1.20	0.27	0.27
2009.00	18.00	11.00	4.00	1.00	34.00	8.50	2.12	1.29	0.47	0.12
2008.00	16.00	6.00	2.00	0.00	24.00	6.00	2.67	1.00	0.33	0.00
						AVG St	**2.35**	**1.16**	**0.36**	**0.13**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			-0.25	
Estimate of trend at beginning of quarter 1 L_0			7.13	
Smoothing constants:		alpha =	0.20	beta=	0.1	gamma=	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.35		
Q-2				1.16		
Q-1				0.36		
Q0				0.13		
Q1- 2007	15	6.78	-0.26	2.34		
Q2	8	6.59	-0.25	1.17	7.56	0.44
Q3	1	5.63	-0.32	0.34	2.28	1.28
Q4	0	4.24	-0.43	0.12	0.69	0.69
Q1-2008	16	4.42	-0.37	2.46	8.91	7.09
Q2	6	4.27	-0.35	1.19	4.72	1.28
Q3	2	4.31	-0.31	0.35	1.34	0.66
Q4	0	3.20	-0.39	0.11	0.47	0.47
Q1-2009	18	3.71	-0.30	2.70	6.93	11.07
Q2	11	4.58	-0.18	1.31	4.06	6.94
Q3	4	5.78	-0.04	0.39	1.56	2.44
Q4	1	6.49	0.03	0.11	0.60	0.40
Q1-2010	17	6.47	0.03	2.70	17.62	0.62
Q2	9	6.57	0.03	1.32	8.52	0.48
Q3	2	6.32	0.01	0.38	2.56	0.56
Q4	2	8.69	0.24	0.12	0.70	1.30
Q1-2011	20	8.63	0.21	2.66	24.07	4.07
Q2	11	8.74	0.20	1.31	11.64	0.64
Q3					3.17	**MAPE**
Q4					0.94	2.38
Q1-2012					24.18	
Q2					11.72	
Q3					3.47	
Q4					0.99	
Q1-2013					24.11	
Q2					11.77	
Q3					3.41	Average annual demand=	40.18
Q4					1.09	

Forecast vs. Actual demand (Tunics)
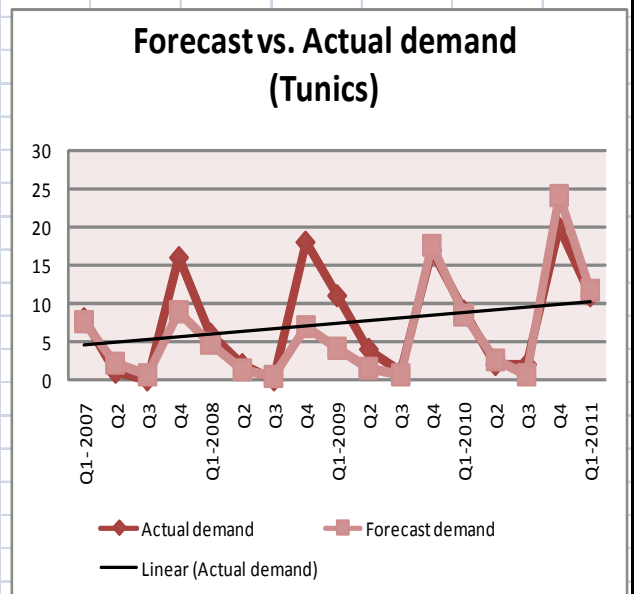
9. Forecast model for Thejane

Thejane										

Item: Skirts (s)

Forecast parameters values:

							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010.00	37.00	27.00	16.00	4.00	84.00	21.00	1.76	1.29	0.76	0.19
2009.00	33.00	24.00	14.00	5.00	76.00	19.00	1.74	1.26	0.74	0.26
2008.00	29.00	19.00	11.00	2.00	61.00	15.25	1.90	1.25	0.72	0.13
						AVG S$_t$	**1.80**	**1.26**	**0.74**	**0.19**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T$_0$				0.50	
Estimate of trend at beginning of quarter 1 L$_0$				21.75	
Smoothing constants:		alpha =	0.20	beta=	0.1	gamma=	0.1

