

Analysing the relationship between inventory management and sustainable supply chain management

R Opperman

 orcid.org/0000-0002-3127-6953

Mini-dissertation submitted in partial fulfilment of the
requirements for the degree *Master of Business
Administration* at the North-West University

Supervisor: Mr JA Jordaan

Graduation: May 2018

Student number: 20727933

Keywords

Supply Chain

Inventory Management

Stock holding

Forecast

Back orders

Sales

Stock out

Just in time

Inventory turnover

Lead times

ABSTRACT

There is a scarcity in research articles identifying the relationship between supply chain and inventory management. This study is required to identify the inventory variables that can be used to optimise the supply chain in a multinational business.

The indication is suitable in the business environment, as inventory is a contributing part to sustainable supply chain and even more important, inventory is seen as the life line of a company. The study has also researched other factors that have an influence on a business, to ensure customer satisfaction, good sales and sustainable profits.

The study defines variables through literature review on variables and metrics in inventory and supply chain management that accurately describe the relationship between the variables. The study also determines which inventory management variables should be optimised in to order to maximise the profits in a multinational company.

These investigations would provide benefits in the form of enhancing the competitiveness, capturing the customer demand on time by having inventory available and even expansion of opportunities within a business. In chapter 2 an in-depth literature study was done on supply chain and inventory to finally understand how this can contribute to a better business function by having an improved relationship.

The integration of the supply chain is emphasised on the importance, to ensure the flow of the product and service are done correctly. Therefore a supply chain strategy should be formulated with complete and accurate information through proper collaboration upstream and downstream. Supply chain and inventory management correlation was also mentioned by Ralston *et al.* (2015:63), that supply chain management is a system-wide inventory saving process where inventory managers should make use of data and disseminators. The aim is to contribute to the firm under the supply chain management atmosphere.

The objectives highlight that inventory management should provide uninterrupted production, sales, and/or customer-service levels at the minimum cost.

The key focus after satisfying the customer needs for supply chain should be to contribute to profitability by smooth processes. Azevedo *et al.* (2011:870) found that a supply chain promotes best practices in an organisation where it not only provides sustainable business with regards to being competitive but improves the overall profitability of an organisation

The bullwhip effect was also elaborated to have a better understanding. This effect provides emphasis on the distribution channels and how they are being impacted by focusing on how agile and quick your reactions needs to be with regards to the market demands. The market demands are sometimes unpredictable which could lead to a negative effect on a business.

The bullwhip effect is seen as a phenomenon whereby the forecast shows cases where supply chain inefficiencies and the fluctuations in inventory management is too big to respond on, based on the customers' demands and the upstream supply chain lead times (Lee *et al.*, 2015:116).

The foundation of the literature provides guidance on methods that are statically analytics, required on the key elements to optimise the supply chain. Therefore this should provide an indication on supply chain and inventory management to resolve the primary research question, on how the inventory variables impacts a business, and how can those variables be used to optimise the supply chain in a multinational business.

Supply chain and inventory management was linked to key literature like Williams & Tokar (2008:224), showcasing the importance of a stock out response. Therefore Chapter 3 indicated why it is vital in the supply chain management, as the level of commodities will either be at a high level, impacting the cash flow of the business or at any specific point where shortages are created which could lead to an impact on income/profit due to not having the products available to sell when the customer needs are raised (Kwon & Suh, 2004:8). The required statically methods are defined to see whether to utilise the methods to assist in contributing to statically significance.

Acar and Gardner (2012:847) placed emphasis that a forecast driven model is based on the projected demands and what types of inventory should be kept to satisfy the customer expectations. Closs *et al.* (2010:56) found that inventory levels that are

maintained at an optimal level increase customer satisfaction that could lead to better market penetration due to stock availability and reduced stock outs. Stadler (2015:26) indicated the supply chain is responsible for the movement of the product but it depends on the inventory availability to move the stock. Therefore based on the literature there should be some kind of connection and understanding about what variables lead to a positive or negative impact on a business.

The support of the methods to test the hypothesis with regards to the variables that are available and the methods, show that the combination should provide acceptable building blocks to come to a conclusion through the mathematical findings. These findings and understanding would contribute to the process to provide a possible answer on how important the relationship between inventory management and supply chain is to have a sustainable business.

The hypothesis test started by understanding the median sales figure during a specific period as this method is pro-dominantly used to forecast future sales of the business. These past figures provided a result that projected false figures were being used and skew the perspective on the future of the business putting it at risk. Lee et al. (2015:116).

This method indicated that the sales over the forecast period, shows significance with regards to inaccuracy on forecast and further methods are required to understand the impact the prediction future sales values will have on a sustainable business.

Therefore the mean was tested to see where the middle point of each variable is and the degree of variance over the median. The results contributed by indicating the forecast accuracy and the degree of error the forecast has.

The importance was highlighted by the previous test therefore standard deviation was tested as well. The test helps to contribute to the study by calculating the spread of the mean in the sample set. However, seeing that the data set has actual confidential numbers, it was decided to test the coefficient of variation instead, to see the variation in percentage format rather than units. The test of coefficient of variation assesses the function of precision in the data set to illustrate the difference in variation in percentages between the variables. The results indicate the significance

of the problem statement. Correlations test was done to understand the relationships and what variables are causal.

The Pearson product-moment correlation coefficient was used to find the variables that had a direct or indirect correlation with each other. The Pearson product-moment correlation found that the forecast is very significant in the process. With the correct forecast in place there will be a positive effect on sales and inventory holding that should keep your inventory in line with demands assuring that stock outs are kept at a minimum. (Christopher & Ryals, 2014; Handfield et al., 2015; Mangan & Lalwani, 2016)

Seeing that forecast drives a business's inventory levels, Vastag & Whybark (2005:134) model theory was used on inventory turnover. Vastag & Whybark's (2005:134) theory was created to indicate the efficiency with regards to inventory management and how well supply chain is supporting the business.

However the study saw a gap in their model and recommended incorporating Williams & Tokar (2008:224) importance of a stock out response. The theory that should be achieved from the data set is to be at a 100% turnover rate if you have sold an amount of units a month including the stock outs that equates to the total demand for the month.

Following the previous test, multiple regressions test was done as well to support the variables correlation. Multiple regressions illustrate the influence on the variables might be one or more. The result shows that there is a high significance between sales, quantities on hand as well as back order with forecast, where the results illustrated a high significance between forecast and back orders with sales. The other multiple correlation tests had a high significance between sales, quantity in receipt routing and forecast with back order, back orders with quantity in routing as well as forecast and quantity on hand.

The study found significance between the relationship of inventory and supply chain management in the business environment. Not only was this supported through previous literature, the empirical findings resulted to the same. The study identified that there is one primary variable that has a direct link to optimise a supply chain through inventory management and this is the forecasting process.

Hence the importance to optimise and improve the forecasting process is a fundamental commencement as it has a direct impact on the end results. Businesses should focus on improving the forecast process through reliable inputs in the forecast, either making use of new technologies (algorithms, systems) or methods (trend projections, seasonal indexes) to establish a trustworthy indication of future sales.

Results of an improved forecast will ensure a positive effect on sales as well as a reduction on stock outs, as the inventory levels would be at the right level, at the right time, at the right place, when the customer requires the products. Business would keep up with the globalised world where the supply chain is optimised as competition is fierce and businesses would capitalise on the products being sold and ultimately contributing to profits.

Table of contents

ABSTRACT	ii
LIST OF TABLES	xi
LIST OF EQUATION	xii
LIST OF FIGURES	xiii
ABBREVIATIONS.....	xv
DEFINITIONS OF SUPPLY CHAIN MANAGEMENT AND INVENTORY MANAGMENT	xvii
CHAPTER 1: NATURE AND SCOPE OF THE STUDY.....	1
1.1 Background and importance of the study	1
1.2 Problem statement	1
1.3 Objectives of the study	3
1.4 Research objective	3
1.5 Delimitations and assumptions.....	4
1.6 Literature and Empirical selections for the study	5
1.6.1 Literature/theoretical study.....	5
1.6.2 Empirical study.....	14
1.7 Layout of the study	16
1.8 Summary of Chapter 1	17
CHAPTER 2: LITERATURE REVIEW OF SUPPLY CHAIN MANAGEMENT AND INVENTORY MANAGEMENT	18
2.1 Introduction.....	18
2.2 Literature review	18
2.3 External factors influencing supply chain and Inventory Management	27
2.4 The ideal Supply Chain Model.....	29
2.5 Elements that contributes to supply chain and Inventory Management.....	30
2.6 Literature impact on Managerial Implications	34
2.7 Summary of Chapter 2	34

CHAPTER 3: METHOD AND ELEMENTS	36
3.1 Introduction.....	36
3.2 Types of methods.....	37
3.2 Reason to why certain methods are being used.....	38
3.3 Explanation of data being used for this quantitative study.....	42
3.4 Summary of Chapter 3	42
CHAPTER 4: EMPIRICAL STUDY.....	44
4.1 Introduction.....	44
4.2 Gathering of data.....	45
4.2.1 Assessing the information.....	45
4.2.2 Quality of the information	46
4.2.3 Severity of the information	46
4.3 Results and discussion.....	46
4.3.1 Introduction	46
4.3.2 Median	47
4.3.3 Mean.....	48
4.3.4 Standard deviations	49
4.3.5 Correlations.....	52
4.3.6 Inventory turnover	55
4.3.7 Multiple regressions.....	57
4.3.7.1 Forecast Multiple regression	57
4.3.7.2 Sales Multiple regression	60
4.3.7.3 Back order / Stock Outs Multiple regression	63
4.3.7.4 Inventory on hand multiple regression	66
4.3.7.5 Inventory on routing multiple regression	69
4.4 Empirical findings on Managerial implications.....	72
4.5 Summary of Chapter 4	73
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS	75

5.1	Conclusion from literature.....	75
5.2	Conclusion from Empirical.....	77
5.2.1	General – Primary questions.....	77
5.2.2	Specific – Secondary questions	78
5.3	Final conclusion.....	79
5.4	Recommendations and managerial implications outcomes.....	80
5.5	Achievement of the objectives of the study	80
5.6	Recommendations for future research	82
	BIBLIOGRAPHY.....	83
	ANNEXURES	94
	Appendix A:.....	95
	Appendix B:.....	101
	Appendix C:.....	103

LIST OF TABLES

Table 1: Abbreviations xv

Table 2: Definitions xvii

Table 3 Barriers to effective Supply Chain Management..... 20

Table 4: Factors contributing to Inventory and Supply Chain Management 31

Table 5: Relationship factor module for an optimised supply chain 33

Table 6: Median..... 47

Table 7: Mean..... 49

Table 8: Standard deviation statistics 50

Table 9: Coefficient of variation 51

Table 10: Correlations 52

Table 11: Correlations with Forecast 54

Table 12: Inventory Turnover..... 55

Table 13: Inventory Turnover including Back Orders..... 56

Table 14: Multi linear Regression - Dependent variable Forecast 60

Table 15: Multi linear Regression - Dependent variable Sales 63

Table 16: Multi linear Regression - Dependent variable quantity on hand..... 69

Table 17: Multi linear Regression - Dependent variable Quantity in routing 72

Table 5: Relationship factor module for an optimised supply chain 78

Table 14: Multi linear Regression - Dependent variable Forecast 79

Table 5: Relationship factor module for an optimised supply chain 81

LIST OF EQUATION

Equation 1: Mean	38
Equation 2: Illustration of the mean	38
Equation 3: Median.....	39
Equation 4: Standard deviation.....	39
Equation 5: Pearson product-moment correlation coefficient	40
Equation 6: Multiple correlation coefficients.....	41
Equation 7: Inventory turnover.....	41
Equation 8: Linear regression.....	42
Equation 9: Coefficient of variation	50

LIST OF FIGURES

Figure 1: Supply chain integration model	20
Figure 2: Information and Communication flows through a business	21
Figure 3: The Supply Chain environment	29
Figure 4: Sales versus Forecast.....	48
Figure 5: Inventory Turnover Model with and without Back Orders	56
Figure 6: Scatter Plot - forecast vs. back orders.....	58
Figure 7: Scatter Plot - forecast vs. sales	58
Figure 8: Scatter Plot - forecast vs. quantity on hand	59
Figure 9: Scatter Plot - forecast vs. quantity in receipt routing.....	59
Figure 10: Scatter Plot - sales vs. quantity on hand	61
Figure 11: Scatter Plot - sales vs. quantity in receipt routing.....	61
Figure 12: Scatter Plot - sales vs. forecast demand	62
Figure 13: Scatter Plot - sales vs. back orders	62
Figure 14: Scatter Plot - back order vs. sales	64
Figure 15: Scatter Plot - back order vs. quantity on hand.....	64
Figure 16: Scatter Plot - back order vs. quantity in receipt routing	65
Figure 17: Scatter Plot - back order vs. forecast.....	65
Figure 18: Multi linear Regression - Dependent variable back orders	66
Figure 19: Scatter Plot - quantity on hand vs. quantity in receipt routing.....	67
Figure 20: Scatter Plot - quantity on hand vs. forecast.....	67
Figure 21: Scatter Plot - quantity on hand vs. back order.....	68

Figure 22: Scatter Plot - quantity on hand vs. sales 68

Figure 23: Scatter Plot - quantity in receipt routing vs. back orders..... 70

Figure 24: Scatter Plot - quantity in receipt routing vs. forecast..... 70

Figure 25: Scatter Plot - quantity in receipt routing vs. sales 71

Figure 26: Scatter Plot - quantity in receipt routing vs. quantity on hand..... 71

ABBREVIATIONS

Table 1: Abbreviations

Abbreviation / Key Terms	Meaning
Back order	Stock was not available at a given point in time but the customer still indicated that he would take the stock once it arrived
Downstream supply chain	Logical flow of inventory from manufacturing to store level to customer
EDI	Electronic Data Interface. Information format feeding systems
ERP systems	Enterprise Resource Planning system
FMCG	Fast Moving Consumer Goods
JIT	Just in Time. Meaning that the goods order are arriving the appropriate time when it is needed.
Lead-times	The time it takes the goods to be received from order date to actual arrival at destination. Key consideration points are the travelling distance and travel time.
Loss of sale	Stock was not available at a given point in time and the customer indicated he will go somewhere else.
Relay approach	Handing over within the same company task to be executed effectively and reaching the same goal.

Abbreviation / Key Terms	Meaning
Reverse logistics	This is the main process where the products are taken from final destination all the way back to the manufacturing to see the relevant steps that are required and lead time.
Six Sigma	Is data-driven approach for removing inefficiencies in any development in an organisation
Supply Chain	The sequence of processes involved in the manufacturing and distribution of a product from factory to customer.
Upstream supply chain	Customer demand is captured at store level and requires the factory either to produce or ship goods to fulfil customer demands
Vertically integrating business	Companies that are specialised throughout all aspects within one company

DEFINITIONS OF SUPPLY CHAIN MANAGEMENT AND INVENTORY MANAGEMENT

Table 2: Definitions

<p><i>SCM requires traditionally separate materials functions to report to an executive responsible for coordinating the entire materials process, and also requires joint relationships with suppliers across multiple tiers. SCM is a concept, “whose primary objective is to integrate and manage the sourcing, flow, and control of materials using a total systems perspective across multiple functions and multiple tiers of suppliers.”</i></p>	<p><i>(Stevens & Johnson, 2016:41)</i></p>
<p><i>Supply chain strategy includes: “... two or more firms in a supply chain entering into a long-term agreement; ... the development of trust and commitment to the relationship; ... the integration of logistics activities involving the sharing of demand and sales data; ... the potential for a shift in the locus of control of the logistics process.”</i></p>	<p><i>Monczka et al. (2015:42)</i></p>
<p><i>“The objective of managing the supply chain is to synchronize the requirements of the with the flow of materials from suppliers in order to effect a balance between what are often seen as conflicting goals of high customer service, low inventory management, and low unit cost.”</i></p>	<p><i>(Schönsleben, 2016:45)</i></p>
<p><i>“Supply chain management deals with the total flow of materials from suppliers through end users...”</i></p>	<p><i>(Stadtler, 2015:5)</i></p>
<p><i>Inventory control is imperative to manage the cycles of the stocks as it comes in and to ensure inventory is at an adequate level.</i></p>	<p><i>(Axsäter, 2015:24)</i></p>
<p><i>Inventory managements assist effective supply chain and logistics to ensure stock is available to move through the departments.</i></p>	<p><i>(Christopher & Ryals, 2014:30)</i></p>
<p><i>Inventory control assists a business finances to ensure cash flow is not tied up and inventory cost is kept at a low.</i></p>	<p><i>Wisner et al. (2014:13)</i></p>

CHAPTER 1: NATURE AND SCOPE OF THE STUDY

1.1 Background and importance of the study

There is a scarcity in research articles identifying the correlation between inventory management and sustainable supply chain in an organisation. There has been a recent increase of research done on supply chain focusing on inventory management and the impacts it could have on the company as well as the links in supply chain. Christopher and Ryals (2014:34) revealed that supply chain, linked with inventory management, should be at its highest level, as supply chain is comprised of two uncomplicated, integrated progressions of Production Planning and Inventory Control Process that contribute to the Distribution and Logistics Process

There are other findings that are highlighted in the balancing of inventory therefore it is crucial in the supply chain management. The level of merchandise could either be high, impacting cash flow level, or an event of shortages which could impact income/profit due to selling the manufactured goods to the customer when they require it (Kwon & Suh, 2004:8).

The inventory will have a positive impact on your financial results, as the inventory at its minimal is good due to the low levels of expense. Expenses could consist of warehousing, transport and insurance cost that have accumulated. It is of essence to have stocks to meet the supply requirements based on demand and forecasting (Michalski, 2008:24). Therefore it is imperative to have this research done to see if there are connections between certain variables for a business to utilise as there is a lack of research regarding this topic.

1.2 Problem statement

Understanding the essence of supply chain is imperative for a company in order to link the role that inventory management plays. The network in supply chain consists of numerous links of upstream and downstream flows, where activities are required to ensure there are no fractures in the links for each process. Any breakage in the link will have a consequence on customers which could impacts the company from a financial point as it is seen as a possible loss of income (Mentzer *et al.*, 2006:8).

Emphasis should be on the inventory management and what role it plays in a sustainable supply chain (Mangan & Lalwani, 2016:14). The direction to achieve a sustainable supply chain and the focus point must be placed on managing the inventory levels properly by identifying where they are the most vulnerable.

Research indicates that the role inventory management plays in supply chain is only part of one of the fundamentals, therefore this study is there to indicate the connection it has with supply chain and to highlight the risk that is identified in each area. A risk on your inventory levels could be identified throughout the entire chain. Quantitative analysis would be used to determine the impacts and perspectives on sustainable supply chain and what role proper inventory management plays. This method of research will determine whether inventory management and supply chain has a positive connection could become sustainable.

The aim would be to test the findings of Mohammaddust *et al.* (2017:652), where high customer service, low inventory management, and low unit cost will assist the business by having an effective supply chain. This will determine whether there is a contradiction between what was stated by Cooper & Ellram (1993:18) in their research. They revealed that the key objective is to improve customer satisfaction and requests/requirements by increasing the stock availability and lessen the order cycle frequency.

Identifying whether the inventory management could lead to a sustainable supply chain would require a thorough quantitative analysis research approach.

The relationship between inventory management and sustainable supply chain management in this study will indicate to management the type of attention the topic requires. It would be a key area to present the findings to management the findings. Michalski (2008:36) identified the following in his research: "The estimation of the influence of changes in firm decisions in the sphere of inventory management is a compromise between limiting of risk by having a greater inventory level and limiting a cost of inventory. It is the essential problem of the corporate financial management." Furthermore in Michalski (2008:42) it was revealed that the level of inventory holdings is acceptable at a low level due to cost but it also revealed that the impact of low inventory level could be a key problem within the supply chain requirements.

By resolving this problem the results would add value to management by identifying the relationship between supply chain management and inventory management as a and what financial impacts it may have on supply chain management and other functions (Ross, 2015:356). Therefore an investigation is necessary to identify the types of variables that could impact the relationship related to inventory management and supply chain management, by focusing on the consequences it could have in a business environment.

1.3 Objectives of the study

What types of variables could be identified that impacts the relationship between inventory management and supply chain management, mainly focusing on the consequences in a business environment?

1.4 Research objective

The importance of the network in a supply chain is crucial as it consists of numerous links of upstream and downstream flows where activities are required for each process to ensure no fracture in the links. This is to ensure there is business continuity. Any breakage in the link will have a consequence on customers which could impact the company from a financial point as it is seen as a possible loss of income (Mentzer *et al.*, 2006:22). Therefore the primary research would be to identify the inventory variables that can be used to optimise the supply chain in a multi-national.

Suitable suggestions in inventory management would be required to provide solutions in the business environment, as inventory is a contributing part to sustainable supply chain and even more important, inventory is seen as the life line of a company. If you have no stock available to offer, the company is losing profits, market share, customers and most important their reputation. Therefore the secondary research objectives would focus on:

- To define variables and metrics in inventory management that accurately describes the effective inventory management through a literature study.
- To define variables and metrics that accurately describes sustainable supply chain management through a literature study.

- To determine which inventory management variables should be optimised in order to maximise the profits in a multinational company.

These secondary research statements would help a business in today's market and business environment, as a business cannot afford to take any step back as markets are highly competitive and globalised. Therefore these investigations would provide benefits by enhancing the competitiveness and capturing the customer demand on time, by having inventory available and even expansion opportunities within a business.

1.5 *Delimitations and assumptions*

Data collected mainly focused on inventory levels as well as market demands and trends, taking into consideration the reverse logistics approach. The calculations indicate how long it would take to get stock into the warehouse, where the replenishment cycle would be a key element based on the forecast cycles.

The study focuses mainly on activities that impact the supply chain and where inventory is applicable. There might be other external variables that impact the chain of flow but for this literature review, it would focus on inventory levels that are available to the market and the link to cash flow and return on additional sales.

Majority of the data analysed is from a basis point of one year and will be viewed to indicate any fluctuation and association in a clear format. The main focus areas are fundamentally figures, which are related to inventory and supply chain activities. The study also assumes, based on the information that is used in the research, the different levels to other types of companies, but in the end the correlation should remain the same with a similar impact on a business. This indicates a possible link in the business where a focus area should be applied.

The other key assumption that plays a role in the supply chain is all the external variables. These variables will determine whether your lead times will increase or decrease or remain consistent. This is to ensure that the JIT principle is executed effectively, ensuring that the demand that is created through a forecasting process is arriving at the right time and place by taking into consideration the lead-times from sources and suppliers.

1.6 Literature and Empirical selections for the study

1.6.1 Literature/theoretical study

There has been a steady interest in supply chain over the years (Gurtu *et al.*, 2015:193). Businesses found that they needed to extend their relationships outside the customary to be more collaborative to fit in with the quick globalisations of markets. Businesses also found that staying isolated is a disadvantage and needed expertise to improve the inefficiencies (Stefanovic & Milosevic, 2017).

Various findings have been created for an effective supply chain. This is crucial to ensure an effective understanding of a business to stay competitive through a supply chain strategy (Ross, 2015).

There has however been a short fall on the topic as the supply chain is viewed from the automotive industry's perspective (Arbjørn & Paulraj, 2013). To breach this gap it would be fundamental to break through to the field of supply chain as it would provide an understanding on how inventory levels plays a role in a business from a customer point of view as well as from a business side to escalate growth and profits (Croson *et al.*, 2014).

Therefore an analysis would be needed to see the impacts on customers and what would happen to the demand if inventory levels are not sufficient (Wu *et al.*, 2013). The inventory levels of the business are crucial at any specific given time. However to have an effective supply chain a business should work on a collaborative approach throughout the company to meet the business strategy (Christopher & Ryals, 2014).

Before certain links are assumed in the study, collective approach of other studies are necessary to establish an effective supply chain as well as the role of inventory management. The majority of studies found, concentrate on inventory production processes (Dekker *et al.*, 2013:8) as well as how the process of procurement should be done (Hawkins *et al.*, 2015:93). On the other side there has also been a recent increase in interest in inventory management and the impact it has on a business, and especially on the supply chain. The importance has shifted due to the importance of market demands due to the high level of vulnerability and instability (Christopher & Ryals, 2014:34).

Williams and Tokar (2008:224) has identified the importance of a stock out response. They found that the occurrence of a stock out in general lead to two types of impacts, one being a back order created, or an instant loss of sale if the order could not be fulfilled when the need was created at a specific point in time. Due to many competitors in a globalised world, the customer would move on to the next alternative until they have satisfied their need in terms of requirement fulfilment.

