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DETERMINANTS OF OCCASIONAL FUEL SHORTAGE AT OSHAKATI, NAMIBIA

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Abstract

The critical role of a fuel-efficient distribution system cannot be under-estimated in a thriving economy. The efficiency of the distribution system is mostly challenged during distress times such as the pressure of the festive seasons; as the increased economic and social activities during this times are highly dependent on an efficient fuel distribution. The main aims of the study included identifying antecedents of fuel supply, determinants of the choice of the fuel station, modes of distribution of fuel on 24 hours supply, delivery challenges experienced during the festive season, causes of fuel shortages and probing for solutions to the fuel shortages problems. The study concludes that antecedents of supply capabilities by fuel stations include historical sales, current sales, increasing demand, strategic position of the fuel station and rail/ road services while delivery challenges identified in the study with regards to festive seasons highlights railway failures, lack of efficient road tankers and inefficient regional depots. The study empirical findings provide that the main causes of the perpetual fuel shortages during festive seasons are mainly failure to efficiently and effectively manage demand and logistics constraints on distribution networks, rail and road services. The study recommends that there is need to increase rail wagons and locomotives, new regional depots and increase both carriage and storage capacity in fuel stations.

Keywords: Fuel shortage, Supply, Seasonal demand, forecasting, Transport Operations

INTRODUCTION

The petroleum industry supply chain is considered to be more inflexible and more complex compared to other industries (Enyinda, Briggs, Obuah & Mbah 2011). Thus, the industry's success is highly depended on the well-observed future demand for petroleum products for both upstream and downstream activities of petroleum supply, such as exploration, refining, distribution, demand forecasting, transportation, storage and marketing. The Namibian National Oil Company, NAMCOR, controls the exploration activities for oil and gas upstream (Ministry of Mines and Energy, 2019) and are currently limited to explorations, marketing and regulations, due to a scarce petroleum resources and no refinery capacities, which makes her solely depended on huge imports from South Africa through the Walvis Bay harbour and rails in lubricants and refineries. The high focus in this study is however placed on downstream activities, i.e**.** Petroleum Supply and Distribution carried out by the 5 licensed fuel retailers; BP Namibia Limited, Caltex Oil (Namibia) (Pty) Ltd, Engen Namibia (Pty) Ltd, Shell Namibia Limited and Total Namibia (Pty) Ltd.

The demand forecasting of petroleum products, as well as an efficient distribution system, becomes a crucial input to managing supply and inventory management. This is evident in the persistent fuel shortage in the northern part of Namibia during the festive season. Shankar, (2001) suggest that a series of physical distribution and order processing activities must be performed in a manner that coordinates cross-functional activities and supply chain integration to deliver products to customers in a cost-effective manner while facilitating the efficient flow of fuel to the retail fueling stations (Swafford, Ghosh & Murthy, 2006). These activities include demand forecasting, order processing, route planning, transportation, procurement, customer service, material control, distribution communications, depot and storage. Poor management of these physical distribution activities leads to poor inventory management resulting in overstock or stock-outs.

The largest ethnic group in Namibia are the Ovambo (49.8%), (Namibian Statistics Agency, 2011), the natives of the northern part of the country. In the course of the year, the majority of these natives reside in different parts (towns) of the country where they are employed and/or in search of good living conditions. It is a norm for the natives of the northern regions to spent their festive seasons with families at their respective places of origin, i.e. the North. Oshakati is considered as the economical capital city to the five northern regions, Omusati, Oshana, Ohangwena, Oshikoto and Kunene region, it has moderate infrastructure and facilities. As a result of natives travelling from all over the country to the northern part of the country, it creates a seasonal increase in demand for all products. Fuel is the central force driving all economic activities, thus an increase in economic activities has a direct influence on the fuel consumption and/or requirement. It is no surprise, since the year 2005, that Oshakati Town has been experiencing a growing concern on fuel shortages days before Christmas celebrations till just over the New Year i.e. from 14 December – 2 January or even later (New Era, 2005). Transportation is the major economic sector in consumption of a large number of petroleum products in the form of petrol and diesel, by 2010 the total consumption of Motor Gasoline was estimated to be 9 200 Barrels per Day, (Namibian Statistics Agency, 2011). This statistic highlights the impact of the fuel shortage on the livelihood and all business activities due to a disruption in the transportation system. (Enyinda et al., 2011) suggest that an uninterrupted flow of oil and gas are important to the economic health of any economy.