Period	Actual sales(X$_t$)	L$_t$	T$_t$	S$_t$	Forecast	Error
Q-3				1.80		
Q-2				1.26		
Q-1				0.74		
Q0				0.19		
Q1- 2007	31	21.24	0.40	1.77		
Q2	22	20.81	0.32	1.37	27.27	5.27
Q3	12	20.14	0.22	0.80	15.63	3.63
Q4	5	21.55	0.34	0.21	3.87	1.13
Q1-2008	29	20.79	0.23	1.91	38.65	9.65
Q2	19	19.60	0.09	1.46	28.71	9.71
Q3	11	18.50	-0.03	0.86	15.74	4.74
Q4	2	16.65	-0.21	0.23	3.94	1.94
Q1-2009	33	16.61	-0.20	2.10	31.31	1.69
Q2	24	16.41	-0.20	1.61	24.01	0.01
Q3	14	16.23	-0.20	0.95	13.93	0.07
Q4	5	17.27	-0.07	0.25	3.61	1.39
Q1-2010	37	17.27	-0.06	2.32	36.18	0.82
Q2	27	17.12	-0.07	1.77	27.69	0.69
Q3	16	17.03	-0.08	1.04	16.12	0.12
Q4	4	16.71	-0.10	0.28	4.31	0.31
Q1-2011	40	16.74	-0.09	2.56	38.50	1.50
Q2	31	16.83	-0.07	1.95	29.41	1.59
Q3					14.40	**MAPE**
Q4					3.77	2.60
Q1-2012					35.26	
Q2					26.97	
Q3					15.84	
Q4					4.26	
Q1-2013					38.85	
Q2					29.61	
Q3					17.42	Average annual demand=	86.32
Q4					4.66	

Forecast vs. Actaul demand (Skirts)
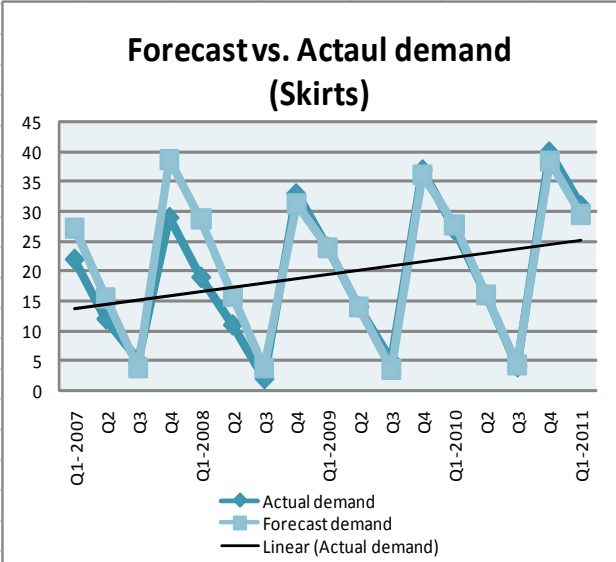
Item: Tunics (T1)						Seasonal factor				
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010.00	18.00	12.00	6.00	0.00	36.00	9.00	2.00	1.33	0.67	0.00
2009.00	15.00	11.00	4.00	1.00	31.00	7.75	1.94	1.42	0.52	0.13
2008.00	17.00	10.00	3.00	3.00	33.00	8.25	2.06	1.21	0.36	0.36
						AVG St	2.00	1.32	0.52	0.16

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.31							
Estimate of trend at beginning of quarter 1 L_0			9.47							
Smoothing constants:		alpha =	0.20	beta=	0.1	gamma=	0.1			

