The influence of inventory management system in medical laboratories on healthcare service delivery in North West

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DECLARATION

I, **Thabo Simon Seale**, declare that this study, “The influence of Inventory Management System in Medical Laboratories on Healthcare Service delivery in North West,” is my own work carried out under the supervision of Prof Jan Meyer and Dr Martha Matashu. This mini-dissertation has not been submitted for any study or qualification in any institution of higher learning. All sources used in the study have been strictly indicated and acknowledged through references.

Signed……

Date…….

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ABSTRACT

Background

Laboratory medicine is an essential branch of medicine that allows clinicians to make clinical decisions on diagnosis, treatment, prevention and disease management. Effective inventory management and control in medical laboratories is a challenge in many laboratories across South Africa, leading the researcher to conduct this study. This study aims to determine the influence of the diagnostic laboratory inventory management system on healthcare service delivery. One of the objectives is to establish the effectiveness of supply chain and inventory management systems employed by medical laboratories in Ngaka Modiri Molema district municipality, assessing the effectiveness of the current inventory management system employed by National Health Laboratory Services (NHLS) in Ngaka Modiri Molema district municipality. This study used a quantitative methodology, and a self-administered questionnaire was used to collect primary data from 3 healthcare facilities in Ngaka Modiri Molema district municipality. Data collected were entered and analysed using Statistical Package for Social Sciences (SPSS), and results interpreted through graphs and percentages. The findings from this study revealed that healthcare service delivery is negatively affected by laboratory inventory management systems and supply chain management practices, and most laboratories experience stock-outs.

This study discovered that the medical laboratory inventory management system in the chosen area influences healthcare service delivery and the organisation's performance. It is recommended that an ideal inventory management policy make it possible to captivate challenges such as uncertainty of demands for laboratory tests be developed.

Keywords: Inventory management, inventory control, inventory management system, supply chain management, diagnosis, medical laboratory, healthcare service delivery and turnaround time**.**

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CHAPTER 1

INTRODUCTION TO THE RESEARCH BACKGROUND

1.1 INTRODUCTION

This study examined the influence of inventory management system in Medical Laboratories on Healthcare Service delivery in Ngaka Modiri Molema district municipality in North West. It is commonly held that an efficient and reliable laboratory service constitutes a well-functioning health system. Moreover, excellent laboratory service contributes immensely to patient care, disease investigation and surveil (Yao, Maruta, Luman, & Nkengasong, 2014:1). According to Price and John (2014:72), the significant influences on the evolution of clinical medicine and healthcare delivery are acknowledged to be invention and innovation, the critical part of this innovation being laboratory medicine. This suggests that a role played by laboratory service in clinical medicine is through evolution and creation in terms of introducing new technologies that can improve test methods, turnaround time and patient care.

The introduction of new ideas, concepts, and technologies in the laboratory significantly impact clinical medicine and healthcare service. Price and John defined innovation as "the intentional introduction and application within a role, group, organisation, ideas, processes, products or procedures, new to the relevant unit of adoption and designed to significantly benefit the individual, the group, or wider society" (Price & John, 2014:72). Research must explore the Influence of the Inventory Management System in Medical Laboratories on Healthcare Service delivery.

As the healthcare landscape continues to evolve, professionals in laboratory medicine face a growing number of pressure (Menhardt, 2017:41). There is pressure for laboratory professionals to invent new technologies to expedite testing cost-effectively, new technologies for laboratory information systems and inventory management. Mussap (2014:202) posits that an abrupt reduction in expenses by cutting down hospital budgets,

specifically laboratory medicine, is because of gravity for ‘fiscal containment’ and the progressive decline in the availability of resources in healthcare. Inventory management is one of the highly time-consuming functions of many medical laboratories. However, if not adequately controlled, inventory can cause disruptions to operations, jeopardise the ability of the laboratory to produce results promptly and drive unplanned costs. This is worsened when numerous places within the network are affected. Therefore, it is imperative to manage inventory in the laboratory because not having sufficient inventory items on hand could lead to the inability of the laboratory to perform specific tests needed by the physician and the patient (Menhardt, 2017:41).

Krasowski, Chudzik, Dolezal, Steussy, Gailey, Koch, Kilborn, Darbro, Rysgaard, and Klesney (2015:1) stated that laboratory test results impact diagnosis, prognosis and control of illnesses as diagnostic laboratory forms an essential part of clinical medicine nowadays. However, laboratory tests make a considerable contribution to the general expenses of hospitalisation. Overall costs of hospitalisation are due to misuse of laboratory diagnosis, which may include either overutilisation or underutilisation and incorrect testing. Overutilisation implies ordering tests more often than usual, and underutilisation suggests no ordering of clinically significant tests. Cadamuro, Gaksch, Wiedemann, Lippi, von Meyer, Pertersmann, Auer, Mrazek, Kipman and Felder (2018:85) argue that medical school curriculum, isolated and specific course in laboratory diagnosis is primarily insufficient or lacking altogether. As a result, clinicians lack specific expertise compared to pathologists in taking issues about clinical data, pre-, intra- and post-analytical, into consideration when interpreting laboratory results. Furthermore, there is a possibility that laboratory investigations might inappropriately be requested since there is uncertainty from the clinicians’ side about appropriate tests to order or their reasonable interpretation. All these revelations indicate that there is a relationship between hospital costs and laboratory costs.

When a hospital is over-utilising laboratory services, the laboratory is forced to ensure that the material used to process tests requested are readily available. Unavailability of the right inventory items on hand may lead to delays in turnaround time (TAT) and

misdiagnosis of patients. Gupta, Kapil and Sharma (2018:297) defined TAT as the period elapsed from the moment tests are requested to receive a report. Any clinical laboratory considers TAT one of the most important parameters to measure performance (Gupta *et al.*, 2018). This was emphasised by Isack, Mutingi, Kandjeke, Vashishth, and Chakrabor (2018:134) when they also stated that many medical laboratories use TAT to measure the performance of laboratory services. This study strives to determine the influence of medical laboratory's inventory management system on healthcare service delivery in NMM District municipality, North West province in the Republic of South Africa (RSA).

1.2 BACKGROUND OF THE STUDY

Adeli (2017) postulates that laboratory medicine is one of the branches of medicine that provides clinicians and healthcare workers with objective data to make appropriate clinical decisions. It is an essential branch of medicine that allows clinicians to make clinical decisions on diagnosis, treatment, prevention and disease management. Furthermore, laboratory medicine supplies professionals in healthcare with data based on the evidence necessary to provide safe, effective, excellent services and proper patient care. Hickner, Thompson, Wilkinson, Epner, Shaheen, Pollock, Lee, Duke, Jackson, and Taylor (2014:268) share the same sentiments, as they also alluded that laboratory tests are vital tools to complete clinical diagnosis. Even though several studies have been undertaken on the role of laboratories and health systems, preliminary research was conducted on the influence of medical laboratory's inventory management system on healthcare service delivery.

The World Health Organization (WHO) in 2008 stated that in Africa, a fraction of society treated for confirmed cases of malaria was relatively small compared to other countries worldwide. W.H.O recommended that a parasitological diagnosis be employed to confirm clinical suspicion of malaria before treatment can be administered to mitigate these findings. To curb clinical misdiagnosis of malaria, the Republic of Zambia called for parasite-based diagnosis of malaria. To appropriately diagnose malaria, a proper health facility infrastructure with efficient equipment, regularly supplied with consumables and

reagents, is required. In addition, improved malaria diagnosis necessitates a multi-faceted method, and a focus must not be on empowering technicians to conduct malaria tests independently. The concerning issue of stock depletions for necessary reagents and equipment maintenance must be addressed (Worges, Whitehurst, Yamo, Moonga, Yukich, & Benavente (2018). This demonstrates that the ability of health systems to outbreaks of certain diseases at a national level is dependent not only on the ability to diagnose but also on the availability of inventories in the health system. For instance, according to Mosissca, Kabede, Mindaye, Getahun, Tulu, and Desta (2016:1), Tuberculosis (TB) is a contagious and transferable infection triggered by *Mycobacterium tuberculosis (M. tuberculosis*) and sporadically *Mycobacterium bovis (M. bovis)*. Moreover, nearly 9 million reported cases of TB and 1.3 million demises are associated with this disease on an annual basis, and most cases occur in countries with low income.

Sputum smear microscopy is the only routine and available diagnostic method in resource-limited countries. This is an easy, efficient and cost-effective technique to detect pulmonary tuberculosis cases, which is considered the most infectious (Mosissa *et al.*, 2016:5). Therefore, if the laboratory produces unreliable TB results, patients with this infectious disease may be misdiagnosed, ensued by continuing spread of this disease in the community, and cause more harm to infected individuals, leading to patient treatment without this disease erroneously. Sinishaw, Gebregergs, and Shiferaw (2015) indicated that to detect tuberculosis (TB) cases and monitor treatment response of diagnosed patients, efficient laboratory services are imperative.

A sufficient supply of laboratory reagents to perform tests that detect a bacteria that causes TB is equally crucial for providing laboratory services. Consequently, (Sinishaw *et al.*, 2015) reported that to administer stock control and distribution of reagents, the Ethiopian Federal Ministry of Health introduced a Logistics Management Information System (LMIS) in 2007. However, supply chain management of supplies needed for various health programs was not integrated into the system. In a study undertaken by Sinishaw *et al.* (2015) for assessment of distribution and laboratory consumables stock levels utilised in health centres for Amhara province in Northern Ethiopia for TB, it was discovered that regional laboratories are responsible for the distribution of TB diagnostic

reagents to respective Zones, depending on an intake. Health centers or Woreda health offices procure consumables directly from Pharmaceuticals and Fund Supply Agency (PFSA) and they get distributed by PFSA to health centers. This is an attempt to give support, evaluate and take corrective action if need arise. Every other month consumables get transported to each facility. When there is a request for reagents and emergency orders, the requesting facility should facilitate these orders' transportation.

To place an order for TB laboratory consumables and reagents, technicians at the pharmacy use Report and Resupply Form (RRF). It is a process done monthly. Sinishaw *et al.* (2015:5) indicated that for diagnosis and follow-up tests of TB patients, all the reagents and consumables for the TB laboratory are vital. Therefore they must always be available. However, their study discovered that four of the health centers from ten were insufficiently stocked, with 18% having a total stock out of at least one reagent. There was also evidence that the issue of understocking was not a regional but a national problem. Also, it was discovered that one of the critical predicaments for TB control in Ethiopia was stock-outs of laboratory reagents (Sinishaw *et al.*, 2015:6).

Isack *et al.* (2018:134) argue that most healthcare facilities are pressurised to enhance the medical laboratory's operational performance. Furthermore, as countries progressively necessitate intervention based on evidence for decision-making in healthcare, there is a rise in demand for medical laboratory services every year. The Namibia Ministry of Health and Social Services (2012), cited by Isack *et al.* (2018:134), posits that efficient laboratory service is vital for quickly diagnosing ailments. This suggests that medical laboratory should produce laboratory report for clinical investigation as soon as possible. The laboratory reports will allow clinicians to act promptly based on the findings and make necessary decisions concerning the patient's ailment. A study conducted by Moyo, Porter, Chilima, Mwenda, Kabue, Zungu, and Sarr (2015) discovered that clinicians use more than 90% of laboratory results to diagnose patients or plan their management such as admissions and discharging them, monitor treatment and rule out diseases. Mboera, Ishengoma, Kilale, Massawe, Rutta, Kagaruki, Kamugisha, Baraka, Mandara, and Materu (2015:2), also stated that a laboratory remains the spine of the

healthcare system because endorsement of any diagnosis made is essential for identification of specific diseases, determining drug resistance and guiding treatment.