When a business with a supply chain is not sufficiently servicing the business as it is supposed to with regards to making goods available to the customer at a specific point due to not having stocks available, the demand could be backordered. This gives the supply chain a certain deadline to meet the customer demand as and when the inventory becomes available. If the satisfactory level is not reached the demand could become lost. When a demand becomes unfulfilled, it indicates that at that specific point and time the customer demands were not met due to a lack of available inventory and a sale was lost. As mentioned by Williams and Tokar (2008:224): *“the stock out assumption is of importance in terms of the model’s application and relevance to various supply chain echelons.”*

From the above it is noticeable that in such a competitive market, inventory plays an essential part in a business survival (Relph & Milner, 2015:48) to ensure that the demand that is generated, is supplied. Therefore in today’s business environment an increased focus is shifted on the supply chain side of a business to ensure that there is a balance between capturing the market demands as well as sustaining an acceptable level of inventory not to tie up any unnecessary cash flow. Mangan and Lalwani (2016) mentioned that the customer expectations have increased globally due to the cost and services that have added a premium to certain products. The essence for any organisation is to have a solid supply chain to depend on, by ensuring that the goods are made available to meet the customers’ demands at the appropriate time with the least possible cost.

In addition to the above, Min & Zhou (2002:231) agree with Mangan and Lalwani (2016) that business has developed in such a way that the attention in the organisation has shifted to a common effectiveness and efficient functions rather than being segmented. This was the era of supply chain models to ensure that important functions like planning, controlling and implementation falls under the same scope. Monitoring was added afterwards to ensure whatever might have been

rolled out was sustainable and that it was working. This was purely created from a business strategic view to ensure that the decisions made are from a strategic point with reliable information available. Ensuring that the information is available from beginning to end to ensure the customer demand would be met as well when required.

Inventory is a fundamental part of a business and supply chain therefore Michalski (2008:83) touched on the aspect of how high inventory levels and low inventory levels could impact a business. Michalski (2008:83) found that the inventory guiding principle will lead to innovative inventory levels in a business that will influence business significance. The main reason would be that majority of the opportunity cost are found in the inventory as well as the cost associated to it. This will lead to a negative effect on the cash flow in the future which could possibly lead the business to a risk status. Michalski (2008:83) brought up that the cash flow decision will determine a future strategic decision that could lead to an operational risk. Therefore three major impacts were identified:

1. Impacts the life of the business as cash is tied up in inventory.
2. A link that is not functioning in the supply chain where inventory is disrupted either with over allocating or under allocating.
3. The rate of capital cost to assist in funding the business's outstanding cash flows for normal operations as projections are not executed as anticipated.

Michalski (2008:84) further elaborated that when there is a possibility to have too much inventory, the risk supported by Williams and Tokar (2008:224) that too little could lead to stock outs. Therefore the balance needs to be of such sorts that cash flow is tied up at a minimal in inventory so that a high level of demand could be satisfied. This is of the essence to understand the link of this study to determine what the level should be would contribute to the relationship of inventory management and supply chain.

As seen by Michalski (2008:94) findings there is a possibility to have too much inventory, the findings Kwon & Whan (2004:8) confirms that there is still some uncertainty when looking at the supply chain process. Papadopoulos (2015) believes that there are still many "glitches" in the Supply Chain and the biggest is due to high

levels of inventory throughout the process to where shortages of other products could be found. Therefore the balance is not achieved as they ideally want Williams and Tokar (2008:224) theory of minimal stock outs or back orders.

The level of inventory that is available at the current time of the demand is brought up again as this is crucial to an organisation. Stevens and Johnson (2016) believes in order to counter this instability that the Six Sigma could be a possible solution to ensure better supply chain levels as well as proper inventory levels. The reason why Six Sigma is mentioned, as it has been proven to be effective by serving the customer better in conjunction of saving cost, ultimately gearing up the business to enhance the performance. Profits would increase due to the inefficiencies that would be removed within the organisation. Kwon & Whan (2008) research leads us to believe that an effective supply chain requires supporting methods and tools to be implemented. This is to ensure the correct mixes of inventory are met to serve the customers' demands when needed having the processes in place already.

The reason for the selection on the literature above is that they lean more towards a model to carry no inventory but still want to sell your goods in the market. Stevens and Johnson (2016:43) called this type of approach the "pure lean" supply chain. Pure lean supply chain indicates that no inventory should be carried and that demands are served when it is raised in a business. But Williams (2017:67) acknowledge that it would be unbelievable to reach something like this in practice but it is just not feasible. They also recommend to rather ensuring minimal inventory levels will serve the demands with a robust supply chain in place ensuring that the controlling, planning and executing is taken care of efficiently.

The findings thus far are quite clear that there is not really a perfect balance that can be achieved and it is more on a basis of trial and error, as there are two main sides that need to be taken into consideration. The demands of the market and the speed of requirement due to the changes and the impact globalisation have on all economies have been amplified (Gregory & Rawling, 2016:46). Secondly your inventory is a fundamental part of an organisation to survive and ensure continuous business (Aslani *et al.*, 2014:6). All this is taken care by the supply chain that has been created in recent years.

The benefits are clear that the inefficiencies are addressed by ensuring a more collaborative approach to ensure a better understanding through end to end servicing the customer's high expectations in a fast moving market (Agnihotri *et al.*, 2016:179).

Attaran M & Attaran S (2007:4) identified the benefits that a collaborative supply chain will lead to better planning, where the level of forecast or demand will be captured more accurately, that will ensure a better level of supplies with not over committing to too much inventory and still serving the customer in an erratic market.

They have also found that there is a significant increase in profits by ensuring a collaborative approach through the supply chain as goals and targets are clear throughout the business.

Attaran M & Attaran S (2007:8) found four key aspects that revolutionised the supply chain solutions to offer. Firstly they found that information is a crucial part to be tracked. This ranges from customers' orders to even ordering materials to distinguish a pattern and/or seasonality. With the mass data that is available in the modern era the majority of the information is transmitted through EDI into ERP systems. Secondly, it important that the need for a continuous replenishment program or system is in place as it will ensure the stock movements are taken care of and topped up as required based on the information provided.

Thereafter you would also need to understand through the collaboration process that customer response would be positive only if there is an efficient relationship system in place. This could lead to savings where required but also a transparency and tracking of information. Lastly Attaran M & Attaran S (2007:10) focused intensely on the way collaboration is structured. They found that the supply chain needs to take into consideration the planning, forecasting and ordering cycle to ensure that inventories are managed effectively, based on all the information provided to ensure the decisions taken are well educated based on trends and current inventory processes. Therefore it could be said that the four key aspects would lead the business to more efficient processes and remove the uncertainty as the relationship has improved from beginning to end and the stakeholders have a clearer view of what is required to cover the demand.

Based on the collaborative / combined approach it is quite clear that a supply chain is important to a business strategy and as Hoejmose *et al.* (2013:619) indicated in their findings that it is fundamentally important to align the supply chain to the business. Handfield *et al.* (2015:16) found that supply chain capability is vital to a company's business strategy as the supply chain is dependent on the key success thereof. Therefore supply chain management reassures management of processes across departments to ensure the business strategy is executed correctly.

Based on Mangan and Lalwani (2016:55) findings and Michalski (2008:83) the link becomes more further clear that inventory levels could be instrumental to a business if it is in line with the strategy and geared up correctly with the link of a collaborative approach mentioned by Attaran M & Attaran S (2007:10) throughout the company.

Seeing that supply chain is fundamentally relying on inventory, Fan *et al.* (2015:124) found a few interesting findings that inventory could have on a supply chain design. The first finding was that in an environment where competitiveness is high the business tends to be under stocked due to the demand uncertainty to their product but the market demand could be high. Therefore it could create an opportunity to rather be overstocked (Altug, 2014:44) in order to supply the demand if there might be a spike. This is very applicable in today's world where it is much globalised and products are mostly free to get due to the high levels of competitiveness in the markets.

This is linked to Williams and Tokar (2008:224) which ensure that items are not backordered or even worse losing sales in a competitive market. An interesting finding from Fan *et al.* (2015:124) is that qualified performance needs to be set up. This would mean measuring business in the industry to compare to other competition, and substitutes they have to offer to ensure a unique selling proposition through an operational level.

Therefore a supply chain is very important in the beginning stages of any business (Baird & Ziskend, 2016:34) to ensure when inventory is kept and how products are distributed so that all inefficiencies are taken care of. In conjunction to having markets that are evolving and the requirements of a lot of information to help ensure that inventory levels are supporting the markets but also not putting the business under risk.

Thus far a lot of the focus on the literature has been done on how important supply chain is with the utmost suitable inventory levels for a business. Now the other function is to understand what is classified as a suitable inventory level (Bacchetti *et al.*, 2013:273)? Should this be identified through the company strategy? Or should the supply chain determine the levels to ensure the company strategy is reached?

Chopra and Sodhi (2014:72) suggested a company who responds the most effectively to the changes in an ever evolving market will survive the longest. But what was clear in the findings was that your inventory position needs to be so significant that your customer satisfaction is at such a level where a business stands out in a market but also not putting the business at risk with a large amount of inventory. This model is focused on customer centric.

Therefore inventory turnover is crucial to a business. Vastag & Whybark (2005:134) found that to have an effective supply chain there should be an implementation of inventory movements. This is to ensure that the business stays competitive and gives an indication on how inventory is moving through the company. It was also mentioned that the famous principle of JIT should still be one of the most effective measures to control inventory as well as cash flows (Green *et al.*, 2014:134). Once this principle is achieved it reflects back on the supply chain that effective processes are in place or it could show the other side around.

Sarkar and Sarkar (2013:931) mentioned as well that to calculate a good inventory turnover ratio would be to sum up all the sales through the company divided by the inventory. This would be a fundamental part of supply chain as it will show how effective it is with the current process in place or if an improvement is required with a stronger focus on JIT. Therefore when viewing the above literature it is clear that businesses supply chain needs to be aligned to the strategy (Monczka *et al.*, 2015:512) and based on the strategy the supply chain should adjust the inventory levels to reach those ambitions set by the business.

An interesting finding that is rather new and not researched a lot is the basis on how a supply chain can incorporate a stock out or a back order thoroughly, Croson *et al.* (2014:195) explored designing a model where it is acceptable not to carry inventory and rather weigh up the impact of a stock out versus a back order.

Keeping in mind it is not ideal as mentioned by Williams and Tokar (2008:224) to be in such a situation. But what Croson *et al.* (2014:195) is referring to is that it is not that big of an impact to have a confirmed back order where a customer has indicated that they will utilise the stocks now or when it arrives. Therefore shortages are allowed to a certain extent as seeing either way the sale is made but the impact of cash flow is minimal. Although once again it is contradicting what Chopra and Sodhi (2014:70) mentioned, for supply chain to be effective it has to give an excellent customer experience with a service they will not forget.

However with these levels of stock out or back orders Croson *et al.* (2014:194) build a type of model where back orders and stock outs could be calculated once certain variables are known like lead times and capacity to ensure that a sustainable inventory level for a business is met.

Referencing back to the risk of inventory it has in the supply chain it is still very reliant on what the demands are in the market and how quick your business can react (Stadtler, 2015:27). If we take for example any business selling a product will have a specific lead time from manufacturing to getting it on the shelf. The idea for supply chain is to ensure there is a continuous flow of product as it leads to service a customer demand and keeping the inventory levels at a minimal at the same time.

However, how a supply chain reacts to a spike in demand where there is a gap in the supply chain will indicate how effective the strategies are as well as how the inefficiencies are taken care of. There is also another way of looking at the supply chain, when the expected demand is not there and there is a sudden pile up of inventory, how it would be able to manage the over flow (Lee *et al.*, 2015:116). Will the supply chain be able to excel or contract once events like this occurs in a volatile market that is much globalised and remain calm?

Tarafdar and Qrunfleh (2017) emphasised in their findings the interest business has in supply chain to support them on the above question. They believed that in the new era businesses are rather vertically integrating themselves with other experts. This has led to business becoming more specialised in what they are known for, to ensure that customers receive the best service based on various factors like:

- Product cost is more competitive by keeping other cost down.

- Improvement of overall quality in the products as “specialised” companies are involved.
- Better cash flow as cash is allocated correctly.
- Ambitions are starting to become reality through effective process.

This is mainly found through Tarafdar and Qrunfleh (2017) findings, that overall performance of a business will improve once the entire supply chain is under proper management. In addition to their findings it was also clear that competition is on an increase not only nationally but also internationally therefore relying on the supply chain to be more effective and keeping costs down. Tarafdar and Qrunfleh (2017) findings highlighted that customers have multiple sources from which they can choose to satisfy demand. Thus linking the business strategy and performance is crucial to locate a product throughout the distribution channel for maximum customer accessibility at the least possible cost. It gives a clear indication that demands have changed creating a predicament on maintaining inventory at the right specific point but as well as time.

It creates a level of uncertainty when it comes to inventory levels due to the dynamics of the markets and demands (Liu & Wang, 2016:108). Therefore, demands or forecast in this case plays a crucial part to distinguish patterns or trends.

Nevertheless Fleischmann *et al.* (2015:94) supported that there is no real seasonality as the market and behaviour of customers and competitors are changing creating, a risk on your inventory holdings and ultimately impacting your supply chain.

Advance planning is needed to support the business and supply chain activities (Fleischmann *et al.*, 2015:75). Once the inventory is at a higher level than required, it leads to cash flow issues as the majority of the business's cash flow is tied up in inventory as well as potential profits.

Therefore, it comes back to Williams and Tokar (2008:224) that for a supply chains it is a headache not to have too many inventories but also not to lose a sale to a customer in a market with many competitors.

Ideally your business needs to incorporate a certain tolerance of back orders as mentioned by Williams and Tokar (2008:224) but also to measure it maybe through

the findings of Tarafdar and Qrunfleh (2017) on their model to calculate the loss of sales as well as back orders. This is to ensure the findings of Michalski (2008:83) that your cash flow is not tied up into too much inventory as well as possible obsolete stocks.

In addition to that Michalski (2008:83) theory is also supporting Vastag & Whybark (2005:134) theory to have a constant flow of inventory turnaround in the supply chain to support Michalski (2008:83) findings on by supporting possible business cash flow problems.

Referring back to an effective supply chain having an Attaran M & Attaran S (2007:4) principle in the business where they identified the benefits of a collaborative supply chain as this will lead to better planning where the level of forecast or demand should be.

Therefore supply chain guides the business to ensure a balance of better levels of inventories (Wisner *et al.*, 2014:325) with not over committing to too much inventory putting the business at jeopardy keeping the strategy in mind

This would provide a base when reviewing the literature reviewed in chapter 2 where supply chain and inventory management should be looked at separately and identifying the relationship amongst them to see how it could be strengthened.

1.6.2 *Empirical study*

The evolution of the research question out of the literature review would suggest the following testing and methods to be done to answer the problem statement successfully.

The data extracted out of an organisation in the automotive industry would indicate the performance that transpires in practice and to observe if there are any authentic connections when a hypothesis is done.

The categories of variables used are mainly focused around a core function of a supply chain.

Therefore the following variables would be relied on to answer the problem statement:

- Inventory levels
- Inventory in the chain
- Demands / Forecast
- Back orders
- Sales

The quantitative data will mainly focus on identifying if there is a connection when certain variables increase or decrease. Hence, testing is required on the null hypothesis. This is to suggest that there is a comprehensible correlation or not and that up to a certain point the statistical level is significant enough to play a role.

Furthermore, it would also be required to assert that a statistical correlation between the variables are identifiable or even might be significant enough to include or exclude in answering the primary question. Mainly variables used are those out of the literature that where identify, which go hand in hand and contributes to sustainable supply chain or it could be rejected out of the study as there might be no significance.

This type of study might even require a multivariate analytics approach, as there are so many aspects of a supply chain that could lead to impacts on the inventory levels

Using the guidelines from Bryman & Bell (2011:320) a bivariate analysis will be used to see if two variables are correlated. Therefore, Pearson's correlation coefficient test will be appropriate to use when it comes to determining the significance two variables will have on each other.

Furthermore the possibility the sample set could give is a multivariate analysis test. Bryman & Bell (2011: 328) mentioned that is should only be used if there are several variables that could have an impact on a comparable topic. The multivariate analysis will allow a structure of three or more variables to identify correlations between specific topics.

The study should effectively answer the problem statement with the information available. The type of analysis is relevant to the topic as well as a reliable sample set

that is provided to give the study the best possible statistical significance results. The sampling of variables is mainly selected based on literature from Williams and Tokar (2008:224) and Michalski (2008:83) where they have discovered the importance of the variables as well as the significance to a supply chain.

1.7 *Layout of the study*

Chapter 1 states the primary and secondary research questions that are being investigated. A brief literature background is done to understand what Inventory Management and Supply Chain Management is all about.

Following Chapter 1, Chapter 2 is followed by an in-depth investigation of current literature that has been found by various authors focusing on the variables and aspects of supply chain management and inventory management. Therefore these findings contribute to a better understanding of how these divisions have an impact on business profits.

Once a clear understanding is formulated on the literature in Chapter 2, it is followed by Chapter 3, indicating that the hypothesis between supply chain and inventory management does exist and the following test would be used:

The types of methods utilised in the statically analysis are:

- Median
- Mean
- Standard Deviation
- Correlations (Making use of a bivariate and multivariate test)
 - Bivariate correlations (Pearson product-moment correlation coefficient)
 - Multivariate correlations
- Vastag & Whybark (2005:134) theory of inventory quality test
- Linear regression

Following the explanation of what each statically method contributes to this study Chapter 3 is followed by Chapter 4 on how the information has been gathered. Chapter 4 correspondingly provides the findings of the statically results and analysis inventory and supply chain has.

Thereafter Chapter 5 is to provide a conclusion and future recommendations on the topic of inventory and supply chain management relationship. The question should also be answer through the statistical findings if the primary and secondary research question was answered and what recommendations could be used to improve this study based on the outcomes.

1.8 Summary of Chapter 1

There is a scarcity in research articles identifying the relationship between supply chain and inventory management. Therefore this chapter illustrated the importance of the divisions within an organisation.

The primary research established was to identify the inventory variables that can be used to optimise the supply chain in a multinational business.

The indication is suitable in the business environment, as inventory is a contributing part to sustainable supply chain and even more important inventory is seen as the life line of a company. The secondary research objectives support the key factors that a business should focus on how ensure customer satisfaction, good sales and sustainable profits:

- There the study needs to define variables and metrics in inventory management that accurately describe the effective inventory management through a literature study
- There the study needs to define variables and metrics that accurately describe sustainable supply chain management through a literature study
- There the study needs to determine which inventory management variables should be optimised to order to maximise the profits in a multination company.

These investigations would provide benefits in the form of enhancing the competitiveness, capturing the customer demand on time by having inventory available and even expansion of opportunities within a business. In chapter 2 an in-depth literature study will be done on supply chain and inventory to finally understand how this can contribute to a better business function by having an improved relationship.

CHAPTER 2: LITERATURE REVIEW OF SUPPLY CHAIN MANAGEMENT AND INVENTORY MANAGEMENT

2.1 Introduction

In this chapter the characteristics for each variable will be viewed separately by narrowing down the attributes and identifying connections they might have. Therefore support from other studies and their literature will be used to review inventory management and supply chain management separately. A model will be created to have a proper understanding of the type of relationship and impact each aspect has on a business.

2.2 Literature review

An understanding of how supply is defined is essential. NC State University (2017) has defined supply chain management as: "Supply chain management is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by the supply chain firms to develop and run supply chains in the most effective & efficient ways possible. Supply chain activities cover everything from product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities."

Therefore NC State University (2017) created a concept of supply chain management mainly base on two main innovative:

1. Every product or service that gets into the market or used by a customer, represents the cumulative chain of events of multiple or single organizations that was successful.
2. Supply chains are known for a long time; however they have expanded into an expert field managing the complete chain of activities that eventually delivered products to the final customer.

This creates the understanding that all flows that are informative and physical are tied up together through the organisation. The physical flows refer to the product movement from manufacturing, storage and delivery.

The informational flow refers to partners and contributors of the chain and what is required for the plans to be executing effectively and to ensure they do not get disrupted.

According to the Business Dictionary (2017) supply chain is defined as: “Entire network of entities, directly or indirectly interlinked and interdependent in serving the same consumer or customer. It comprises of vendors that supply raw material, producers who convert the material into products, warehouses that store, distribution centres that deliver to the retailers, and retailers who bring the product to the ultimate user. Supply chains underlie value-chains because, without them, no producer has the ability to give customers what they want, when and where they want, at the price they want. Producers compete with each other only through their supply chains, and no degree of improvement at the producer's end can make up for the deficiencies in a supply chain which reduce the producer's ability to compete.”

Hervani, Helms and Sarkis (2005:331) indicated in their study that supply chain management is the coordination and management of a complex network. The network they were referring to is all the activities involved from production to where the customers have acquired the product or service.

Supply chain is seen as the life line to a business as indicated by Hervani, Helms and Sarkis (2005:331); supply chain covers all vital areas of the business namely:

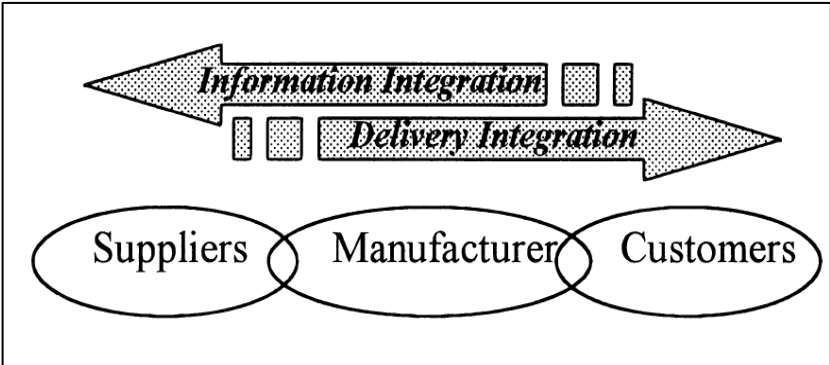
- Scouring raw materials and parts
- Manufacturing and assembling
- Storage
- Order capturing and dispatch
- Distributions through numerous channels inbound and outbound

Based on the above, their findings are clear that supply chain works with inventory however never manages it. Supply chain is seen as the department that moves the product at the right time and place as mentioned by Vastag & Whybark (2005:134) through the JIT principal.

Frohlich and Westbrook (2001:186) made it clear through their research that integration is imperative through a supply chain and supporting research of Attaran M & Attaran S (2007:8) indicates once again how important information is.

The module that Frohlich and Westbrook (2001:186) created is illustrated as per below:

Figure 1: Supply chain integration model



The integration of the supply chain is imperative to ensure that the flow of the product and service is done correctly. Frohlich and Westbrook (2001:186) illustration shows the importance of integrating a backward coordination of information and forward flow of delivery to a customer. This can all relate to the forecast factor that is so imperative to manage the variables Hervani, Helms and Sarkis (2005:331) has broken down. However the information needs to be clear starting, with customer expectations and what the chain can provide effectively.