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.00		
Q-2				1.32		
Q-1				0.52		
Q0				0.16		
Q1- 2007	15	9.33	0.27	1.96		
Q2	8	8.89	0.20	1.28	12.66	4.66
Q3	1	7.65	0.05	0.48	4.72	3.72
Q4	0	6.16	-0.10	0.14	1.23	1.23
Q1-2008	17	6.58	-0.05	2.02	11.89	5.11
Q2	10	6.79	-0.02	1.30	8.35	1.65
Q3	3	6.66	-0.03	0.48	3.26	0.26
Q4	3	9.47	0.25	0.16	0.95	2.05
Q1-2009	15	9.26	0.20	1.98	19.66	4.66
Q2	11	9.27	0.18	1.29	12.28	1.28
Q3	4	9.23	0.16	0.47	4.52	0.52
Q4	1	8.76	0.10	0.16	1.52	0.52
Q1-2010	18	8.90	0.10	1.99	17.56	0.44
Q2	12	9.07	0.11	1.29	11.58	0.42
Q3	6	9.88	0.18	0.49	4.35	1.65
Q4	0	8.05	-0.02	0.14	1.57	1.57
Q1-2011	19	8.33	0.01	2.02	15.94	3.06
Q2	9	8.07	-0.02	1.27	10.76	1.76
Q3					3.85	**MAPE**
Q4					1.30	2.03
Q1-2012					15.96	
Q2					10.36	
Q3					3.81	
Q4					1.26	
Q1-2013					15.99	
Q2					10.39	
Q3					3.92	Average annual demand= 31.56
Q4					1.13	
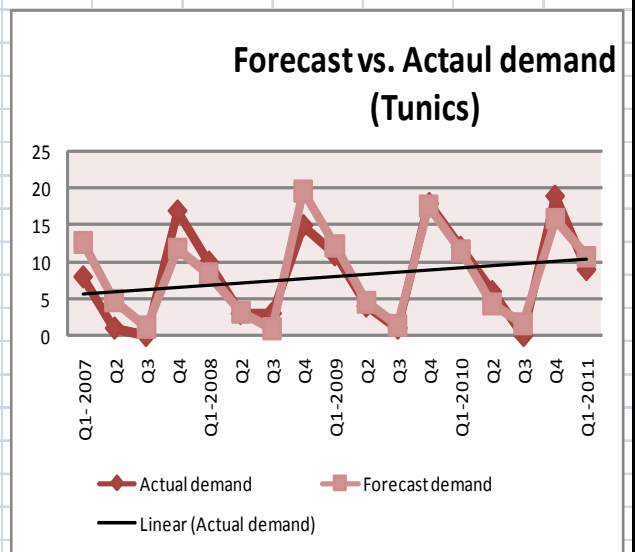
Forecast vs. Actaul demand (Tunics)

Legend: Actual demand — Forecast demand — Linear (Actual demand)

Item: T-Shirts (T2)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010.00	36.00	22.00	6.00	1.00	65.00	16.25	2.22	1.35	0.37	0.06
2009.00	38.00	28.00	9.00	0.00	75.00	18.75	2.03	1.49	0.48	0.00
2008.00	32.00	24.00	5.00	2.00	63.00	15.75	2.03	1.52	0.32	0.13
						AVG St	**2.09**	**1.46**	**0.39**	**0.06**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T0   -0.63
Estimate of trend at beginning of quarter 1 L0   15.31

Smoothing constants:		**alpha =**	0.20	**beta=**	0.1	**gamma=**	0.1

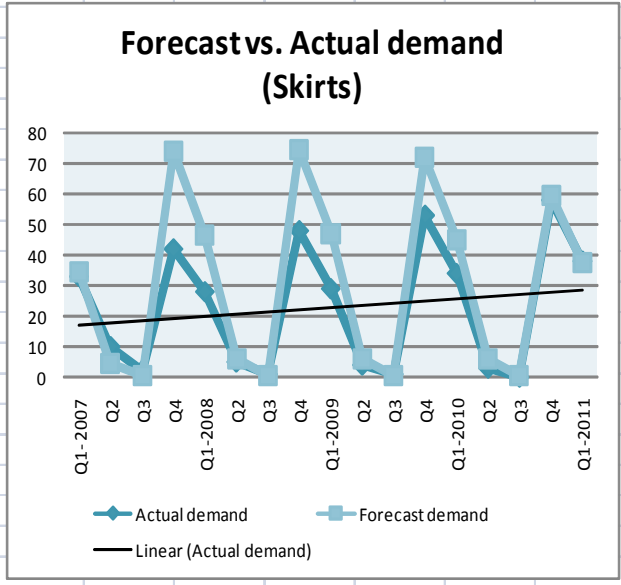| Period	Actual sales(Xt)	Lt	Tt	St	Forecast	Error
Q-3				2.09		
Q-2				1.46		
Q-1				0.39		
Q0				0.06		
Q1- 2007	33	3.16	0.32	2.93		
Q2	21	5.66	0.53	1.69	5.07	15.93
Q3	3	6.49	0.56	0.40	2.41	0.59
Q4	0	5.64	0.42	0.05	0.42	0.42
Q1-2008	32	7.04	0.52	3.09	17.75	14.25
Q2	24	8.90	0.65	1.79	12.74	11.26
Q3	5	10.16	0.71	0.41	3.79	1.21
Q4	2	16.11	1.24	0.06	0.59	1.41
Q1-2009	38	16.34	1.14	3.01	53.56	15.56
Q2	28	17.11	1.10	1.77	31.22	3.22
Q3	9	19.00	1.18	0.41	7.41	1.59
Q4	0	16.14	0.78	0.05	1.23	1.23
Q1-2010	36	15.92	0.68	2.94	50.95	14.95
Q2	22	15.76	0.59	1.73	29.41	7.41
Q3	6	15.99	0.56	0.41	6.76	0.76
Q4	1	16.88	0.59	0.06	0.91	0.09
Q1-2011	41	16.77	0.52	2.89	51.29	10.29
Q2	25	16.71	0.46	1.71	29.97	4.97
Q3					6.99	**MAPE**
Q4					1.05	6.18
Q1-2012					51.72	
Q2					30.42	
Q3					7.10	
Q4					0.94	
Q1-2013					50.43	
Q2					29.78	
Q3					7.03	Average annual demand= 89.23
Q4					0.95	

