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INVENTORY FORECASTING AND CONTROL DECISIONS FOR EFFECTIVE INVENTORY MANAGEMENT IN THE SOUTH AFRICAN AUTOMOTIVE COMPONENT MANUFACTURING INDUSTRY: PRE COVID-19 AND LOCKDOWN PERIOD

Sandra Perks
Corresponding Author: Nelson Mandela University, South Africa
Email: Sandra.perks@mandela.ac.za

Jason Delport
Nelson Mandela University, South Africa
Email: s221454551@mandela.ac.za

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Abstract

The COVID-19 global health pandemic significantly affected the global economy and the automotive industry when lockdown measures were implemented. This study seeks to investigate the influence of inventory forecasting and control decisions on effective inventory management in the South African automotive component manufacturing (SAACM) industry. Using a positivistic paradigm with a quantitative research approach, data was sourced from 162 Automotive Component Manufacturers (ACMs) to establish whether their inventory forecasting and control decisions changed from prior COVID-19 to the lockdown period during the COVID-19 pandemic. The multiple regression analysis found statistically significant relationships between inventory forecasting decisions and effective inventory management prior to COVID-19, inventory control decisions and effective inventory management prior to COVID-19 and inventory forecasting decisions and effective inventory management during the lockdown period. Thus, regardless of the COVID-19 pandemic, inventory managers in ACMs in South Africa (SA) should use inventory forecasting methods such as demand forecasting, economic order quantity and materials requirement planning. They should further consider using an inventory information sharing system and inventory replenishment procedure to manage inventory more effectively.

Keywords: COVID-19, Effective Inventory Management, Inventory Forecasting, Inventory Control, Lockdown Period, South Africa

1. Introduction

The automotive industry represents an increasingly important strategic role in the South African economy as it directly influences the government's economic policy goals, such as contribution to Gross Domestic Product (GDP), providing employment, staff skills development and substantial foreign direct investment (Export.gov, 2019). In SA, the automotive industry is the third largest economic sector and adds more than 29% to the country's industrial manufacturing, and during 2020 it contributed 4.9% to the nation's GDP (AIEC, 2021). In 2019, exports of automotive goods reached a record R178,8 billion and investments amounted to R3,5 billion in the automotive component manufacturing industry (AIEC, 2020).

In 2020, the world was hit by the COVID-19 health pandemic which significantly affected the global economy (ReportLinker, 2020). Lockdown restriction measures were implemented by governments to prevent the spread of the virus and doing so delayed the manufacturing of new vehicles in the automotive manufacturing industries (ReportLinker, 2020). In SA, a full lockdown was implemented from 26 March 2020 and the relief on some lockdown restriction measures came on 01 May 2020 to return to 50% manufacturing capacity (Rumney, 2020). As the global automotive industry was already faced with declining vehicle sales and rapidly changing customer demand in 2019, the COVID-19 global pandemic affected every aspect of the automotive industry from the manufacturing of new vehicles and automotive components to the sale of vehicles at dealer outlets (OICA, 2021). The shutting down of underused plants was evident, especially in the European region, with idle manufacturing space and at that point no income generation from vehicle sales for Original Equipment Manufacturers (OEMs) (Ewing, 2020).

In SA, the SAACM industry consists of a diverse group of various tier-level automotive suppliers with a sales turnover amounting to R78 billion in 2020, of which almost 50% were sales made to local OEMs and the balance went to exports of components and aftermarket sales (AIEC, 2021). The goal of the SAACM industry is to supply components quickly with dependable conveyance at the most reduced cost, especially when the OEM's inventory is low (De Villiers *et al*. 2017). The SAACM industry needs to compete with global automotive suppliers to remain relevant and to increase their local and global market share (Naude and Badenhorst-Weiss, 2012). This is especially important as the ACM industry is not as competitive as those in other developing countries and should therefore improve their local supply base to enable expansion (Lamprecht and Tolmay, 2017). However, for the SAACM industry to stay relevant and competitive, it needs to pay attention to OEMs as they are reducing the number of suppliers to manage a more efficient supply chain (Tolmay and Badenhorst-Weiss, 2015).