Benton and Maloni (2005:3) supported Frohlich and Westbrook (2001:186) with the integration however it would not be possible based on the four aspects Benton and Maloni (2005:3) highlighted in their study: “Supply Chain strategy must be formulated with complete and accurate information”. Through their study they acknowledged shortcoming as shown in Table 3:

Table 3 Barriers to effective Supply Chain Management

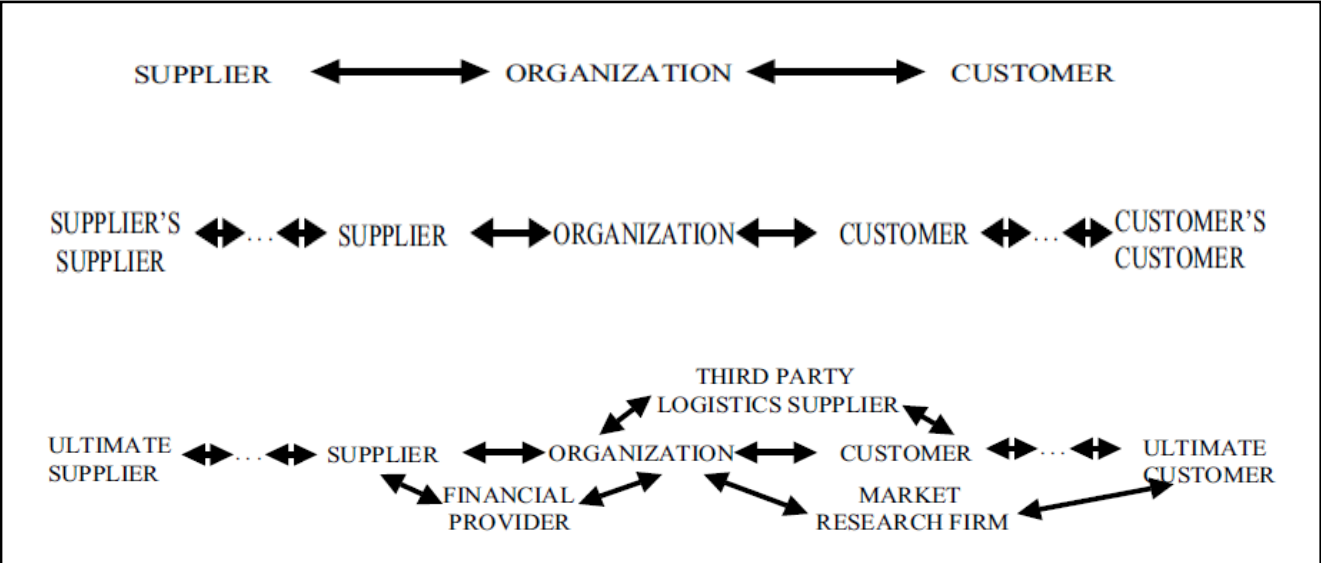
Barriers to effective Supply Chain Management

Failure to share information
Lack of self-awareness
Lack of partner awareness
Lack of Supply Chain satisfaction
Lack of customer understanding
Lack of understanding supply chain within the organisation

Seeing that Benton and Maloni (2005:3), Frohlich and Westbrook (2001:186) and Vastag & Whybark (2005:134) highlighted the importance of information sharing and the lack there off, and that it could have tremendous impacts on a business due to disruption in the Supply Chain.

Mentzer et al (2015:5) illustrated the simplest form of supply chain management should be from the supplier through to the organisation, then to the customer however the up to it most complex through all the fine points of the company Figure 2 and ties back to the flow of information and communication channels:

Figure 2: Information and Communication flows through a business



Mentzer et al (2015:5) concluded based on their literature review, the proposed function of supply chain management philosophy acquires the following characteristics:

1. Systematic outlook viewing the supply chain as a whole. This requires managing all the flows of goods inventory from manufacturing to the customer
2. A strategic orientation toward cooperative efforts to be unified throughout the organisation both operationally and strategically
3. End user focused to create unique selling or service proposition to the customer showcasing value and ensuring customer satisfaction.

Seeing the importance and sometimes the complexity of information Ralston *et al.* (2015) indicated that vertically integrated supply chain strategies works better. This provides the independence required for the supply chain to manage effectively throughout and support of Mentzer et al (2015:5) findings.

Ralston *et al.* (2015:63) mentioned the “relay approach” to be more effective within one organization where departments hands over and cross covers the service to their customers effectively. This mitigates the risk of losing any market share as the entire organisation has the same goal in mind.

The relationship between supply chain and inventory management was highlighted by Ralston *et al.* (2015:63) that supply chain management is a system-wide inventory saving process, where inventory managers should make use of information and disseminators with the support of negotiators that contributes to the firm under the supply chain management atmosphere. This shows that collaboration should take place within the organization referring back to Attaran M & Attaran S (2007:8) and ensuring no stock outs or back orders are created (Williams & Tokar, (2008:224) through clear collaboration and information.

Winter and Knemeyer (2013:37) agreed that information is key when it comes to supply chain management however when determining the network and structure it is imperative to identify the key members that would contribute information to the supply chain team. This is normally set up through the business to determine the key roles and aspirations for the business.

The first question to ask based on Lambert and Enz (2017:15) theory is who should be part of the process, followed by the process owner to determine the information and lastly how the interrogation would be monitored and controlled. This reiterated that supply chain is not a silo effect but a broad division assisting and managing multiple aspect of the business to ensure it is a success.

When combining all the above supply chain management literature and applying it to the automotive industry Meyr (2004:453:457) researched indicates that there are two models are utilised:

1. The forecast driven model
- &
2. Order driven model

The forecast driven model is based on the budget planning for the next year with the outlooks they perceive based on external factors. According to Meyr (2004:453) it is imperative for the forecasting process to be reviewed on a monthly basis to keep up with the external changes and to ensure the supply chain has the right volumes to move.

On the order driven model it represents in the forecast of what actual units will be sold. When viewing this model the customer has already created the demand as they have a need for the product however they are not able to supply. Meyr (2004:15) mentioned that this is for your more premium products however it does not fall in the FMCG category for premium products due to the fierce market conditions and globalisation.

To support these models from Meyr (2004:15), Lee (2012:25) highlighted that any type of process chain selected should always be agility, adaptability and alignment.

Lee (2012:25) found that agility is required to respond to short term changes with regards to supply and demand from customer and markets. Therefore Lee (2012:25) is almost contradicting to what Meyr (2004:15) found in the models as either or. The indication is leaning towards an interchangeable approach at times to accommodate the customer and market requirements. When the agility is of such a standard disruptions will be minimal with very little cost implications. Adaptability is to adjust the design of the supply chain to accommodate the market changes over time, to serve the customer effectively and efficiently with the latest trends and technologies available.

Lee (2012:25) made it clear that if an organisation is not aligned, they will not be able to reach full utilisation and optimisation within the organisation due to all participating contributors not being aware. Therefore collaboration is fundamental as indicated by Attaran M & Attaran S (2007:8). Lee (2012:15) built the model of Triple-A supply chain:

- **Agility**
- **Adaptability**
- **Alignment**

As Lee (2012:15) mentioned: “The best supply chains identify structural shifts, sometimes before they occur...” Therefore this model is relevant to the study and the summary provided by Lee (2012:15) in figure 4 showcases the integrities of this model:

From Lee (2012:15) findings under agility, adaptability and alignment there is a direct and/or indirect impact on inventory, therefore it is imperative to understand how inventory management contributes to the business and how it contributes to all the models above.

Before proceeding with the literature a clear definition is provided of inventory management by the Business Dictionary (2017: “Activities employed in maintaining the optimum number or amount of each inventory item.

The objective of inventory management is to provide uninterrupted production, sales, and/or customer-service levels at a minimum cost. Since many companies inventory is the largest item in the current assets category (Kumar & Bahl, 2014:458), inventory problems can contribute to losses or even business failures due to short fall of product availability.”

Inventory management has become much more in recent years than just counting the stock a business has. Inventory management steers a business to understanding the realities to ensure that informative decisions are taken to balance the demand of now and the future keeping in mind the operational cost to ensure profitability is lucrative (Muller, 2011:27).

Fleischmann *et al.* (2015:93) made it clear that advance planning should start with inventory management. This is to ensure that the products are arriving on the right time with the right cost, to ensure that there is no loss of sales or backlogs of customers' requests. This is where forecasting would be needed with the right level of collaborative information shared amongst teams to follow the business strategy.

It is important to understand that excess amount of stocks influence the working capital of a business as the stocks are tied up in inventory and could upset business operational cost (Wild, 2017:24). Therefore, a fine balance is required when inventory management is done to ensure that demand is fulfilled and capital is not tied up from perspective. Certain inventory management business models are designed to support a business by making an informative decision based on the model outcomes.

Shin *et al.* (2016:44) focused on the importance of just in time (JIT) inventory management and found that there is a relationship between inventory levels and profitability. The results directly shows there is a benefit by using JIT in a business, however the tenuous validation between profitability and JIT is not adding value to a business. The severity of JIT within a business will impact your profitability where the principal should actually contribute.

Other techniques would be investigated to support the inventory management model which contributes through the continuous supply chain links.

Millstein *et al.* (2014:80) emphasised that the ABC analysis is required in a business, and is one of the most widely used techniques in inventory management. The idea behind the ABC analysis is to classify products into three ordered classes called A, B and C, where class A comprises of the essential products in the business and category C, compromises of the least important products in the business but are still required for the market. The ABC classification of inventory items is based on various variables set up by a business and allocated certain weighted scores.

Mitra *et al.* (2015:54) utilised in their findings that the FSN model contributes to business inventory management and performance. The FSN model indicates:

- Fast-moving,
- Slow-moving and
- Non-moving inventory

Therefore Vastag & Whybark (2005:134) indicated that inventory turnover is crucial to ensure business profitability. Mitra *et al.* (2015:54) found that the priorities of products shifts based on the inventory techniques being used and the FSN model contributes to this. Kumar *et al.* (2017:26) advised it would be suitable for the management of the business to select the FSN model products to assist the selection of the ABC model. However not all products should fall under ABC and only the fast-moving products should as this will support business profitability. For the slow-moving products a different business approach should be taken as cash is tied up in inventory. The worst case indicated by Kumar *et al.* (2017:39) is non-moving items as these units are not an issue to get in to inventory however to get them sold is more of a challenge.

Santhi and Karthikeyan (2016:442) made use of the VED inventory model that focuses on:

- Vital inventory
- Essential inventory
- Desirable inventory

This model contributed to two goals. The first it to ensure that regular products are kept that are vital to the business continuation as well as keeping inventory to a minimum, which impacts the cost factor by keeping a company lucrative in regards to profitability.

The vital products that are being referred to by Santhi and Karthikeyan (2016:442) are those products that the business does not have will cause the business to a complete standstill.

When essential products are grouped it shows significant opportunity that will have an impact on the business where the risk is relatively tolerable compared to vital grouping products. Desirable products will be tolerated by the business and consumer will understand the nature of the product and what it adds.

Kumar *et al.* (2017:41) made is clear on the importance between the ABC and VED model as both these models aim to group products and provide valuable results in each model. From an ABC model perspective, it provides the classification process of the stock the business has where the VED model indicates what happens to the business if the stock is not available.

Stadtler (2015:27) indicated a crucial variable that impacts you inventory, supply chain and cash flow is the lead time to import or manufacture products. The longer the lead time the longer it takes for the business to sell and make profit. This also has an effect if there might be a possible bullwhip on how agile and quick your reactions to the market can be with regards to changes in the market and the effect it could have on your cash flow. Therefore a certain amount of safety stocks is still required for a business as Aleem and Khalil (2013:232) indicated.

This is to ensure customer satisfactions are maintained by supplying the increased demand that was not anticipated by the forecast. With the inclusion of safety stock it provides a buffer on stocks outs as well as for the supply chain to increase the demand of movement through the forecast.

2.3 External factors influencing supply chain and Inventory Management

For a business it should be imperative to understand the external factors influencing a business even having the best model implemented and best practices there ARE always factors that could influence a business. Therefore this should provide a benefit for a business to assist in understanding these factors and what they could contribute.

Hudnurkar *et al.* (2014:201) found that due to market changes it is important to understand the market demands and changes as the opportunity might be quick and the supply chain to ridged, therefore agility should be required and a proper market understanding.

The biggest impact a supply chain and inventory management can get is when the distribution channels goes through a bullwhip effect. This is a phenomenon where the forecast shows cases of supply chain inefficiencies as the fluctuations in inventory management is too big to responds. This is based on the customers' demands and the upstream supply chain (Lee *et al.*, 2015:116).

Jaipuria and Mahapatra (2014:41) highlighted the importance during a bullwhip effect to establish an accurate forecasting of the demand as unpropitious demand forecasting leads to an upsurge of overcall operational cost that could impact the bottom line of the business. Therefore Jaipuria and Mahapatra (2014:41) indicated that a moving average within the forecast would assist to reduce the impact of a bullwhip effect either up or down.

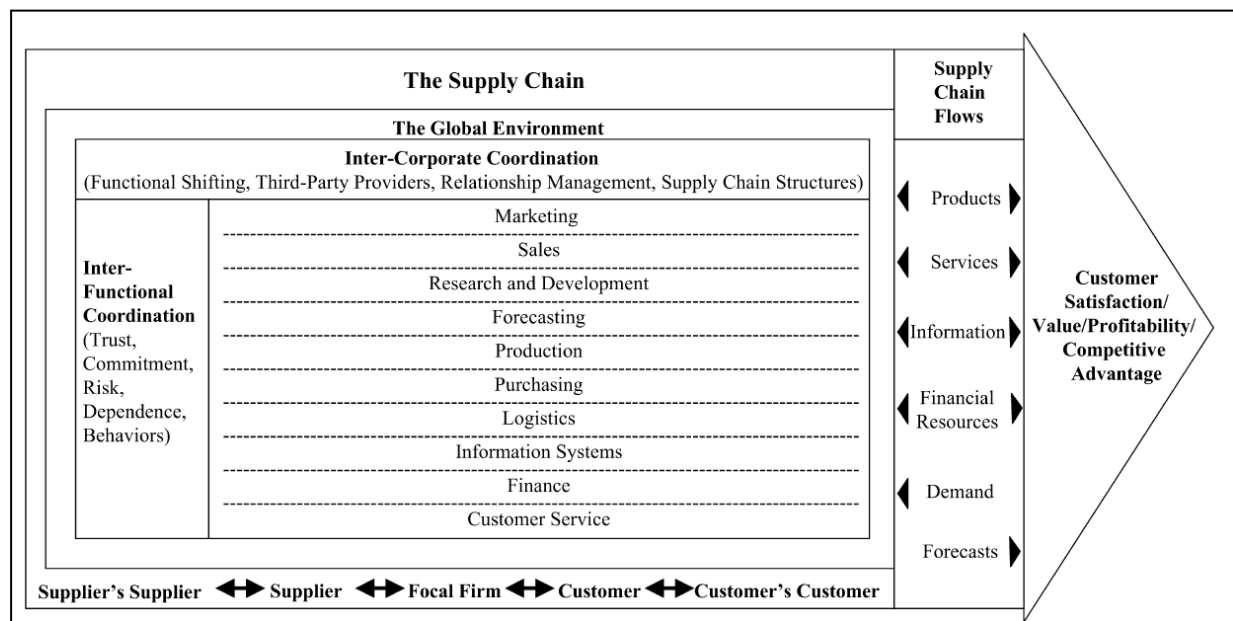
The findings of de Almeida *et al.* (2017:210) supported the findings of Jaipuria and Mahapatra (2014:41) that the operations should not panic and be agile to support the business. Therefore between the departments collaboration and trust should be established through business exchanges that help the process to reduce cost. As de Almeida *et al.* (2017:210) mentioned: "... aspects of behaviour towards partners of supply chain companies can mitigate the operational causes of the bullwhip effect by improving the information and knowledge sharing, demand forecasting, replenishment policy and reducing the risk coordination among the chain participants."

2.4 The ideal Supply Chain Model

The question should be is there an ideal supply chain model that manages the inventory effectively? There are so many variables and cross functional departments required to ensure a supply chain is successful. Therefore in

Figure 3 below it provides the ideal supply chain:

Figure 3: The Supply Chain environment



The figure illustrates the importance of a balanced global environment identified by Wisner *et al.* (2014:34). However to have a strong inter-functional coordination is crucial as it is a business controlled collaboration that is needed across all functions as Liu and Wang (2016:108), Morita *et al.* (2015:240) and Braunscheidel and Suresh (2018:308) indicated.

Liu *et al.* (2014:52) stated that the supply chain should play a coordination role to ensure flows are met. The flows that are being referred to are the products, services, information and servicing the customer's demand, with the forecast that is built for the future. However depending on the size of the business and people it all varies for an effective model.

Stevens and Johnson (2016:34) stipulated that the organisational functions that contribute, a strategic approach that supply chain has towards customer satisfaction and the organisation.

The significance of this model is to contribute to a business to illustrate the responsibilities and contributors actions to the business as Stevens and Johnson (2016:34) highlighted. This refers back to the collaboration of Hudnurkar *et al.* (2014:201) and de Almeida *et al.* (2017:209). They found that assisting with effective decision making, through shared information from various departments, and suppliers, will serve the customer (Agnihotri *et al.*, 2016:179).

The key focus after satisfying the customer needs for supply chain should be to contribute to profitability through smooth processes. Azevedo *et al.* (2011:870) found that a supply chain promotes best practices in an organisation where it not only provides sustainable business with regards to be competitive but improves the overall profitability of an organisation.

Niraj *et al.* (2001:15) stated that a supply chain model should be built around the customer as the product that is being purchased is linked to the organisation profits keeping the customer centricity alive but without the support of Agnihotri *et al.* (2016:179) collaborative approach the business would not achieve optimised profits (Azevedo *et al.*, 2011:870). This showcases that each and every single department in a business plays a fundamental role to ensure the inventory is available at the right time to satisfy the customer expectations.

2.5 *Elements that contribute to supply chain and Inventory Management*

As a consequence there are certain elements that contribute to the relationship between inventory management and supply chain management either working on their own or in unison (Stevens & Johnson, 2016:45).

These variables identified through this paper would contribute to test the relationship between inventory management and supply chain management. Keeping the business and customer in mind and ultimately contributing to the business (Niraj *et al.*, 2001:14). Therefore in Table 4 below it indicates what the requirements are for each department:

Table 4: Factors contributing to Inventory and Supply Chain Management

Inventory Management	Inventory Metrics	Supply Chain Management	Supply Chain Metrics
Forecast driven	Forecast	Orders driven	Sales
Collaboration with in Company needed		Collaboration with in Company needed	
Keep inventory at optimal level	Forecast deviation	Keep cost low	Inventory cost
Maintain the product level	Stock outs /Back Orders	Move the product	Inventory Turn Over Ratio
Aim to reduce inventory cost	inventory cost	Aim to reduce total cost	Total Cost
Lead Time	Forecast / Stock availability and Stock Outs	Lead Time	Forecast / Stock availability and Stock Outs
Safety Stock incorporations	Stock Outs / Back Orders	Agility	Inventory Levels

The table illustrates the metrics that is concluded from the variables that impacts either supply chain management or inventory management. From these themes it is important to understand the literature review which could be supported by measuring figures from a business and to do the hypothesis on the relationship.

However, literature would be required to support these with regards to supply chain management and inventory management.

Acar and Gardner (2012:847) placed emphasis that a forecast driven model is based on the projected demands and the types of inventory that should be kept to satisfy the customer expectations. Verdouw *et al.* (2010:186) contradicted to Acar and Gardner (2012:847) as the production should only start when a need is raised by a customer. Therefore it would be imperative to test this to see the relationship between inventory availability and stock outs.

Collaboration within the company refers back to the collaboration between Hudnurkar *et al.* (2014:201) and de Almeida *et al.* (2017:209). They found that this step is crucial in assisting the business in effective decision making by sharing information from various departments and suppliers to serve the customer (Agnihotri *et al.*, 2016:179), however, this is not measured with a statistic approach, but could be perceived as an increase in a business forecast and inventory levels with minimal stock outs to capture the customer demand.

Closs *et al.* (2010:56) found that inventory levels that are maintained at an optimal level, increases customer satisfaction that could lead to better market penetration due to stock availability. Bolton *et al.* (2011:1576) concluded that having optimal inventory levels on a consistent bases and it does not move as planned, could lead to financial friction due to cash flow constraint where cost could be extended from operational aspects. It would be imperative to measure the forecast deviation from the actual sales to see how accurate the information shared is from a global level. The inventory cost would be a good variable to correlate against the forecast deviation in the future studies as this research and information is restricted.

When a business is collaborative about their products in supply chain management views this as the movement of the product from manufacturing to the customer. On the other side Inventory Management is viewed as having the products available to capture the customer demand when the need is created. Stadtler (2015:26) indicated the supply chain is responsible for the movement of the product however they are also responsible for the cost of moving this product as each unnecessary movement adds to the cost impacting the bottom line of the products. Therefore processes should be in place to ensure efficiency (Monden, 2016:45).

Fiestras-Janeiro *et al.* (2011:466) found that in a corporate environment it is hard to satisfy the needs of the business with regards to keeping inventory at a low due to cash flow but also to have stock available to ensure that there are none to minimal stock outs. Nevertheless this has been seen as an encounter in a business where the test should compare to inventory levels and back orders and in addition sales as this should provide the importance of the relationship between supply chain management and inventory management. This will provide the business the opportunity to understand the importance of safety stock set up in the inventory

management as well as for the supply chain to test their agility in regards to any bullwhip effects (Jaipuria & Mahapatra, 2014:2041)

Lead-time is a fundamental aspect in both supply chain management and inventory management and should be taken into consideration (Sarac *et al.*, 2010) as this will ensure your stock ordering processes have incorporated these buffers to apply the JIT principle effectively (Green *et al.*, 2014:132). This is where lead time is put to the test, measuring on forecast versus the sales to be as close as possible and stocks outs at a minimal indicating that three variables are operating on an effective level.

Therefore a model could be constructed on how the business would benefit from the relationship aspect of both supply chain and inventory management.

Table 5: Relationship factor module for an optimised supply chain

Inventory Management	Supply Chain Management	Business Benefits
Forecast driven	Orders driven	Customer Satisfaction / Increase in profits
Keep inventory at optimal level	Keep cost low	Increase in cash flow / Increase in profits / Customer satisfaction
Maintain the product level	Move the product	Reduction is operational cost / Increase in profits / Customer satisfaction
Aim to reduce inventory cost	Aim to reduce total cost	Reduction is operational cost / Increase in profits
Lead Time	Lead Time	Reduction is operational cost / Increase in profits
Safety Stock incorporations	Agility	Customer Satisfaction / Possible increase in profits depending on exponential increase in operational cost.

2.6 *Literature impact on Managerial Implications*

The aim of this study is to provide assistance to businesses to make informative decisions, if there might be shortcomings within an organisation. From the literature the presence of a few key aspects were highlighted that contributes to supply chain and inventory management:

- Collaboration
- Managing a forecast effectively
- Customer satisfaction
- Keeping back orders to a minimal
- Optimise stock level
- Understanding the market

This provides business the opportunity to utilise tools, methods and metricises to monitor and control these functions to ensure effective businesses objectives are achieved. This not only contributes to profit improvements and cash flow management but, more importantly, the impact your product has on a globalised world servicing the customer expectations as anticipated.

2.7 *Summary of Chapter 2*

Throughout Chapter 2 the importance of supply chain and inventory management is recognisable through the literature. The integration of the supply chain is emphasised on the importance, to ensure the flow of the product and service are done correctly. Therefore a supply chain strategy should be formulated with complete and accurate information through proper collaboration upstream and downstream.

The chapter also highlighted the correlation between supply chain and inventory management by Ralston *et al.* (2015:63), that supply chain management is a system-wide inventory saving process where inventory managers should make use of data and disseminators. The aim is to contribute to the firm under the supply chain management atmosphere.

The objectives highlight that inventory management should provide uninterrupted production, sales, and/or customer-service levels at the minimum cost.

The key focus after satisfying the customer needs for supply chain should be to contribute to profitability by smooth processes. Azevedo *et al.* (2011:870) found that a supply chain promotes best practices in an organisation where it not only provides sustainable business with regards to being competitive but improves the overall profitability in an organisation

This chapter highlights a business's impact on supply chain and inventory management which is known as a bullwhip effect. This effect provides emphasis on the distribution channels and how they are being impacted by focusing on how agile and quick your reactions needs to be with regards to the market demands. The market demands are sometimes unpredictable that could lead to a negative effect on a business.

This is a phenomenon whereby the forecast shows cases that supply chain inefficiencies and the fluctuations in inventory management is too big to respond on, based on the customers' demands and the upstream supply chain lead times (Lee et al., 2015:116).

The basis has been set to support chapter 3 on methods that are required on the key elements to optimise the supply chain. Therefor this should provide an indication on supply chain and inventory management to resolve the primary research question on how the inventory variables impacts a business and how can those variables can be used to optimise the supply chain in a multinational business.

CHAPTER 3: *METHOD AND ELEMENTS*

3.1 *Introduction*

It is crucial to understand the variables that impact supply chain in order to answer the problem statement. Throughout the literature a few key variables were highlighted that will be tested through statistics methods.

Beamon (1988:2) indicated that supply chain is an important link to inventory management: “At its highest level, a Supply Chain is comprised of two basic, integrated processes: (1) the Production Planning and Inventory Control Process, and (2) the Distribution and Logistics Process.” Therefore the inventory levels will indicate a clear roll with regards to the supply chain effectiveness.

This is mainly to test Williams & Tokar’s (2008:224) important theory of a stock out response. They found through their findings that a stock out in a broad-spectrum, leads to two types of impacts, and one being a back order raised as the customer will have to wait or an instant loss of sale if the order cannot be fulfilled at the specific point when the need was created. Due to a globalisation the customers have choices available from a vast range of competition. Therefore the variables and sample set used will be related to the automotive industry.