Isack *et al.* (2018) viewed a rise in demand for efficiency and quality in the laboratory industry over the past years with a slight improvement in financial conditions for the healthcare system. Also, the expectation is for healthcare systems to be cost-effective, accessible, safe and affordable. This triggered a need for strategies on how the industry can be changed for the better. To meet this demand and improve the healthcare systems, some countries have adopted lean principles to effectively manage operations in healthcare systems and medical laboratories (Hussain & Malik, 2016). This statement is supported by Bhat, Gijo, and Jnanesh (2014), who writes that most hospitals and laboratories have adopted a lean thinking approach in operations like reducing registration time.

Samuel and Novak-Weekley (2014) propose that lean is a management system first founded by Toyota Motor Corporation that supports production systems based on continuous process improvement and employee engagement. Furthermore, even though the origin of the lean concept is in the manufacturing industry, other establishments, such as medical laboratories, have employed its practices. It is evident from the literature that when poor practices get adopted in the medical laboratory, waste can be alleviated, costs reduced, and efficiency increased. Isack *et al.* (2018:135) revealed that after successes of lean principle in other industries, health organisations such as the Institution for Innovation and Improvement in the United Kingdom (UK), the National Health Service (NHS) Confederation and the Institution of Healthcare Improvement in the United State of America (USA) have since advocated for the use of Lean principle. It means that same principles applied in lean manufacturing will be applied by health professionals to increase efficiency of patient care and reduce costs.

Gupta *et al.*, (2018:296) demonstrated that healthcare professionals are forced to figure out how their work processes can be improved and identify a possible way of saving time, material/consumables, money, and goodwill by adopting lean principles. Additionally, implementing lean in the long-term yields substantial efficiency, effectiveness, quality of

work and client gratification. These scholars alluded that Lean is a mindset that plays a vital role in managing complicated healthcare processes. Moreover, it is an innovative way of enhancing value to the client and growth of business in healthcare organisations in healthcare.

In India, the healthcare industry is currently testing how lean processes can be applied to deliver quality results, elevate customer satisfaction and improve the working environment for workers while serving more clients with an equal number of resources (Gupta *et al.*, 2018:296). Hayes and his colleagues have also pointed out that there is a need for improved quality of service delivered. At the same time, cope with increasing healthcare demands and reduce the cost of healthcare per capita (J. Hayes, Reed, Fitzgerald, & Watt, 2014:229). It is evident from these findings that it does not matter how big the country's population is. Every healthcare system expects to deliver high-quality services, even with limited resources at its disposal. Therefore, the honours are on healthcare facility managers to run the operations effectively and efficiently. Inventory management is one of the most critical assets in any organisation. If it is not adequately managed, it has the potential of causing disruptions to production or services rendered. A study conducted by Sinishaw *et al.* (2015) revealed that it is impossible for health facilities and healthcare providers to offer assistance with inappropriate health commodities.

Mboera *et al.* (2015:2) identified that HIV/AIDS is among the primary causes of morbidity and mortality in adult individuals worldwide. Moreover, recent statistics revealed that in 2012, approximately 35 million people were infected with HIV worldwide, and 70% of them were in Sub-Saharan Africa (Mboera *et al.*, 2015). This suggests that HIV/AIDS remains one of the killer diseases amongst African people. Therefore, there is a need for an urgent intervention from the Ministries of Health in the African continent to curb the spread of this virus. One of the interventions needed from Ministries of Health is improved laboratory services in the healthcare system. It is one of the essential factors in diagnosing the disease and monitoring the treatment administered by infected patients. Ramessur, Hurreeram, and Maistry (2015) have also pointed out that medical laboratory services (MLS) are a department that plays a crucial role in the public health sector by assisting

clinicians with screening, testing and evaluation of diseases and providing patients with healthcare services of a high standard. It is evident from these statements that under no circumstances should laboratory services be interrupted by any shortfalls in laboratory equipment and the supply of consumables to perform tests.

Yao *et al.* (2014:1) pinpointed that laboratory managers are crucial in ensuring that laboratory services are quality and timeless. Furthermore, to strengthen health systems and scale up health service delivery, leadership and effective management are paramount. This opines that laboratory managers are at the centre stage of rendering high standards to the patients. For this reason, laboratory managers should attain proper skills for management responsibilities, with more focus put on inventory management and equipment maintenance. Consequently, (Yao *et al.*, 2014) made revelations that US Centers for Disease Control and Prevention (CDC) collaborated with the American Society for Clinical Pathology, the Clinton Health Access Initiative and World Health Organization's Regional Office for Africa (WHO AFRO) to create a program called Strengthening Laboratory Management Toward Accreditation (SLMTA) to assist with a structured laboratory management training and implementation of quality management system. This is management training programme based on competency through short instructive courses and continual improvement plans to achieve measurable laboratory improvements immediately. This program gives practical approaches when dealing with daily challenges using resources at one's disposal.

SLMTA was rolled out in 47 countries in 2013 (Yao *et al.*, 2014:2). Through this program, it was discovered in Rwanda that most laboratories suffered from severe disruptions of services due to stock-outs of reagents and equipment breakdowns emanating from inadequate maintenance. As a result, one of the laboratories enrolled with SLMTA was assigned with an improvement project of tracking the number of tests rejected due to stock-out and equipment downtimes for three months. It was discovered that the laboratory was losing more revenue on tests not done as compared to the cost of avoiding stock depletions and equipment downtimes (Yao *et al.*, 2014:6). In Tanzania, The Ministry of Health and Social welfare (MoHSW) collaborated with the Centers for Disease Control and Prevention (CDC) in the USA. They propelled the Laboratory Logistics Systems to

give critical information on the efficiency of laboratories to help with managing, tracing and resupplying laboratory material (Mboera *et al.*, 2015:2).

In South Africa, all public health laboratories are under National Health Laboratory Service (NHLS). Through the countrywide network of quality-assured diagnostic laboratories. The NHLS is the primary clinical support services provider to the National, Provincial, and local health department (NHLS Strategic Plan 2018-2020). It is a parastatal founded in 2002 through the legislation mandated by the government to provide medical laboratory services to more than 80% of the South African population (CSIR, 2015:7). It ensures that its mandate is fulfilled by performing diagnostic tests on patients' specimens such as blood, fluids, different human excretions, body organs and tissues.

In Ngaka Modiri Molema district municipality, there are three public health laboratories situated in various public hospitals. Clinicians and healthcare workers use these facilities to investigate ailments, confirm the clinical diagnosis, initiate patient treatment, or evaluate treatments already administered by their patients. Alemnji, Zeh, Yao, and Fonjungo (2014:450) described the role and core function of medical laboratories to speedily provide accurate, reliable results to support diagnosis, outbreak investigations and surveillance. Laboratories carry out tests using either automated analysers or manual method. All these methods require chemicals, reagents, or consumables to achieve the ultimate goal of producing accurate and reliable results to assist the clinician in making clinical decisions.

The NHLS, like many other laboratories around the world, do not manufacture or prepare their reagent. They receive a supply of reagents through the procurement system. A study conducted by Mosissa *et al.* (2016) revealed that no laboratory facility in Ethiopia Addis Ababa was preparing its reagents. The reagents arrive in the laboratory not as raw material but ready to use stock (inventory). As a result, laboratories should adequately manage this critical asset of the organisation to avoid overstocking, which poses a thread of wastage or understocking, leading to stock-outs followed by disruptions in healthcare services. In their study, Sinishaw *et al.* (2015:6) argue that healthcare facilities, in general,

cannot provide services without suitable health commodities. One can conclude this argument that it is equally impossible for medical laboratories to render services of a high standard in the absence of necessary material/commodities.

In the study conducted by Mboera *et al.* (2015), it was discovered that in most of the laboratories in Tanzania, even though there was a better availability of supplies, deliveries were not done on time. As a result, HIV laboratory diagnosis and the capacity to implement External Quality Control (EQC) and External Quality Assurance (EQA) at different levels were affected. Furthermore, stock-outs of some consumables and reagents in Haematology and Biochemistry departments were common, especially CD4 count reagents, because of reliance on donor support and single supply. This suggests that relying on a single supply for laboratory reagents poses a risk of experiencing disruptions in healthcare service delivery due to the unavailability of laboratory supplies. Therefore, this study aims to establish challenges faced by the three (3) public medical laboratories in Ngaka Modiri Molema district municipality in North West province, South Africa.

1.3 RESEARCH PROBLEM STATEMENT

It is evident from the discussion in sub-section 1.2 above that an effective inventory management system is a prerequisite for ensuring a well-functioning health service delivery system. This is supported by Mataranyika and Beukes (2014), who inscribes that laboratories form the backbone of the healthcare system because they identify causes of disease outbreaks and provide critical test results that aid diagnoses. This suggests that poor service delivery on laboratory services may negatively impact patient care because physicians and clinicians usually depend on laboratory results to decide patient treatment. Mataranyika and Beukes (2014) further alluded that if laboratories provide accurate results, hospitalisation costs are reduced by lessening the period at which patients stay in the hospital. Besides, the provision of precise results also minimises surgical and treatment errors and improve medical interventions. This is in line with revelations made by Gupta *et al.* (2018:297) that laboratory personnel prefer shortened TAT of tests, which

may be helpful to clinicians when diagnosing, treating and discharging their patients earlier, leading to improved clinicians' efficiency and satisfied patients.

Mataranyika and Beukes (2014) observed that a delay and inaccurate processing of test results is one contributing factor to elevated deaths from diseases considered to be of public concern, for instance, cancer, TB, Malaria, HIV, and Cholera. Management of these diseases requires routine check-up and laboratory testing of patient samples. Roberts, Cohn, Bonner, and Hargreaves (2016:1043) are also in agreement with the statement mentioned above, as they also stated that revised treatment guidelines by WHO recommends the start of antiretroviral therapy (ART) earlier and have strengthened a need for effective monitoring of treatment and adherence support to decrease morbidity and mortality, and also to inhibit new infections. Roberts *et al.* (2016) further indicated that Viral Load testing is one of the tests performed in the laboratory to monitor HIV treatment and adherence. Therefore, for the laboratory to perform these tests, there must be laboratory equipment in good working conditions and sufficient reagents or stock on hand. Failure to ensure the availability of reagents/consumables or effective inventory management puts the laboratory at a high risk of stock depletions ensued by delays and inaccurate processing of tests on patient's samples. This is following a study conducted by Sinishaw *et al.* (2015) revealed that health centres that failed to fulfil the effective conveyance of TB laboratory reagents criteria were posing a considerable challenge to a continuous supply of reagents and consumables, which would likely be associated with a weak diagnosis of TB and follow up on laboratory services.

The main problem identified in most of the NHLS in the selected area for this study is often stock depletions, in some cases overstocking. This is a clear indication that either some laboratories do not have an effective inventory management system or there is no inventory management system. Both overstocking and understocking impact negatively in terms of costs to NHLS and the Department of Health. Nemtajela and Mbohwa (2017:702) defined stock out as an event where customer's demand cannot be achieved. For instance, when a laboratory experience stock-out at the hospital, some tests get rejected if they could not be processed within a certain period. An alternative to test

rejection is the referral of that test to another laboratory, and this is usually causing delays associated with prolonged TAT, and this alternative has its disadvantages.