This exploratory study was done to identify the logistics factors that may help explain, and thus suggest a solution to the persistent fuel shortages at Oshakati town during festive seasons. The study focuses on Oshakati Engen Namibia (PTY) LTD and Vivo Energy Namibia to determine the factors that affect their supply of and demand for fuel at Oshakati and how these factors change during festive seasons.

LOGISTICAL FACTORS (DISTRIBUTION) INFLUENCING THE SUPPLY OF FUEL

Distribution activities are vital components in a supply process of fuel from supplier to consumers to an extent that these activities could lead to stock-out situation and lost sales if not managed well. The following are distribution management activities:

Customer Service

Even during each fuel shortage crisis, customers desire a reliable service where accurate, complete and timely services are provided. Fuelling service stations in Oshakati town in most cases fail to adhere to the service quality dimensions, (i.e. tangibles, responsiveness, recovery, knowledge, reliability, flexibility and accessibility (Olorunniwo, Hsu and Udo, 2006). Order accuracy and order completeness are important components that organisations like retail fuelling stations should get right to avoid delay in product delivery, stock-outs, and lost sales. Order processing triggers the distribution system process and directs the actions to be taken in satisfying the demand (Welker and Vries, 2005). This is a significant lesson that might yield benefits to retail fuelling stations.

Demand Forecasting

Forecasting of fuel would eliminate predictable variability from future demand stream, allowing for production and distribution to be planned much more precisely (Van Der Merwe, 2005). Forecasting the demand of fuel is a difficult task to accomplish successfully and yet it is more important because lack of knowledge about the demand leads to limited information and resources to develop distribution plans for products among different depots, fuelling stations and customers (Melikoglu, 2014). A company can use a combination of both quantitative and qualitative forecasting techniques to predict demand (Li, Rose & Hensher, 2010). Such techniques consider past historical numerical sales information as well as current market judgment knowledge to construct a good demand forecast. The ability to generate consistently accurate forecasts over time with an analytics-based solution is critical to maintaining profitability (Balasubramanian, 2002). Therefore, fuel distributors can adopt an advanced forecasting technology and processes to enhance demand forecasting processes and address related challenges to work towards improved demand and supply alignment and profitable demand response.

Seasonal Demand

The demand for fuel can become unstable and fluctuates extensively especially during the festive season. It is a seasonal demand, which is a periodic upward fluctuation that occurs every year with about the same time and intensity (Li et al., 2010). Demand fluctuation could result from the economic or business activity which occurs again and again during a year as a result of changes in climate, holidays and vacation (Maharjan, 2012); hence the same applies to the demand for fuel at Oshakati during the festive seasons. The ability for the fuelling stations to match supply and demand is only fruitful when products or services have reached the market where they are wanted or desired on time. Forecasting demand accurately is one side of the coin while on the other side reside the capacity and ability to distribute the products or deliver the services with right quality specifications at the right destinations at the right time and the right price.

Outsourcing

Most transportation activities within the petroleum downstream industry are outsourced because of the lack of specific resources such as railway facilities and hazardous transportation facilities (Tsai, Lai, Lloyd & lin, 2012). Fuelling stations at Oshakati town also lack the recourses required to distribute fuel efficiently. Transportation services are outsourced to the likes of TransNamib Holdings (LTD) and Unitrans Namibia (PTY) LTD, because of lack of transportation equipment and infrastructures. In Namibia, the railway services are managed and operated by TransNamib Holdings (LTD). Hence, outsourcing is ideal and creates value for fuelling stations by supplementing the resources that are costly to develop internally.

Procurement

It is important for fuel distributors such as Engen Namibia (PTY) LTD and Vivo Energy Namibia to ensure that a supplier is reliable and flexible in providing fuel when required by the customers to avoid a stock-out situation that could lead to lost sales and poor customer service. The value lies within the coordination of orders and delivery of fuel while providing a crucial link between suppliers and internal activities (Swafford et al., 2006). Fuel distributors should maintain an integrated and interactive relationship with the fuelling stations and also fosters a fruitful lasting relationship with suppliers to help ensure smooth placement of orders without fuel supply interruptions.