There are other findings that are highlighted in the balancing of inventory. It is vital in the supply chain management as the level of commodities may perhaps be either at a high impacting cash flow level or an event of shortages which could impact income/profit due to selling the commodities to the customer when they require it (Kwon & Suh, 2004:8) which impacts the company in both ways.

In conjunction to the above, the inventory has an impact on your financial books as it is at its minimal, due to the low levels of expenditure. Expenses could consist of warehousing, transport and insurance cost that have accumulated. When viewing the inventory, adequate stocks are there to meet the supply requirements based on the demand and forecasting. The company will be able to capture the demand effectively and grow profits and shares of the market (Michalski, 2008).

Seeing that inventory contributes to such an influential role in a business Vastag & Whybark (2005:134) mentioned that to calculate a good inventory turnover ratio would be to sum up all the sales through the company divided by the inventory. This test would be crucial to see whether an effective supply chain has been utilised in the business' case. This would require the business to view the JIT principle in supply chain and its effective and efficiencies with the current process in place or if an improvement is required.

Acar and Gardner (2012:847) placed emphasis that a forecast driven model is based on the projected demands and what types of inventory should be kept to satisfy the customer expectations. Closs *et al.* (2010:56) found that inventory levels that are maintained at an optimal level increase customer satisfaction that could lead to better market penetration due to stock availability and reducing stock outs. Stadler (2015:26) indicated that supply chain is responsible for the movement of the product but it all depends on the inventory availability to move the stock. This will provide the business the opportunity to understand the importance of safety stock set up in the inventory management as well as for the supply chain to test their agility with regards to any bullwhip effects (Jaipuria & Mahapatra, 2014:2041)

For this reason the statistics would be utilised to understand the relationship Inventory has on supply chain.

3.2 *Types of methods*

The types of methods to be used for statically analysis would be:

- Median
- Mean
- Standard Deviation
- Correlations (Making use of a bivariate and multivariate test)
 - Bivariate correlations (Pearson product-moment correlation coefficient)
 - Multivariate correlations
- Vastag & Whybark (2005:134) theory of inventory quality test
- Linear regression

3.2 Reason to why certain methods are being used

The meaning would be a good reference to start off with as Schoenherr and Speier-Pero (2015:131) and Brown *et al.* (2014:32) found, seeing that the data is converted into a basis point due to confidentiality. This will provide support to observe the norm of the stock and growth rates of a normal business year on year. This deviation would also be able to eliminate big variations from the basis.

The equation below illustrates that the mean is calculated as follow:

Equation 1: Mean

$$\text{mean} = \frac{\text{Sum.of.all.data.values}}{\text{Number.of.data.values}}$$

Symbolically illustrating of Equation 2,

Equation 2: Illustration of the mean

$$x = \frac{\sum x}{n}$$

x = indicates the mean of the set of x values

$\sum x$ = is the sum of all the x values

n = is the number of x values in the sample set

The median would also be important as indicated by Wu and Chen (2014:265) and Croson *et al.* (2014:195), seeing that the calculation is different. The calculation of the median is a set of numbers where half the numbers are lower and half the numbers are higher in the sample set to showcase the median. This is also known as the average. The calculation takes the total set of numbers, divided by the number of items in that sample set.

The following equation can be used to calculate the median:

Equation 3: Median

$$Meadian = l + \frac{h}{f} \left(\frac{n}{2} - c \right)$$

Where:

l = lower class boundary of the median class

h = size of the median class interval

f = frequency corresponding to the median class

n = total number of observations

c = cumulative frequency preceding the median class

Falchi *et al.* (2015:271) found it to be an imperative requirement in his study when it came to inventory as the test of standard deviation measures the deviation levels from the mean, to see how sensitive the data set might be. Chopra, Reinhardt and Mohan, (2007) also utilised the standard deviation to see the impact on a supply chain and in addition tested the deviation to come to a statically significance result of how important supply chain is in an organization. The deviation assisted by providing the variation between the mean and deviation to understand the full impact and therefore could contribute to this study. The equations for standard deviation and deviation are calculated as follow:

Standard deviation Equation 4 is as follows:

Equation 4: Standard deviation

$$S = \sqrt{\frac{\sum (x - \bar{x})^2}{n}}$$

S = indicates the standard deviation of the sample

\sum = means the sum of

x = each value in the data set

\bar{x} = mean of all the values in the data set

n = is the number of x values in the sample set

The correlations test will be predominate throughout the testing phase as it is essential to answer the problem statement regarding the relationship between inventory management and sustainable supply chain management. The correlation testing would be noteworthy to test, as the findings could be presented to Management. As Michalski (2008) mentioned, decisions in the speciality of inventory management is a compromise, and the supply chain feature plays a responsible role in contributing to the level of inventory and cost. Consequently the Pearson product-moment correlation coefficient would contribute to see whether certain variables have a direct or indirect correlation with each other, providing a thoughtful approach of deliverables and measurable results to assist answering the problem statement presented.

Bivariate correlations are identical to the Pearson product-moment correlation coefficient test. Lee Rodgers and Nicewander (1988) said: "The Pearson product-moment correlation coefficient is a dimensionless index, which is invariant to linear transformations of either variable. Pearson first developed the mathematical formula for this important measure in 1895:"

The the Pearson product-moment correlation co-efficient test using the following equation:

Equation 5: Pearson product-moment correlation coefficient

$$r = \frac{\sum(z_x z_y)}{n}$$

r = Pearson product-moment correlation coefficient

z_x = a z score for the variable X

z_y = a z score for the variable Y

n = number of pairs of X and Y values

Abdi (2007) establish through his learning that multiple correlations may well have a benefit when using multiple variables as it is generally used to analyses the regression of the quality forecast of the dependent variables.

The multiple correlation co-efficients are calculated as follow in Equation 6:

Equation 6: Multiple correlation coefficients

$$R = \sqrt{\frac{r_{yx1}^2 + r_{yx2}^2 - 2r_{yx1} \cdot r_{yx2} \cdot r_{x1x2}}{1 - r_{x1x2}^2}}$$

r_{yx1} = correlation coefficient for y and x1

r_{yx2} = correlation coefficient for y and x2

r_{x1x2} = correlation coefficient for x1 and x2

Vastag & Whybark (2005:134) theory of inventory quality tests have proven that when a good inventory management system is in place it is normally supported by other well managed practices. Therefore this test will utilise the connection between supply chain management and inventory management. Vastag & Whybark (2005:137) made it clear throughout their study that without the assistance of inventory management, it will not contribute to a better-quality of accomplishment. What Vastag & Whybark (2005) did was taking a normal account calculation of inventory turnover and interprets it rather as a measure of effectiveness of inventory. Therefore, if the inventory turnover is good the management and operations of the chain of the supportive functions are effective.

Due to the sensitivity of the cost of sales, normal sales units will be used to determine the yearly basis of inventory turnover, as this will illustrate the movement of the stock in and out functions of the Supply Chain.

The Inventory turnover is calculated as follow in Equation 7:

Equation 7: Inventory turnover

$$inventoryturnover = \frac{sales}{averageinventories}$$

Hasselback *et al.* (2014:293) and Cannella *et al.* (2014:211) found it imperative to use linear regression to understand the direct link variables might have on each other. The linear regression is a test to understand the relationship between different variables to see if a possible prediction could be concluded.

The linear regression Equation 8 is calculated as follow:

Equation 8: Linear regression

$$Y_i = b_0 + b_1 X_i$$

3.3 *Explanation of data being used for this quantitative study*

The following variables will be used for testing purposes:

- Back Orders / Stock outs captured
- Sales
- Quantity of inventory on Hand
- Quantity in receipt routing
- Forecast
- Coverage of Inventory for the month

All these variables have been supported by the literature review as a contributor to supply chain management and inventory management.

3.4 *Summary of Chapter 3*

Throughout Chapter 3 supply chain and inventory management was linked to key literature like Williams & Tokar (2008:224), showcasing the importance of a stock out response. Therefore Chapter 3 indicated why it is vital in the supply chain management, as the level of commodities will either be at a high level, impacting the cash flow of the business or at an specific point where shortages are created, which could lead to an impact on income/profit due to not having the products available to sell when the customer needs are raised (Kwon & Suh, 2004:8). The required statically methods are defined to see whether to utilise the methods to assist in contributing to significance in the results.

Acar and Gardner (2012:847) placed emphasis that a forecast driven model is based on the projected demands and what types of inventory should be kept to satisfy the customer expectations. Closs et al. (2010:56) found that inventory levels that are maintained at an optimal level increase customer satisfaction that could lead to better market penetration due to stock availability and reduced stock outs. Stadtler (2015:26) indicated the supply chain is responsible for the movement of the product but it depends on the inventory availability to move the stock. Therefore based on the literature there should be some kind of connection and understanding about what variable leads to a positive or negative impact on a business.

The support of chapter 3 with regards to the variables that are available and the methods, show that the combination should provide acceptable building blocks to support chapter 4. These findings and understanding would contribute to the process to provide a possible answer on how important the relationship between inventory management and supply chain is to have a sustainable business.

CHAPTER 4: EMPIRICAL STUDY

4.1 Introduction

The sample set used to do the testing is from January 2010 to December 2015. The hypothesis is done over a long period of time to provide an adequate chance for any possible bullwhip effects (de Almeida *et al.*, 2017:209; Jaipuria & Mahapatra, 2014; Lee *et al.*, 2015). A total of 6 years, based on an average, and done on monthly scales, where the sampling is set to 72 months. The sample set should give a reliable answer as no random sampling is done and it is a full comprehensive set. The five variables will allow the study to effectively estimate the findings through a bivariate test as well as a multivariate test based on Pearson's correlation co-efficient test.

All numbers are quoted on an index basis where January 2010 was the base of this study. The reason why this specific sample set is used is to assist in answering the problem statement by using the following:

- All this information is available.
- Information is reliable.
- Types of variables used are related to supply chain as well as inventory of a business.
- The sample set will allow testing various correlations to identify the relationship and the impact it would have.

The actual figures are extracted out of an ERP system through a reporting tool. Through the sample set it would allow the study to test the following from a month to month basis as well as a yearly average:

- Median
- Mean
- Standard Deviation
- Correlations (Making use of a bivariate and multivariate test)
- As well as allow to do Vastag & Whybark (2005:134) theory of inventory quality
- Linear regression

The study should effectively answer the problem statement based on the literature review outcome as well as with the information available. This type of analysis is relevant to the topic as well as a reliable sample set, which is provided to give the study the best possible statistical outcome. The sampling of variables is mainly selected based on literature from Williams & Tokar (2008:224) and Michalski (2008:83) where they have discovered the importance of the variables as well as their significance to Supply Chain.

From a quantitative approach the data is all historical. These are all validated figures by the business that are used to reflect the final results. This will however be the raw data and will be worked on, on a basis scales due to confidentiality and sensitivity of the information. The types of variables could be significant to identify the relationship between inventory and sustainable supply chain management

4.2 Gathering of data

From a quantitative approach the data is all historical. These are all validated figures by the business that will reflect the results. This will however be the raw data and will be worked on a basis scales due to confidentiality.

The following variables will be used for testing purposes:

- Back Orders
- Sales
- Quantity of inventory on Hand
- Quantity in receipt routing
- Forecast
- Coverage of Inventory for the month

The aim would be to identify the connection and impact the variables would have when there are fluctuations in inventory and what correlates back to your sustainable supply chain by taking into consideration customer satisfaction.

4.2.1 Assessing the information

Assessing the information is quick and easy. The raw data is however confidential but once transferred to a base in preparation of this research study, it is safe to do a

hypothesis. The data is provided from the system on a month to month basis with each respected variable figures linked to that specific month.

4.2.2 Quality of the information

The quality of the information is very reliable as these are actual figures that were reported each month from 2010 to 2015 in the automotive industry.

The data is cross-referenced and checked through all departments and through the ERP system ensuring that the EDI information that is uploaded in the reporting cube is accurate after all departments have validated the figures.

4.2.3 Severity of the information

The information at hand is highly confidential therefore it is converted to a basis mark, January 2010 being the starting point. This still reflects the trends and variance between the data as it fluctuates. Therefore analysing the information should provide statistical significance. To ensure testing is as accurate as possible, calculations are done on the actual figures and not the percentages to ensure a reliable result and assisting to the statistical significance or no significance results.

4.3 Results and discussion

4.3.1 Introduction

For the period under discussion the study makes use of 71 data sets, although most of the frequencies are very slightly skewed, we assume normality based on the central limit theorem.

4.3.2 Analytical Tool

A SPSS (2016) analytical software program was used to formulate findings through the statistical program. The SPSS (2016) tool has previously been used by other authors on supply chain management and inventory management like Frohlich and Westbrook (2001:180) and Lopes de Sousa Jabbour *et al.* (2011:26) that added a benefit to their findings.

For other statistical needs Excel was used for those specific parts that is part of a Microsoft's (2016) program application.

4.3.2 Median

The median sales figure during a specific period is used as these are the most important input in the process of forecasting future sales. Therefore it was deemed important to plot the median sales figure and compare it with historical forecasts.

The figures that need to be considered are the deviation between the forecasted sales and actual sales. The manner in how these impact businesses could be significant as it is related to the type of information and collaboration in the businesses.

The past figures could provide a skew perspective on the future of the business as said by Lee *et al.* (2015:116). The calculation method through Excel (Microsoft, 2016) provided the following information on a yearly basis where January 2010 was the basis:

Table 6: Median

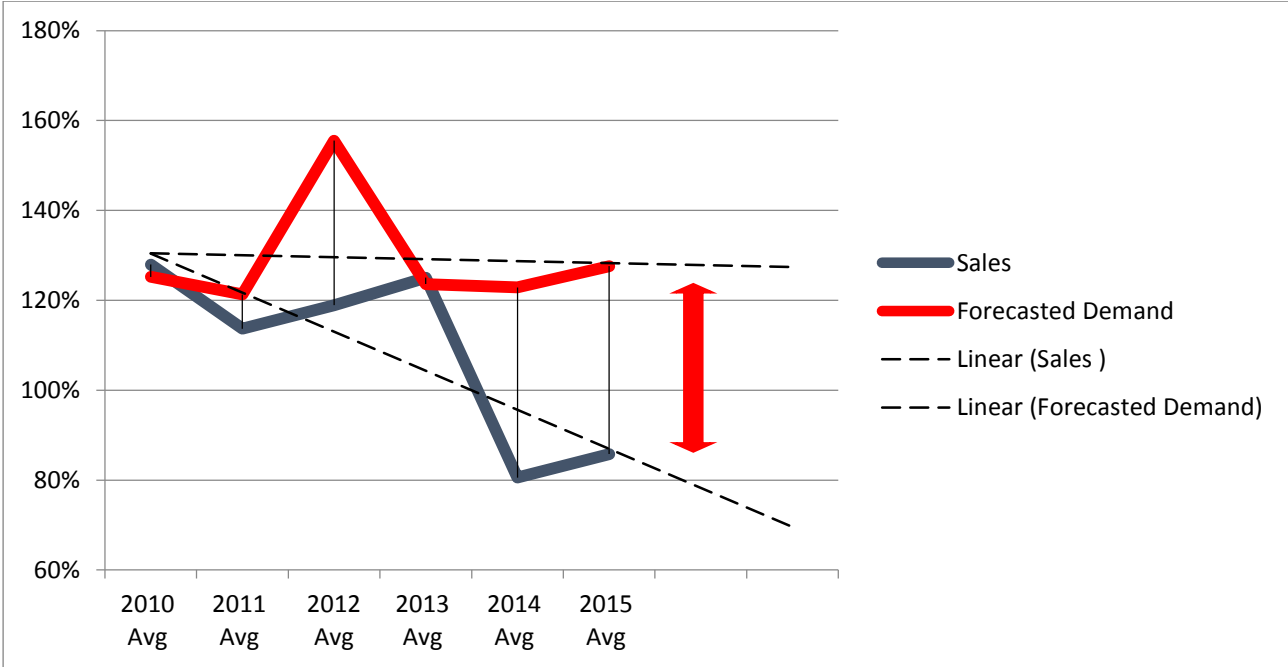
Months	Back Orders	Sales	Quantity on hand	Quantity in receipt routing	Forecasted Demand
2010 Avg	62%	128%	85%	121%	125%
2011 Avg	69%	114%	56%	130%	121%
2012 Avg	49%	119%	82%	133%	156%
2013 Avg	63%	125%	61%	160%	124%
2014 Avg	25%	81%	85%	83%	123%
2015 Avg	54%	86%	48%	109%	128%

The full month results can be viewed in the Annexure A: Exhibit 1.

The current business viewed, utilises the median factor to forecast. This would have a signification impact on the business if the forecast is not quick and agile to support the business needs or it might over project the needs impacting the business (de Almeida *et al.*, 2017:209), (Axsäter, 2015:45).

An illustration is therefore required to see how close the forecast is by comparing to sales to mitigate the risk for a business. The graph will support that there are irregularities in sales and forecast variables:

Figure 4: Sales versus Forecast



The illustration provides a negative linear movement in the future, however, the linear movement between sales and forecast is not moving in parallel to support the customer.

The possible risk of overstocking is imminent if the forecast is not adjusted downwards to a realistic level to protect a business.

This method is used to compare the sales and the forecast by showing a high level of forecast inaccuracies and other methods that should be used to predict future sales values as the variance is not sustainable for a business.

4.3.3 Mean

The mean would be a good reference to start off with as Schoenherr and Speier-Pero (2015:131) and Brown *et al.* (2014:32) described, seeing that the data is converted into a basis point due to confidentially this should show some importance. This will provide support to observe the norm of the stock and growth rates of a normal business year on year. This deviation would also be able to eliminate big

variations from the basis. The mean is being tested to see where the middle point of each variable is and the degree of variance it has over the median. This contributes to forecast accuracy by calculating a degree of error as the projected sales might be a few basis points up or down.

The calculation method through Excel (Microsoft, 2016) provided the following information throughout the data base:

Table 7: Mean

Mean	%
Back Orders	56%
Sales	103%
Quantity on hand	65%
Quantity in receipt routing	121%
Forecasted Demand	130%

The statistics illustrates that over one third of customer demands are not captured, even reaching sales of over a 100%. The forecast is illustrated at a level of 130 however when Sales and Back Orders are combined it is 159%. This gives the perception that the forecast is not at the right level due to demand being higher than anticipated, which reduces the inventory on hand to a level of 65%.

4.3.4 *Standard deviations*

The importance of standard deviation is to calculate the spread of the mean in the sample set. The aim for standard deviation results is to be low as this provides support that the data being used is closely correlated. A high deviation illustrates the data set is spread out wide.

The data was populated in SPSS (2016) to calculate the standard deviation through the statistics program.

Table 8: Standard deviation statistics

Descriptive Statistics						
		Statistic	Bootstrap			
			Bias	Std. Error	95% Confidence Interval	
					Lower	Upper
Back Orders	Mean	***	1.60	395.45	***	***
	Std. Deviation	***	-37.572	235.750	***	***
	N	71	0	0	71	71
Sales	Mean	***	38.51	1282.89	***	***
	Std. Deviation	***	-116.529	779.643	***	***
	N	71	0	0	71	71
Quantity on hand	Mean	***	-117.18	2325.29	***	***
	Std. Deviation	***	-233.413	1101.659	***	***
	N	71	0	0	71	71
Quantity in receipt routing	Mean	***	-29.74	1605.07	***	***
	Std. Deviation	***	-108.117	969.885	***	***
	N	71	0	0	71	71
Forecasted Demand	Mean	***	1.69	1086.64	***	***
	Std. Deviation	***	-111.442	816.213	***	***
	N	71	0	0	71	71

Due to the actual confidential data sets being used, a *** has been placed to indicate the level of error and bias. Therefore this has led the study to test the coefficient of variance due to the sensitivity of the data but to support the variability.

Why the coefficient of variation assists the variability is due to the function it is assessing. The precision of the data set is assessed to illustrate the difference in percentage between the variables. The equation is as follows:

Equation 9: Coefficient of variation

$$Coefficient.of.variation = \frac{std.deviation}{mean} \times 100$$

The result calculated through Mircosoft (2016) illustrated the following findings:

Table 9: Coefficient of variation

Descriptive Statistics		Statistic
Back Orders	Coefficient of Variation	48%
Sales	Coefficient of Variation	29%
Quantity on hand	Coefficient of Variation	32%
Quantity in receipt routing	Coefficient of Variation	34%
Forecasted Demand	Coefficient of Variation	23%

The results indicate that there are big variations on back orders and inventory, where sales has 29% variance either up or down from the data set where the forecast is only 23%. The gap between the sales and forecast is a 6% variance over time, impacting either a cash flow issue or the demand inaccuracy as the back order fluctuations are widely spread.

The coefficient of variation illustrates that the basis of inventory management and supply chain is erratic. This could be due to the following widely spread factors found from the literature. The list below illustrates only a few factors:

- Forecast inaccuracy
- Customer behaviour is seasonal
- Lead times impacts
- Manufacturing constraints
- Raw material constraints

As seen with the mean and median it is imperative to improve forecast accuracy of potential sales to ensure the operational departments to produce, transport and management effectively capture the anticipated demand of the customers.

To support the test done this far it is important to understand the correlations and relationships that cause each variable to be either positive or negative.

4.3.5 Correlations

The correlations test is used predominately as this method is essential to answer the problem statement regarding the relationship between inventory management and sustainable supply chain management. The correlation testing would be noteworthy to test, to support previous empirical testing to provide a clear understanding of the relationship.

Consequently, the Pearson product-moment correlation coefficient contributes by assisting whether certain variables have a direct or indirect correlation with each other, providing a thoughtful approach of deliverables.

Therefore the data was populated in SPSS (2016) to calculate the correlation through the statically program.

The findings were as follows:

Table 10: Correlations

Correlations		Back Orders	Sales	Quantity on hand	Quantity in receipt routing	Forecasted Demand
Back Orders	Pearson Correlation	1	.406**	-.288*	.420**	-0.144
	Sig. (2-tailed)		0.000	0.015	0.000	0.230
Sales	Pearson Correlation	.406**	1	0.002	.244*	.376**
	Sig. (2-tailed)	0.000		0.990	0.040	0.001
Quantity on hand	Pearson Correlation	-.288*	0.002	1	-.249*	.357**
	Sig. (2-tailed)	0.015	0.990		0.036	0.002
Quantity in receipt routing	Pearson Correlation	.420**	.244*	-.249*	1	-0.039
	Sig. (2-tailed)	0.000	0.040	0.036		0.745
Forecasted Demand	Pearson Correlation	-0.144	.376**	.357**	-0.039	1
	Sig. (2-tailed)	0.230	0.001	0.002	0.745	

The Pearson correlation coefficient measures the magnitude of the linear relationships on continuous variables. The significance is utilised to see whether there is a correlation therefore a significance of 95% and more is being used.

The first correlation test of back orders to sales indicates that there is a 41% correlation noted and a -28% on inventory available. This shows that your inventory does not have the required stock available as per the customer request and furthermore back orders has a positive impact on sale as the stock is not available to receive the income however the demand has been captured. The correlation between back orders and forecasted demand was not significant to mention as it is an unreliable test result however with inventory on the way it provided a significant result of 42% on back orders as these units should serve the customer demand. That is raised as a back order.

The second correlation was to identify the impact sales on the sample set. The new information that came to light is that sales and inventory on hand could not be reported as the significance is not sufficient. Thus when viewing the forecast it provided a -37% impact as the sales and forecast is not in line as shown by the mean and median given a significant error variance. The view on inventory that is on the way, that could be to cover the back orders, has seen a positive effect on sales by 24% meaning that the stock that is in the pipe line would be covered through either back orders transforming over to sales or is the safety stock as referred by Aleem and Khalil (2013:231)

The third correlation on inventory available that has not been discussed as yet, is the significance impact of -25% inventories in routing. This shows that the stock composition has a huge effect on the replenishment of inventory levels based on a 36% positive forecast impact, showing that the forecast inaccuracy has an impact on the inventory levels. However when the fourth correlation test done on inventory in routing and forecast no significance was giving in the reliability of the data. This illustrates that forecast is a key variable to impacts.