Due to COVID-19, one of the issues that the automotive industry must pay attention to for recovery is to ensure that they manage their inventory effectively as it can create a competitive advantage for any business at any time (Atnafu and Balda, 2018). Inventory management decisions include the planning and control of inventory, to make a product accessible to the customer (Bowersox *et al*. 2013). South African manufacturing businesses are frequently faced with inventory problems such as unnecessary stock, out of stock items, delays in raw material deliveries and inventory record discrepancies due to poor inventory management (Chan *et al*. 2017). By not implementing inventory planning and control systems, local businesses experience high inventory costs, poor customer service, increased wastage due to inventory obsolescence and poor inventory recordkeeping (Disney *et al*. 2016).

Therefore, it is important to make sound inventory decisions for effective inventory management in the SAACM industry. This leads to the problem in the investigation for this article, to determine which inventory forecasting and control decisions leads to effective inventory management in the SAACM industry prior to the COVID-19 pandemic and during the lockdown period.

This article will show which inventory decisions are important regardless of the influence of the COVID-19 pandemic, which is important prior to COVID-19 and during the lockdown period. This paper therefore contributes to theory in that it identifies which inventory forecasting decisions are always important in the automotive sector regardless of occurrences in the business environment or even during a very disruptive business environment pandemic such as COVID-19. It further shows the changes in inventory forecasting in the automotive sector from prior to COVID-19 to during the lockdown period. However, confirmation which and if these changes may remain or revert to the prior to COVID-19 period after the complete lifting of lockdown restrictions, is required. The article also confirms that there was no need for inventory control decisions during the COVID-19 lock-down period. However, retesting of the inventory control decisions is required to confirm whether this is still the case after the lifting of the lockdown period.

2. Effective inventory management

Inventory management is a high-risk decision and, as such, a business should decide between the cost of having inventory available and being out of stock (Badenhorst-Weiss *et al*. 2017). Wauran *et al*. (2018) assert that inventory accounts for 40% of the total capital investment in a business, therefore important for business continuity. Effective inventory management requires ensuring continuous inventory availability to avoid unnecessary manufacturing stoppages and the potential to lose customer sales (Botha *et al.* 2017; Coyle *et al.* 2017). To manage inventory effectively, businesses need to ensure that there is an effortless flow of inventory items within the warehouse but with reduced materials handling (Shah and Khanzode, 2017). Incoming raw material deliveries must be monitored to ensure that the standards of the prescribed inventory specifications are met (Badenhorst-Weiss *et al.* 2017). Wisner *et al.* (2019) indicate that businesses should continuously monitor the quality of the purchased components to ensure that poor quality material is identified and returned to suppliers. To prevent inventory shortages, businesses must communicate any inventory shortage information immediately to the suppliers (Govind *et al.* 2017).

Effective inventory management also requires sound warehouse management relating to easy retrieval of inventory items and this requires that there are adequate warehouse staff (Onckocke and Wanyoike, 2016). Jaqueta *et al.* (2020) remind businesses to ensure that customer demands and service levels are met by consistently supplying them with the right inventory items. Customers also expect reliable, on time delivery of final products (Coyle *et al.* 2017). Masnita *et al*. (2017) advise that the delivery of the correct raw material by suppliers should be monitored to ensure that customer order demands are met. Stone (2011) states that businesses that address customer complaints and inventory queries improve customer satisfaction. Technology can be used to generate accurate customer billing and invoices and eliminate manual customer invoice information errors (Ali and Asif, 2012).

It must be noted that the aim of this study was to determine inventory forecasting and control decisions prior to COVID-19 and to use the same items to test how and if these decisions changed during the lockdown period. Literature pertaining to COVID-19 related studies was thus not deemed suitable for testing prior to COVID-19 inventory decisions. The literature was used to develop the items to be tested for inventory forecasting decisions and inventory control decisions constructs as further shown in the operationalization of the constructs.

2.1. Inventory forecasting decisions

Inventory forecasting decisions are about the estimation of future inventory demand according to the order quantity, lead times and inventory planning in determining the reorder points (Govind *et al*. 2017). Chan *et al*. (2017) specifically find that a significant relationship exists between inventory forecasting and effective inventory planning. Another study by Oppermann (2018) also confirms the positive relationship between inventory forecasting and effective inventory management.

Muchaendepi *et al*. (2019) advise that when making inventory forecasting decisions, a business should use a master manufacturing plan that outlines procedures, rules and records regarding when to schedule orders for the parts and components needed to manufacture the final product. Inventory forecasting requires that a business make sound decisions about protecting itself against demand variability (Coyle *et al*. 2017). Continuous monitoring to ensure there is enough safety stock is advantageous if wishing to cope with customer demand uncertainty (Shen *et al.* 2017). It is thus important to correctly forecast inventory demand to ensure the right inventory is available when required to minimize the risk of losing customer sales due to inventory being unavailable. Through the sharing of inventory forecast information, businesses can accurately forecast how many inventory items are needed for manufacturing (Ali *et al*. 2012).