Transportation Operations

Traffic and transportation management controls the movement of petroleum products and performs activities such as selecting the method of shipment (air, rail, pipeline, water, truck); choosing the specific path or routing to be taken by the product; complying with various local, state and federal transportation regulations and being aware of both domestic and international shipping requirements (Jeffs & Hills, 1990). Each mode of transport has challenges and limitations that can cause disruptions in the flow of petroleum products desired by customers at a certain fuelling station. Road mode, for instance, face several challenges in moving petroleum products such as bad roads, theft/robbery, accidents, traffic congestion, mechanical problems, and delays at police and customs checkpoints, short delivery due to evaporation, and diversion of product, inter-state revenue task personnel, delay in salary, and delay in off-loading and old stock of tankers in use (Obasanjo, Francis, and Williams, 2014).

Rail transport mode has an advantage over road mode in terms of weight and safety handling which creates economies of scale as it serves as bulk transport for logistics operators (Woroniuk, Marinov, Zunder and Mortimer, 2013). Despite the absolute advantage of rail mode over the road, rail freight continued to lose a large percentage of market share to road haulage. Matthews (2014) also seconded Woroniuk et al., (2013) on a declining issue of rail freight services. Rail transport is generally underutilised. The infrastructures are rigid and not flexible in the short term and so they inhibit performance by transport. The infrastructures are also hardly maintained, and they continued to be in a poor state.

The third possible mode of transporting fuel within a deadlocked country is the pipeline, which is very safe and secured. It is also the least expensive mode provided whether the requisite volumes of flow and attendant economies of scale are achieved. Freight Pipelines are unseen and unobtrusive but efficient and reliable, and therefore logistics operators have a desired 24-hour delivery time (Egbunike & Potter, 2011). Petroleum pipeline transport is also rarely used because only a few countries have pipeline systems in place; policymakers lack interest and are resistant to change or technological advancement; the benefits of pipeline systems are not fully understood. Intermodal transformation with existing modes might be a challenge. In Sub-Saharan countries, only South Africa and Kenya have petroleum pipeline operation systems (Matthews, 2014).

Transportation decisions are influenced by six parties, namely the shipper (consignor), destination party (consignee), carriers and agents, governments, internet and the public (Sanchez-Rodrigues, Potter, & Naim, 2010). The government desires a stable and efficient transportation environment to support economic growth. The government plays a bigger role in the petroleum market where the price is controlled by monetary policy. The government is involved in oversight of carrier operation and pricing practices by setting legislations that determine basic rules in the transport sector. However, legislation can impose restrictions on logistics companies if they are not sufficiently flexible. Law enforcement such as load limits, speed limits, hazardous regulations, border clearance and transit times ensure security and safety to the public, however, they are bureaucratic and causes inefficiencies in the petroleum delivery schedules.

In agreement with Sanchez-Rodrigues et al., (2010) conceptual model categorising different factors that impact on transport operations. Factors such as road network congestion, supply disruptions and operational problems in offloading and loading; delivery constraints resulting from delivery curfews at customer facilities, limited storage capacity at the depots; volatile demand and information issues caused by seasonality, poor demand forecast error and lack of visibility; legislation; rigid infrastructure; technology; lack of coordination and communication; and intermodal operations had an impact on fuel transport operations at Oshakati Town.

Demand and Supply

Suppliers in the fuel market need to balance the supply of and demand for fuel to avoid over-supply or under-supply. A balance is a situation in which the relevant metrics vary within bounds that allow for a dynamic harmony between supply and demand - a zone of balance (Mack, Jiang, & Peterson, 2013). Fuel distributors and fuelling stations can achieve the balance zone by aligning supply and demand to avoid the inefficiencies associated with over-supply or under-supply (Hymanson, 2013). The fundamental of demand and supply alignment requires an organisations' ability to acquire, interpret and use data that improves decision-making and supports profitability and growth, hence satisfying the demand. The majority of supply chain glitches occur due to lack of alignment between demand planning and supply planning, which results in too much or not enough inventory, or too much/not enough capacity (Lewin, 2003).

The integration of demand & supply should not be underestimated. Research by Walters (2008) also proved that there is a mutually dependent relationship between supply and demand. Demand precisely outline the supply chain target, while the supply chain-side capacities support, shape and sustain demand. To achieve a state-of-the-market supply chain, fuelling stations need to focus on more than just supply efficiencies. They need to integrate their demand and supply regimes to build a platform for achieving a competitive advantage.