The reason as to why forecast is a key influencing variable on the supply chain is due to the fact that a high positive correlation of 37% and 36% on sales and inventory respectively showcases from the literature, if you have the correct forecast in place there will be a positive effect on sales and inventory holding that should keep your inventory on the way in line with demands and stock outs to a minimal (Christopher & Ryals, 2014; Handfield *et al.*, 2015; Mangan & Lalwani, 2016)

The below table illustrates the coefficients impact on where forecast is the fixed variable:

Table 11: Correlations with Forecast

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	r	Std. Error	Beta		
Sales	0.401	0.095	0.477	4.224	0.000
Quantity on hand	0.137	0.052	0.287	2.644	0.010
Quantity in receipt routing	0.018	0.075	0.028	0.243	0.809
Back Orders	-0.747	0.345	-0.267	-2.167	0.034

a. Dependent Variable: Forecasted Demand

Keeping in mind Pearson’s correlation coefficient guidelines to interpretation on the severity of the impact is as follows:

- r that is below 0.1 has a small effect on the variables and practically no significant relationship
- r that is below 0.3 has a medium effect on the variables and practically visible relationship
- r that is below 0.5 has a large effect on the variables and practically significant relationship

Therefore the inventory turnover Vastag & Whybark (2005:134) would contribute to understanding the importance of forecasting in a sustainable supply chain through effective inventory management.

Based on the findings through Pearson Correlations a tendency could be concluded that the forecast assists a business by ensuring that the right level of inventory is available at the right time when a customer requires the product. This will ensure

profitability and customer satisfaction. This contribution to a business profits by keeping the stock out level low, will counter the higher than ordinarily inventory in the pipe line that is tying up the cash flow of a business to be lower.

4.3.6 *Inventory turnover*

Inventory turnover is crucial to a business. Vastag & Whybark (2005:134) found that to have an effective supply chain there should be an implementation of inventory movements. This is to ensure that the business stays competitive and gives an indication on how inventory is moving through the company.

It was also mentioned that the famous principle of JIT should still be one of the most effective measures to control inventory as well as cash flows (Green *et al.*, 2014:134). Once this principle is achieved it reflects back on the supply chain through effective processes that are in place. Therefore Vastag & Whybark (2005:134) indicated that inventory turnover is crucial to ensure business profitability through the supply chain. Vastag & Whybark (2005:134) theory was created to indicate the efficiency with regards to inventory management and how well supply chain is supporting the business.

Table 12: Inventory Turnover

Inventory Turnover	Results
2010	59%
2011	78%
2012	56%
2013	80%
2014	37%
2015	70%

Seeing an average of 63% over the years indicates the inefficiencies. Therefore Williams & Tokar (2008:224) identified the importance of a stock out response. That could be a possible solution to determine whether the inventory levels might be the issue or another variable. Williams & Tokar (2008:224) found that when a stock outs occurs, there are generally two types of impacts, one being a back order is created, that is measured through the back order variables that are available, or an instant loss of sale that is not captured.

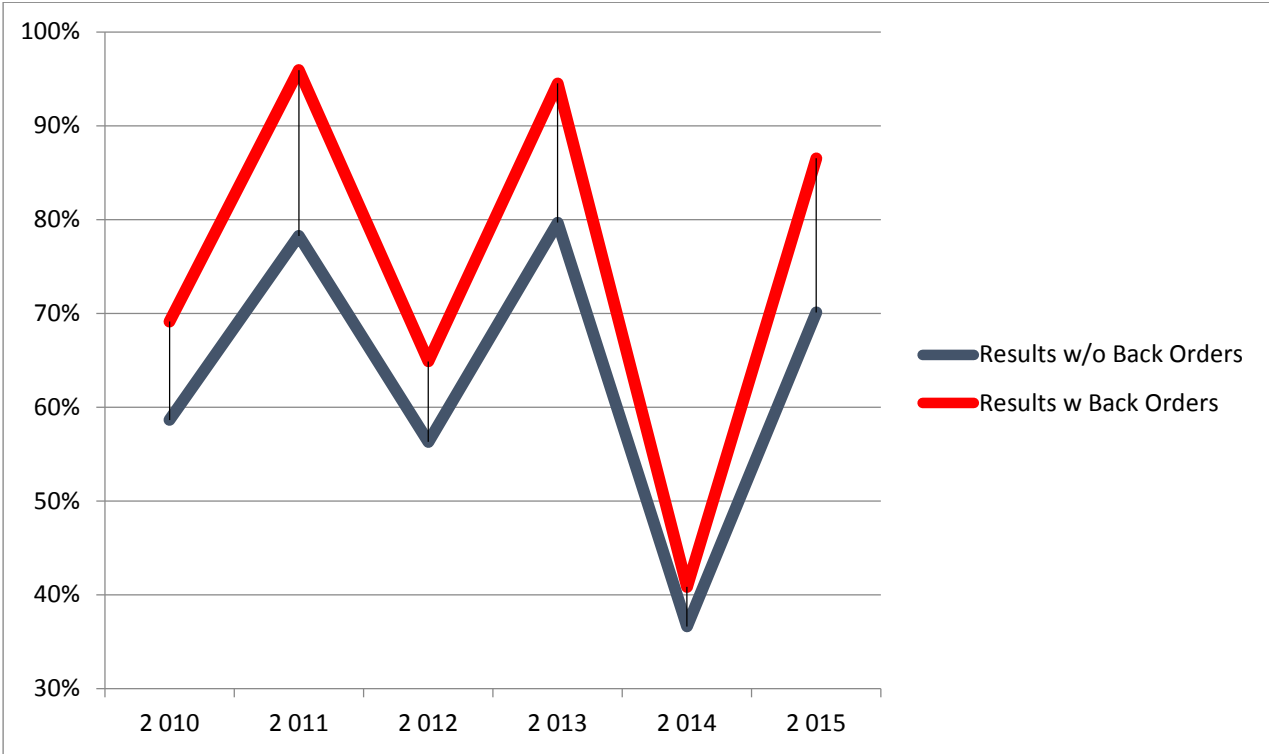
Therefore based on the inventory turnover model further assumptions may perhaps be utilised to determine if low turnover is correlated. A back order is seen as a sale by (Williams & Tokar, 2008:224), therefore by adding the back order level to the sales it provides significant changes:

Table 13: Inventory Turnover including Back Orders

Inventory Turnover	Results
2010	69%
2011	96%
2012	65%
2013	95%
2014	41%
2015	87%

When the two models are illustrated on a graph together the illustration shows that the inventory turnover is not due to a lack of demand but could be due to the fact that the forecast is not maintained at a realistic level. That could lead to a business impact with regards to profits and operational cost (Wild, 2017:24).

Figure 5: Inventory Turnover Model with and without Back Orders



The theory that should be achieved from the data set is to show a 100% turnover rate, if you have sold a substantial amount of units in a month including the stock outs that equals to the total demand for the month. This should provide a one to one ratio of total demand and inventory as this could be either due to poor inventory management on ABC or FSN models.

4.3.7 Multiple regressions

Multiple regressions would assist the correlations and inventory turnover model if there is one or more domino effects on the other variables.

These are shown as causal relationships that would assist to add value to the correlation findings. The advantage of the multiple regressions shows the influence on the one or more variables and provides assistance to identify the outliers in the data set. Therefore the data was populated in SPSS (2016) to calculate the multiple regressions through the statically program. Please note that both the X and Y axis has been blocked out due to the sensitivity of the information. Each variable is analysed as follows:

4.3.7.1 Forecast Multiple regression

The scatter diagram (Box plot) is being used through (SPSS, 2016) to provide a statically illustration. The following scatter plots indicates the relationship between the variables where forecast is the dependant variable:

Figure 6: Scatter Plot - forecast vs. back orders

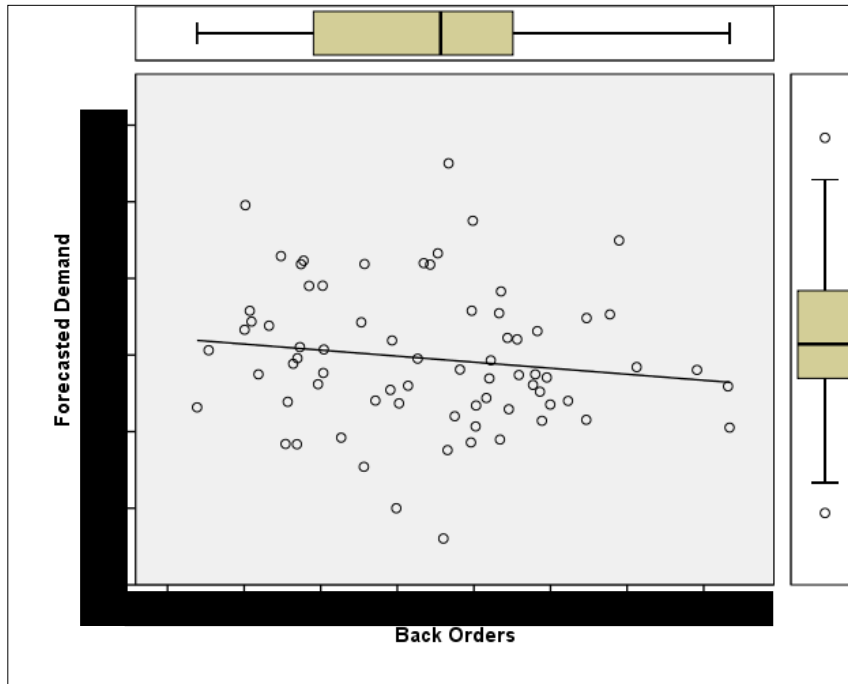


Figure 7: Scatter Plot - forecast vs. sales

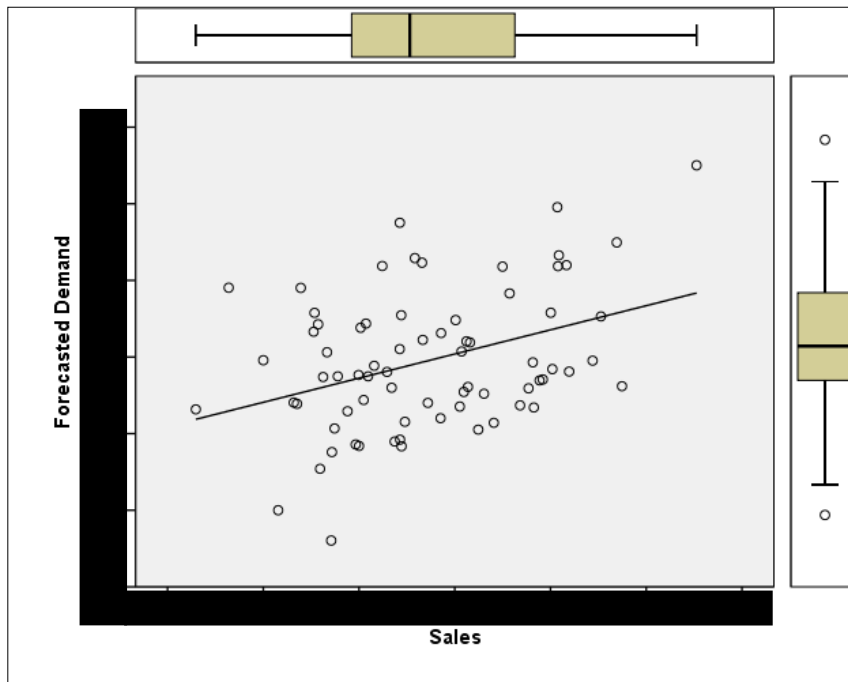


Figure 8: Scatter Plot - forecast vs. quantity on hand

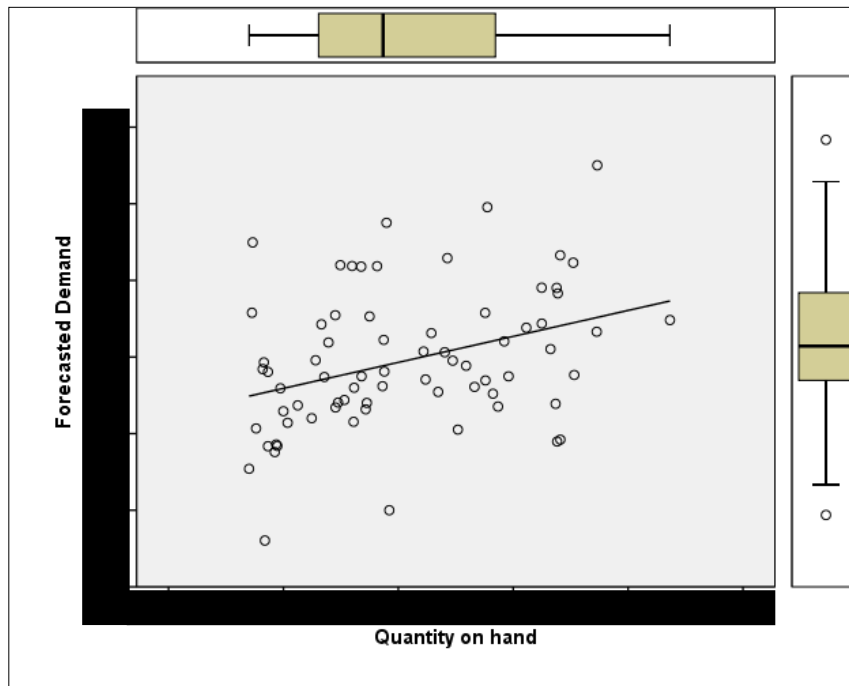


Figure 9: Scatter Plot - forecast vs. quantity in receipt routing

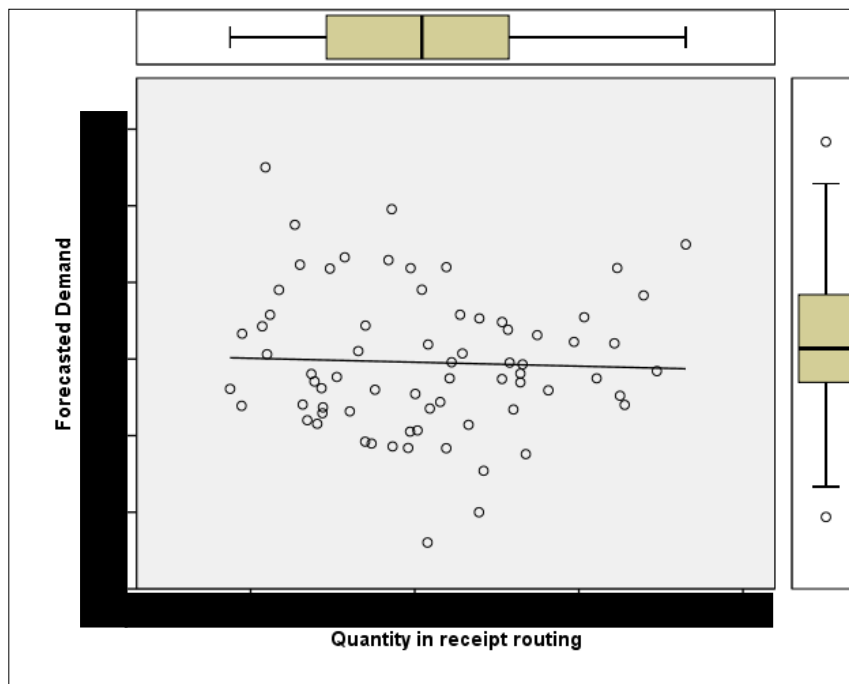


Table 14: Multi linear Regression - Dependent variable Forecast

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Sales	0.401	0.095	0.477	4.224	0.000
Quantity on hand	0.137	0.052	0.287	2.644	0.010
Quantity in receipt routing	0.018	0.075	0.028	0.243	0.809
Back Orders	-0.747	0.345	-0.267	-2.167	0.034
a. Dependent Variable: Forecasted Demand					

The result shows that there is a high significance between sales, quantities on hand as well as back orders with the necessary forecast. This hypothesis showcases that the dependent variable contributes to the other variable ensuring the following:

- Forecast estimates the possible future sales
- Forecast shows what quantity should be available to sell
- Forecast shows that back orders will be at minimal if the forecast is in line with market expectations and sales.

4.3.7.2 Sales Multiple regression

The scatter diagram (Box plot) is being used through (SPSS, 2016) to provide a correlation illustration. The following scatter plots indicate the relationship between the variables where sales is the dependant variable:

Figure 10: Scatter Plot - sales vs. quantity on hand

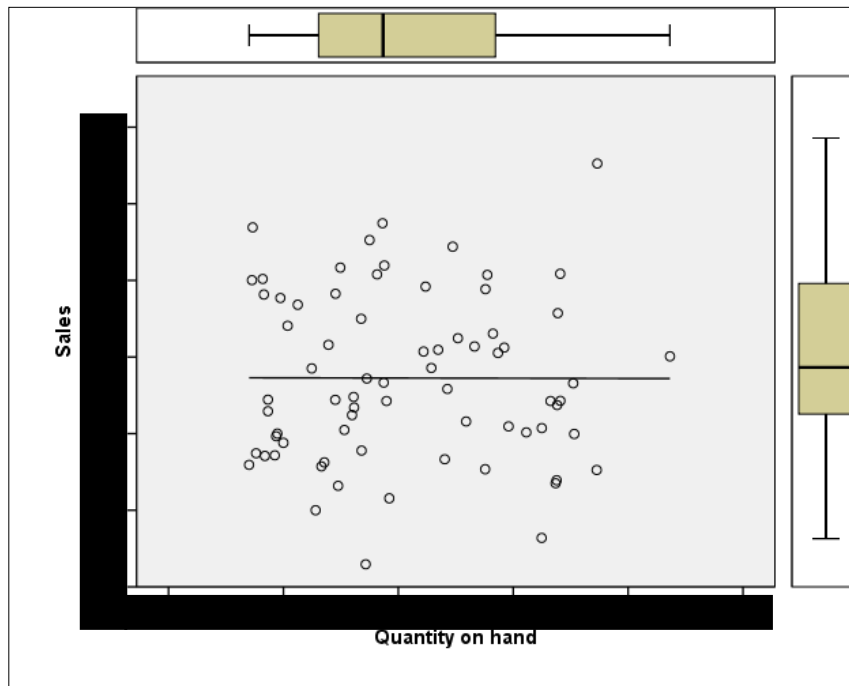


Figure 11: Scatter Plot - sales vs. quantity in receipt routing

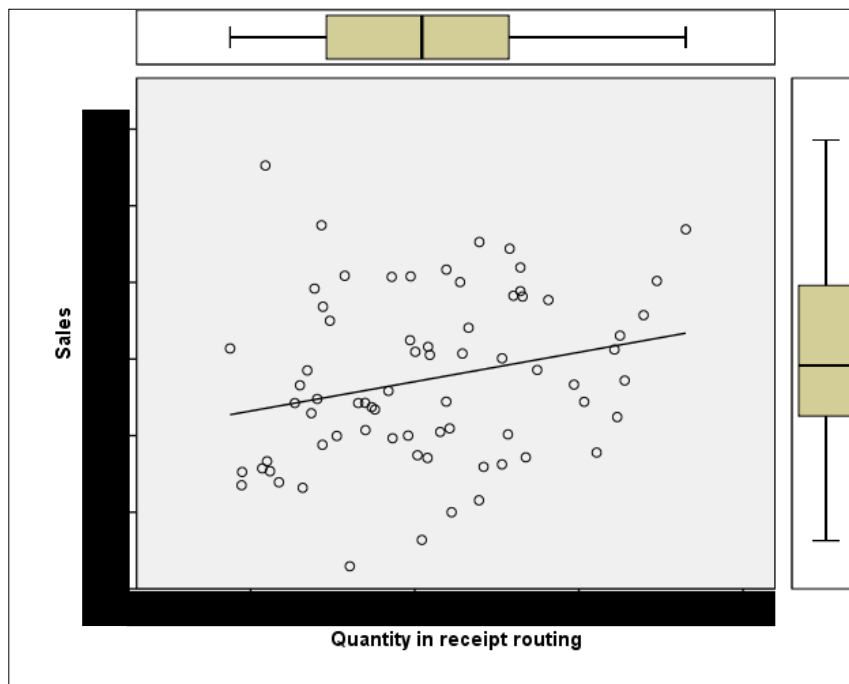


Figure 12: Scatter Plot - sales vs. forecast demand

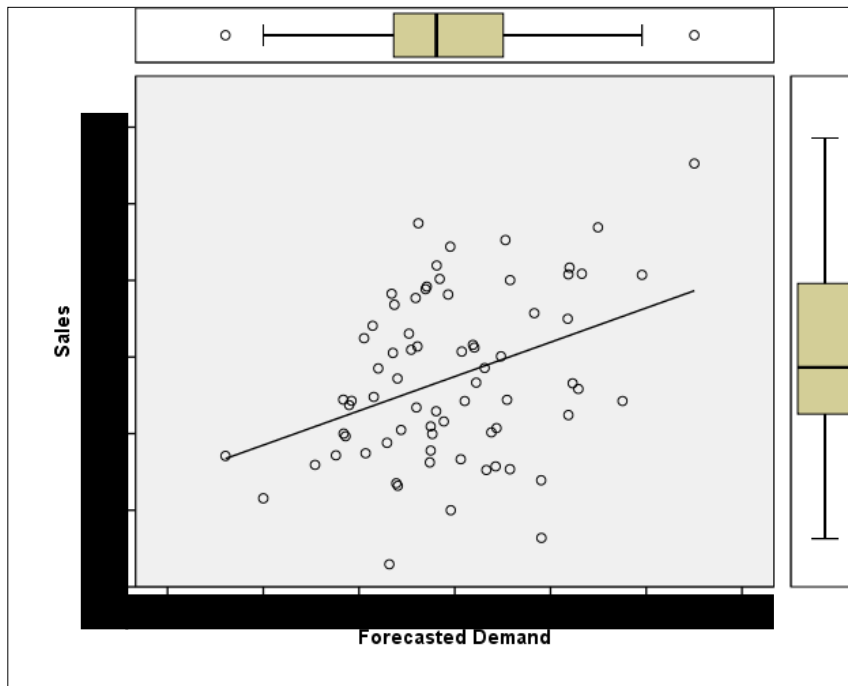


Figure 13: Scatter Plot - sales vs. back orders

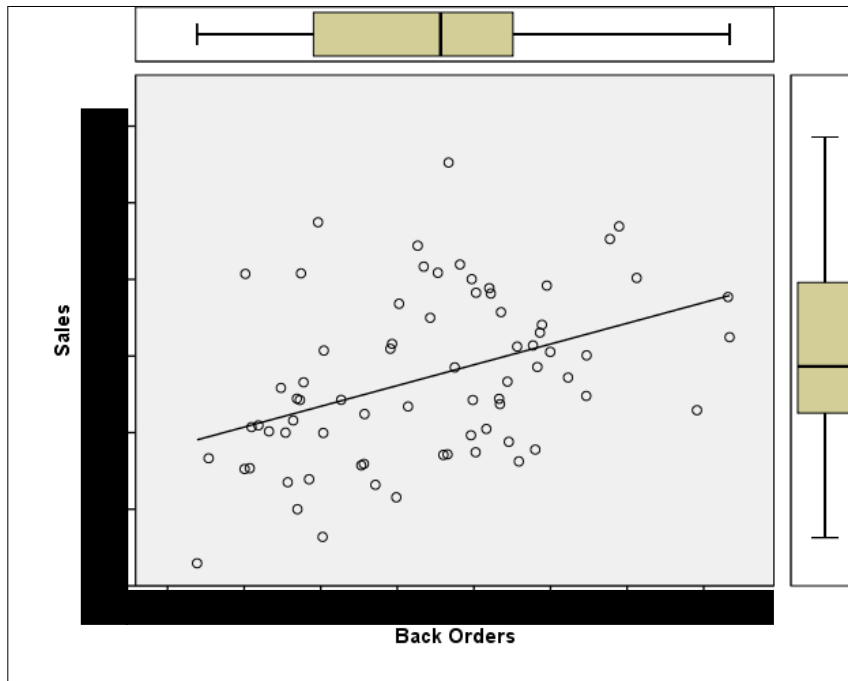


Table 15: Multi linear Regression - Dependent variable Sales

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Quantity on hand	-0.008	0.063	-0.014	-0.129	0.897
Quantity in receipt routing	0.060	0.086	0.076	0.692	0.492
Back Orders	1.445	0.370	0.434	3.907	0.000
Forecasted Demand	0.531	0.126	0.446	4.224	0.000
a. Dependent Variable: Sales					

The result shows that there is a high significance between forecast and back order with sales. This hypothesis showcases that the dependent variable contributes to the other variable ensuring the following:

- Sales would be present if the forecast is accurate
- Sales would be present if there are no back orders as this is due to stock outs.