Forecast vs. Actual demand (T-shirts)
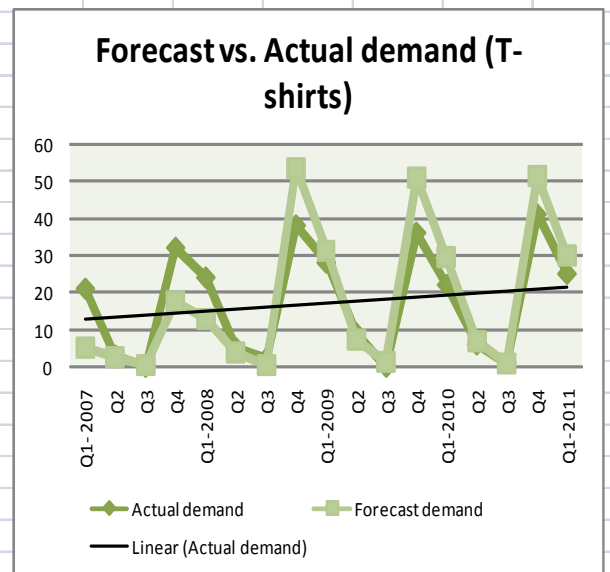
10. Forecast model for Segolokwane

Segolokwane										

Item: Skirts (s)

Forecast parameters values:

							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010.00	53.00	34.00	3.00	0.00	90.00	22.50	2.36	1.51	0.13	0.00
2009.00	48.00	29.00	4.00	1.00	82.00	20.50	2.34	1.41	0.20	0.05
2008.00	42.00	28.00	5.00	1.00	76.00	19.00	2.21	1.47	0.26	0.05
						AVG St	**2.30**	**1.47**	**0.20**	**0.03**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0				0.50	
Estimate of trend at beginning of quarter 1 L_0				23.25	
Smoothing constants:		alpha =	0.10	beta=	0.1	gamma=	0.001

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.30		
Q-2				1.47		
Q-1				0.20		
Q0				0.03		
Q1- 2007	40	23.11	0.44	2.30		
Q2	33	23.44	0.43	1.47	34.62	1.62
Q3	10	26.48	0.69	0.20	4.77	5.23
Q4	2	31.12	1.08	0.03	0.81	1.19
Q1-2008	42	30.80	0.94	2.30	74.04	32.04
Q2	28	30.48	0.82	1.47	46.71	18.71
Q3	5	30.66	0.75	0.20	6.27	1.27
Q4	1	31.59	0.77	0.03	0.94	0.06
Q1-2009	48	31.21	0.66	2.30	74.46	26.46
Q2	29	30.65	0.53	1.47	46.92	17.92
Q3	4	30.06	0.42	0.20	6.25	2.25
Q4	1	30.76	0.45	0.03	0.92	0.08
Q1-2010	53	30.39	0.37	2.30	71.85	18.85
Q2	34	29.99	0.29	1.47	45.31	11.31
Q3	3	28.74	0.14	0.20	6.08	3.08
Q4	0	25.99	-0.15	0.03	0.87	0.87
Q1-2011	58	25.77	-0.16	2.31	59.54	1.54
Q2	38	25.63	-0.16	1.48	37.77	0.23
Q3					5.11	**MAPE**
Q4					0.77	8.39
Q1-2012					58.65	
Q2					37.53	
Q3					5.11	
Q4					0.77	
Q1-2013					58.69	
Q2					37.56	
Q3					5.11	Average annual demand= 102.46
Q4					0.77	