One of the methods that can be used to forecast inventory order needs for the manufacturing of final products is Economic Order Quantity (EOQ) (Atnafu and Balda, 2018). EOQ can assist in forecasting what is regarded as the ideal inventory purchasing quantity for replenishment (Ogbo *et al*. 2014). To accurately plan the required raw material needed for the manufacturing of final products, a Materials Requirement Planning (MRP) system is useful as it updates the bill of materials for each inventory item (Wisner *et al*. 2019).

Forecasting inventory requires determining the right time to schedule orders as delivery times should be considered to fine-tune inventory levels, based on real customer demand (Onchoke and Wanyoike, 2016). Delivery time is the time that suppliers take to deliver the inventory to the customer (Lester, 2017). Evaluating the delivery time of incoming raw material is thus a critical decision in determining inventory availability necessary for the manufacturing of final products (Kanakana and Laseinde, 2016). Wisner *et al*. (2019) recommend calculating the re-order level based on the minimum inventory level required for each inventory type. Sohail and Sheikh (2018) propose the monitoring and adjusting of safety stock levels as inventory lead times change. They further advise that the optimal re-order level should preferably be the same order quantity each time that the inventory needs replenishment. In addition to forecasting inventory demand accurately, inventory should be controlled daily.

2.2. Inventory control decisions

Ogbo *et al*. (2014) find a positive relationship between inventory control and effective inventory management. They assert that inventory control is crucial for managing inventory effectively for high manufacturing performance. In addition, Radzuan *et al*. (2014) find a direct link between inventory control practices and effective inventory management that highlights the importance of inventory monitoring and inventory replenishment decisions. Inventory control decisions are about monitoring inventory status, inventory tracking, confirming the accuracy thereof, sharing inventory information and inventory replenishment (Belalia and Ghaiti, 2016).

The first step in inventory control is to check the status of all inventories (Tundura and Wanyoike, 2016). Mukoya and John (2019) propose using an electronic inventory status system for inventory control. Due to the various types of inventories held within a business, finding a good inventory tracking system is crucial in identifying and tracking inventory items (Onkundi and Bichanga, 2016). In Africa, there are various developments concerning inventory control software assisting with inventory levels (Tundura and Wanyoike, 2016). One of the most used systems to access efficient and accurate inventory information is barcoding and radio frequency identification (RFID) (Kiswii and Wandera, 2019). This inventory tracking system can also be used to monitor the accurate location and movement of inventory items at the storage locations (Kiswii and Wandera, 2019).

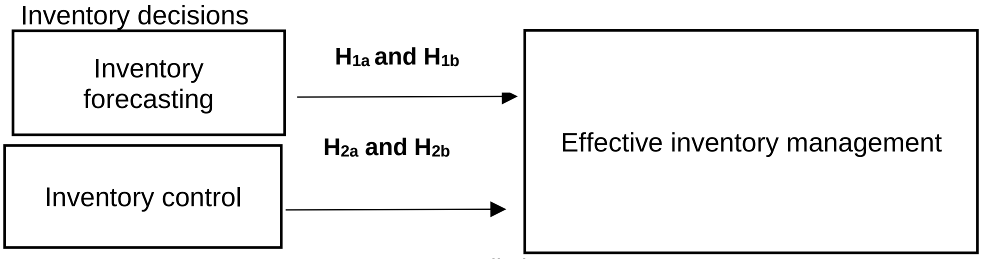
A study by Tundura and Wanyoike (2016) states that, to maintain accurate inventory records, a business can use daily cycle counting. In addition, conducting inventory audits can assist in identifying incorrect inventory counts (Onchoke and Wanyoike, 2016). It is essential to audit inventory to accurately determine whether the physical inventory on hand matches the inventory information on the inventory record system (Al Barrak *et al*. 2017). Auditing inventory item quantities is thus important to ensure accurate inventory recordkeeping to prevent inventory shortages (Coyle *et al*. 2017). Another inventory control decision is about how to share inventory information throughout the supply chain to avoid inventory stock outs as far as possible (Afolabi *et al*. 2017).