4.3.7.3 Back order / Stock Outs Multiple regression

The scatter diagram (Box plot) is being used through (SPSS, 2016) to provide a statically illustration. The following scatter plots indicate the relationship between the variables where back orders is the dependant variable:

Figure 14: Scatter Plot - back order vs. sales

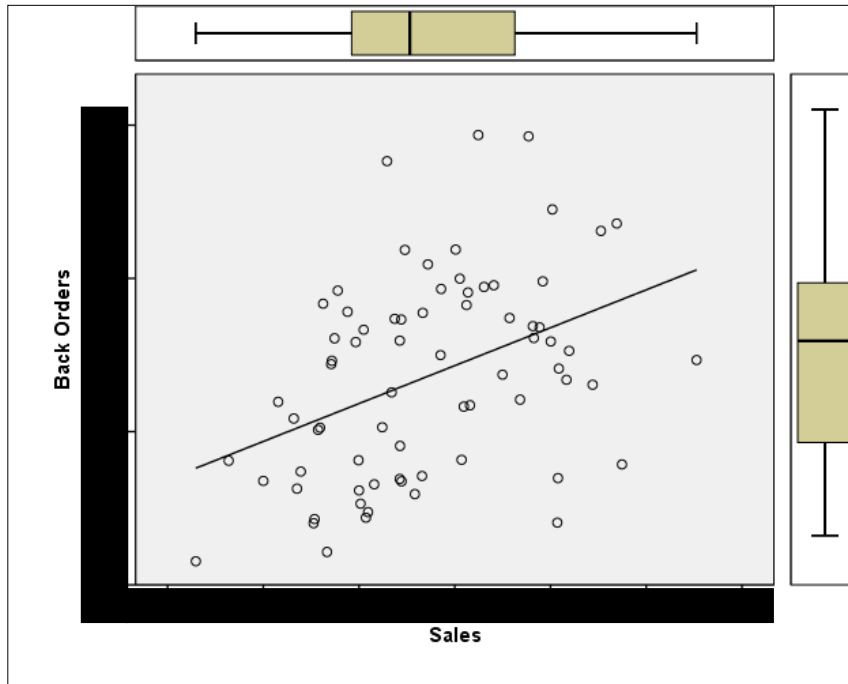


Figure 15: Scatter Plot - back order vs. quantity on hand

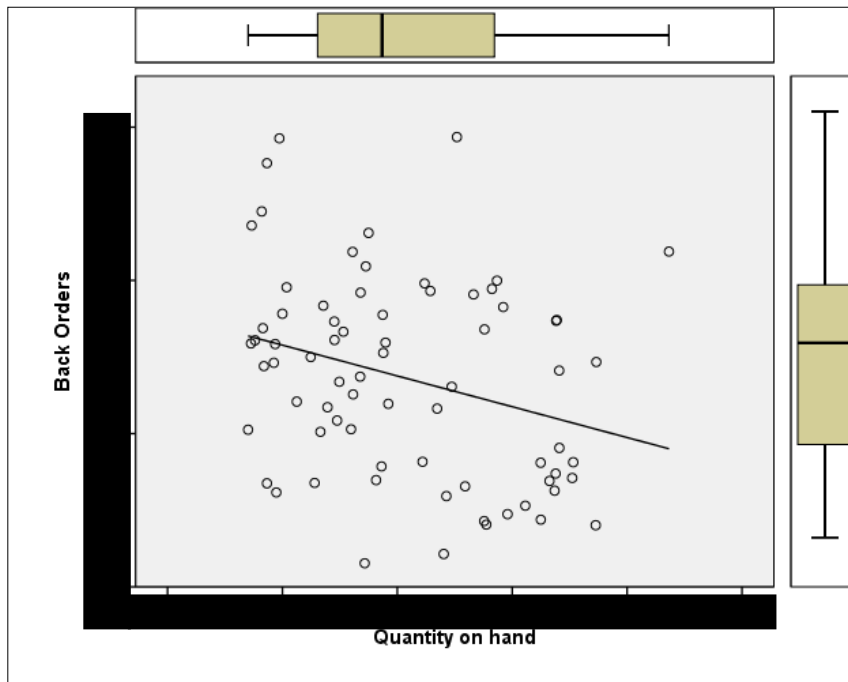


Figure 16: Scatter Plot - back order vs. quantity in receipt routing

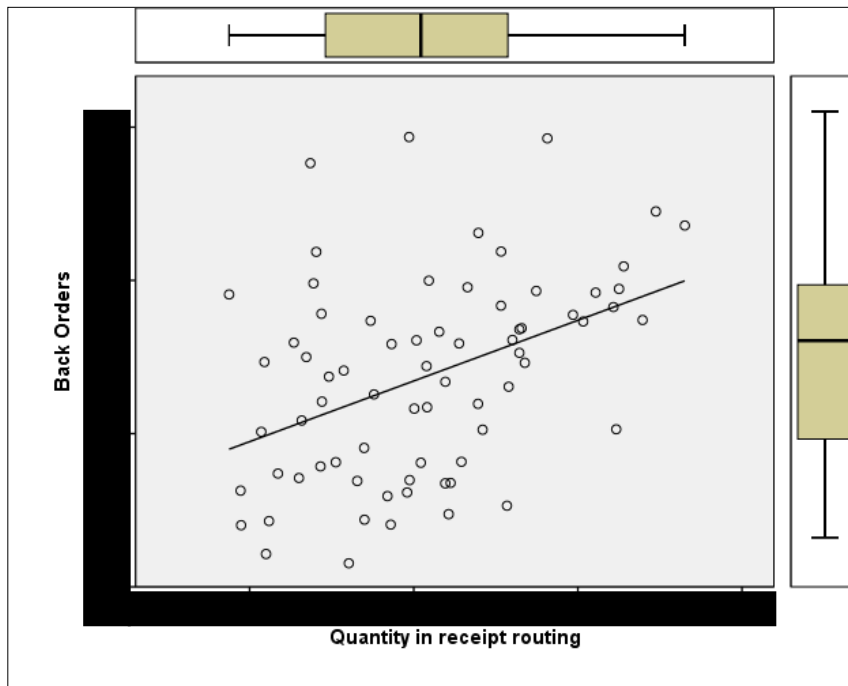


Figure 17: Scatter Plot - back order vs. forecast

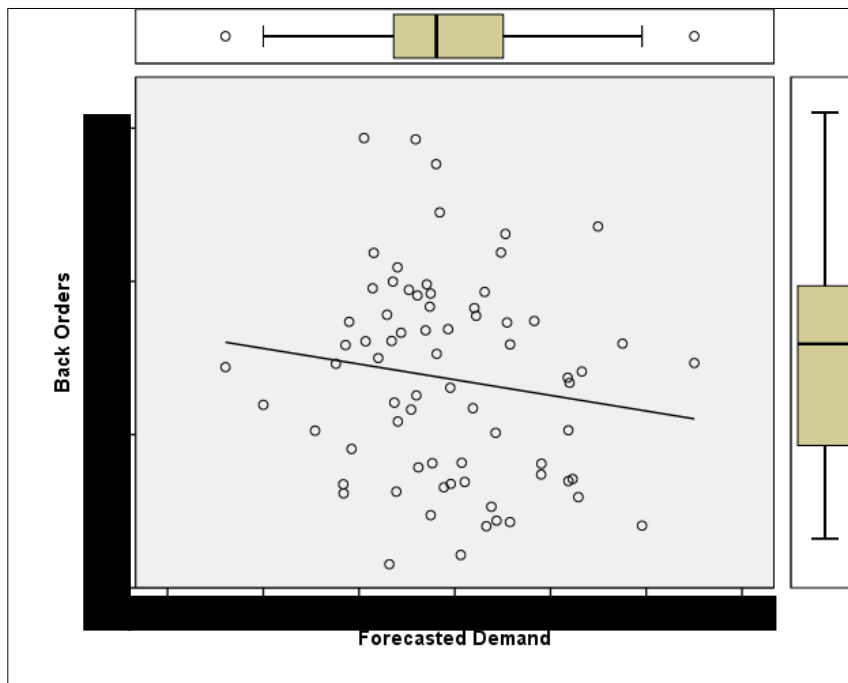


Figure 18: Multi linear Regression - Dependent variable back orders

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Sales	0.132	0.033	0.435	3.938	0.000
Quantity in receipt routing	0.064	0.025	0.270	2.583	0.012
Forecasted Demand	-0.089	0.041	-0.246	-2.145	0.036
Quantity on hand	-0.024	0.019	-0.137	-1.260	0.212
a. Dependent Variable: Back Orders					

The result shows that there is a high significance between sales, quantity in receipt routing and forecast with back order. This hypothesis showcases that the dependent variable contributes to the other variable ensuring the following:

- The back orders will transmit over to sales once the stock has become available
- The inventory that is on the way indicates a positive correlation to reduce back orders
- The forecast has a positive effect on back orders as the forecast is maintained at an accurate level the stock outs will reduce.

4.3.7.4 Inventory on hand multiple regression

The scatter diagram (Box plot) is being used through (SPSS, 2016) to provide a statically illustration. The following scatter plots indicate the relationship regression between the variables where inventory is the dependant variable:

Figure 19: Scatter Plot - quantity on hand vs. quantity in receipt routing

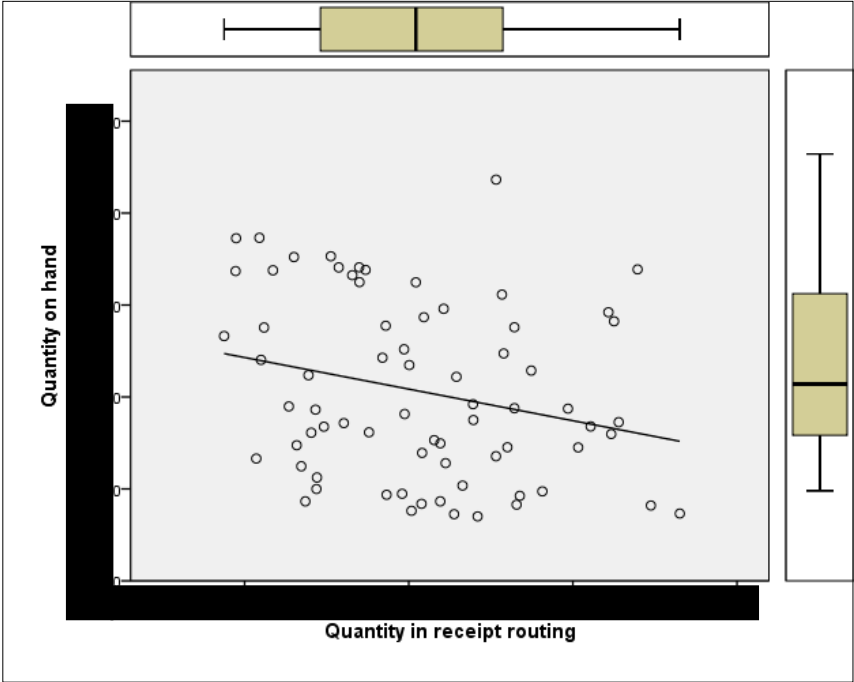


Figure 20: Scatter Plot - quantity on hand vs. forecast

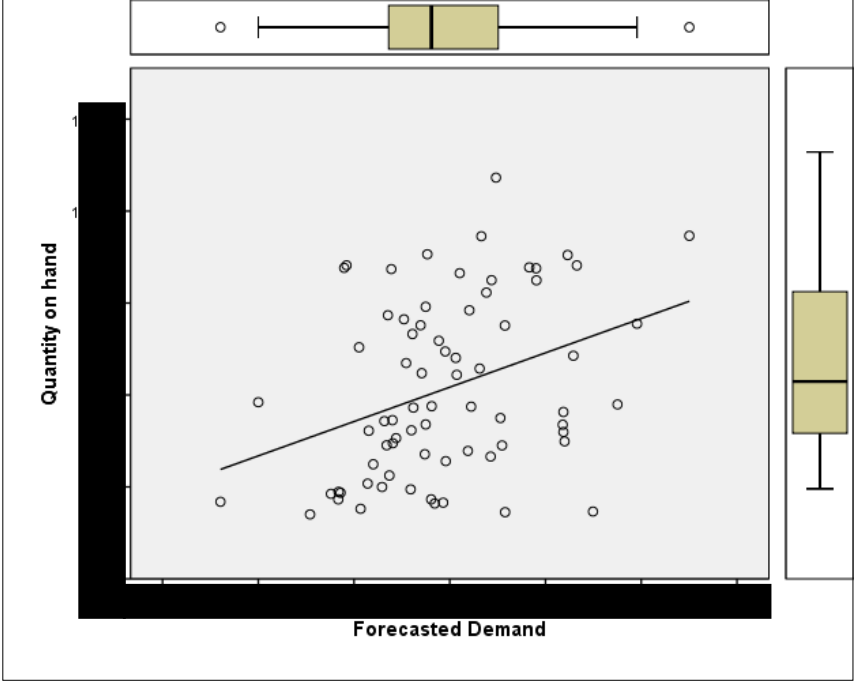


Figure 21: Scatter Plot - quantity on hand vs. back order

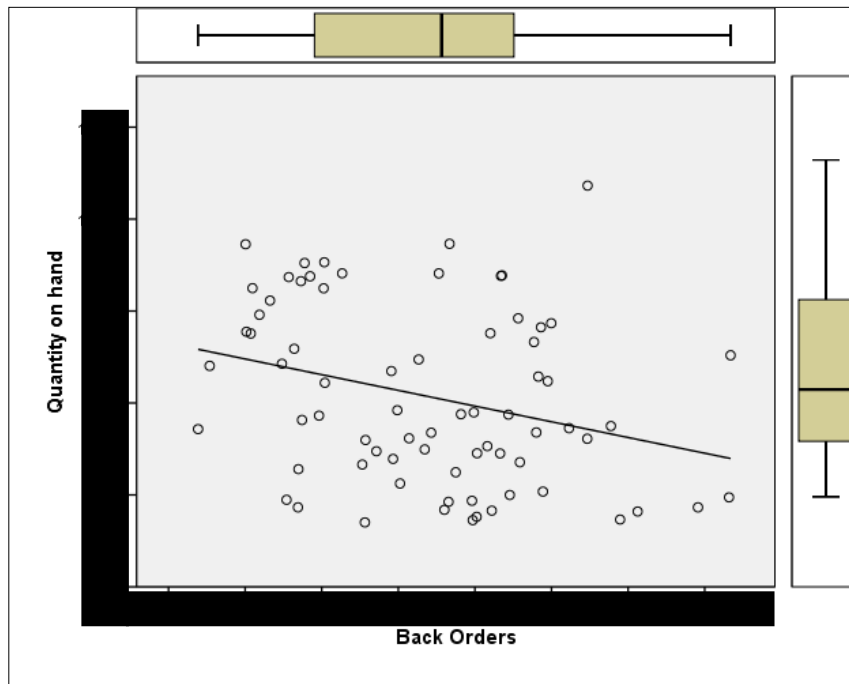


Figure 22: Scatter Plot - quantity on hand vs. sales

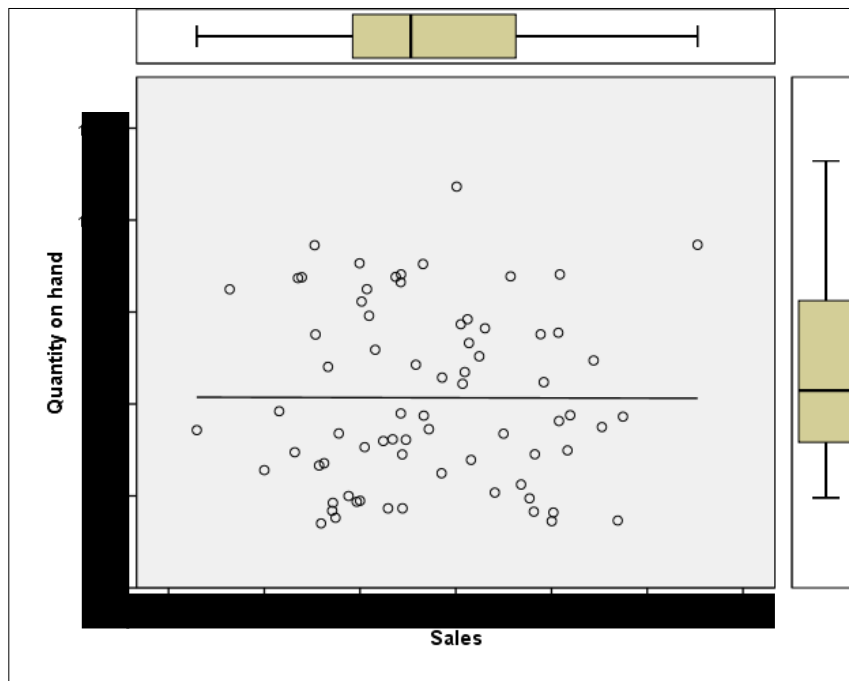


Table 16: Multi linear Regression - Dependent variable quantity on hand

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Back Orders	-1.000	0.793	-0.171	-1.260	0.212
Sales	-0.032	0.242	-0.018	-0.132	0.895
Quantity in receipt routing	-0.219	0.167	-0.159	-1.314	0.193
Forecasted Demand	0.697	0.265	0.332	2.633	0.011
a. Dependent Variable: Quantity on hand					

The result shows that there is a high significance between forecast and quantity on hand. This hypothesis showcases that the dependent variable contributes to the other variable ensuring the following:

- The quantity on hand is driven by the forecast

Therefore the forecast should be maintained at a realistic level.

4.3.7.5 Inventory on routing multiple regression

The scatter diagram (Box plot) is being used through (SPSS, 2016) to provide a statically illustration. The following scatter plots indicate the relationship regression between the variables where inventory on routing is the dependant variable:

Figure 23: Scatter Plot - quantity in receipt routing vs. back orders

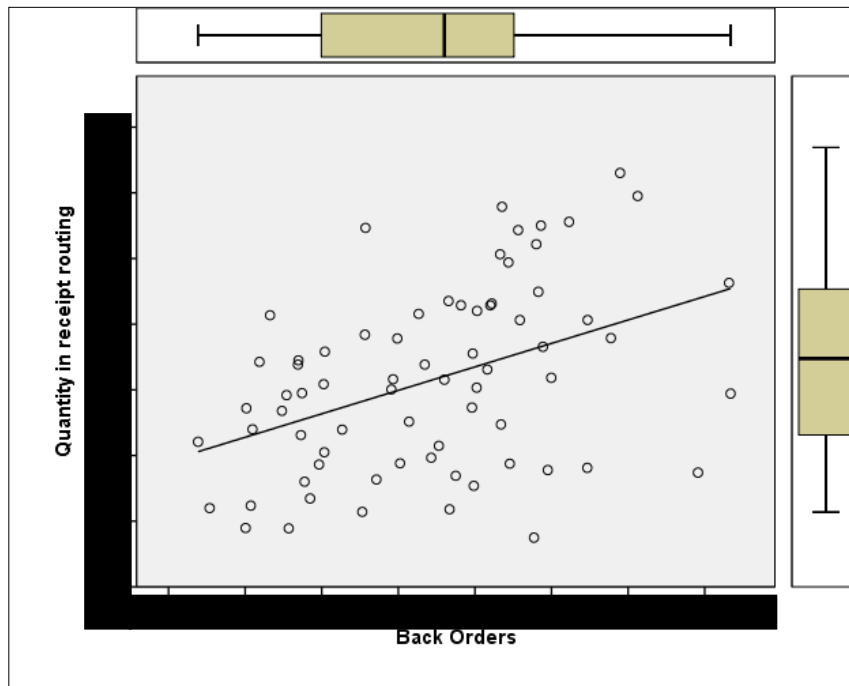


Figure 24: Scatter Plot - quantity in receipt routing vs. forecast

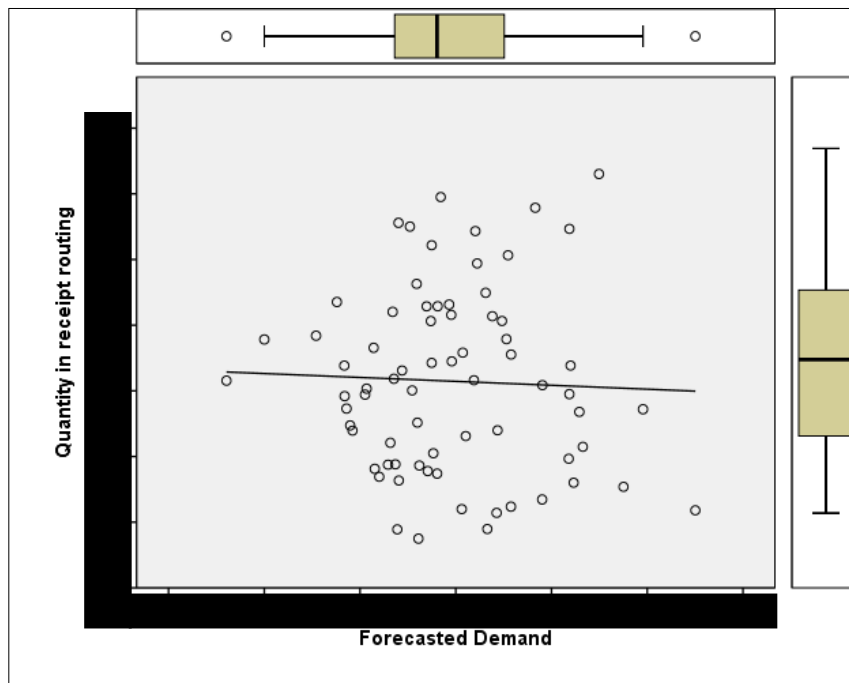


Figure 25: Scatter Plot - quantity in receipt routing vs. sales

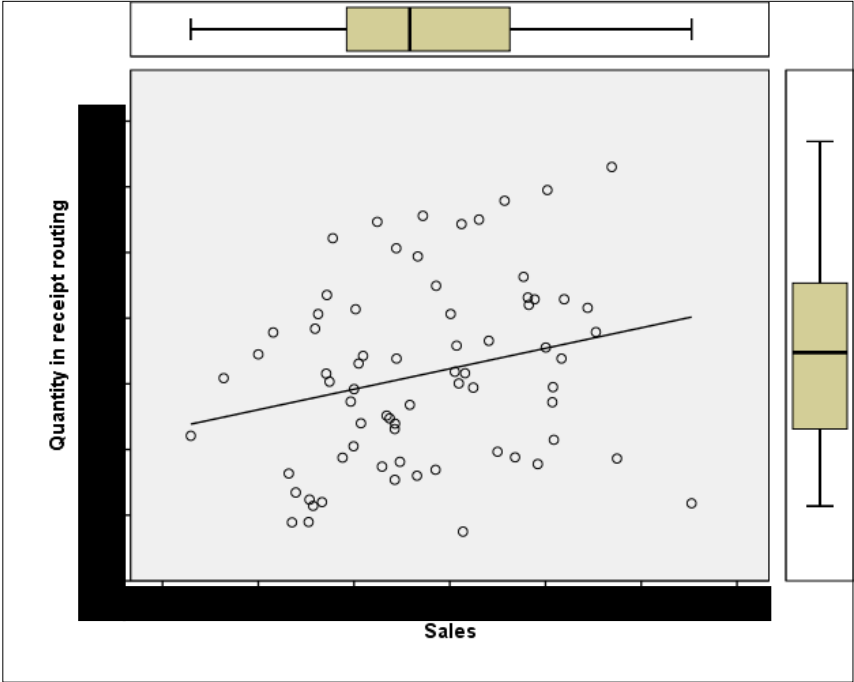


Figure 26: Scatter Plot - quantity in receipt routing vs. quantity on hand

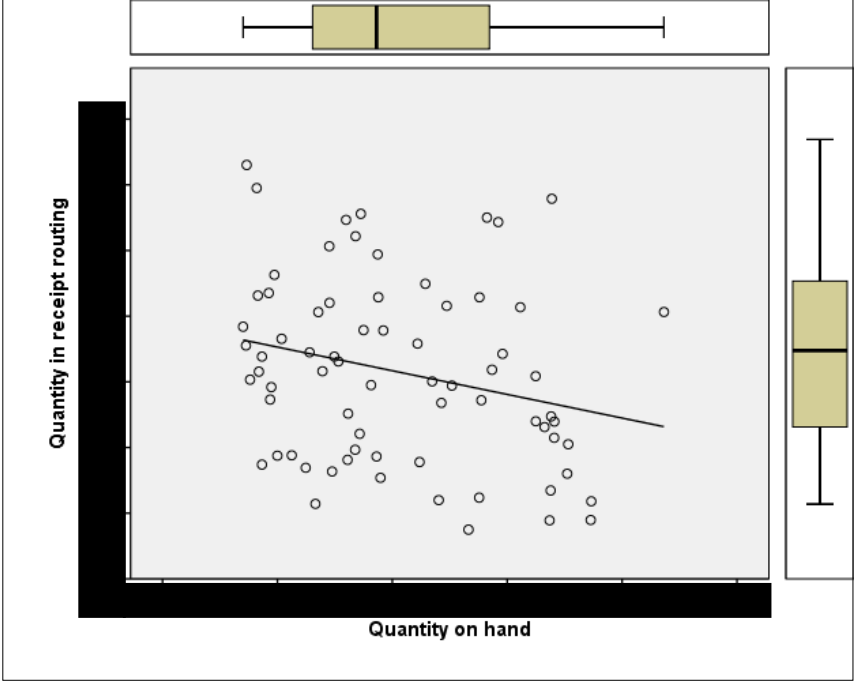


Table 17: Multi linear Regression - Dependent variable Quantity in routing

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Quantity on hand	-0.118	0.088	-0.163	-1.339	0.185
Back Orders	1.444	0.557	0.340	2.594	0.012
Forecasted Demand	0.049	0.202	0.032	0.243	0.809
Sales	0.121	0.175	0.095	0.692	0.492
a. Dependent Variable: Quantity in receipt routing					

The result shows that there is a high significance between back orders with quantity in routing. This hypothesis showcases that the dependent variable contributes to the other variable ensuring the following:

- The quantity on the way in theory would be the stock that should provide the back order to become a sale.