Forecast vs. Actual demand (Skirts)

Item: Tunics (T1)							Seasonal factor			
Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Q1	Q2	Q3	Q4
2010.00	44.00	36.00	7.00	1.00	88.00	22.00	2.00	1.64	0.32	0.05
2009.00	45.00	27.00	4.00	2.00	78.00	19.50	2.31	1.38	0.21	0.10
2008.00	41.00	30.00	4.00	0.00	75.00	18.75	2.19	1.60	0.21	0.00
						AVG St	**2.16**	**1.54**	**0.25**	**0.05**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T_0			0.63	
Estimate of trend at beginning of quarter 1 L_0			22.94	
Smoothing constants:		alpha =	0.20	beta=	0.1	gamma=	0.1

Period	Actual sales(X_t)	L_t	T_t	S_t	Forecast	Error
Q-3				2.16		
Q-2				1.54		
Q-1				0.25		
Q0				0.05		
Q1- 2007	39	22.46	0.51	2.12		
Q2	28	22.02	0.42	1.51	35.38	7.38
Q3	8	24.35	0.61	0.26	5.61	2.39
Q4	1	23.97	0.51	0.05	1.25	0.25
Q1-2008	41	23.45	0.41	2.08	51.84	10.84
Q2	30	23.06	0.33	1.49	36.11	6.11
Q3	4	21.81	0.17	0.25	6.03	2.03
Q4	0	17.58	-0.27	0.04	1.08	1.08
Q1-2009	45	18.18	-0.18	2.12	36.03	8.97
Q2	27	18.02	-0.18	1.49	26.85	0.15
Q3	4	17.46	-0.22	0.25	4.47	0.47
Q4	2	22.83	0.34	0.05	0.76	1.24
Q1-2010	44	22.69	0.29	2.10	49.13	5.13
Q2	36	23.21	0.32	1.50	34.31	1.69
Q3	7	24.46	0.41	0.25	5.84	1.16
Q4	1	24.01	0.32	0.05	1.21	0.21
Q1-2011	48	24.03	0.29	2.09	51.15	3.15
Q2	39	24.67	0.33	1.51	36.45	2.55
Q3					6.26	MAPE
Q4					1.11	3.22
Q1-2012					52.99	
Q2					37.31	
Q3					6.21	
Q4					1.21	
Q1-2013					52.54	
Q2					37.45	
Q3					6.30	Average annual demand=	96.72
Q4					1.20	
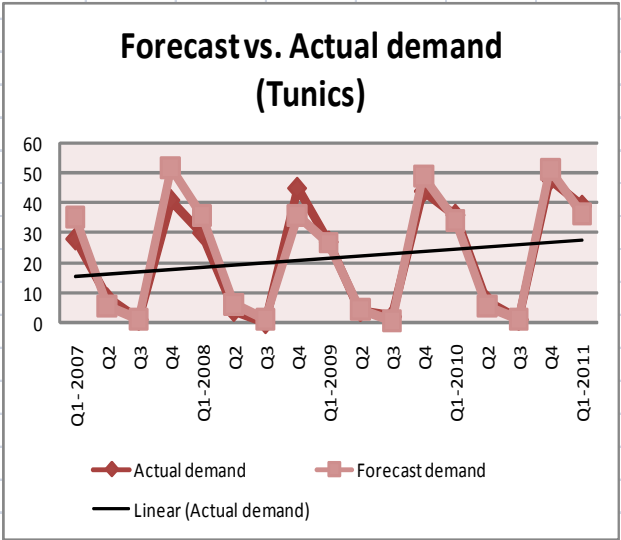
Forecast vs. Actual demand (Tunics)

Item: T-Shirts (T2)

Forecast parameters values:

Year	Q1	Q2	Q3	Q4	Annual Sa	Average	Seasonal factor			
							Q1	Q2	Q3	Q4
2010.00	68.00	49.00	18.00	7.00	142.00	35.50	1.92	1.38	0.51	0.20
2009.00	66.00	48.00	16.00	3.00	133.00	33.25	1.98	1.44	0.48	0.09
2008.00	61.00	39.00	16.00	1.00	117.00	29.25	2.09	1.33	0.55	0.03
						AVG St	**2.00**	**1.39**	**0.51**	**0.11**

Initialization of forecast:

Estimate of trend at beginning of quarter 1 T$_0$			0.56	
Estimate of trend at beginning of quarter 1 L$_0$			35.50	
Smoothing constants:		alpha =	0.20	beta=	0.1	gamma=	0.1

Period	Actual sales(X$_t$	L$_t$	T$_t$	S$_t$	Forecast	Error
Q-3				2.00		
Q-2				1.39		
Q-1				0.51		
Q0				0.11		
Q1- 2007	56	34.45	0.40	1.96		
Q2	44	34.21	0.34	1.38	48.44	4.44
Q3	18	34.70	0.35	0.51	17.62	0.38
Q4	5	37.13	0.56	0.11	3.86	1.14
Q1-2008	61	36.37	0.43	1.93	73.97	12.97
Q2	39	35.09	0.26	1.35	50.77	11.77
Q3	16	34.54	0.18	0.51	18.06	2.06
Q4	1	29.55	-0.34	0.10	3.90	2.90
Q1-2009	66	30.20	-0.24	1.96	56.50	9.50
Q2	48	31.06	-0.13	1.37	40.52	7.48
Q3	16	31.07	-0.12	0.51	15.65	0.35
Q4	3	30.50	-0.16	0.10	3.24	0.24
Q1-2010	68	31.21	-0.08	1.98	59.43	8.57
Q2	49	32.05	0.02	1.39	42.72	6.28
Q3	18	32.75	0.09	0.51	16.26	1.74
Q4	7	39.73	0.77	0.11	3.41	3.59
Q1-2011	71	39.58	0.68	1.96	80.26	9.26
Q2	50	39.41	0.60	1.38	55.87	5.87
Q3					20.25	**MAPE**
Q4					4.18	5.21
Q1-2012					78.38	
Q2					54.89	
Q3					20.28	
Q4					4.16	
Q1-2013					79.26	
Q2					55.52	
Q3					20.45	Average annual demand=	159.32
Q4					4.45	

Forecast vs. Actual demand (T-shirts)
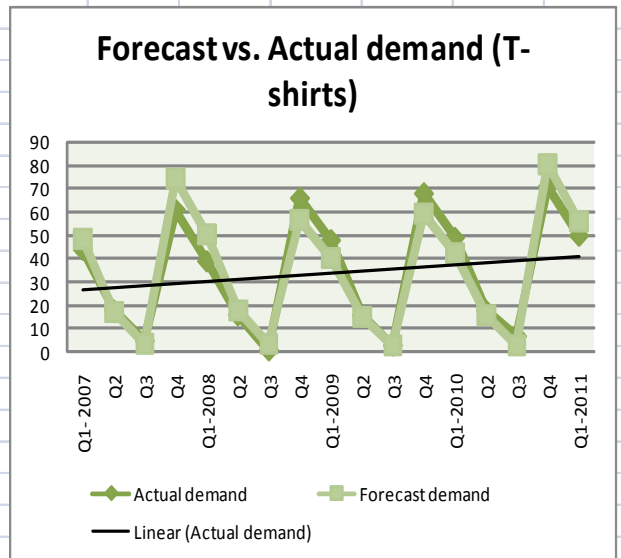
Appendix C: Inventory policy

Inventory Cost Elements (of the Basic EOQ Model)

Annul prime rate: 0.09

		p	K	h
Item	Material name	Purchasing cost/unit	Set-up cost	holding cost
Skirts	Minimet	R 24.00	R 11.50	R 2.16
	Tetrex	R 35.00		R 3.15
Tunics	Minimet	R 39.00	R 19.40	R 3.51
	Tetrex	R 80.00		R 7.20
T-shirts	Lacosta	R 61.50	R 10.00	R 5.54
Track suits	Wool material	R 87.50	R 23.50	R 7.88
	Quantex	R 127.50	R 26.50	R 11.48