An information sharing system is a useful communication tool for sharing customer demand variabilities along the supply chain (Papanagnou, 2021). Dealing with demand variability to avoid excessive inventory levels requires taking into consideration direct customer demand information (Tundura and Wanyoike, 2016). It makes good business sense to keep inventory levels to a minimum to cope with demand variabilities (Multanen, 2011). An inventory replenishment procedure can indicate how much inventory must be re-ordered and aligned with the inventory replenishment cycle (Chopra and Mendl, 2016; Shah and Khanzode, 2017).

2.3. Hypothesized model of inventory forecasting planning and control for effective inventory management

The literature review guides the development of the hypothesized model as seen below.

Figure 1. Hypothesized model of inventory forecasting and control decisions for effective inventory management



Source: Own compilation

It must be noted this hypothesized model was extracted from a larger study. All good studies require the operationalization of the constructs of the study. The operationalization of the constructs is based on the preceding literature and contains the items used to test the constructs. Table 1 presents the operational definitions of the constructs tested in the study.

Table 1. Operational definitions of the constructs

Operationalization of constructs	Authors
Inventory forecasting decisions are about ensuring adequate inventory is available by taking into consideration customer demand variability, delivery time, component order needs, economic order quantities and optimal re-order inventory levels.	Ali *et al*. (2012); Atnafu and Balda (2018); Chan *et al*. (2017); Coyle *et al*. (2017); Govind *et al*. (2017); Kanakana and Laseinde (2016); Lester (2017); Muchaendepi *et al*. (2019); Ogbo *et al*. (2014); Onchoke and Wanyoike (2016); Oppermann (2018); Shen *et al. (*2017); Sohail and Sheikh (2018); Wisner *et al*. *(*2019)
Inventory control decisions are about using inventory auditing procedures and inventory systems that can identify inventory status, track inventory, and share information about inventory levels for timeous inventory replenishment.	Afolabi *et al.* (2017); Al Barrak *et al.* (2017); Belalia and Ghaiti (2016); Chopra and Mendl (2016); Coyle *et al.* (2017); Kiswii and Wandera (2019); Mukoya and John (2019); Multanen (2011); Ogbo *et al.* (2014); Onchoke and Wanyoike (2016); Onkundi and Bichanga (2016); Papanagnou (2021); Radzuan *et al*. (2014); Shah and Khanzode (2017); Tundura and Wanyoike (2016)
Effective inventory management is about ensuring customer satisfaction by consistently supplying the required inventory quantity and quality that meet their specifications at the right time and address queries and complaints promptly, while considering having adequate stock levels for operations, keeping accurate inventory records for customer and supplier billing and minimizing warehouse inventory handling costs.	Ali and Asif (2012); Badenhorst-Weiss *et al.* (2017); Botha *et al.* (2017); Coyle *et al.* (2017); Govind *et al.* (2017); Jaqueta *et al.* (2020); Masnita *et al*. (2017); Onchoke and Wanyoike (2016); Shah and Khanzode (2017); Stone (2011); Wauran *et al*. (2018); Wisner *et al.* (2019)

To establish which inventory forecasting and control decisions influence effective inventory management of ACMs, the following hypotheses were formulated and tested:

H_{1a}: Inventory forecasting decisions prior to COVID-19 influence effective inventory management of ACMs.

H_{1b}: Inventory forecasting decisions during the lockdown period influence effective inventory management of ACMs.

H_{2a}: Inventory control decisions prior to COVID-19 influence effective inventory management of ACMs.

H_{2b}: Inventory control decisions during the lockdown period influence effective inventory management of ACMs.

3. Methodology

This study utilizes the positivistic research paradigm associated with the quantitative research approach that employs the computing and analysis of data collected to try and answer the questions asked (Rahman, 2016). The target population for this study is the ACMs in SA. The South African motor industry operates in the Eastern Cape, Gauteng and KwaZulu Natal provinces and to lesser extent in the North West and Western Cape provinces (Tolmay and Badenhorst-Weiss, 2015). The automotive industry in SA comprises the local OEMs, other international OEMs and automotive suppliers (NAAMSA, 2020). According to NAAMSA (2020), an estimated 500 ACM suppliers exist in SA, of which 153 registered ACMs are associated with the National Association of Automotive Component and Allied Manufacturers (NAACAM) (AIEC, 2020). NAACAM represents the interest of 153 ACMs, and the Retail Motor Industry Organisation (RMI) represents the interests of the vehicle dealerships in SA. Data was sourced from 153 ACMs across all provinces in SA using nonprobability judgement sampling. Only those employed as logistics managers, supply chain managers, production supervisors, master production schedulers, cycle count operators and warehouse staff were invited to participate as they are regarded as the most knowledgeable about effective inventory management. A list of ACMs members of NAACAM was obtained at the time of data collection.