Demand is flexible and will always be; therefore it requires flexible supply, which is being truly a "demand-driven" (Walters, 2008). Demand-driven entails immediate sensing of customer demand and an instant supply chain response (SAS Institute Inc., 2008). Becoming demand-driven allows fuelling stations to be more responsive to consumer needs while increasing profitability (Demand-driven supply chains, 2013). A demand-driven supply chain involves transforming a traditional supply chain into an integrated multi-tier supply network; eliminating information latency and unnecessary touchpoints, thereby reducing operating costs and improving profitability and customer service. Supply chain executives should look for ways to obtain real-time, transparent and visibility across all tiers in the supply chain to better align supply with actual demand to help reduce supply disruptions and capital expenses. Balasubramanian (2002) shared a practical scenario of an integrated supply network where each tank at the gas station in California is equipped with an electronic level monitor that conveys real-time information about its status through a cable to the station's management system.

Fuel distributors must develop flexible people, equipment and practices capable of varying the rate of distribution to meet the current rate of demand (SAS Institute Inc., 2008). How a company "senses and responds" to its customers is a primary determinant of its overall success.

Based on the literature review the following was hypothesized, and therefore shown on the following research model;

H1. Historical sales influence the supply or order quantity of fuel during festive seasons.

H2. Current sales influence the supply or order quantity of fuel during festive seasons.

H3. Increasing demand influence the supply or order quantity of fuel during festive seasons.

H4. Location of fuel station influences the supply or order quantity of fuel during festive seasons.

H5. Rail and road services influence the supply or order quantity of fuel during festive seasons.

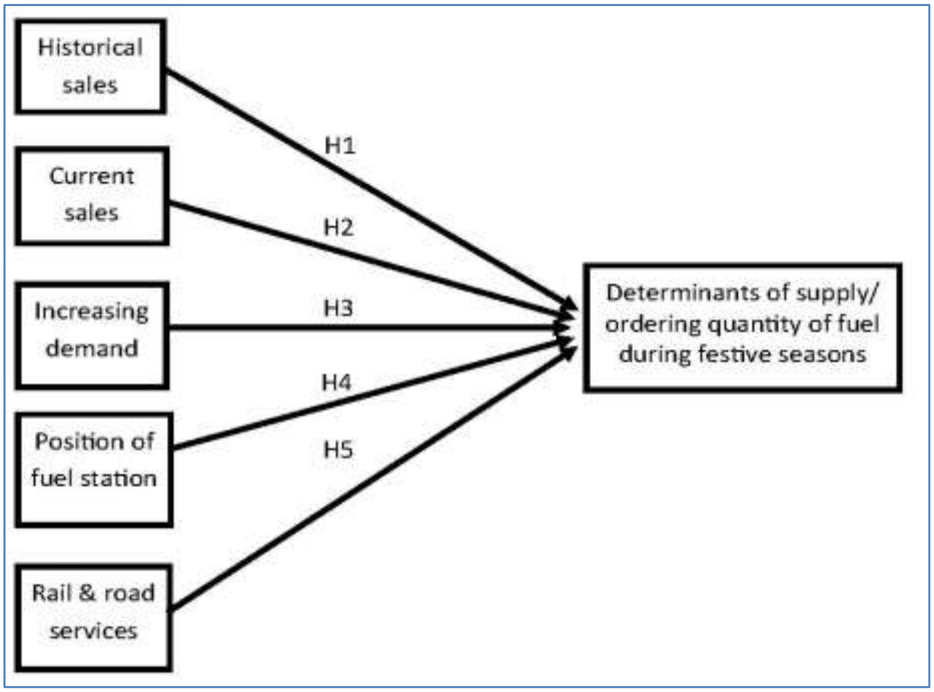

Figure 1: Proposed Research model

METHODOLOGY

This a mixed research study engaging customers and fuelling station distribution team to gain a balanced insight into the fuel supply shortage phenomena and its detrimental effects. A flexible exploratory design was adopted in the study which allowed the dynamics of the study to be discovered, allowing the investigative team to find the causes and suggest solutions to occasional fuel shortages during the festive season. A questionnaire with both closed- and open-ended questions were conveniently distributed to collect the data from the objects under study. The study used a sample size (n) of sixty (60) with fifty-five (55) successful respondents comprising site supervisors, petrol attendants and customers.

RESULTS AND DISCUSSIONS

Table 1: Response rate

	Quantity	**Percentage**
Questionnaires administered	60	100%
Questionnaires returned	55	91.6%

Questionnaires returned (55) were measured against questionnaires issued (60) and there was a 91.6% response rate which is acceptable for further data analysis (Fincham, 2008).