Basic EOQ Model

Assumptions:

> WL Winston (2004) states the following assumptions for the Basic EOQ Model
> 1. Demand is deterministic and occurs at constant rate (Demand is known from forecast model)
> 2. Any order of any size placed incurs a set-up cost K
> 3. The lead time for each order is zero (Material is sourced directly from suppliers and hence no lead time is incurred)
> 4. M-Creations works on a "No shortages allowed" policy
> 5. The cost per unit-year of holding inventory is h

Model output:

School	Item	Material required	Demand	EOQ	Ordering cost	Purchasing cost	Holding cost	Total cost	Orders/year
Ramokhutlwane	Skirt	Tetrex	71	27.50	29.70	R 2 485.00	R 43.31	R 2 558.00	3
	Tunic	Tetrex	42	21.55	37.81	R 3 360.00	R 77.57	R 3 475.38	2
	T-shirt	Lacosta	55	14.10	39.01	R 3 382.50	R 39.01	R 3 460.53	4
	Track suit	Quantex	20	9.61	55.14	R 2 550.00	R 55.14	R 2 660.29	2
Supatsela	Skirt	Tetrex	64	21.62	34.05	R 2 240.00	R 34.05	R 2 308.09	3
	Tunic	Tetrex	42	15.04	54.16	R 3 360.00	R 54.16	R 3 468.32	3
	T-shirt	Lacosta	106	19.57	54.16	R 6 519.00	R 54.16	R 6 627.32	5
	Track suit	Quantex	32	12.16	69.75	R 4 080.00	R 69.75	R 4 219.50	3
Nkadimeng	Skirt	Tetrex	62	21.28	R 33.51	R 2 170.00	R 33.51	R 2 237.02	3
	Tunic	Tetrex	57	17.53	R 63.09	R 4 560.00	R 63.09	R 4 686.19	3
	T-shirt	Lacosta	78	16.79	R 46.46	R 4 797.00	R 46.46	R 4 889.92	5
	Track suit	Wool material	20	10.93	R 43.02	R 1 750.00	R 43.02	R 1 836.04	2
Motlhako	Skirt	Minimet	73	27.88	R 30.11	R 1 752.00	R 30.11	R 1 812.22	3
	Tunic	Minimet	64	26.60	R 46.68	R 2 496.00	R 46.68	R 2 589.36	2
	Track suit	Wool material	32	13.82	R 54.42	R 2 800.00	R 54.42	R 2 908.83	2
Machipe	Skirt	Minimet	42	21.15	R 22.84	R 1 008.00	R 22.84	R 1 053.68	2
	Tunic	Minimet	26	16.95	R 29.75	R 1 014.00	R 29.75	R 1 073.51	2
	Track suit	Wool material	25	10.12	R 58.06	R 2 187.50	R 39.84	R 2 285.40	2
Dibathuto	Skirt	Minimet	91	31.20	R 33.69	R 2 193.53	R 33.69	R 2 260.91	3
	Tunic	Minimet	96	32.58	R 57.19	R 3 746.02	R 57.19	R 3 860.39	3
Tlhako	Skirt	Minimet	120	35.80	R 38.67	R 2 889.35	R 38.67	R 2 966.68	3
	Tunic	Minimet	75	28.88	R 50.68	R 2 942.41	R 50.68	R 3 043.78	3
St Joseph	Skirt	Minimet	49	22.91	R 24.74	R 1 182.81	R 24.74	R 1 232.29	2
	Tunic	Minimet	40	21.08	R 36.99	R 1 567.20	R 36.99	R 1 641.17	2
Thejane	Skirt	Minimet	86	30.32	R 32.74	R 2 071.71	R 32.74	R 2 137.19	3
	Tunic	Minimet	32	18.68	R 32.78	R 1 230.79	R 32.78	R 1 296.35	2
	T-shirt	Lacosta	89	17.96	R 49.69	R 5 487.58	R 49.69	R 5 586.96	5
Segolokwane	Skirt	Tetrex	102	27.35	R 43.08	R 3 586.06	R 43.08	R 3 672.22	4
	Tunic	Tetrex	97	22.83	R 82.19	R 7 737.88	R 82.19	R 7 902.26	4
	T-shirt	Lacosta	159	23.99	R 66.40	R 9 798.22	R 66.40	R 9 931.03	7

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