The literature discussion in the article (content validity) informs the new measuring scale as there was no existing scale to test both for prior to COVID-19 and during the lockdown period. With the same items tested it allows for showing changes in inventory forecasting and control decisions made prior to COVID-19 and during the lockdown period. Five newly developed items each test inventory forecasting and inventory control decisions using a 5-point Likert scale varying from strongly agree (5) to strongly disagree (1) while 20 items test effective inventory management. The internet-based questionnaire link on Google Forms was sent to the contact person on the NAACAM's list employed in the 153 ACMs for distribution to the identified participant groups. The questionnaire was pre-tested by an academic expert in supply chain management for face validity. A pilot study of thirty respondents was surveyed to further eliminate problems prior to distribution to the full sample.

After data cleaning, the data analysis of 162 usable questionnaires took place using the statistical computer package STATISTICA 14. Using exploratory factor analysis (EFA), the measuring instrument validation was by only considering factor loadings above 0.5 without cross loadings. A Cronbach's alpha cut-off point of at least 0.7 confirming factor reliability (Hair *et al*. 2014). Both descriptive and inferential statistics were calculated. Inferential statistics calculated include the Pearson product-moment correlation coefficient to establish the association between the independent constructs, as well as with the dependent variable (Walker, 2017) and Multiple Regression Analysis (MRA) to determine the cause-and-effect relationships between the independent and dependent constructs (Uyanik and Guler, 2013).

4. Empirical results

The demographic data reveals that 22% of the respondents are master production schedulers, followed by warehouse staff (20%), production supervisors (19%), supply chain managers (17%), logistics managers (12%) and 10% are cycle count operators. Just more than one third of respondents (34%) have 16 to 20 years working experience in total, followed by 11 to 15 years (25%) and more than 20 years (22%). The remainder of the respondents indicates that they have six to 10 years (15%), and two to five (4%) years in total working experience.

Nearly one third of respondents (33%) have six to 10 years working experience within the automotive industry, followed by a quarter (25%) between 11 and 15 years and 17% between 16 and 20 years. Only 14% of respondents had 2 to 5 years working experience in the automotive industry and 11% more than 20 years. A significant number of respondents (41%) are employed in their current position six to ten years, followed by almost one third (31%) being in their current position two to five years and between 11 and 15 years (15%). Only a few respondents' (9% and 4% respectively) are in their current position for 16 to 20 years or more than 20 years.

For prior to COVID-19, three constructs were extracted (inventory forecasting decisions, inventory control decisions and effective inventory management), while only two constructs (inventory forecasting decisions and effective inventory management) for during the lockdown period. Inventory control decisions for during lockdown had less than three items with the minimum factor loading, thus not meeting construct validity requirements. Table 1 represents the factor extraction analysis, validity and reliability statistics for the items prior to COVID-19 and during the lockdown period. During the lockdown period is indicated in brackets.

Table 1. Results of the factor extraction analysis, validity and reliability statistics for prior to COVID-19 and during the lockdown period

Constructs	Retained items	Factor loadings		Eigenvalue	Cronbach's alpha
		Minimum	Maximum		
Inventory forecasting decisions	4 (6)	0.549 (0.633)	0.812 (0.752)	5.74 (6.29)	0.748 (0.841)
Inventory control decisions	4	0.579	0.718	1.24	0.779
Effective inventory management	19 (16)	0.526 (0.502)	0.824 (0.809)	8.82 (7.85)	0.924 (0.904)

Source: Author's own preparation

The Eigenvalues of the extracted constructs all exceeded 1. All constructs are deemed reliable with Cronbach's alpha values higher than 0.7.