4.4 Empirical findings on Managerial implications

Through the empirical findings the most prominent variable that stood out by far was the forecast.

Businesses should put a big emphasis on when forecast building is done as the empirical indicated that forecast drives the inventory levels of a business and the literature illustrated that inventory is the life line of a business.

The domino effect of forecast is that it drives the inventory levels as well as anticipates the possible sales projection; therefore the inputs in the forecast process should be done through not only algorithms based calculations, but also inputs from the business through a collaborative approach. This would ensure that the right amount of inventory is available to sell to a customer when the demand is created and this ensures that there are no stock outs and promotes a profitable business. The contribution of an accurate forecast is the key to keep inventory costs to a minimal as well as operational cost to manage the inventory.

Business should take forecast processes serious and invest time in understanding in the figures to understand it how it drives your inventory levels as well as ensuring that the supply chain is managed properly.

4.5 Summary of Chapter 4

Chapter 4 started off by understanding the median sales figure during a specific period as this method is pre-dominantly used to forecast future sales of the business. These past figures provided a result that projected false figures were being used and skew the perspective on the future of the business, putting it at risk. Lee et al. (2015:116).

This method indicated that the sales over the forecast period, shows significance with regards to inaccuracy on forecast and further methods are required to understand the impact the prediction future sales values will have on a sustainable business.

Therefore the mean was tested to see where the middle point of each variable is and the degree of variance over the median. The results contributed by indicating the forecast accuracy and the degree of error the forecast has.

The statistics illustrated that over one third of customer demands where not captured. The forecast also illustrated at a level of 130%. Sales and Back Orders are combined at 159% providing the perception that the forecast is not at the right level due to higher demand which reduced the inventory on hand to a level of 65%.

The importance was highlighted by the previous test therefore standard deviation was tested as well. The test helps to contribute to the study by calculating the spread of the mean in the sample set. However, seeing that the data set has actual confidential numbers, it was decided to test the coefficient of variation instead, to see the variation in percentage format rather than units.

The test of coefficient of variation assesses the function of precision in the data set to illustrate the difference in variation in percentages between the variables. The results indicate the significance of the problem statement. Correlations test was done to understand the relationships and what variables are causal.

The Pearson product-moment correlation coefficient was used to find the variables that had a direct or indirect correlation with each other.

The reason as to why forecast is a key influencing variable on the supply chain, is due to the fact that there is a high positive correlation of 37% and 36% on sales and inventory respectively. With the correct forecast in place there will be a positive effect on sales and inventory holding that should keep your inventory in line with demands assuring that stock outs are kept at a minimum. (Christopher & Ryals, 2014; Handfield et al., 2015; Mangan & Lalwani, 2016)

Seeing that forecast drives a business's inventory levels, Vastag & Whybark (2005:134) model theory was used on inventory turnover. Vastag & Whybark's (2005:134) theory was created to indicate the efficiency with regards to inventory management and how well supply chain is supporting the business

However the study saw a gap in their model and recommended incorporating Williams & Tokar (2008:224) importance of a stock out response. The theory that should be achieved from the data set is to be at a 100% turnover rate if you have sold an amount of units a month including the stock outs that equates to the total demand for the month.

Following the previous test, a multiple regressions test was done as well to support the variables correlation. Multiple regressions illustrate the influence on the variables might be one or more. The result shows that there is a high significance between sales, quantities on hand as well as back order with forecast, where the results illustrated a high significance between forecast and back orders with sales. The other multiple correlation tests had a high significance between sales, quantity in receipt routing and forecast with back order, back orders with quantity in routing as well as forecast and quantity on hand.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusion from literature

The literature provided a basis to see whether variables were identified that optimised inventory management to ensure a sustainable supply chain. Michalski (2008:83) found that the inventory guiding principles will lead to innovative inventory levels in a business that will influence the significance of a business. The main reason for this is due to the majority of opportunity costs found in the inventory as well as the cost associated with it within the business. This will lead to affect the cash flow negatively in the future which could possibly lead the business into a risk status. Michalski (2008:83) brought up that that cash flow decision will determination a future strategic decision of a company and could lead to an operational risk. Variables like inventory on hand are therefore a key aspect to ensure it is kept optimal, and proposed to use the model of Vastag & Whybark (2005:134) together with Williams & Tokar, (2008:224) proposed the use a combination of the model theory in conjunction with back order / stock outs.

The changes and impact globalisation has had on all economies has been amplified and this is supported by the demands of the market and the speed the inventory is required. (Gregory & Rawling, 2016:46). Referencing back to the risk of inventory it has in the supply chain it is still very reliant on what the demands are in the market and how quick your business can react (Stadtler, 2015:27). Croson *et al.* (2014:195) explored this theory by designing a model where it is acceptable not to carry inventory and weigh up the impact of a stock out versus a back order.

Lee (2012:25) found that agility is required to respond to short term changes with regards to supply and demand from customers and markets. The sales, back orders and demand is therefore a key driver to obtain stock quickly in order satisfy the demand.

To ensure swift actions within a business Attaran M & Attaran S (2007:4) identified the benefits of a collaborative supply chain that contributes to better planning. The level of forecast or demand will be captured more accurately by ensuring a better level of supplies, by not over committing to too much inventory and still serving the customer in an erratic market. This method is purely used, as stated by Chopra and

Sodhi (2014:72), that a company who responds the most effectively to the changes in an ever evolving market, will reach long term sustainability and survive the longest.

Stadtler (2015:27) indicated a crucial variable, that impacts the inventory, supply chain and cash flow, is the lead time to import or manufacture products. The longer the lead time, the longer it takes for the business to sell and make a profit on the customer purchase (Chopra & Sodhi, 2014:72).

The biggest impact that could affect supply chain and inventory management is if the distribution channels goes through a bullwhip effect. This is a occurrence where the forecast shows cases of supply chain inefficiencies as the fluctuations in inventory management is too big to respond on the customers' demands and the upstream supply chain (Lee *et al.*, 2015:116). Jaipuria and Mahapatra (2014:41) highlighted that during a bullwhip effect, an inaccurate forecasting of the demand is established and this inopportune demand forecasting leads to an upsurge of overall operational costs that impact the bottom line of the business.

The primary research question regarding forecasting acting as a major contributor to inventory levels, could therefore be answered by the literature. This depends on whether the market demands are on the same level and could contribute by optimising the supply chain in a multinational.

The literature study illustrated the variables and metrics in inventory management, which accurately described how effective inventory management related to forecast. The same principle applied towards supply chain management as the forecast is seen as the short term strategy to move stock in and out based on anticipated sales.

To ensure optimised profits, inventory management and supply chain management should work in unison to ensure the forecast is realistic and that the forecast protects the business cash flow as well as captures the market demands effectively.

5.2 *Conclusion from Empirical*

5.2.1 *General – Primary questions*

General findings out of the empirical testing indicated that inventory management contributes to the supply chain effectiveness. The hypothesis is that your inventory levels should be close to the market demand. Where a lead-time is applicable to a business it escalates the importance of forecast accuracy.

This is not only to support the business from a financial point of view, but can assist in contributing to cash flow. This would be required to measure how the cash flow impacts a business's inventory levels by referring to the non-confidential information.

The primary research is needed to understand the variables that influence inventory management and to optimise supply chain in a multi-national business. The literature indicated by a leaner model, carries no inventory, but still keeps the customer satisfied. Stevens and Johnson (2016:43) branded this type of approach the "pure lean" supply chain approach. The pure lean supply chain approach indicates that no inventory should be carried but rather fulfils backorders over a forecasted plan of sales. Williams (2017:67) acknowledge that it would be farfetched to utilise this model in a business as the dependence on inventory in a globalised world should be seen as a necessity. They also recommend to ensure a minimal inventory level as this will serve the demands with a robust supply chain in place that will ensure that the controlling, planning and executing is taken care of efficiently. The generic tool for controlling and planning inventory is through a forecast, the executing part of the process is through the supply chain.

The primary findings of the empirical results showed that through the multiple regressions, the only significance on inventory was the forecast. The relationship between inventory and supply chain would not be present in any business if it wasn't for a forecast.

Forecast has a strong impact on a business and the hypothesis supported this statement. The significance between the forecast and sales, illustrated that when the inventory is at the right level and is driven by the correct forecast sales it will benefit a business. The benefit of not only capturing the customers demand will further add value to the business by contributing to fewer stock outs and customer satisfaction.

Illustrating an efficient and effective business in a globalised world through a strong relationship is vital. Time invested in the forecast will provide adequate levels of inventory to the market through the supply chain process.

5.2.2 Specific – Secondary questions

When referring back to the metrics illustrated in Table 5 below, the importance and understanding of what is needed will add to understanding the impact one part of the business can have over the overall business divisions:

Table 18: Relationship factor module for an optimised supply chain

Inventory Management	Supply Chain Management	Business Benefits
Forecast driven	Orders driven	Customer Satisfaction / Increase in profits
Keep inventory at optimal level	Keep cost low	Increase in cash flow / Increase in profits / Customer satisfaction
Maintain the product level	Move the product	Reduction is operational cost / Increase in profits / Customer satisfaction
Aim to reduce inventory cost	Aim to reduce total cost	Reduction is operational cost / Increase in profits
Lead Time	Lead Time	Reduction is operational cost / Increase in profits
Safety Stock incorporations	Agility	Customer Satisfaction / Possible increase in profits depending on exponential increase in operational cost.

Not only has this table assisted by answering two out of the three secondary research objectives, it also contributed at a global level by assisting business managers to understand how inventory management and supply chain management is dependent on each other. Inventory management variables that should be optimised to ensure that a business maximised the profits in any business should be:

- Forecast accuracy
- Agile supply chain to move the goods
- Inventory controlling

The result shows that there is a high significance between sales, quantities on hand as well as back order with forecast. The results illustrated a high significance between forecast and back orders with sales. The other multiple correlation tests had

a high significance on sales, quantity in receipt routing and forecast with back orders. Back orders with quantity in routing as well as forecast and quantity on hand as indicated in Table 14

Table 19: Multi linear Regression - Dependent variable Forecast

Coefficients					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Sales	0.401	0.095	0.477	4.224	0.000
Quantity on hand	0.137	0.052	0.287	2.644	0.010
Quantity in receipt routing	0.018	0.075	0.028	0.243	0.809
Back Orders	-0.747	0.345	-0.267	-2.167	0.034
a. Dependent Variable: Forecasted Demand					

Businesses should utilised this as their starting point and ensure that if they want to move products into their targeted market they should be geared up through a realistic forecast with various inputs to ensure reliability. This would indicate to the entire supply chain that the volumes they should move in and out from supplier to customer will ensure that agility is present to mitigate any possible bullwhip effect (Jaipuria & Mahapatra, 2014:2407). If any deviations are encountered by the forecast, management of inventory is imperative to ensure adjustments are made as effectively and efficiently as possible to ensure the business remains lucrative and sustainable by not losing profits to other competitors.

5.3 Final conclusion

The study found significance between the relationship of inventory and supply chain management in the business environment. Not only was this supported through pervious literature, the empirical findings resulted to the same.

The study identified that there is one primary variable that has a direct link to optimise a supply chain through inventory management and this is the forecasting process.

Hence the importance to optimise and improve the forecasting process is a fundamental commencement as it has a direct impact on the end results. Businesses

should focus on improving the forecast process through reliable inputs in the forecast either making use of new technologies (algorithms, systems) or methods (trend projections, seasonal indexes) to establish a trustworthy indication of future sales.

Results of an improved forecast will ensure a positive effect on sales as well as a reduction on stock outs as the inventory levels would be at the right level, at the right time, at the right place, when the customer requires the products. Businesses would keep up with the globalised world where the supply chain is optimised, as competition is fierce and businesses would capitalise on the products being sold and ultimately contributing to profits.

5.4 Recommendations and managerial implications outcomes

Business management teams should understand the importance of building a forecast for future projection. The forecast should not just be seen as a sales target for the future. The implications of a forecast is huge for a business because if it is too high it causes friction on the cash flow and if it is too low it creates unhappy customers due to stock outs.

Management should utilise the forecast as a steering tool across all departments and should be challenged on a regular basis to make changes as and when needed, due to volatility of the market and the sensitivity of the forecast has on the supply chain.

For a business to survive there should be an understanding that the inventory is the primary contributor to success but needs to be managed through the supply chain and the forecast, which should drive the inventory levels based on variable inputs to ensure a near perfect correlation between sales and forecasted sales.

5.5 Achievement of the objectives of the study

The primary research required was to understand the variables that influence inventory management by optimising supply chain in a multi-national business. The study was achieved by identifying the key contributing variable that can be used for inventory management to optimise the supply chain in a multi-national. This referred back all to the forecast process. The literature indicates a leaner model that carries no inventory but still keeps the customer satisfied. Stevens and Johnson (2016:43) branded this type of approach the “pure lean” supply chain method.

The primary findings from the empirical were through the multiple regressions where the only significance on inventory was the forecast. The relationship between inventory and supply chain would not be presence in any business if it was not for a forecast. This means for a business to survive there should be a thoughtful thinking process on inventory management. Meaning that the inventory is the primary contributor to success, but needs to be managed through the supply chain, and the forecast should determine the inventory levels based on various involvements in the forecast process.

The study required to comprehend the variables that contribute to both inventory management and supply chain management in a business through literature review. The below table was established that was contributed through the literature findings:

Table 20: Relationship factor module for an optimised supply chain

Inventory Management	Supply Chain Management	Business Benefits
Forecast driven	Orders driven	Customer Satisfaction / Increase in profits
Keep inventory at optimal level	Keep cost low	Increase in cash flow / Increase in profits / Customer satisfaction
Maintain the product level	Move the product	Reduction is operational cost / Increase in profits / Customer satisfaction
Aim to reduce inventory cost	Aim to reduce total cost	Reduction is operational cost / Increase in profits
Lead Time	Lead Time	Reduction is operational cost / Increase in profits
Safety Stock incorporations	Agility	Customer Satisfaction / Possible increase in profits depending on exponential increase in operational cost.

The relationship factor module for an optimised supply chain was supported by the literature review in regards to the empirical findings to understand from the secondary research objective what variables contributes to managing the inventory effectively to ensure a business profits is maximised.

The final fundamental conclusion is that the forecast process is the critical aspect for the relationship between inventory management and an optimised supply chain model for a business to be sustainable.

5.6 *Recommendations for future research*

The study did find some irregularities that require further research to be done, as to understand the full effects on a business. The two main recommendations are as follows:

1. Variables like inventory costing levels and sales values should be added
2. Test the combination of Vastag & Whybark (2005:134) and Williams & Tokar (2008:224) findings to illustrate forecast accuracy when there is production or capacity issues

Due to the sensitivity of the information when it comes to inventory cost holding and net sales values of a business, it should be tested in future to see the impact higher inventory has on cash flows and what additional returns in profits it could bring. Providing a business shares this information it would add significant value to the business to understand the approach they would like to take based on financial capabilities and performances.

The reason why Williams and Tokar (2008:224) identified the importance of a stock out response, is to determine whether the inventory levels might be the issue or if focus should be made on another variable. Williams and Tokar (2008:224) found that when a stock outs occurs, there are generally two types of impacts, one being a back order is created, that is measured through the back order variables that are available, or an instant loss of sale that is not captured. Therefore their might be a supporting factor to Vastag & Whybark (2005:134) module of inventory turnover to find if the forecast is the issue that is driving the inventory levels or due a other impact like production or raw material inefficiencies.

This would not only aid this study but contributing to business to understand certain methods and modules that could monitor and measure the shortcomings when it comes to customer satisfaction and business optimisation through the supply chain.

BIBLIOGRAPHY

Abdi, H. (2007). Encyclopaedia of Measurement and Statistics. Encyclopaedia of Measurement and Statistics. [Online] Available at: <http://www.utd.edu/~herve>.

Acar, Y. & Gardner, E.S. 2012. Forecasting method selection in a global supply chain. *International Journal of Forecasting*, 28(4):842-848.

Agnihotri, R., Dingus, R., Hu, M.Y. & Krush, M.T. 2016. Social media: Influencing customer satisfaction in B2B sales. *Industrial Marketing Management*, 53:172-180.

Aleem, A. & Khalil, M.S. 2013. Inventory Optmization through Safety Stock Schemata. *Mehran University Research Journal of Engineering and Technology*, 32(2):221-232.

Altug, M. 2014. Opportunity or threat? The impact of domestic gray markets on supply chains.

Arlbjørn, J.S. & Paulraj, A. 2013. Special topic forum on innovation in business networks from a supply chain perspective: current status and opportunities for future research. *Journal of Supply Chain Management*, 49(4):3-11.

Aslani, A., Hassanzadeh, M. & Musazadeh, A. 2014. Surveying the Relationship between Working Capital and Economic Value Added at Firms Listed in Tehran Stock Exchange. *Nigerian Chapter of Arabian Journal of Business and Management Review*, 2(3):1-7.

Attaran, M. & Attaran, S. 2007. Collaborative Supply Chain Management: The most promising practise for building efficient and sustainable supply chains. (In *The Business Journal of Process Management*, Vol 13, Nr. 3, pg. 390-404)

Azevedo, S.G., Carvalho, H. & Machado, V.C. 2011. The influence of green practices on supply chain performance: a case study approach. *Transportation research part E: logistics and transportation review*, 47(6):850-871.

Bacchetti, A., Plebani, F., Saccani, N. & Syntetos, A. 2013. Empirically-driven hierarchical classification of stock keeping units. *International Journal of Production Economics*, 143(2):263-274.

Baird, R. & Ziskend, H. 2016. America Is Not in Decline, and Startups Are an Important Reason Why: A Case Study of Albuquerque, New Mexico (Innovations Case Narrative: Village Capital and Revolution LLC, the "Rise of the Rest"). *America*, 11(1-2).

Beamon, B.M. 1998. Supply Chain Design and Analysis: Models and Methods. (In *International Journal of Production Economics*, Vol. 55, No. 3, pp. 281-294).

Benton, W. and Maloni, M. (2005). The influence of power driven buyer/seller relationships on supply chain satisfaction. *Journal of Operations Management*, 23(1), pp.1-22.

Bolton, P., Chen, H. & Wang, N. 2011. A unified theory of Tobin's q, corporate investment, financing, and risk management. *The Journal of Finance*, 66(5):1545-1578.

Braunscheidel, M.J. & Suresh, N.C. 2018. Cultivating Supply Chain Agility: Managerial Actions Derived from Established Antecedents. *Supply Chain Risk Management*. Springer. p. 289-309).

Brown, S.T., Schreiber, B., Cakouros, B.E., Wateska, A.R., Dicko, H.M., Connor, D.L., Jaillard, P., Mvundura, M., Norman, B.A. & Levin, C. 2014. The benefits of redesigning Benin's vaccine supply chain. *Vaccine*, 32(32):4097-4103.

Bryman A, Bell E, Hirschsohn, Dos Santos, Du Toit, Masenge, Van Aardt & Wanger. 2011. *Research Methodology Business and Management Contexts*. Oxford University Press South Africa

Byrne, B., Shavelson, R. and Muthén, B. (1989). Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin*, 105(3), pp.456-466.

BusinessDictionary.com. (2017). Good one to know!. [online] Available at: <http://www.businessdictionary.com/definition/supply-chain.html> [Accessed 9 Oct. 2017].

BusinessDictionary.com. (2017). What comes after those ellipses?. [online] Available at: <http://www.businessdictionary.com/definition/inventory-management.html> [Accessed 9 Oct. 2017].

Brynard, P. A., & Hanekom, S. X. 2006. Introduction to research in management-related fields (2nd Ed.). Pretoria: Van Schaik Publishers. (p. 14)

Cannella, S., Ashayeri, J., Miranda, P.A. & Bruccoleri, M. 2014. Current economic downturn and supply chain: the significance of demand and inventory smoothing. *International Journal of Computer Integrated Manufacturing*, 27(3):201-212.

Chopra, S., Reinhardt, G. and Mohan, U. (2007). *The importance of decoupling recurrent and disruption risks in a supply chain*. *Naval Research Logistics*, 54(5), pp.544-555.

Chopra, S. & Sodhi, M.S. 2014. Reducing the risk of supply chain disruptions. *MIT Sloan Management Review*, 55(3):73.

Christopher, M. & Ryals, L.J. 2014. The supply chain becomes the demand chain. *Journal of Business Logistics*, 35(1):29-35.

Closs, D.J., Nyaga, G.N. & Voss, M.D. 2010. The differential impact of product complexity, inventory level, and configuration capacity on unit and order fill rate performance. *Journal of Operations Management*, 28(1):47-57.

Cooper, M.C., Lambert, D.M, and Pagh, J.D, (1997), "Supply Chain Management: More Than a New Name for Logistics," *The International Journal of Logistics Management*, Vol. 8, No. 1, pp. 1-14.

Cooper, M. and Ellram, L. (1993). Characteristics of Supply Chain Management and the Implications for Purchasing and Logistics Strategy. *The International Journal of Logistics Management*, 4(2), pp.13-24.

Croson, R., Donohue, K., Katok, E. & Serman, J. 2014. Order stability in supply chains: coordination risk and the role of coordination stock. *Production and Operations Management*, 23(2):176-196.

de Almeida, M.M.K., Marins, F.A.S., Salgado, A.M.P., Santos, F.C.A. & da Silva, S.L. 2017. The importance of trust and collaboration between companies to mitigate the bullwhip effect in supply chain management. *Acta Scientiarum. Technology*, 39(2):201-210.

Dekker, R., Fleischmann, M., Inderfurth, K. & van Wassenhove, L.N. 2013. Reverse logistics: quantitative models for closed-loop supply chains: Springer Science & Business Media.

Falchi, A.G., Muggia, C., Grecchi, I., Michelini, I., De Silvestri, A. & Tinelli, C. 2015. Validation of decisional balance inventory test in Italian: assessment of motivation in weight loss. *Italian Journal of Medicine*, 9(3):268-272.

Fan, T., Tao, F., Deng, S. & Li, S. 2015. Impact of RFID technology on supply chain decisions with inventory inaccuracies. *International Journal of Production Economics*, 159:117-125.

Fiestras-Janeiro, M.G., García-Jurado, I., Meca, A. & Mosquera, M.A. 2011. Cooperative game theory and inventory management. *European Journal of Operational Research*, 210(3):459-466.

Fleischmann, B., Meyr, H. & Wagner, M. 2015. Advanced planning. Supply chain management and advanced planning. Springer. p. 71-95).

Frohlich, M.T. & Westbrook, R. 2001. Arcs of integration: an international study of supply chain strategies. *Journal of Operations Management*, 19(2):185-200.

Frohlich, M. and Westbrook, R. (2001). Arcs of integration: an international study of supply chain strategies. *Journal of Operations Management*, 19(2), pp.185-200.

Graves, S. (1999). Addendum to "A Single-Item Inventory Model for a Non stationary Demand Process". *Manufacturing & Service Operations Management*, 1(2), pp.174-174.

Green, K.W., Inman, R.A., Birou, L.M. & Whitten, D. 2014. Total JIT (T-JIT) and its impact on supply chain competency and organizational performance. *International Journal of Production Economics*, 147:125-135.