Isack *et al.* (2018) argue that prolonged TAT in most cases is associated with many factors, including specimen referral system, serious stock-outs and instrument breakdown, among other things. The same sentiments are shared by Nemtajela and Mbohwa (2017), who indicate that cancellation/rejection of test orders typically emanates from stock depletion in some instances. In laboratory testing, tests can be cancelled/rejected due to the unavailability of reagents to perform those tests, which negatively impacts the efficiency of the laboratory. One of the implications of delays or rejections is that the hospital is compelled to wait longer than the agreed turnaround time for patients results. As a result, the hospitalisation of these patients gets prolonged because clinicians usually cannot decide whether to discharge or continue treatment before laboratory results could be made available in the ward. Additionally, more costs are incurred by the hospital due to an extended stay of the patients.

Isack *et al.* (2018:136) released a report from the Namibia Institute of Pathology (NIP) in 2014 indicating that reduced TAT allows the laboratory to reduce cost, promote customer satisfaction and increase efficiency. Hamid Abu Bakar, Lukman Hakim, Choy Chong, and Lin (2009:75) defined customer satisfaction as a psychological attitude dictating customer's negative or positive feeling about the value they receive because of using a specific company's product or services. Similarly, the NHLS loses a lot of revenue and customer's confidence due to tests that get rejected because they use consumables to collect laboratory specimens, and these consumables are not acquired free of charge. On the other hand, overstocking is not a solution. It puts the organisation at the risk of encountering losses caused by possible floods, fire, expired stock, theft, damages caused by storage under unfavourable/uncontrollable room temperatures if there is too much stock in the storeroom. There is no capacity to cater for all of it. This statement is supported by a study conducted by Sinishaw *et al.* (2015), which revealed that of the ten health centres in Ethiopia that had improper storage for TB laboratory consumables and reagents, consumables and reagents were exposed to direct sunlight, others were mixed with other chemicals, and temperatures in the storeroom were not monitored. In Angola,

warehouses were warm and congested due to a low ceiling. This suggests that temperatures in the warehouse should be monitored and controlled, corrective actions taken if temperatures read above the normal range.

It is evident from scholarly revelations that laboratory managers should effectively manage their laboratory's inventory to avoid unnecessary costs and disruptions to service delivery. An effective inventory management system gives laboratory managers favourable visibility into the supply of reagents and utilisation throughout the operation, providing them with an insight into testing, usage of supply and cost throughout the operation network. Thus, the problem identified is that research has not been conducted to formulate an applicable inventory management system for medical laboratories in South Africa.

1.4 RESEARCH QUESTIONS AND OBJECTIVES

1.4.1 Primary research question

Considering the difficulties confronting the South African medical laboratories in inventory management, it can be sensibly expected that more laboratories develop a well-structured inventory management system. This has prompted the following essential questions:

How does the current medical laboratory's inventory management system influence the public healthcare service delivery in Ngaka Modiri Molema district municipality, North West province in South Africa?

1.4.2 Secondary research questions

- How impactful are the medical laboratories' stock depletions on healthcare service delivery?
- What is the influence of inventory management system on laboratory turnaround time?
- How effective is the inventory management system employed NHLS laboratories in Ngaka Modiri Molema district municipality?

- What is the influence of medical laboratory's inventory management system on test rejections or cancellation?
- What is the influence of medical laboratory inventory management system on making clinical decisions on patients?
- How effective is the supply chain management system for the supply of consumables to the public health facilities?
- Is there an inventory management system at the public health facilities to manage laboratory consumables?
- How effective is the supply chain management system for NHLS laboratories in Ngaka Modiri Molema district municipality?

1.4.3 Primary research objective

The primary objective of this study was to determine whether the current medical laboratory's inventory management system influences the public healthcare service delivery in Ngaka Modiri Molema district municipality, North West province in South Africa.

1.4.4 Secondary research objectives

To address the primary research objective of this study, a detailed analysis was given to the following secondary objectives:

- To evaluate the impact of the medical laboratories' stock depletions on healthcare service delivery.
- To identify the influence of inventory management system on laboratory turnaround time.
- To analyse the effectiveness of the current inventory management system employed by NHLS in Ngaka Modiri Molema district municipality.
- To determine the influence of laboratory inventory management system on rejections or cancellation of tests requested by clinicians.

- To diagnose whether the laboratory inventory management system has an influence on making clinical decisions for patients.
- To assess the effectiveness of supply chain management of consumables to the public health hospitals.
- To establish the effectiveness of the inventory management system at the public hospitals for laboratory consumables.
- To investigate the effectiveness of the supply chain management system for NHLS in Ngaka Modiri Molema district municipality.

1.5 SIGNIFICANCE OF THE STUDY

This study seeks to determine the influence of the inventory management system employed at NHLS, the impact of stock out on service delivery, implications associated with overstocking direct material. The effect of uncertainty demand on inventory management in laboratory services will also be assessed. An inference made from this study will include recommendations that will address any gaps identified and highlight inefficiencies emanating from a lack of automated inventory management system in medical health laboratories. Maestre, Fernandez, and Jurado (2018:120) supported this view, which posits that establishing a policy that determines when new orders shall be placed is necessary while considering different types of limitations, for instance, delivery times, uncertainties in demand, economic and storage constraints. The outcomes of this study may be deciphered to the development of procurement policies for the organisations and contribute to the review of service level agreement between suppliers, NHLS and the North West Department of Health.

NHLS is a parastatal that is not compelled to make a profit but serve the public. However, revenue should be generated to sustain this entity. Since inventory is one of the most critical assets that make up a considerable chunk of the organisation’s capital investment, it must be effectively and efficiently managed to minimise costs and maximise profit. This is because sound inventory management systems allow organisations to reduce cost, reduce losses, maintain production, provide good quality laboratory services to public healthcare and meet customer’s demand (Nemtajela & Mbohwa, 2017:700). The

implementation of recommendations from this study may assist medical laboratories in reducing the cost of direct material, decrease the cost of healthcare service for the department of health through improvements on patient care via laboratory medicine. Litigations against the Department of Health due to delayed laboratory diagnosis caused by the unavailability of reagents or medical tests might be reduced, thus reducing the financial burden on NHLS and DOH.

As it has been stated by Krasowski *et al.* (2015:1) that one of the significant contributions to the overall cost of hospitalisation is laboratory testing. Therefore, findings from this study might contribute to the evaluation cum reduction of laboratory medicine and diagnosis costs associated with patient's hospitalisation. According to Hickner *et al.* (2014:272), the ordering of tests has been identified by clinicians as one of the significant barriers. Furthermore, lack of information to physicians about the cost of laboratory tests for patients and cost effects on clinical practice and care has been for many years issue of concern. This study will explore literature and theories on inventory management systems employed by different industries, mainly medical laboratories. The findings might assist NHLS in choosing the most appropriate inventory management model/tools to engage in their diagnostic laboratories. This study is critical because a common need in many businesses and organisations, for instance, in the supply chain, is inventory management within the operation management area (Maestre *et al.*, 2018:120).

1.6 DELIMITATIONS AND ASSUMPTIONS

This study only involved NHLS employees working in the three laboratories around Ngaka Modiri Molema District, who are directly involved in producing the final product (patient results) in a diagnostic laboratory, and healthcare professionals from the department of health (DOH), only nurses, doctors, clinical and unit managers were eligible to participate. NHLS comprised only the following professionals: Medical technologists, medical technicians, phlebotomists, messengers, laboratory clerks, laboratory managers, laboratory supervisors, medical technicians and technologists. No patient participated in the study. The purpose of this study is to assess the influence of the inventory management system employed by the organisation, if there is any, and to evaluate

implications emanating from stock-outs and overstocking of direct material on healthcare service delivery. This research study did not pursue justification of overstocking or stock depletions. It was only attractive on the influence of inventory management system employed by different NHLS on healthcare service delivery. This study provided no advice on which inventory management system should be used should any deficiencies be discovered.

1.7 CHAPTER CLASSIFICATION

- **Chapter 1:**

This chapter is centred around the introduction and background of the research. It comprises a problem statement, specific research questions, objectives of the study, importance and benefit of the proposed research. The research approach utilised is likewise clarified in this chapter.

- **Chapter 2: Literature review**

Chapter 2 gives an intensive literature review dependent on the theoretical results of this study. Different theoretical and empirical studies that have been conducted concerning various challenges influencing healthcare service delivery are analysed in this chapter. It seeks to identify fundamental components of inventory management systems, different types, principles, theories and frameworks in inventory management systems.

- **Chapter 3: Research design and methodology**

This chapter comprises the research design and methodology, which incorporates the target population, sampling technique, and size. Furthermore, this is where the method used to collect, analyse and validate data is explained. It also explains ethical considerations of the study.

- **Chapter 4: Findings and results**

Chapter 4 focuses on the clarification and analysis of the exact findings of the study. Results relating to the statistical analysis conducted from primary data are discussed in

this chapter. Furthermore, answers to the primary and sub research questions are provided, and the outcomes are presented in this chapter.

- **Chapter 5: Conclusion and recommendations**

Lastly, Chapter 5 is devoted to the identification of conclusions of the investigation. Furthermore, it examines the conceivable policy recommendations while considering further research on the current topic. In addition to that, this chapter summarises the research questions and requests for studies in the future.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

The previous chapter outlined an overview of the entire study. This chapter aims to provide a conceptual and theoretical framework of inventory management and challenges faced by different industries (retail, manufacturing and sales), including healthcare facilities.

This chapter addresses more specifically the theoretical objectives of the research study as outlined in the previous chapter. In so doing, the chapter initially gives a literature review regarding concepts such as the following:

- ✓ Inventory – this attempt to acquire a clear understanding of different types and definitions for this concept.
- ✓ Inventory management seeks to identify methods employed by various industries to manage inventory for their organisation's sustainability.
- ✓ Automated planning will assist with a better understanding of various technologies employed to predict and control inventory in different industries.
- ✓ Uncertainty demand – this attempt to explain distinctive methods used to forecast inventory demand and how best to handle unforeseen customer’s request for services rendered.
- ✓ Stock-outs – a concept of stock out and possible causes of stock out will be discussed.
- ✓ Inventory cost – this seeks to identify critical costs associated with inventory management such as carrying, ordering, stock-out and set up charges.
- ✓ Supply chain management – this attempt to establish a role played by the supply chain on inventory management.

Secondly, the importance of effective management thereof. Finally, the chapter will conclude a brief review of various inventory management theories applicable to this study. The literature review seeks to answer questions from the previous research and understand the research questions of this study.

2.2 INVENTORY

There are many ways in which inventory can be defined. However, most researchers share the same sentiments when it comes to its definition. According to a report provided by Nawawi and Salin (2018:1148), “inventories are goods that a business keeps for resale purpose”. These researchers refer to inventories as assets held for sale in the business process, particularly the production process for such sale, support in the form of materials or suppliers awaiting consumption in the production process or services rendered. Nemtajela and Mbohwa (2017) argue that a significant section of investments in the organisation rests on inventory. Equally, Mittal *et al.* (2014:291) agree that inventories constitute a considerable portion and form an essential part of the company’s total current assets. They require effective control as a significant amount of money is invested in them. This suggests that organisations ought to effectively manage inventories to make the best of investment in them. This can be achieved through manual methods or electronic system.