Of the five items testing inventory forecasting decisions, sticking to specific re-order inventory levels to allow for adequate replenishment time plays a role during the lockdown period but not for prior to COVID-19. However, during the lockdown period, analyzing lead time of incoming raw material to ensure inventory availability prior to production, play a role whereas it did not prior to COVID-19. One of the five items testing inventory forecasting decisions for prior to Covid-19 (analyzing the lead time of incoming raw material to ensure inventory availability prior to production) loads onto inventory control**.** These findings are in congruence with other literature studies. Several authors (Govind *et al*. 2017; Kontus 2014) note that inventory forecasting decisions are critical for the estimation of future inventory order quantities, to take into consideration the lead time of orders and to plan inventory re-order points to ensure inventory is available to support customer orders in a pre-COVID study. Furthermore, businesses regard determining the optimal re-order levels for ordering inventory required for manufacturing as vital for manufacturing (Sohail and Sheikh, 2018). Businesses that accurately calculate the inventory order size can cope with customer demand uncertainty and avoid having excessive inventory levels (Posazhennikova and Kravchenkova, 2012). Wisner *et al*. (2019) note that it is vital for businesses to accurately plan the required incoming raw material needed for the manufacturing of final products. Muchaendepi *et al*. (2019) further add that businesses using a manufacturing planning tool in determining the exact scheduling of the components to ensure that the correct final products are manufactured as required. Because of the lockdown restrictions implemented by countries since COVID-19, businesses did not consider ordering inventory to the specific re-order levels required as the inventory levels were revised based on the reduced global vehicle demand (AIEC, 2021).

Various authors confirm that prior to COVID-19, inventory control decisions were important as they tracked and monitored inventory to ensure that accurate inventory information was shared for the timely replenishment of the inventory (Belalia and Ghaiti, 2016; Ogbo *et al*. 2014). However, for during the lockdown period, none of the five inventory control items tested was retained as two of the items that test sharing inventory levels to identify inventory demand fluctuations using an information system and having an inventory replenishment procedure to ensure continuous ordering of required inventory items, also load onto the inventory forecasting construct. Two other items intended to measure inventory control load onto other constructs in the broader study that is not the focus of this article. One of the items had a factor loading of less than 0.5.

However, of the 20 items that test effective inventory management, ensuring fast inventory picking by having adequate warehouse staff does not play a role prior to COVID-19 but do during the lockdown period. This finding confirms that although the respondents in this study do not regard it as such prior to COVID-19, several authors (Shah and Khanzode, 2017; Wauran *et al*. 2018) confirm that effective inventory management is an effortless flow of inventory items within the warehouse that reduces materials handling. In addition, effective inventory management issues prior to COVID-19 relating to reducing inventory carrying cost, reducing inventory handling in warehouses, providing adequate safety stock levels for uncertain times and adequate safety stock levels for uncertain times, as well as supplying customers with the right products at the right times, are not regarded as important during the lockdown period. Because of the lockdown restrictions implemented by countries during the lockdown period, businesses could not operate so stock levels did not require planning or control during the vehicle manufacturing shutdown.

Table 2 summarizes the results of the descriptive statistics of the constructs for prior to COVID-19 and during the lockdown period.

Table 2. Descriptive statistics of the constructs prior to Covid-19 and during the lockdown period

Constructs **Prior to COVID-19 and (During lockdown period)**	**Mean**	**Standard deviation**
Inventory forecasting decisions	4.017 (4.221)	0.583 (0.553)
Inventory control decisions	4.070	0.583
Effective inventory management	4.341 (4.427)	0.433 (0.456)

All constructs have means that tended toward agreement (4) with means ranging from 4.017 to 4.427 indicating that the respondents in the SAACM industry agree that the issues tested for inventory forecasting and control decisions and effective inventory management were relevant to the constructs. All standard deviations are moderately low ranging from 0.433 to 0.583 which indicates relatively low response variances.

Table 3 presents the correlation matrix of the independent and dependent constructs for prior to COVID-19 and during the lockdown period.

Table 3. Correlation matrix of the constructs for prior to Covid-19 and during the lockdown period

Constructs **Prior to COVID-19 and (During lockdown period)**	**IM**	**IF**	**IC**
Effective inventory management	1.000		
Inventory forecasting decisions	0.491 (0.535)	1.000	
Inventory control decisions	0.546	0.553	1.000

It must be noted that the same items did not necessarily load for prior to COVID-19 and during the lockdown period for inventory forecasting decisions and effective inventory management. However, some items both load for prior to COVID-19 and during the lockdown period. Based on the information contained in Table 3, for both prior to COVID-19 and during the lockdown period, moderate associations are reported for effective inventory management with inventory forecasting decisions. Respondents thus associate inventory forecasting decisions, regardless of the presence of a pandemic such as COVID-19, as somewhat related to effective inventory management. Furthermore, for effective inventory management, a moderate association is reported with inventory control decisions prior to COVID-19. Respondents thus associated inventory control decisions for prior to COVID-19 as somewhat related to effective inventory management during the lockdown period. Table 3 further shows that for inventory forecasting decisions, a moderate association is reported with inventory control decisions prior to Covid-19. Respondents thus associated inventory control decisions for prior to COVID-19 as somewhat related to inventory forecasting decisions.