- Gregory, I.C. & Rawling, S.B. 2016. Profit from time: speed up business improvement by implementing time compression: Springer.
- Gurtu, A., Gurtu, A., Searcy, C., Searcy, C., Jaber, M. & Jaber, M. 2015. An analysis of keywords used in the literature on green supply chain management. *Management Research Review*, 38(2):166-194.
- Handfield, R.B., Cousins, P.D., Lawson, B. & Petersen, K.J. 2015. How can supply management really improve performance? A knowledge-based model of alignment capabilities. *Journal of Supply Chain Management*, 51(3):3-17.
- Hasselback, L., Crawford, J., Chaluco, T., Rajagopal, S., Prosser, W. & Watson, N. 2014. Rapid diagnostic test supply chain and consumption study in Cabo Delgado, Mozambique: estimating stock shortages and identifying drivers of stock-outs. *Malaria journal*, 13(1):295.
- Hawkins, T.G., Gravier, M.J., Berkowitz, D. & Muir, W.A. 2015. Improving services supply management in the defense sector: How the procurement process affects B2B service quality. *Journal of Purchasing and Supply Management*, 21(2):81-94.
- Hervani, A., Helms, M. and Sarkis, J. (2005). Performance measurement for green supply chain management. *Benchmarking: An International Journal*, 12(4), pp.330-353.
- Hoejmose, S., Brammer, S. & Millington, A. 2013. An empirical examination of the relationship between business strategy and socially responsible supply chain management. *International Journal of Operations & Production Management*, 33(5):589-621.
- Hudnurkar, M., Jakhar, S. & Rathod, U. 2014. Factors affecting collaboration in supply chain: A literature review. *Procedia-Social and Behavioral Sciences*, 133:189-202.
- Jaipuria, S. & Mahapatra, S. 2014. An improved demand forecasting method to reduce bullwhip effect in supply chains. *Expert Systems with Applications*, 41(5):2395-2408.

Jones, T., & Riley, D.W., (1985), "Using Inventory for Competitive Advantage through Supply Chain Management," *International Journal of Physical Distribution and Materials Management*, Vol. 15, No. 5, pp. 16-26.

Kumar, G.A., Anzil, A., Ashik, K., James, A.T. & Ashok, J.K. 2017. Effective Inventory Management system through selective inventory control. *Imperial Journal of Interdisciplinary Research*, 3(6).

Kumar, P. & Bahl, R. 2014. The effect of inventory management on organizational performance. *International Journal of Innovative Science, Engineering & Technology*, 1(4):453-459.

Lambert, D., Cooper, M. and Pagh, J. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. *The International Journal of Logistics Management*, 9(2), pp.1-20

La Londe, B.J., & Masters, J.M., (1994), "Emerging Logistics Strategies: Blueprints for the Next Century," *International Journal of Physical Distribution and Logistics Management*, Vol. 24, No. 7, pp. 35-47.

Lambert, D.M. & Enz, M.G. 2017. Issues in Supply Chain Management: Progress and potential. *Industrial Marketing Management*, 62:1-16.

Lee, H.L., (2012), The Triple-A Supply Chain. *Production and Operations Management*, 21(6), p.xi-xii.

Lee Rodgers, J. and Nicewander, W. (1988). Thirteen Ways to Look at the Correlation Coefficient. *The American Statistician*, 42(1), pp.59-66

Lee, H.L., Padmanabhan, V. & Whang, S. 2015. The bullwhip effect in supply chains. *IEEE Engineering Management Review*, 43(2):108-117.

Liu, H., Ke, W., Wei, K.K. & Hua, Z. 2014. Moderating Role of Ownership Type in the Relationship between Market Orientation and Supply Chain Integration in E-Business in China. *Journal of Global Information Management (JGIM)*, 22(4):34-53.

Liu, H. & Wang, Y. 2016. Market making with asymmetric information and inventory risk. *Journal of Economic Theory*, 163:73-109.

Lopes de Sousa Jabbour, A.B., Gomes Alves Filho, A., Backx Noronha Viana, A. & José Chiappetta Jabbour, C. 2011. Measuring supply chain management practices. *Measuring Business Excellence*, 15(2):18-31.

Lummus, R.R, & Vokurka, R.J. 1999. Defining supply chain management: a historical perspective and practical guidelines. *Journal of Industrial Management & Data Systems*. Vol. 99, No. 1, pg. 11-17.

Mangan, J. & Lalwani, C. 2016. *Global logistics and supply chain management*: John Wiley & Sons.

Mentzer, J.T., DeWitt, W., Keebler, J.S., Min, S., Nix, N.W., Smith, C.D. & Zacharia, Z.G. 2001. Defining Supply Chain Management. (In *Journal of Business Logistic*, Vol. 22, No. 2, pp. 1-25)

Mentzer, J., DeWitt, W., Keebler, J., Min, S., Nix, N., Smith, C. and Zacharia, Z. (2015). Définir Le Supply Chain Management. *Logistique & Management*, 23(4), pp.7-24.

Meyr, H. (2004). Supply chain planning in the German automotive industry. *OR Spectrum*, 26(4).

Michalski, G. 2008. Corporate inventory management with value maximization in view. (In *Komandorska* 5: 187-192)

Millstein, M.A., Yang, L. & Li, H. 2014. Optimizing ABC inventory grouping decisions. *International Journal of Production Economics*, 148:71-80.

Min, H. & Zhou, G. 2002. Supply Chain modelling: past, present and future. (In *Computers and Industrial Engineering*, Volume 43, pg. 231-249)

Mircosoft. 2016. Excel

Mitra, S., Reddy, M.S. & Prince, K. 2015. Inventory control using FSN analysis—a case study on a manufacturing industry. *Int. J. Innovative Sci. Eng. Technol*, 4(2):49-55.

Mohammaddust, F., Rezapour, S., Farahani, R.Z., Mofidfar, M. & Hill, A. 2017. Developing lean and responsive supply chains: A robust model for alternative risk

mitigation strategies in supply chain designs. *International Journal of Production Economics*, 183:632-653.

Monczka, R.M., Handfield, R.B., Giunipero, L.C. & Patterson, J.L. 2015. Purchasing and supply chain management: Cengage Learning.

Monczka, R., Trent, R., And Handfield, R. (1998), *Purchasing and Supply Chain Management*, Cincinnati, OH: South-Western College Publishing, Chapter 8.

Monden, Y. 2016. Lean management of global supply chain: dynamic combination model of market, product life-cycle, product design, and supply chain. *Lean Management of Global Supply Chain*. World Scientific. p. 3-46).

Morita, M., Machuca, J.A., Flynn, E.J. & de los Ríos, J.L.P. 2015. Aligning product characteristics and the supply chain process—A normative perspective. *International Journal of Production Economics*, 161:228-241.

Muller, M. 2011. Essentials of inventory management: AMACOM Div American Mgmt Assn.

Naylor, B.J., Naim, M.M. & Berry, D. 1998. Legality: Integrating the lean and agile manufacturing paradigms in the total supply chain. (In *The Journal of Production Economics*, Vol, 62. Pg. 107-118)

Netessine, S. & Zhang, F. 2005. Positive vs. Negative externalities in inventory management: Implications for Supply Chain design. *Journal of Manufacturing & Services Operations Management*, Vol. , No. 1, pg. 58-73.

Niraj, R., Gupta, M. & Narasimhan, C. 2001. Customer profitability in a supply chain. *Journal of Marketing*, 65(3):1-16.

North West University. Manual for Master's and Doctoral Studies. October 2013

Ouyang, L.Y., Neng-che, Y. & Wu K.S. 1996. Mixture Inventory Model with Backorders and Lost Sales for Variable Lead Time. *Journal of operation research society*, Vol. 47. Pg. 829-832.

Papadopoulos, F. 2015. Investigating the Impact of Supply Chain Glitches on Business Performance.

Ralston, P.M., Blackhurst, J., Cantor, D.E. & Crum, M.R. 2015. A structure–conduct–performance perspective of how strategic supply chain integration affects firm performance. *Journal of Supply Chain Management*, 51(2):47-64.

Relph, G. & Milner, C. 2015. *Inventory Management: Advanced Methods for Managing Inventory within Business Systems*: Kogan Page Publishers.

Ross, D.F. 2015. *Distribution Planning and control: managing in the era of supply chain management*: Springer.

Scm.ncsu.edu. (2017). What is Supply Chain Management? - SCM | Supply Chain Resource Cooperative (SCRC) | North Carolina State University. [online] Available at: <https://scm.ncsu.edu/scm-articles/article/what-is-supply-chain-management> [Accessed 9 Oct. 2017].

Santhi, G. & Karthikeyan, K. 2016. Recent Review Article on Pharmaceutical Inventory Models. *International Journal of Pharm Tech Research*, 9(5):435-443.

Sarac, A., Absi, N. & Dauzère-Pérès, S. 2010. A literature review on the impact of RFID technologies on supply chain management. *International Journal of Production Economics*, 128(1):77-95.

Sarkar, B. & Sarkar, S. 2013. An improved inventory model with partial backlogging, time varying deterioration and stock-dependent demand. *Economic Modelling*, 30:924-932.

Schoenherr, T. & Speier-Pero, C. 2015. Data science, predictive analytics, and big data in supply chain management: Current state and future potential. *Journal of Business Logistics*, 36(1):120-132.

Shin, H., Wood, C.C. & Jun, M. 2016. Does Effective Inventory Management Improve Profitability?: Empirical Evidence from US Manufacturing Industries. *International Journal of Information Systems and Supply Chain Management (IJISSCM)*, 9(3):26-45.

SPSS, I. 2016. *SPSS (Version 24)*: IBM.

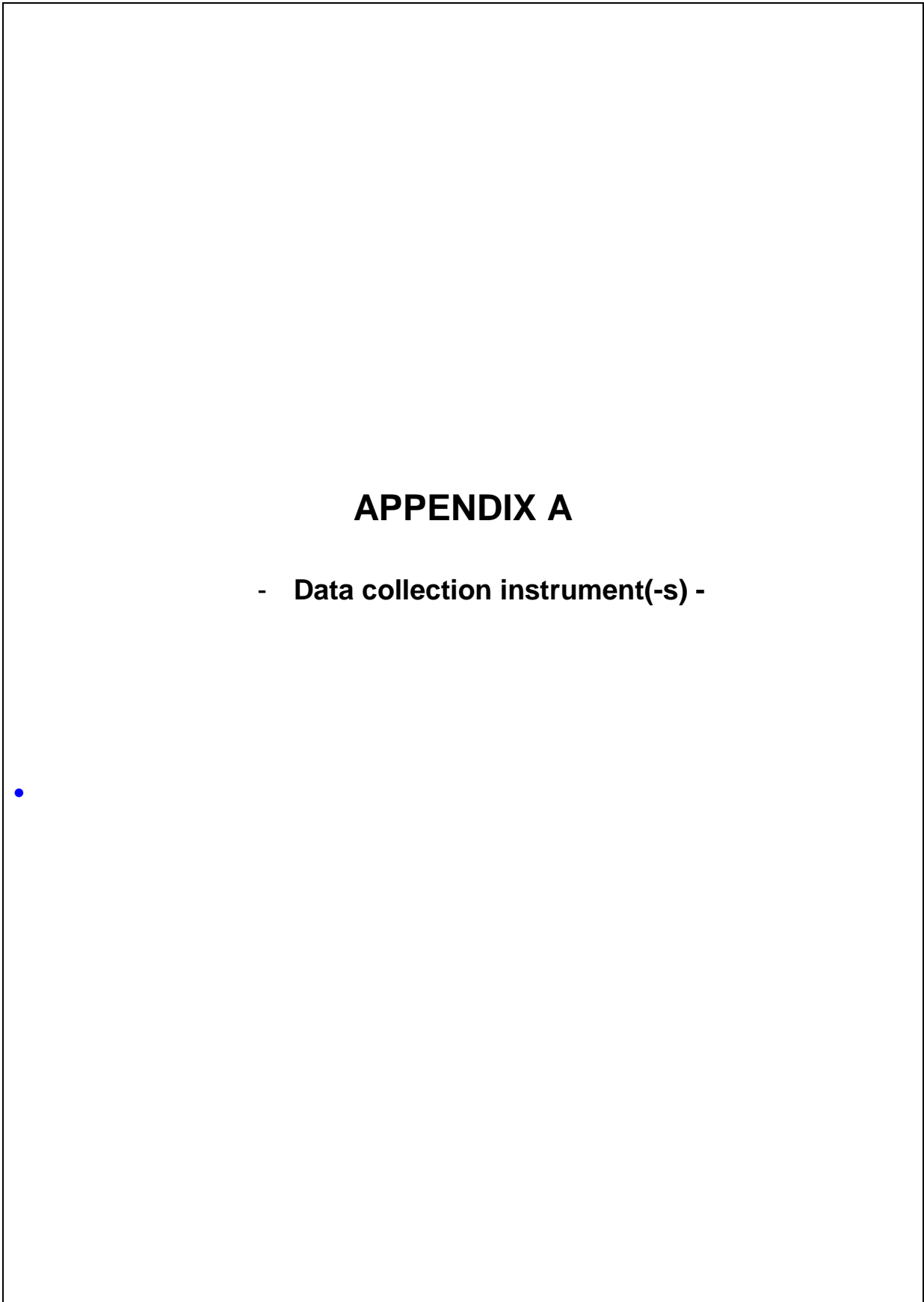
- Stadtler, H. 2015. Supply chain management: An overview. Supply chain management and advanced planning. Springer. p. 3-28).
- Stefanovic, N. & Milosevic, D. 2017. Developing Adaptive Business Intelligence Systems for Agile Supply Chain Analytics. (In. Proceedings of the 2017 International Conference on E-commerce, E-Business and E-Government organised by: ACM. p. 45-50).
- Stevens, G.C. & Johnson, M. 2016. Integrating the supply chain... 25 years on. *International Journal of Physical Distribution & Logistics Management*, 46(1):19-42.
- Tarafdar, M. & Qrunfleh, S. 2017. Agile supply chain strategy and supply chain performance: complementary roles of supply chain practices and information systems capability for agility. *International Journal of Production Research*, 55(4):925-938.
- Stevens, G.C. 1989. Integrating the Supply Chain. (In *International Journal of Physical Distribution and Materials Management*, Vol. 8, No. 8, pg. 3-8)
- Swaminathan, J.M., Smith, S.F. & Sadeh, M. Modeling Supply Chain Dynamics: A Multiagency Approach. (In the journal of Decision Sciences, Vol. 29, Nr. 3, Page 607-629)
- Vastag, G. and Clay Whybark, D. (2005). Inventory management: Is there a knock-on effect?. *International Journal of Production Economics*, 93-94, pp.129-138
- Verdouw, C., Beulens, A., Trienekens, J. & Wolfert, J. 2010. Process modelling in demand-driven supply chains: A reference model for the fruit industry. *Computers and electronics in agriculture*, 73(2):174-187.
- Wild, T. 2017. Best practice in inventory management: Routledge.
- Williams, S.J. 2017. Leanness Plus Agility= Leagility. Improving Healthcare Operations. Springer. p. 57-68).
- Williams, B.D., Tokar, T. 2008. A review of inventory management research in major logistics journals. (In *The International Journal of Logistics Management*, Vol . 16, No. 2, pg. 212-230)

Winter, M. & Knemeyer, A.M. 2013. Exploring the integration of sustainability and supply chain management: Current state and opportunities for future inquiry. *International Journal of Physical Distribution & Logistics Management*, 43(1):18-38.

Wisner, J.D., Tan, K.-C. & Leong, G.K. 2014. Principles of supply chain management: A balanced approach: Cengage Learning.

Wu, D.Y. & Chen, K.Y. 2014. Supply chain contract design: Impact of bounded rationality and individual heterogeneity. *Production and Operations Management*, 23(2):253-268.

Wu, T., Huang, S., Blackhurst, J., Zhang, X. & Wang, S. 2013. Supply chain risk management: An agent-based simulation to study the impact of retail stockouts. *IEEE Transactions on Engineering Management*, 60(4):676-686.



APPENDIX A

- **Data collection instrument(-s)** -

Appendix A:

Exhibit 1

Months	Back Orders	Sales	Quantity on hand	Quantity in receipt routing	Forecasted Demand
2010/Jan	36%	100%	100%	100%	100%
2010/Feb	32%	87%	103%	90%	129%
2010/Mar	51%	159%	79%	152%	135%
2010/Apr	66%	143%	85%	156%	126%
2010/May	77%	126%	87%	192%	121%
2010/June	56%	148%	100%	93%	182%
2010/Jul	68%	98%	99%	102%	99%
2010/Aug	79%	118%	88%	123%	115%
2010/Sep	78%	143%	73%	82%	127%
2010/Oct	63%	141%	56%	153%	114%
2010/Nov	60%	152%	65%	156%	130%
2010/Dec	75%	121%	83%	52%	124%
2011/Jan	82%	108%	62%	193%	116%
2011/Feb	116%	124%	80%	116%	104%

2011/Mar	31%	168%	65%	84%	124%
2011/Apr	66%	89%	57%	127%	118%
2011/May	54%	131%	61%	87%	177%
2011/Jun	48%	137%	48%	85%	115%
2011/Jul	58%	79%	44%	158%	94%
2011/Aug	86%	101%	59%	83%	108%
2011/Sep	72%	77%	53%	149%	128%
2011/Oct	77%	129%	46%	137%	108%
2011/Nov	67%	140%	41%	157%	135%
2011/Dec	76%	81%	61%	183%	128%
2012/Jan	76%	113%	75%	162%	148%
2012/Feb	72%	120%	89%	189%	144%
2012/Mar	69%	133%	99%	200%	165%
2012/Apr	86%	117%	122%	149%	153%
2012/May	58%	190%	107%	64%	223%
2012/Jun	17%	90%	96%	100%	152%
2012/Jul	19%	90%	90%	130%	128%
2012/Aug	27%	100%	98%	98%	140%

2012/Sep	27%	148%	64%	116%	178%
2012/Oct	46%	121%	54%	123%	143%
2012/Nov	63%	146%	39%	134%	157%
2012/Dec	27%	58%	52%	131%	135%
2013/Jan	115%	139%	45%	166%	123%
2013/Feb	97%	146%	41%	205%	132%
2013/Mar	93%	166%	39%	215%	188%
2013/Apr	32%	119%	73%	135%	139%
2013/May	53%	151%	57%	129%	178%
2013/Jun	68%	100%	56%	179%	156%
2013/Jul	46%	119%	76%	118%	121%
2013/Aug	70%	107%	65%	175%	145%
2013/Sep	91%	161%	62%	141%	155%
2013/Oct	41%	95%	59%	190%	178%
2013/Nov	23%	105%	78%	108%	181%
2013/Dec	26%	92%	81%	154%	133%
2014/Jan	21%	88%	93%	151%	150%
2014/Feb	16%	148%	86%	110%	204%

2014/Mar	32%	48%	96%	120%	168%
2014/Apr	28%	107%	103%	77%	179%
2014/May	16%	74%	107%	56%	148%
2014/Jun	29%	70%	99%	69%	168%
2014/Jul	25%	69%	99%	56%	116%
2014/Aug	17%	74%	85%	66%	157%
2014/Sep	8%	78%	77%	65%	139%
2014/Oct	63%	100%	66%	75%	197%
2014/Nov	40%	75%	53%	63%	152%
2014/Dec	6%	38%	62%	95%	114%
2015/Jan	47%	63%	66%	141%	68%
2015/Feb	49%	97%	59%	104%	123%
2015/Mar	59%	112%	51%	79%	110%
2015/Apr	62%	87%	44%	110%	98%
2015/May	70%	84%	45%	85%	113%
2015/Jun	63%	80%	40%	119%	105%
2015/Jul	40%	76%	39%	143%	87%
2015/Aug	27%	100%	42%	129%	97%

2015/Sep	24%	88%	44%	115%	97%
2015/Oct	43%	68%	56%	78%	117%
2015/Nov	109%	96%	42%	81%	130%
2015/Dec	57%	79%	42%	122%	55%

APPENDIX B

- Informed consent form -

Appendix B:

No consent from used in this study as it is a quantitative analysis.

APPENDIX C

- Application for ethical clearance –

Appendix C:

Statement about Ethics for a follow-up evaluation or study / research

NWU Ethics checklist

Please answer each question by ticking the appropriate box ¹:

	Yes	No
1. Does the study involve participants who are particularly vulnerable ² or unable to give informed consent? (e.g. children, people with learning or other mental or physical disabilities, people who are incarcerated, unemployed or otherwise compromised in responding to your questions)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
2. Are you planning on making use of NWU students or direct and secondary/contracted staff members in this research?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
3. Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of self-help groups, residents of a nursing home, the Minister of Education, a tribal chief or village elder)	<input type="checkbox"/>	<input type="checkbox"/>
4. Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
5. Will the study involve discussion of or questions about a sensitive topic? (e.g. sexual activity, drug use, crime, harassment, violence)	<input type="checkbox"/>	<input checked="" type="checkbox"/>
6. Are drugs, placebos or other substances (e.g. food substances, vitamins) to be administered to the study participants or will the study involves invasive, intrusive or potentially harmful procedures of any kind or any physical, psychological or socio-economic intervention?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
7. Will blood or tissue samples be obtained from participants?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
8. Could the study induce physical, psychological or social stress or anxiety or cause harm or negative consequences beyond the risks ³ encountered in normal life?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
9. Will the study require the identification of individuals for follow-up evaluation?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
10. Will financial inducements (other than reasonable expenses and compensation for time) or inducements of any other kind be offered to participants?	<input type="checkbox"/>	<input checked="" type="checkbox"/>
11. I have read the NWU's Manual for Postgraduate Studies and am familiar with the Guidelines for Research Ethics contained therein.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
12. Could the image of the NWU, the relevant academic department, your employer, or any other institution however affected by/involved in the project be negatively affected by this research or put in a bad light?	<input type="checkbox"/>	<input checked="" type="checkbox"/>

¹Adapted from Economic and Social Research Council (2005). Research Ethics Framework (REF). www.esrcsocietytoday.ac.uk

² **Vulnerable groups** raise special issues of informed consent and potential risk. "Vulnerable" participants are not clearly described, but have been noted to include "...children, prisoners, pregnant women, mentally disabled persons, economically or educationally disadvantaged persons" (Common Federal Policy, 1991). Weijer and Emanuel (2000) consider participants to be vulnerable if they are not in a position to provide informed consent, due to their position (such as being in prison), or not possessing adequate intellectual faculty (such as children or the mentally ill)."Children" here are defined as participants younger than 18 years of age. ³ **Risk.** These possible risks are described as an "...invasion of privacy, loss of confidentiality, psychological trauma, indirect physical harm, embarrassment, stigma, and group stereotyping" (Oakes, 2002: 449), and also risks posed to "...a subject's personal standing, privacy, personal values and beliefs, their links to family and the wider community, and their position within occupational settings, as well as the adverse effects of revealing information that relates to illegal, sexual or deviant behaviour" (Economic and Social Research Council (ESRC), 2005: 21). Minimal risk may be defined as where "...the probability and magnitude of harm or discomfort anticipated in the proposed research are not greater, in and of themselves, than those ordinarily encountered in daily life" (Code of Federal Regulations, 2005).

If you answered **no** to all questions, submit the completed and signed form with your title registration. Students should retain a copy of the form and submit it with their dissertation/thesis.

If you answered **yes** to any of the questions, you will need to describe more fully how you plan to deal with the ethical issues raised by your proposal. **This does not mean that you cannot do the research, only that your proposal will need to be approved by the Research Ethics Committee.** You will need to submit your plans for addressing the ethical issues raised by your proposal using the Ethics Approval Application Form. This may be obtained from: <http://www.nwu.ac.za/library/documents/manualpostgrad.pdf>. Alternatively, you may attach a fuller description of the specific issue to this declaration, for discussion by the panel at the Proposal Meeting.

Please note that it is your responsibility to follow the NWU's Guidelines for Ethical Research as set out in the Manual for Postgraduate studies and any relevant academic or professional guidelines in the conduct of your study. **This includes providing appropriate information sheets and consent forms, and ensuring the confidentiality in the storage and use of data.** Any significant change in the question, design or conduct over the course of the research should be notified to the Supervisor and may require a new application for ethics approval.

Candidate

Name and Surname:

Mr Ruan Opperman

Signature:

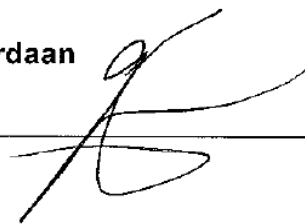


Supervisor

Name and Surname:

Mr Johan Jordaan

Signature:



Chair: Research Proposal Committee:

Name and Surname:

Signature:

Date:

20 November 2017