Mittal, Mittal, Singh, and Gupta (2014:292) propose that inventory is made up of the following:

- Raw materials – these are used in the production of finished goods.
- Work-in-progress comprises materials or semi-finished goods that must be further processed to get a final product.
- Finished goods are ready for use products; their purpose is to warrant adequate and timely supply.
- Stores and Spares – this is also known as purchased gear. They form part of essential ingredients for production processes. They provide support desired for the smooth flow of the production process instead of contributing directly to the final yield of the product. Their short life and the fact that they are stocked up alongside materials make them considered inventory.

- Packing Material – these are materials of the stock essential for the packaging of finished goods. This means material used to package or store the end product to be delivered to the customers.

Other types of inventory stated by Nemtajela and Mbohwa (2017) include the following:

i) Buffer inventory is a stock kept in the storeroom for emergencies such as sudden changes of demands and supply.

ii) Cycle inventory – it is when there is a build-up of raw material while processing the other products. At this stage, the process is incapable of supplying according to the demand.

iii) Decoupling inventory – When working stages are functioning sensibly and self-sufficiently, this will happen.

iv) Anticipation inventory – this is an inventory accumulated in anticipation of demands and unexpected supply interruptions.

v) Pipeline inventory – this one exists because the material cannot be transported all at the same time.

Given all that has been mentioned, one can conclude that inventory is a crucial asset in any organisation. This statement is informed by Carvalho, Silva, and Tavares (2013) when they assert that inventory plays a pivotal role in an effective supply chain. Furthermore, it is an area of primary importance in terms of cost if one considers the total assets of a company and an overall share of investment devoted to it. This is in line with Mittal *et al.* (2014), who writes that additional investment in inventory would involve costs, which would drag on the company's profit. In contrast, a short investment could lead to situations of stock-out and stoppage on production. Equally, a concern that overlooks inventory management will jeopardise the company's profitability and sustainability in the long run. Therefore, proper inventory management is an essential factor in the overall functioning of capital management in an organisation.

Hoberg, Protopappa-Sieke, and Steinker (2017) postulate that one of the critical components of any firm's strategies is its inventory. This is because the availability of adequately specified stock is demanded by customers or required for production. At a

cost, best desired for quality contributes to the sustainability of the firm's operations. This suggests that there should be procedures, rules and regulations to control pricing and management of inventory. Just as Conell, 2006; Krieger and Lee (2004) also stated that inventory control and pricing prominently represent the aspects of operations and marketing, respectively. Furthermore, when there is no consistent policy concerning accountability for routine transactions of inventory, there is a likelihood of a superior variation in unit costs, payment dates for invoices and shipping charges, thus intensifying inventory costs (Transchel, 2017:997). More focus will be put on a finished goods inventory in this study because most medical health laboratories do not manufacture their reagents to perform diagnostic tests but utilise readily for use products.

2.3 INVENTORY MANAGEMENT

Prempeh (2015:1) posits that recently a great deal of attention has been attracted by inventory management from people in academia and industries. Furthermore, he stated that inventory turnover represents the key sources generating revenue, followed by the company's earnings and forms part of the most important assets a company owns. Also, he argues that to avail inventories at the right moment in a correct quantity, there must be proper management of this asset because it is considered a lazy resource that is valuable. This view is supported by Mittal *et al.* (2014:292), who also writes that the main focus of inventory management is possessing sufficient various products of inventory-on-hand to avoid the risk of stock depletion and at the same time keeping that much stock which does not happen to become a burden on the firms' profit. It is evident from the statements above that one should be extra careful with management and control of inventory as there ought to be a balance between what inventory items are on-hand and what is needed to meet customer demands.

Shim & Siegel (2007:112), as cited in Mittal *et al.* (2014:292), inventory management include a trade-off amid the cost and advantages of holding inventory. Prempeh (2015) explained inventory control as the organisation of materials purchasing, controlling and utilisation. He further alluded that the purpose of inventory control is to get the accurate inventory with accurate and precise quantity at the right place at the right time as it is

somehow connected with the production. Ullah and Kang (2014) argue that inventory management plays a crucial role in costs related to the products in the same vein.

Inventory takes a considerable chunk of invested capital in an organisation. If it is not adequately managed, the organisation may find itself in a financial crisis. Therefore, operations managers are expected to effectively monitor usage and management of this vital asset to shun losses on profit, wastage and losing customers. According to Groenevelt, Opalach, Fano, and Linaker (2014:1), inventory management is currently a continuous and labour-intensive effort. This implies the presentation and maintenance of sufficient stock levels on product support devices (display stands, racks, shelves, aisle endcap displays, etc.). For example, it is necessary to keep displayed stock levels close to the maximum levels to give customers a good presentation. Furthermore, in a situation whereby a specific product gets depleted and is not displayed on the shelves anymore, operators of the store typically lose substantial revenue because either customer are unable to get the product they wish to buy, or they are unable to recognise an opportunity to purchase products on an impulse. Additionally, it might not be easy to become aware of low inventory or stock out circumstances in a supply room or warehouse, causing delays in reordering.

To address this situation, store clerks are tasked to monitor stock displayed and respond when it runs low constantly. Products displayed on the shelves are sub-optimal, for instance, disorganised or misplaced. However, these efforts tend to be expensive or frequently prone to errors because they are manual processes. Moreover, these problems of manually monitoring inventory apply to retail environments but non-retail environments where inventory levels are fundamental. Nemtajela and Mbohwa (2017) also view that inventory management entails various activities that managers perform to reduce cost, constant stock-outs, and reduce losses while maintaining production.

Mittal *et al.* (2014) conducted a study that revealed that inventory's scientific management does not only bring substantial cost savings. It comes with an improved production capacity of plants, time and labour cost savings, reduced material costs, wastage, reduction in storage space, smooth sailing of production, easier control of production, etc.

Additionally, practical and scientific management of inventory yields quite a high inventory utilisation ratio decreased write-offs of out-of-date or deteriorated stock, and fewer events of work stoppages or stock-outs ensued by loss of sales. Nawawi and Salin (2018) discovered several approaches to achieve a successful stock management system, and some companies are using manual methods and others computerised systems. They argue that most companies are effectively and efficiently making use of computer software to manage their inventory, but some are still making use of old fashioned way of calculating stock manually, this is where stock is physically inspected and counted by hand. Furthermore, since this process is time consuming, companies usually conduct this activity once a year. From these revelations, one can conclude that companies should employ scientific software to manage their inventory efficiently. This will not only result in cost reduction but also results in the profitability of the company.

Singh (2012), cited in Mittal *et al.* (2014:292), alluded that any company that overlooks inventory management comes across serious issues relating to profitability in the long run. Most of them fail to survive. Feng, Li, McVay and Skaife (2015) share the same sentiments as they claimed that when a company is incapable of having good and effective systems to control purchases, tracing and valuation of the inventory, there are high chances of a mismatch between supply and demand of inventory which leads to poor operating performance.

Hoberg *et al.* (2017:516) highlighted that since the latest economic downturn between 2008 and 2009, most companies had to reduce their assets to maintain fair credit ratings and minimise financial costs. Also, working capital management received intensive attention as a crucial path to drive growth and increase profitability. These scholars cited Goldberg *et al*. (2009) mentioned that companies usually use three levers to lessen requirements for working capital. These are as follows: reducing customer's credit days, extending the supplier's credit days, and optimising the companies' inventories. However, amongst the three aspects mentioned above, Porteus (2002), cited in Hoberg *et al.* (2017:516), discovered that the main focus in the operations management community has been optimising inventories for the past decades.

It is only in recent years where a significant effort was applied towards an improvement of practices in inventory management to reduce stock: to minimise raw material inventories, economic order quantities have been implemented for supplier orders, to minimise work-in-progress materials, processes in production set-up have been upgraded and batch sizes reduced, and lastly, to censor safety stock requirements for finished goods, tools for demand forecasting have been implemented. It is evident from this statement that managers in operations management communities will explore every avenue to curb cost and efficiently manage inventory to maximise profit. For non-profit organisations such as state-owned entities, making a profit is not a priority but an essential aspect of the organisation's sustainability. Even though there is little literature on medical laboratory inventory management systems, laboratories may adopt these levers to reduce working capital requirements and apply some of these efforts to improve their inventory practices.

2.3.1 Automated Planning

Chase and Aquilano (1995:546), cited in Prempeh (2015:2), defined an inventory system as a set of controls and policies implemented to monitor inventory levels and determines how large orders should be, the level to which inventory should be maintained, and when should it be replenished. Studies have revealed that there has been a considerable improvement in inventory management since computerisation was developed. Some organisations have adopted information technology systems such as Material Requirement Planning (MRP), Manufacturing Required Planning (MRPII) and Enterprise Resource Planning (ERP) to cut costs on inventory. Furthermore, automated planning makes it possible to perfect an inventory system computationally and optimally define policy for this model (Carvalho *et al.*, 2013:147). Jonsson and Mattsson (2016:837) alluded that material planning involves using systematic buffer stock and order quantity methods, segmenting, differentiating, and order release. From these exciting developments, one can realise how important and cost-effective it is to use automated planning in inventory management.

In their study on automated warehouse system, Atieh, Kaylani, Al-abdallat, Qaderi, Ghoul, Jaradat, and Hdairis (2016:568) pointed out that an Automated warehousing system compared to a manual handle system is efficient and provides less effort and reliable results. They indicated that manual handling might cause human errors, which may negatively impact warehouse utilisation. Therefore there was a need for automating the warehouse. In the same vein, they claimed that in building an automated warehousing system, one must first identify and re-engineer the processes and procedures carried out in the warehouse and then identify strategies that can be automated. This view is supported by Groenevelt *et al.* (2014:1), who writes that providing practices that automate most of the corroborations of stock on hand and exhibition tasks that were initially addressed by manual methods is advantageous. Besides, it would equally be favourable if these techniques could detail how products are displayed.

From the above discussion, it is pretty clear that it is advantageous to computerise an inventory management system than to handle inventory manually. There is less resource effort, low costs incurred, and reliable results when the inventory management system is automated because fewer human errors are encountered. According to Bruccoleri, Cannella, and La Porta (2014:811), the psychological stability of a worker plays a significant role in the accuracy of inventory records. They discovered that workers who are sensitive to arousal are likely to make errors when exposed to workloads they rarely deal with. Workers who are barely stable against variations have been found to commit more mistakes and keep inaccurate records that eventually yield the bullwhip effect. In the same vein, Fan, Tao Deng, and Li (2014:659) posit that most supply chains are a significant operation problem in inventory inaccuracy. Besides, studies revealed that inventory inaccuracy occurs when its records do not match a physical count of available inventory. Likewise, Strohhecker and Größler (2013:142) stated that people were identified in behavioural research as crucial for the shortfall in inventory management performance.

2.3.2 Advanced material planning and inventory performance

The two fundamental material planning questions to address in this case are, “When to order/deliver?” and “How much to order?” and the standard material planning methods include periodic ordering, run-out time planning, Kanban, Material requirement planning (MRP) and reorder point (ROP). These methods logically employ specific mechanisms to answer questions about time and quantity to determine the uncertainty in balancing supply and demand. Other planning parameters include safety sock, lead times, and order quantities.