Table 2: KMO AND Bartlett'S Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.640
Bartlett's Test of Sphericity	Approx. Chi-Square	58.262
	df	10
	Sig.	.000

The KMO of 0.640 (acceptable standard is > 0.5 - Field, Miles & Field, 2012) shows that the sample was adequate for data collection or analysis, at a significant Bartlett p-value of 0.000 (acceptable p, 0.001 – Field et al, 2005). The p-value should ideally be below to increase confidence in the fact that there are no data errors and redundant variable, the p-value of 0.000 of this study is adequate.

Table 3 shows a collection of constructs and items that were used the respective constructs.

Table 3: Constructs and items used to measure constructs

Items used to measure determinants of supply/ ordering quantity of fuel	
Historical sales	DSO1
Current sales	DSO2
Increasing demand	DSO3
The strategic position of the fuel station	DSO4
Rail and road services	DSO5
Items used to measure the capacity of fuel carriage and storage	
45 000 Liters	CCS1
50 000 Liters	CCS2
80 000 Liters	CCS3
90 000 Liters	CCS4
Items used to measure delivery challenges during the festive season	
Rail failure	DCF1
Lack of efficient road tankers	DCF2
Inefficient regional depots	DCF3
Items used to measure causes of fuel shortages	
Failure to keep buffer stock	CFS1
Logistical constraints on road and rail	CFS2
Items used to measure suggestion for the persistent fuel shortage	
Increased rail wagons and locomotives	SPF1
New depots	SPF2
Increased carriage and storage capacity	SPF3

Table 4 shows the items extracted from Table 3 with their respective standardized factor loadings, individual item reliability and composite reliability coefficient.

Table 4: Latent construct

	Item	Standardized factor loadings	The individual item reliability coefficient	Composite reliability coefficient
Determinants of supply/ ordering quantity of fuel	DSO1	.817	.680	.817
	DSO2	.829	.696	
	DSO3	.831	.698	
	DSO4	.934	.895	
	DSO5	.672	.523	
Capacity of fuel carriage and storage	CCS1	.744	.596	.802
	CCS2	.784	.641	
	CCS3	.897	.786	
	CCS4	.917	.867	
Delivery challenges during the festive season	DCF1	.731	.582	.789
	DCF2	.781	.637	
	DCF3	.797	.657	
Causes of fuel shortages	CFS1	.930	.833	.921
	CFS2	.959	.889	
Suggestion for occasional fuel shortage	SPF1	.888	.922	.839
	SPF2	.832	.836	
	SPF3	.872	.752	

The acceptable standardized factor loading is 0.6 (Bagozzi & Yi, 1988), individual item reliability is 0.5 (Kuo, Wu & Deng, 2009) while composite reliabilities is 0.7 (Segars, 1997) and Table 4 demonstrated acceptable standards met by the study data. The standardized factor loadings demonstrate the relationship between items in the parenthesis and the main factors, the higher the loading the greater the relationship implying the items used to measure the constructs are correct in this context. Individual item reliability indicates the consistency of a set of items (variables) that is the extent to which they measure the same thing, the higher the reliability the greater the items ability to be consistent and measure the construct correctly. Composite reliabilities, also called construct reliability shows that there is internal consistency similar to Cronbach's alpha. Table 4 shows that the questions used and data obtained is relevant, appropriate for the study and a model can further be constructed.

Table 5: Measurement model fit indices

Fit indices	Initial measurement model	Modified measurement model	Recommended values	Source
Chi-square	1.857	1.103	≤ 3.000	Hair et al. (2010)
GFI	0.904	0.938	> 0.900	Hair et al. (2010)
AGFI	0.899	0.926	> 0.900	Hair et al. (2010)
NFI	0.873	0.901	> 0.900	Hair et al. (2010)
TLI	0.889	0.928	> 0.900	Hooper et al. (2008)
CFI	0.916	0.950	> 0.900	Hair et al. (2010)
RMSEA	0.065	0.038	< 0.080	Hair et al. (2010)

Chi-square/Degrees of Freedom ($\chi 2/DF$), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Normed Fit Index (NFI), Tucker–Lewis Index (TLI), Comparative Fit Index (CFI) and root mean square error of approximation (RMSEA) were used to assess the measurement model. Table 5 shows that both the initial measurement model and modified measurement model falls within acceptable and satisfactory levels to the recommended values, implying that data has an acceptable fit and therefore hypothesis testing can further be conducted.