The multi-collinearity results for prior to COVID-19 and during the lockdown period show tolerance values varying from 0.559 to 0.916, which are more than the acceptable limit of 0.1. In addition, the Variance Inflation Factor values of the constructs are below the threshold of 10, varying from 1.091 to 1.789. These results suggest that the constructs are free from multi-collinearity problems and multiple regression analysis can be conducted. Table 4 summarizes the results of the multi regression analysis for the constructs prior COVID-19. During the lockdown period is indicated in brackets.

Table 4. Multiple regression analysis results prior to COVID-19 and during the lockdown period

Dependent variable: Effective inventory management R^2= 0.454 R^2= (0.301)				**Hypotheses**	
Independent constructs	**Beta**	**t-value**	**Sig. (p)**		
Inventory forecasting decisions	0.138	2.597	0.010*	H_{1a}	Supported
	(0.367)	(5.525)	(0.000**)	H_{1b}	Supported
Inventory control decisions	0.200	3.673	0.000**	H_{2a}	Supported

Note: *p<0.05; **p<0.001

Table 4 shows that 45.4% of the variance in effective inventory management can be explained by independent constructs while 30.1% for during the lockdown period. Evidence of a significant statistical relationships are found between inventory forecasting decisions and effective inventory management prior to COVID-19 at $p<0.05$ and during the lockdown period at $p<0.001$. A statistically significant relationship exists between inventory control decisions and effective inventory management prior to COVID-19 at $p<0.001$. This is evident from the t-values which exceed the critical value of 1.96 at a significance level of 0.05 and between 1.96 and 3.09 at a significance level of 0.001. The beta value for inventory forecasting decisions prior to Covid-19 reveals a weak positive influence on effective inventory management, while for during the lockdown period a moderate positive influence on effective inventory management.

Nikolopoulos *et al*. (2020) confirm that although inventory forecasting has always played a pivotal role in effective inventory management, it received prominence during the lockdown period. It seems that the inventory forecasting of ACMs in SA to stick to specific re-order levels to allow for adequate replenishment time only deemed important prior to Covid-19. A prior to COVID-19 study by Sohail and Sheikh (2018) finds that businesses that determine the optimal re-order levels method considers ordering inventory in the same quantity each time inventory is replenished. With most countries on lockdown restrictions due to the Covid-19 pandemic, it was difficult to source raw materials, therefore ACMs in SA seem to regard having enough inventory levels to handle customer demand variabilities as critical for inventory forecasting (AIEC, 2021). To have improved inventory forecasting during the lockdown period, it was increasingly vital for businesses to consider the lead time of incoming raw materials required for the manufacturing of final products. The expected lead time became longer for businesses to source raw material from new suppliers as some supplier businesses closed due to the negative financial impact of the COVID-19 pandemic on their businesses (Huang *et al*. 2021). Conceição *et al*. (2021) suggest that with the rapid demand fluctuations that COVID-19 caused, real-time electronic inventory information sharing between businesses could promote more accurate inventory forecasting decisions and avoid over- and understocking of inventory items. That may prevent businesses from having obsolete inventory items or frequent inventory stock-outs. Furthermore, in a during lockdown COVID-19 study of Penny *et al*. (2021), it was confirmed that businesses need to place a strong emphasis on following an inventory replenishment procedure as it can be costly if inventory is not ordered based on confirmed customer orders as it can increase inventory levels and inventory holding cost if inventory is remaining on the shelves and not bought.

Various authors confirm that for businesses to manage inventory effectively prior to COVID-19, inventory control decisions are important as they must track and monitor inventory to accurately share inventory information for timely inventory replenishment (Belalia and Ghaiti, 2016; Ogbo *et al*. 2014). Businesses must thus accurately determine the delivery time of the required incoming raw material to allow for continuously available inventory for manufacturing of final products (Wauna and Obwogi, 2015). Kanakana and Laseinde (2016) confirm that evaluating the delivery time of incoming raw materials is pivotal in determining the inventory availability before the manufacturing of final products. Tundura and Wanyoike (2016) confirm that businesses that use an electronic inventory system can more effectively manage their inventory as the status of different types of inventories can be speedily identified. Businesses that use a computerized inventory tracking system manage their inventory more effectively as they can accurately identify the location and movement of inventory items (Enow and Isaacs, 2016). Enow and Isaacs (2016) and Kimaiyo and Ochiri (2014) concur that an inventory tracking system is useful for accurately monitoring the movement of inventory items. Lofti *et al*. (2013) further note that businesses that implement an effective information sharing system can manage their inventory more effectively as it enables a business to notice any customer demand fluctuations more quickly. To manage inventory more effectively, Bozarth and Handfield (2013) advise that businesses follow an inventory replenishment procedure to ensure that inventory items are ordered and available when needed for manufacturing. Multanen (2011) states that businesses must make sound inventory control decisions to keep their inventory levels to a minimum based on the replenishment cycle.