2.3.3 Radio Frequency Identification (RFID) technology

According to Fan *et al*. (2014:659), much of the available literature on inventory inaccuracy deals with the question of shrinkage. Accordingly, most investigations on this issue provide elements that generate blunders in inventory systems and concluded that shrinkage was a key generating factor of inaccurate stock. Also, the shrinkage comprises spoilage, inventory theft and damage of goods. Most companies employed radio-frequency identification (RFID) to shun these discrepancies and many other human errors. This information technology system has been publicly proclaimed as a viable solution to the shrinkage of inventory. The following are ways in which RFID can assist reduce inventory shrinkage (Fan *et al*. 2014:659):

- Its aptitude to correctly monitor inventory may decrease theft and directly reduce inventory shrinkage.
- It enhances the accuracy of data acquired by scanning barcode, which is susceptible to human error in most cases.
- Provision of visibility for inventory records to closely match the actual stock on hand, top-ups have been more accurate, giving rise to lesser stock depletions.

It is evident from the statement mentioned above that the employment of technology by many industries reduces and, in some instances, eliminates discrepancy between the physical counting of inventory and the actual values available on the system. According to Fan *et al.* (2015:117), RFID is a critical technology widely used and regarded as a prerequisite or an essential element in the Internet of Things (IoT). Researchers arguably state that the “Internet of Things” refers to the world connected with sensors or devices

whereby items are linked, monitored, and enhanced by either cordless or hybrid systems. It is mainly made up of three components:

- A tag moulded by a chip linked to an aerial.
- A device that releases and receives radio signals from tags in return.
- A middleware which ties RFID device and enterprise systems.

In essence, RFID technologies use radio waves to converse in real-time with several objects at a distance without any contact. Product visibility and traceability among supply chains can be improved using this automatic identification and data capture technology. It has been portrayed as a promising solution to inaccuracies in inventory. Scholars discovered that it is inevitable and prevalent in most industries for inventory inaccuracy to be experienced, which stands for the discrepancy between inventory records and the available amount of product for sale of customers (Fan *et al.*, 2015:117). This is in line with Paltriccia and Tiacci (2016:1493) revelations, who also stated that RFID technology allows identifying objects given tags. It is possible to remotely track items by reading these tags when this technology is employed. Besides, with this technology, potential benefits along the supply chain may improve by decreasing shortfalls in inventory, increasing efficiency of involved processes, and enhancing the precision of information.

Other techniques such as multi-echelon can be employed to solve inventory problems. However, this technique to be complex as it involves mathematical calculations. (Çelebi, 2015) argued that the successive and combinatorial character of multi-echelon stock challenges could only with significant effort be taken care of by conventional improvement methods, which applies differential math. Moreover, the evacuation of convexity expectation on the capacity to be enlarged and the separation procedure might be seriously wasteful because it cannot give something besides local data on optimality. In addition, the quick improvement of data advances throughout the most recent few decades, along with the advancement in streamlining research, created new and effective strategies for taking care of complex combinatorial issues. Examples of these techniques are Meta-heuristics such as Tabu Search, Simulated Annealing, and Genetic Algorithms (GAs), which have become widespread for resolving compound multi-echelon issues of inventory control management. Genetic Algorithm has received considerable attention

among these techniques because of their ability to address non-linear functions and handle numerous objectives.

Contrary to traditional approaches, GAs do not have any limitations on the kind of information employed or a considered problem structure. It can take care of any type of objective function or constraint because of its ability to evolve. This technology can be employed in any industry or business and yield the same results. It is confined to selected types of business and anyone who uses inventory, including medical laboratories.

Researchers have revealed that inventory plays a vital role in creating an effective supply chain. Its capability to direct the flow of logistic, shelter uniformity and continuity ensures an appropriate service level and makes the product valuable and very significant. However, various ambiguity sources are allied with both input and output processes in any inventory system, whereby the supplier, producer, or both can represent the input process. The inherent uncertainties of these two can be connected to mishaps that might arise when transporting any goods, associated with the quality of transport, unplanned disruptions for maintenance, shortage of material or equipment breakdown (Carvalho *et al.*, 2013:147).

2.3.4 Uncertainty Demand

A study conducted by Hoberg *et al.* (2017) discovered that inventories of most firms increment because of demand improbability, delayed lead times and more significant gross margins, yet the connection between holding cost and stock levels are not checked when proxying saving cost by both Rate of Treasury Bill and an estimation of a harsh expense of capital. In this study, more focus will be on the influence of demand uncertainty of laboratory services on inventory management rather than costing part of the inventory. However, the financial aspect in supply chain management and healthcare service delivery will be considered. This is because recently, integrating fiscal perspectives in supply chain management has attracted significant attention among other field operations and services (Hoberg *et al.*, 2017:519).

In most service organisations such as NHLS, it is challenging to envisage the future demand for the service. This is because one does not know when and how many people

will get sick and visit the healthcare facility. For this reason, laboratory managers and workers should monitor and manage their inventory very closely to guard against stockouts, which may result in cancellation and disruptions to some services rendered by the organization. Hancerliogullari, Sen, and Aktunc (2016:684) argue that inventory management is the core of many business's operational performances.

Laboratory managers are expected to keep levels on stock at a minimal level and avoid running out of stock. It is not always easy to achieve both when there is no automated inventory management system. Poor inventory management always comes with financial implications to the company. It can cause customers to lose interest in the company's service and opt for assistance from the competitors. According to Nemtajela and Mbohwa (2017:701), an organization must hold the best possible inventory levels because keeping too much stock may have cost on inventory such as costs associated with space rent, decision making, old unused stock, damages and possible theft. Similarly, not keeping enough stock is equally very costly customers might go to the competitor and cease supporting the organization. This suggests that excelling in customer satisfaction and providing vital customer service while keeping inventory costs at their lowest level is the main aim of good inventory management.

Organizations usually get assisted by inventory monitoring tools to breed steady decisions on placing orders of a product. Consistency in making the right decisions improves forecasting of demands for the future and increases efficiency. Therefore, ordering the suitable material and quantities of stock at the right time is associated with improved performance of the organization and good customer service. Salam, Panahifar, and Byrne (2016:887) supported this view, positing that stock and administration levels are consistently worried for any stock administration framework and a significant competitive factor in any profoundly competitive environment. In the same vein, Nemtajela and Mbohwa (2017) agree that loss of customers and sales by companies can result from insufficient service levels. On the other hand, keeping excessive stock and large quantities of inventories may result in unnecessary holding costs.

2.3.5 Stock outs

Running out of stock can have profound implications that will negatively affect the organizations. The type of industry does not matter. It can be in retail, manufacturing or service organizations, unavailability of stock or material may lead to loss of loyal customers. According to Ehrenthal and Stölzle (2013:59), stock-outs directly impact retailers' financial performance because they lead to losses on sales when customers decide to buy those unavailable items somewhere else or entirely cancel their shopping trip. Ehrenthal and Stolzle further claim that a persistent problem is a stock out in the retailing industry. It is reported that 8.3% of retail stores are not available on the shelves (Ehrenthal & Stölzle, 2013:63). This is despite creativities such as Efficient Consumer Response (ECR) and enhancing electronics such as RFID and point-of-sales data analytics intended to improve alliance of retail stores and suppliers. The same principle can be applied in healthcare services, including medical laboratory services. According to Paltriccia and Tiacci (2016:1495), hospitals handle a vast number of inventory stored inside their premises to serve various divisions when the need arises. Some of this inventory are classified as critical because it must be available in adequate numbers to meet unforeseen events. Therefore, inventory management has become a significant component for the control of the hospital. It was discovered that the use of “order-up-to level” refill policy is one of the distinguishing features of inventory management in hospitals, staff members regularly check each stock at intervals to examine the level of each product inventory and make a top-up accordingly (Paltriccia & Tiacci, 2016:1495).

Other organizations centralize their inventory distribution network, Çelebi (2015:532) argue that a typical agreeable technique is unified stock control, where stock control exercises of the entire framework are accumulated at a specific spot where a member or a group of individuals assumes full responsibility of replenishing stock of the chain and utilize accessible demand and cost data in arranging the activities of the operation. More studies have revealed that centralizing inventory management reduces costs and give provision to improved services by declining insecurity and providing better usage of resources for the entire value chain of operation (Çelebi, 2015:532)

2.4 INVENTORY COST

A few decades ago, especially during that period of late 2000s where there was a financial crisis globally, inventory reduction had become a widely accepted means of reducing costs by many companies, most companies like Wal-Mart, Chrysler and Goodyear, engaged in programs of lowering inventory as a mean to improve their cost structure (Isaksson & Seifert, 2014:999). Nowadays, most organisations direct their strategies to customer needs. Different methods for management and operations are chosen for efficient utilization of resources to meet the end-user requirements. These strategies assist management in realising customer demands and increasing the profitability of Ullah and Kang's organisation.

Inventory management is a science and art of keeping stock at maximum levels to meet customer demands and acquiring fewer costs consistent with other relevant targets and objectives set by management. As a result, it is essential for managers of organizations that deal with inventory to bear in mind that the aim is to satisfy customers' needs and maintain inventory costs at a minimum level (Prempeh, 2015:2). Costs included in inventory management are, among others holding costs, ordering costs and shortage costs. Where holding costs are costs concerning possessing physical items in stock, these encompass insurance, obsolescence and opportunity costs associated with having funds tied up with inventory but could be somewhere else. Ordering costs are costs suffered when making a requisition for an item and receiving it (Prempeh, 2015:2). These involve defining stock quantities is required, formulating invoices, transport cost, and cost incurred for inspecting goods. Another cost incurred when demand exceeds the supply of inventory on hand is called shortage costs. These are usually opportunity costs of sale, loss of customer goodwill and late charges.

Karim, Nawawi, and Salin (2018) have adopted a broader perspective which argues that numerous costs have to be considered in determining the best inventory levels in managing inventory. They agree with (Prempeh, 2015) that 60 – 80% of the total cost of a product or service can be spent on the cost of purchasing and holding inventory. Likewise, Karim *et al.* (2018) identified and defined the following types of inventory cost:

i) **Carrying cost** – is also known as holding a charge. This comprises insurance, storage, taxes, theft, obsolescence, and interest in funds or lending to finance the goods.

ii) **Ordering costs** – these are costs incurred when placing an order. This kind of cost entails expenses about workforce, human resource procurement department, expenditures relating to communication such as telephone, mail and other costs associated with any paperwork.

iii) **Stockout cost** – in this case, the price is incurred due to the fact the company failed to fulfil the customer's order, which results in lost sales, both short and long-term. A customer may be temporarily or permanently lost to competitors to their product or get services from them, resulting in lost revenue.

iv) Nemtajela and Mbohwa (2017) point out another type of cost:
Setup cost – this is a type of cost associated with production changes. It is a cost incurred when a production plant changes from one batch of a product to another. One has to pay for the material needed to set up machines and clean out the material used in the previous batch.

According to (Ullah & Kang, 2014), in the area of inventory management, a model such as Economic Order Quantity (EOQ) has been broadly employed to calculate the optimum lot size based on setup and holding costs. This model has been stretched to the Economic Production Quantity (EPQ) model, assuming a constant production rate in any manufacturing organisation. These basic models have been extended, attempting to explain day-to-day practical situations in business life.