Table 6: Hypothesis testing

Hypothesis	Standardised estimate	Remark
H1	.731**	H1 supported
H2	.230*	H2 supported
H3	.690**	H3 supported
H4	.539*	H4 supported
H5	.616**	H5 supported

Notes: * $p < 0.05$, ** $p < 0.01$

In testing the initially proclaimed hypothesis, data were subjected to two levels of significance and error, ranging from 0.05 (95% confidence level) to 0.01 (99% confidence level) and H1, H2, H3, H4 and H5 were supported. This implies that the study supports that historical sales (H1), current sales (H2), increasing demand (H3), location of fuel station (H4) and both rail and road services (H5) influence the supply or order quantity of fuel during festive seasons.

CONCLUSION

The study concludes that antecedents of supply or order quantity of fuel by fuel stations include historical sales, current sales, increasing demand, strategic position of fuel station and rail/ road services while delivery challenges identified in the study with regards to festive seasons touches on rail failures, lack of efficient road tankers and inefficient regional depots. The study empirical findings provide that the main causes of serious or perpetual fuel shortages at festive seasons are mainly failure to keep buffer stock and logistics constraints on rail and road services.

RECOMMENDATIONS

To alleviate the impact of occasional fuel shortage crises at Oshakati during festive seasons, among increasing rail wagons and locomotives, new depots and increased carriage and storage capacity, the following recommendations should be implemented;

Supply chain partners synergy

Synergy within the entire fuel supply chain partners may help alleviate shortage crises. Key players within the Namibian petroleum downstream supply chain namely the suppliers, fuel regulator (NAMCOR), fuel retailers, filing stations, depots, third party logistics (3PLs) companies like TransNamib Holdings (LTD) and Unitrans Namibia (PTY) LTD may form collaborative and dependent agreement relationship working towards a common goal of satisfying customers demand and maximizing profit. A fuel shortage crisis at Oshakati during the festive seasons is critical and it is experienced for a long period, individual efforts may not help to resolve this problem. Oshakati town is deep far in the north and lacks infrastructure that enhances the sale or marketing of fuel to customers in a timely and satisfactory manner.

Storage facilities

Petroleum downstream supply chain team in Namibia may consider long term solutions such as a need to build large reservoir tank or increase the number of depots in Oshakati town or nearby area like Ondangwa to facilitate storage of fuel so that they can accommodate all service stations in the northern regions. This suggestion implies that this is a long term investment that requires a huge amount of time, money and resources such as land. It is worth noting the increase in economic activities in the northern part of the region indicates that a lack of sufficient storage facilities will render the fuel shortages not only a seasonal problem but will eventually become a way of life if not addressed.

Transport infrastructure

The coordinated effort of petroleum downstream supply chain team in Namibia may give sound recommendations on maintaining Railway infrastructures to the government of the Republic of Namibia. This could be done by influencing the government of Namibia to realise the economic value of railway services by conducting informative session and seminars with the Ministry of Works and Transport. A good image of railway services could serve as a testimony, which attracts or encourages international trade because Namibia is strategically positioned, with the Atlantic Ocean which facilitates trade with other countries. If railway terminals are maintained, then the total cost of ownership could be realised via rail transport mode because Namibia is connected to seven neighbouring countries.

There is a high possibility that an integrated petroleum downstream supply chain team may achieve the alignment of demand for fuel with a supply of fuel at Oshakati town. If the above recommendations materialized, it will be easier to align all physical distribution activities such *as* inventory control, demand forecasting, distribution communications, materials handling, order processing, procurement, traffic and transportation and storage of fuel to balance supply and demand of fuel. Forecasting of fuel demand may not be compromised or influenced by the capacity of storage tanks or lack of reservoir depots. Fuel may also be ordered on time during the festive seasons

Collaborative forecasting

Supply Chain is grounded on the concepts of collaboration and the creation and use of connections that exist between chain members to provide timely and reliable information that will progress the productivity for everyone. Collaborated demand management is crucial in sustaining visibility, increasing velocity while reducing variability in the entire supply chain. To counteract the fuel shortages in the northern part of Namibia, a collaborated and integrated forecasting approaches supported by the adoption and utilisation of forecasting tools to manage demand is crucial. This will require supply chain members to coordinate and synchronise operations and systems (Van Der Merwe, 2005) to ensure available data is used to make well-informed decisions driving the attainment of the chain strategic goals.

LIMITATIONS OF THE STUDY

The limitations encountered during the course of this study relate to firstly, its focus on festive seasons, the seasonality timing of the study entail that the study may not be able to explain other factors outside this period which may lead to a shortage of fuel supply. Secondly, the geographic scope of the study (Oshakati) means that the factors identified herein may not be applicable to other regions.

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