However, during the lockdown period, inventory control decisions for ACMs in SA seem not to influence effective inventory management. Studies by Conceição *et al*. 2021 and Sudan and Taggar (2021) during and post the lockdown period contradict the finding in this study. However, these studies are not on the motor vehicle manufacturing sector. It is acknowledged that as ACMs in SA in 2022 are in full production with all lockdown restrictions lifted, inventory control decisions may again have become important for effective inventory management.

5. **Conclusions and recommendations**

ACMs in SA deem inventory forecasting as influential for effective inventory management prior to COVID-19 and during the lockdown period but to a more significant extent during the lockdown period. It appears that ACMs in SA have always taken into consideration customer demand variability to avoid overstocking, use EOQ to order items and update their bill of materials when needed to accurately determine the inventory needed to produce the final product. Prior to COVID-19, ACMs in SA ensure that they stuck to specific re-order inventory levels to allow for adequate replenishment time. However, during the lockdown period, they seem to focus more on inventory forecasting decisions such as analyzing lead times of incoming raw material to ensure inventory is available prior to production. When lockdown restrictions were in place delivery of items took longer due to travel time curfews. Prior to Covid-19 ACMs in SA regard inventory control decisions as sharing inventory levels to identify inventory demand fluctuations via an information system and using an inventory replenishment procedure to ensure continuous ordering of the required inventory items, whereas during the lockdown period it is inventory forecasting decisions.

Whereas inventory control decisions prior to Covid-19 influence effective inventory management of ACMs in SA, it is not so during the lockdown period. These results may differ currently (2023) as the data was sourced in late 2020. The inventory control decisions prior to Covid-19 that are important related to the analysis of lead time of incoming raw materials, using an electronic system to identify inventory status specification and for tracking the movement of inventory items, inventory level sharing and replenishment procedure to ensure continuous ordering of required items.

Prior to COVID-19 and during the lockdown period, effective inventory management is about accurate inventory recordkeeping and auditing, reducing inventory stock-out costs by monitoring safety stock levels, ensuring suppliers met product specifications and on-time delivery and meeting customer demand and quality specifications, together with correct invoicing and billing. However, reducing inventory carrying costs, reducing materials handling within the warehouse, providing adequate safety stock levels for uncertain times, and supplying customers with the right products always are only important prior to COVID-19. During the lockdown period, ensuring fast inventory picking by having adequate warehouse staff is important, even though businesses were not being fully operational during the pandemic due to the lockdown restrictions.

Thus, ACMs in SA should always pay attention to inventory forecasting, regardless of a pandemic such as COVID-19 by:

- confirming their customer demand forecast on a weekly basis with OEMs and other tier suppliers to combat customer demand variability by rapidly responding to any inventory order cancellations and adjusting incoming raw materials;
- purchasing only the ideal inventory quantity based on smaller size economic order quantities to avoid overstocking of inventory and keeping inventory holding costs to a minimum; and
- accurately updating the bill of materials in the MRP system linked to current demand to ensure the right delivered raw materials for manufacturing and avoid unwanted inventory.

ACMs in SA should also apply the inventory control lessons learned from the impact of a pandemic such as COVID-19 to be more prepared in the future. They should:

- work closely with suppliers to localize components currently ordered internationally to reduce lead times to avoid the challenge of importing components from foreign countries into SA;
- negotiate with suppliers to have more frequent deliveries of inventory to reduce long supplier lead times;
- make physical inventory counting the first step of the inventory replenishment procedure to check alignment with the inventory information on the electronic system to avoid over- or under inventorying holding;
- invest in a digital communication channel to ensure that real time inventory information and customer demand fluctuations are immediately shared within the business and with suppliers and customers;
- communicate to all staff concerned the inventory policies information on how to manage demand fluctuations; and
- encourage an open-door communication policy with staff, suppliers and customers where any inventory management problems or suggestions can be shared openly.

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