Because of all that has been said, operation managers need to make thorough calculations to keep stock levels at a minimal level where there is a balance between stock availability and customer demands. According to Nemtajela and Mbohwa (2017:702), ordering sufficient inventory to fulfil customers' request is less impactful on storage costs. Furthermore, a thread of stock-out can be overcome by increasing the top-up point by putting safety stock. These scholars suggest that holding costs should represent at least a quarter of stock on hand. Ullah and Kang (2014:2448) supported this statement and writes that generally, inventory carrying costs should be 25% of inventory

value on hand. However, many other writers are holding a different view of what has been stated above. For instance, Azzi, Battini, Faccio, Persona, and Sgarbossa (2014:110) noted no actual holding costs. Managers usually approximate the carrying cost according to different rules of thumb depending on the type of industry.

From this literature review, one can deduce that operations managers ought to know the quantity of stock to order and when to make a requisition for replenishments. However, this is often difficult for managers at service organizations because predicting when the customer will require services is not easy. Therefore, operations managers should order extra stock, which will serve as a buffer stock to save guard against unpredicted events where there is a sudden change or disruptions on supply and demand. In this case, sudden changes or disruptions may include outbreaks of disease that need laboratory diagnosis, TB and Pap Smear campaigns or disorders caused by public demonstrations in the form of a strike. An outbreak is when there is a disease of an unknown origin at a specific part of the country/province. For instance, if there is a suspected food poisoning at a particular school, there will be a sudden increase in samples sent to the laboratory for investigations. When there is TB or Pap Smear campaign, the Department of Health randomly screens people around the communities, usually unannounced to the laboratory. This effectively means that the honours are on medical laboratories to ensure that they have enough stock at their disposal to deal with any kind of outbreaks. This can only be achieved through an effective and efficient inventory management system.

2.5 SYNOPSIS

The discussion in this chapter was on conceptual and theoretical framework of inventory management and challenges faced by various industries including healthcare facilities. This chapter sourght to review literature on the importance of an effective inventory management system and theoretical objectives of the research study as outlined in the previous chapter. A brief review of various inventory management theories applicable to this study was discussed. The subsequent chapter, chapter 3 will discuss the research design, approach and methodology applied throughout this study.

CHAPTER 3

RESEARCH DESIGN AND METHODOLOGY

3.1 INTRODUCTION

A reviewed literature in the previous chapter concentrated on definitions of inventory management and different types of inventory management systems. Therefore, this chapter aims to unfurl the exact methodology utilized and employed throughout the study. The first part of this chapter starts with a philosophical basis to give a foundation to the research design, approach and population target. This chapter further clarifies the various methodologies used to choose a sufficient sample for this study and expounds on the strategies used for data collection from the selected participants. In conclusion, the chapter deliberates on the study's limitations, statistical techniques utilized for data analysis and ethical considerations.

3.2 RESEARCH PARADIGMS

A very much structured and grounded research study includes a canny and vital discussion on the approach employed in a research study or paradigm embraced by a researcher (Cresswell, 1994). Research paradigms are regularly alluded to as a series of expectations or convictions of the researcher that features the premise that drives the course of inquiry (Groenewald, 2004:44). According to Guba and Lincoln (1994:107), A paradigm may be perceived as a series of fundamental beliefs dealing with first principles. It represents how the researcher views the world and provides a perspective on how other people adjust to these environmental factors. Biddle and Schafft (2015:325) supported this view, who writes that paradigms are assortments of disciplinary uncertainties and standards shared by researchers working in a field in the broadest Kuhnian sense. Along these lines, paradigms comprised a lot of expert duties. They conceded to understandings and reservations regarding the questions that might be genuinely presented inside a field of inquiry and the techniques generally fitting for tending to those inquiries. Therefore, to comprehend why researchers settle on specific decisions and choices during their research procedure, it is imperative to explain and understand a researcher's worldview

or belief system. It gives rationality to how their research was approached (Morgan, 2007:69).

Healy and Perry (2000:118) assert that scientific research paradigms are by and large theoretical systems within which a few researchers work. That is, a worldview is a perspective or "a lot of connected suspicions about the world which is shared by a network of researchers investigating the world". The following are four of those paradigms:

- Positivism
- Critical theory
- Constructivism
- Realism

Guba and Lincoln (1994) incorporate scientific paradigms into the four classes of positivism, realism, critical theory, and constructivism, each with the three components of ontology, epistemology and methodology. Quickly, ontology is the "truth" that researchers explore. Epistemology is the connection between that reality and the researcher, and methodology is the strategy utilized by the researcher to research that reality (Healy & Perry, 2000:119). In the same vein, Guba (1990) communicates that these standards, which may likewise be referenced as "logical exploration ideal models", can be qualified by the responses to the ontological, epistemological and methodological inquiries their followers give. Table 3.1 summarises the four categories of scientific paradigms and their elements, explaining the study's ontological, epistemological, and methodological perspectives.

Table 3-1: Four categories of scientific paradigms and their elements.

Paradigm				
Element	**Positivism**	**Critical theory**	**Constructivism**	**Realism**
Ontology	Reality is real and apprehensible	“Virtual” reality shaped by social, economic,	Multiple local and specific “constructed” realities.	Reality is “real” but only imperfectly and

		ethnic, political, cultural, and gender values, crystallised over time.		probabilistically apprehensible.
Epistemology	Objectivist: findings true.	Subjectivist: value mediated findings.	Subjectivist: created findings.	Modified objectivist: findings probably true.
Common methodologies	Experiments/surveys: Verification of hypotheses, chiefly quantitative methods.	Dialogic/dialectical: researcher is a "transformative intellectual" who changes the social world within which participants live.	Hermeneutical/dialectical: researcher is a "passionate participant" within the world being investigated.	Case studies/convergent interviewing: triangulation, interpretation of research issues by qualitative and quantitative methods such as structural equation modelling.

Adapted from Healy and Perry (2000:119)

The following subsection clarifies the specific research design that was utilized for this study.

3.3 RESEARCH DESIGN

To conduct a successful research study, there must be a scope of requirements, which incorporates a well-established plan that sketches various activities that must be done and, more explicitly, how these activities should be executed. A well-arranged research design plays a significant role in accomplishing the goals and objectives set in any research study. A research design implies the types of strategies and methods a research

study follows for data collection, analysing, interpreting, and reporting results to fulfil its analytical objectives (Yu, 2009:801). According to Choy (2014:99), to design a study, a decision has to be made on what type of a case or samples to select for measurement of relevant factors and also establish which kind of research techniques will be employed, questionnaire or experiment.

Crotty's (1998), cited in Creswell and Creswell (2017:4), suggested that the following four questions be considered when designing a research proposal:

- What epistemology is informing the research? For instance, subjectivism, objectivism and so forth?
- What is the theoretical perspective behind the chosen methodology (positivism and post-positivism, interpretivism and critical theory?
- What is the strategy or action plan linking the method to the outcomes, and what informs the choice and use of techniques employed (survey research, ethnography, or experimental research)?
- Which procedures and techniques are proposed to be used (focus group, interviews or questionnaire)?

These scholars posit that the four questions demonstrate the level of interrelations with decisions that go with research design processes. They further alluded that these aspects inform a choice of approach.

3.4 RESEARCH APPROACH

McCusker and Gunaydin (2015:541) reiterated that research is a universal and challenging process of inquiry that seeks to describe a phenomenon, develop and put descriptive theories and concepts to the test, with the ultimate aim of contributing to a scientific body of knowledge. To execute these processes, one has to choose which approach amongst different research approaches to employ in their study.

The research approach can be characterized as a technique wherein data, and information of an investigation is gathered and analysed (Wei, 2010:17). According to Creswell and Creswell (2017), the specific methods of collecting and analysing data is the principal element of what goes into a research method. Furthermore, the knowledge

claims, strategy and process form part of a research approach, which tends to be qualitative, quantitative or mixed. This suggests that one can choose between the three research approaches most suitable for their study (i.e., qualitative, quantitative or mixed approaches).

Table 3-2: The difference between qualitative, quantitative and mixed.

Research Approach	Description
Qualitative approach	Is the one whereby the researcher is making knowledge claims primarily based on constructive perspective, participatory perspectives or both. Different strategies seeking information such as phenomenologies, ethnographies, case studies, ground theory studies or narratives are used. In this approach, open-ended, initial data is collected to develop themes from it.
Qualitative Approach	Is the one whereby the inquirer often starts by making use of post-positivist claims for developing knowledge. Strategies employed to inquire information include experiments and surveys. Data is collected by a predetermined instrument which yields statistical data.
Mixed Approach	A mixed-method in which the investigator has a habit of basing knowledge claims on pragmatic grounds. Strategies of inquiry employed involve collecting data either concurrently or consecutively to understand the research problem better. Furthermore, data collection encompasses gathering text and numeric data to accommodate qualitative and quantitative information in the final database.

Source: Creswell and Creswell (2017:18)

To achieve the research objectives of this study, a quantitative methodology as the organized survey was utilized. It was based on survey research whereby a questionnaire comprising of scale response questions was designed and given to laboratory employees and healthcare practitioners to participate in the study. The researcher sought to identify the influence of inventory management systems in medical laboratories on healthcare services delivery and address problems associated with these systems. This statement is supported by Creswell and Creswell (2017:21), who argues that the research problem is a subject that must be addressed.

Bryman (2012:53) proposed that quantitative research is defined as “A research strategy that emphasises quantification in the data collection and analysis”. Accessing quantifiable data and information is comparatively easy compared to qualitative research, which necessitates more time and substantial effort in the field. Resources are allocated to a pretty small sample of the population (McCusker & Gunaydin, 2015:539). In the quantitative research approach, a questionnaire is directed to participants identified through various forms of sampling, usually selected randomly (Choy, 2014:99). This is evident in Islam (2015), who in his study utilized a survey in the form of a questionnaire to determine a relationship between healthcare dimensions and their loyalty.

In a paper written by McCusker and Gunaydin (2015), it is stated that efficiency is one of the elements encapsulated within quantitative research methodology. These authors further claim that the allocation of existing resources may be well managed when putting the quantitative method into practice due to the potential of gathering large amounts of data within a short period. Additionally, quantitative analysis allows organizations to act swiftly on the research findings by formulating valid policy informed by evidence-based statistics. For these reasons, a quantitative research approach was employed for this study, whereby data was collected through a self-administered questionnaire.

3.5 SAMPLING STRATEGY

The methods and designs used concerning drawing a sample size from a given populace are enveloped in a sampling strategy to make provision for precise and solid conclusions (Zikmund and Babin, 2013:312). A sample is frequently alluded to as a subset bunch that

somewhat represents the whole population. The process of sampling infers reasons why a research study needs only a certain percentage of the population. It is to some degree challenging to incorporate the whole population under a research study. This statement is supported by Taherdoost (2016), who writes that the researchers doubtfully collect data from the entire population for the research question to be answered. He further states that since researchers have limited time and means to investigate the whole population, they apply a sampling strategy to reduce cases. This suggests a need to select a sampling technique and sample to represent the entire population.

Before looking at various sampling techniques, it is significant to note what is implied by sampling, alongside reasons why researchers will probably choose a specific sample. Taking a subset from a picked sampling frame or the whole population is called sampling. It can be utilized to create extrapolation about a population or make generalization corresponding to an existing notion (Taherdoost, 2016:20).

Wilson (2016:69) proposes that there are two types of sampling techniques which include:

- Probability or random sampling and
- Non-probability or non-random sampling

Probability sampling implies that there are equal chances for every individual in the study population to be selected. Probability sampling is further classified into the following types: Simple random sampling, Systemic random sampling, stratified random sampling, cluster sampling, multiphase sampling and multistage sampling (Acharya, Prakash, Saxena, & Nigam (2013:330). Non-probability sampling is usually allied with qualitative and case study research design. It is further classified into the following types: Quota sampling, snowball sampling, convenience sampling and judgemental sampling (Taherdoost, 2016:22).

For this study, the probability sampling technique was used. Even though the entire population is not represented in this technique, it allows the researcher to select the relevant target population randomly. Furthermore, it is the most efficient and easiest data collection method from the population and classified as unbiased.

3.5.1 Cross-sectional

This study was a cross-sectional study in nature. According to Sedgwick (2014:1), In a cross-section study, the aim is to find a sample representing the entire population by taking a cross-section of that population. Furthermore, a cross-section study is different from a longitudinal study by design. In a longitudinal study, participants are observed at several time points, trends in an outcome are monitored over a period. In general, cross-sectional studies are cheap, quick and straightforward to perform. They usually base their survey on the questionnaire (Sedgwick, 2014:2).

Lillis and Mundy (2005) and Arnold (2006), cited in Ammar (2017: 239), alluded that cross-sectional information is a foundational research approach utilized to limit research bias, add to the hypothesis and improve finding's generalizability. Likewise, it is unique about other standard methodologies related to earlier investigations have utilized. Their analysis to comprehend well-being administration is used among family units with various financial status in Isfahan province, Ranjbar Ezzatabadi, Khosravi, Bahrami, and Rafiei (2018) applied analytical cross-sectional study among households situated in that province. These scholars used stratified sampling to choose a unit of their study alienated into 14 municipalities. A questionnaire with three groups: demographics, financial status, and health service use was used to collect data. A cross-sectional study was the most suitable for this study, as compared to a longitudinal study.

3.6 TARGET POPULATION

Alvi (2016:10) argues that the target population denotes all the individuals who meet the specified model indicated for a research study. The target population is attributed as the principal wellspring of data expected to address the study's set objectives. Therefore, it is critical to pick a suitable sample size as it guarantees that adequate information is acquired that makes provision for steadfast inference and outcomes. For this study, a stratified sampling technique was employed to select participants. According to Taherdoost (2016:21), a population is alienated into subgroups or strata and then sample each subgroup. Subgroups are a characteristic arrangement of things. They may be founded on but not limited to organization size, sex/gender or occupation. Ackeff (1953),

cited in (Taherdoost, 2016:21), argued that stratified sampling is frequently utilized in various populations. Its purpose is to guarantee that each layer/strata are well represented. Acharya *et al.* (2013:331) share the same sentiments that in stratified random sampling, data is separated into different strata/subgroups with shared characteristics such as sex, age, race, income, ethnicity, occupation and education. These authors further alluded that one of its advantages is that it assures the population needed in the groups is represented. Besides, estimations and comparisons can be made in the characteristics of each stratum. It also decreases variability from systematic sampling. A Strata in this study were public hospitals in Ngaka Modiri Molema (NMM) district, where there are NHLS in the premises.

This study was conducted in 3 public medical laboratories and hospitals, excluding one hospital which does not have a fully functioning laboratory. The identified target population were some of NHLS North West employees and some of the healthcare professionals employed by the North West Department of Health in Ngaka Modiri Molema. The aim is to use a minimum of 42 respondents from the 3 NHLS laboratories and 110 healthcare workers employed by DOH in Ngaka Modiri Molema District. Targeted vital informants will be 60 nurses, 35 doctors, two clinical associates, 10 Unit managers, three physicians/specialists from the three public health hospitals and one phlebotomist, one procurement officers, 15 laboratory clerks, four laboratory supervisors, three laboratory managers, eight medical technologists and ten technicians at the 3 NHLS laboratories in the NMM district. These were employees directly or indirectly involved in producing patient results and providing healthcare services to the public.

3.7 INCLUSION AND EXCLUSION CRITERIA

3.7.1 The inclusion criteria:

- Fully functional laboratories situated in hospital premises in Ngaka Modiri Molema
- Permanent NHLS employees have insight and access to the information required for this study.

- An employee employed by NHLS for a period longer than one (1) month who are directly or indirectly in producing patient results, i.e., medical technologists, technicians, phlebotomists, laboratory clerks, assistance, supervisors and managers.
- Permanent healthcare workers employed by DOH for a period longer than one (1) month directly or indirectly involved in providing healthcare services and have made use of laboratory services to make clinical decisions, i.e., nurses, doctors, clinical associates, physicians/specialists and clinical managers.
- Healthcare workers are working at public hospitals where there is a laboratory on the premises.

3.7.2 The exclusion criteria:

- Cleaners, security guards, drivers, messenger/porters, and any temporary workers are not involved directly or indirectly in producing patient results and providing healthcare services to the public. Besides, their occupation does not require them to make use of laboratory services and are not involved in any patients' clinical decision-making. Therefore they are not eligible to partake in this study.
- Hospitals with depo laboratories, public healthcare clinics and hospitals with no NHLS laboratories in their premises will be excluded.

It might be a challenge to get maximum participation from participants due to their work, shift systems,/working hours in different facilities. Employees working for NHLS and healthcare workers in Ngaka Modiri Molema will be randomly selected and asked questions using a questionnaire.

3.8 DATA COLLECTION

Data collection is a methodology that involves how data will be gathered from the selected sample components. A method employed to collect data is significant because how the data accumulated is used and what explanations it can make are directed by the philosophy and coherent methodology attempted by the researcher (Paradis, O'Brien,

Nimmon, Bandiera, and Martimianakisis, 2016:263). In a quantitative approach, data collection involves using either surveys or observation (Blumberg, Cooper and Schindler, 2008:278). (Zikmund and Babin, 2013:237) stated that in an observation method, data is collected by observing occurrences of certain events and keeping a record of them as they unfold. Paradis *et al.* (2016:264) provided a more explicit explanation that observations can be utilized to collect information either by using senses such as touching, smelling, hearing or vision. Then again, the method of using questionnaires to gather information, which allows responses to be on a developed measuring instrument, is alluded to as a survey method. (Rahman, 2017:103) posit that the dispersion of these instruments can either be through a conventional mailing system, through platforms online, by phone interviews, one-on-one meetings or by methods for self-administered questionnaires.

For this study, a self-administered questionnaire was utilized to collect data about the knowledge and insights of the participants with regards to the influence of the laboratory inventory management system on healthcare service delivery. The questionnaire comprised rate scale questions to obtain respondent knowledge about laboratory inventory management and healthcare service delivery. According to Isack *et al.* (2018:141), an ordinal Likert scale is regarded as the most helpful data analysis method. Therefore, a five (5) point Likert scale will be used in this study. This is where participants are asked to rate statements on the extent of their knowledge either to a small degree, to some extent, to a moderate degree, to a greater extent, or not at all.

3.8.1 Questionnaire design

Krosnick (2018:263) propounds that a questionnaire is the heart of the survey. A sampling technique, recruiting and preparing mediators and administrators, programming PCs, and other preliminary work is all in the service of a discussion among researchers and respondents. Consequently, the results of a survey are significantly relying on a questionnaire that script this discussion, irrespective of how the debate has interceded. As indicated by (Krosnick, 2018:264), the quality of the analysis relies upon excellent

quality information that originates from a great plan of an instrument used for data collection. That is the questionnaire administered in the form of a survey.

A significant part of a good research study is to ensure that an instrument used to collect data addresses the requirements and objectives of the research. Krosnick (2018:267) supported this statement, who stated that a great questionnaire entails appropriate questions and allows efficient data collection, which contributes to accurate testing of theories, decision-making, and making provision for investigations that are accurate towards a study. This suggests that a questionnaire is constructed plays a pivotal role in getting a desired and reliable outcome from a study.

To avoid or limit mistakes in responses, a questionnaire should be designed according to Krosnick (2018:263). Considering the previously mentioned statement, the questionnaire utilized in this investigation was developed to guarantee precise and reliable data collection. The questions asked in a questionnaire were clear and straightforward statements. A cover letter that plainly expressed the study's objectives and guaranteed participants to remain anonymous throughout the survey was enclosed. The cover letter is attached as appendix 3.

A questionnaire for laboratory personnel comprised seven sections (attached appendix 4). Section A of the questionnaire includes the participants' demographic information, i.e., gender, age, level of education, occupation, years of work experience, and department/section in which they are stationed. Section B of the questionnaire seeks to gather information on participant’s knowledge about medical laboratory inventory management system. Section C aims to gain information based on the influence of medical laboratory processes on inventory management system and turnaround time. In comparison, the effectiveness of the inventory management system on laboratory performance will be tested in section D of the questionnaire. Section E asks questions that seek to find factors affecting medical laboratory performance on supply chain and inventory management system. The last section of the questionnaire, section F, aims to extract information about the effectiveness of laboratory analyzers on lab inventory management system, turnaround time, and healthcare service delivery in general.

Participants are allowed to write their comments in section G if anything is not covered in the above sections.

3.8.2 Administration of questionnaires

To avoid direct contact with participants and influence the study outcomes, a third party or mediators (clinical managers, laboratory managers and supervisors) were used to administer questionnaires. The questionnaires were hand-delivered to clinical managers, laboratory supervisors and managers of the participating hospitals for them to distribute them to the participants at a suitable time, either during their staff or departmental meetings, and humbly request them to spend few minutes of their time answering the questionnaire on their convenient time. These questionnaires were accompanied by a covering letter in which a brief discussion on the following aspects will be provided:

- The aim and nature of the study.
- Ethical clearance of the study.
- Confidentiality of information gathered and voluntary participation.

Participants were requested not to write their names on the questionnaire. Their privacy was ensured by granting them the liberty of answering the questionnaire either at the home, workplace or anywhere in the private venue of their choice. Participants were given a maximum of 7 days to complete the questionnaire and return them to their respective managers' office. When they get to their manager's offices, they will be requested to put them in a box provided by the researcher to ensure privacy, anonymity, confidentiality and free participation without fear of victimization. These boxes will be designed so that participants can only put in completed questionnaires and be unable to access what is inside the box. Mediators assisting with data collection will not see how individual participants filled/answered their questionnaires. Only the researcher and the principal investigating officer will have access to what is inside the box. Furthermore, these boxes will be kept safely in the manager's office where no one can access them. Once all the questionnaires have been returned, the researcher will then collect the boxes from the hospital and laboratory managers' offices of the participating facilities for analysis.

3.9 RELIABILITY AND VALIDITY

Reliability and validity are generally the duos and essential highlights in assessing any measurement instrument for proper research (Mohajan, 2017:1). Reliability and validity are focal issues regarding the utilization of surveys in quantitative research studies (Brinkman, 2009:42). Heale and Twycross (2015:66) argue that, to some extent, a practice based on evidence incorporates the implementation of the findings of research studies that are well-conducted. In addition, contemplation must not be given exclusively to the study's outcomes but the research rigour. Rigour alludes to the degree to which the researchers attempted to improve the nature of the research studies (Heale & Twycross, 2015:66). In quantitative research, this is accomplished through measurement of reliability and validity.

In quantitative research, the quality of the study and the outcomes of that study is checked by measuring its reliability, validity and objectivity (Pandey & Patnaik, 2014). Heale and Twycross define Validity as an accuracy whereby observable measures represent the concept in the study. Reliability defined as a degree to which visible measures described in a theoretical concept are precise, accurate and stable even after multiple observations (Heale & Twycross, 2015:66). Drotz (2014) also opines that external validity determines the validity of the findings in another perspective, or the results are generalizable. He further argues that Reliability is when the study's outcomes remain the same even when that study can be conducted again.

Mohajan (2017:11) identified that there are two types of Reliability:

- **Stability** – It is described as the limit of a measure to proceed as before after some time regardless of uncontrolled testing conditions or respondent themselves. In addition, there are two methods in which stability is tested, i) test-retest reliability and parallel-form reliability.
- **Internal consistency reliability** - It is an extent of dependability used to survey how various test items testing the same construct produce comparative results. Also, it may be represented in two main layouts: The inter-item consistency and Split-half reliability (Mohajan, 2017:12). The reliability of administered

questionnaire determined by an internal consistency measure called Cronbach's alpha coefficient was used. According to Tavakol and Dennick (2011:53), Cronbach's alpha coefficient gives knowledge to a degree in which items in the scale are interrelated. Estimations of the alpha range from 0 to 1, where higher values are characteristics of a better inward consistency. Nonetheless, by and large, when the value of alpha is greater than 0.7 it demonstrates a satisfactory level of consistency (Pallant, 2010:183).

There are four types of validity (Heale & Twycross, 2015:66):

- **Content Validity**
- **Construct Validity**
- **Face Validity and**
- **Criterion Validity**

For this study, Construct validity was used to legitimize the procedure and instrument employed to collect data. Construct validity is particularly significant for the empirical measures and hypothesis testing for the construction of theories. Researchers make theoretical constructs to comprehend, clarify, and foresee behaviour (Mohajan, 2017:18).

Considering the statement mentioned above, the researcher determined the convergent validity of the test to see if any other scales could be utilized to measure similar construct validity. One of the following reliability measures could be applied to check the consistency of the measure, Cronbach's alpha, Stability reliability, Equivalence reliability, and Representative reliability. However, in this study, the researcher applied a Cronbach's alpha statistic method with a value close to 1 (0.7), indicating reliability to test for reliability. This was the most appropriate method to test the reliability of the study as it is quantitative research (Isack *et al.*, 2018:142).

3.10 DATA ANALYSIS

Since data was collected using a questionnaire, some descriptive statistics such as mean, median, mode, standard deviation frequency distribution were equally used to collect data. A nominal scale of 1 – 5 will be used to code collected data and subjected to a

frequency distribution table to manipulate it even further. Information coded was presented graphically and interpreted accordingly. The collected data was entered and analysed using Statistical Package for the Social Sciences (SPSS) and results explained using graphs and percentages. Bless *et al*., (2013:245) posits that quantitative research uses tools like descriptive statistic where data is presented in tables and frequency distributions to disclose its vital properties. The demographics / biographical data were summarized using frequency tables. For each section of the questionnaire: the reliability of the study was confirmed by using Cronbach's Alpha, then the validity authorised using confirmatory factor analysis, then the responses per section were presented using clustered bar charts.

Spearman's rank correlation coefficients were used to determine the relationship between the constructs and ordinal biographical variables.

3.11 ETHICAL CONSIDERATION

Before commencing with the study, ethical clearance was sought from Health Research Ethics Committee at North-West University. Upon receiving approval from this committee to conduct this study, permission to administer a questionnaire to the participants was requested from the two participating institutions. When participants were approached to agree and partake in the study, informed consent was sought. This was accomplished by sending a questionnaire with a consent letter, requesting them to consent for participation in the study. Participants were guaranteed confidentiality, anonymity and privacy throughout the study. They were ordered not to mention any identifying information of their personal details or those of the facilities they work for. Data collected from the study was safely kept in a lockable cabinet for five years. Hard copies will be shredded after this duration and electronic data deleted from the password-protected computer.

3.12 SYNOPSIS

The primary purpose of this chapter was to unfurl the research design and methodology employed in the study to give an unmistakable perspective concerning why certain activities and procedures were selected during the process of this research. Throughout

the process, appropriate data collection, statistical analysis, and real-life occasions can be logically explained. Throughout the data analysis, a descriptive approach, which included cross-tabulation and frequency distribution, was used. Moreover, a quantitative methodology was embraced and made use of the survey method for primary data collection. This permitted the investigation to gather an enormous sample of data collected in the two selected areas of study.

Healthcare workers from the Department of Health and National Health Laboratory Service were the respondents who formed part of the sample in this study. Consequently, a random sampling technique was utilized. Participants who participated in this study were employees who worked at the hospitals where NHLS laboratories were on the premises and NHLS employees in the NMM district municipality in the North West province, South Africa. This excluded Thusong hospital is not having a fully functioning diagnostic laboratory. A sample size of 150 was considered suitable to accomplish the objectives of the investigation. A self-administered questionnaire was utilized to gather essential data and comprise a scope of segments that incorporated the socioeconomics of the respondents and other challenges faced by various health facilities. All ethical considerations were followed while also cautiously making sure that a reliable and valid instrument was utilized.

The various systems that were utilized for data collection were clarified. Data were analysed by IBM SPSS (form 24.0) software used for multiple statistical procedures. These systems comprised descriptive statistics that used frequency distributions and cross-tabulations to analyse data. The next chapter applies the approaches that were explained in this chapter. The next chapter will present the findings and challenges faced by medical laboratories and hospitals in Ngaka Modiri Molema district municipality.

CHAPTER 4

RESULTS AND FINDINGS OF THE STUDY

4.1 INTRODUCTION

Chapter 3 deliberated on a research methodology employed in this study. This chapter will analyse essential data that have been gathered and decipher the outcomes of the study. Much needed quantitative information was collected from healthcare workers and laboratory personnel in three (3) chosen areas of this study. This chapter comprises seven sections.

The first part examined the demographics of the participants. The second section discusses knowledge of laboratory personnel on the medical laboratory inventory management system, followed by the third section, which ponders the influence of medical laboratory processes on inventory management system and turnaround time. The fourth section will determine the effectiveness of the employed inventory management system on the overall performance of laboratories in the chosen area of the study. The fifth and sixth sections will look at the factors affecting the performance of medical laboratories on supply chain and inventory management system and discuss the effectiveness of laboratory analysers on laboratory inventory management system, turnaround time and healthcare service delivery, respectively.

Lastly, section 7 will discuss the influence of the laboratory inventory management system on healthcare service delivery according to data collected from healthcare workers. In so doing, this section will deliberate on challenges faced by healthcare facilities about laboratory services, ensured by an ideal inventory management system to be employed by healthcare facilities and medical laboratories to enhance healthcare service delivery. This study utilized descriptive statistics like frequency distributions and cross-tabulations to analyse and discuss the results. Moreover, to test the reliability of constructs, Cronbach Alpha values were determined. All of them were found to be at least 0.7, implying that the items in each of the constructs were reliable. These statistical methods were applied primarily to address the objectives of this study.

4.2 DEMOGRAPHICS OF PARTICIPANTS

The primary purpose of this section of the questionnaire is to provide a background of the respondents, and preliminary data was extracted using frequency distribution. The focus was on the following are the factors in the demographics:

- Gender
- Age group
- Education level
- Occupation
- Years of service in the department
- Location of the workplace

This section gives an account of the demographic qualities of the participants. Demographical data comprises age, gender, educational level and other demographic attributes (Malhotra, 2010:350). These qualities are utilized to group participants and assist the researcher to comprehend the outcomes more readily. However, for this study, results were not compared based on demographics. Frequency tables, pie charts and bar graphs were utilized to project extracted data. A total of 155 participants from both Department of Health and National Health Laboratory Service participated in this study. Demographical data of the participants were accrued from Section A of the survey.

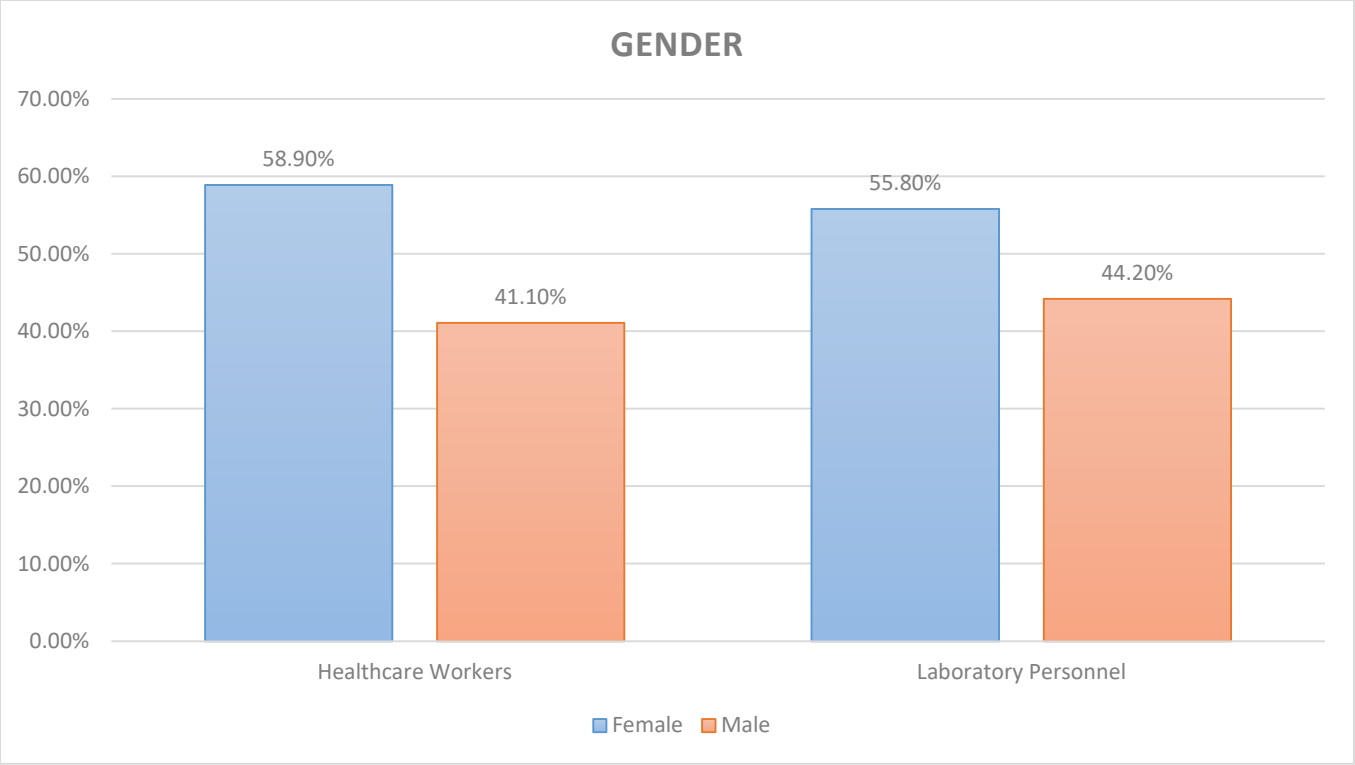


Figure 4-1: Gender

4.2.1 Gender of participants

Figure 4.1 depicts that majority of the participants are females from both healthcare workers and laboratory personnel, 58.9% and 55.8%, respectively. Whereas their male counterparts from healthcare workers and laboratory personnel made up a portion of 41.1% and 44.2%, respectively. This suggests that most employees at DOH and NHLS from the area of this study are females.

4.2.2 Age group of participants

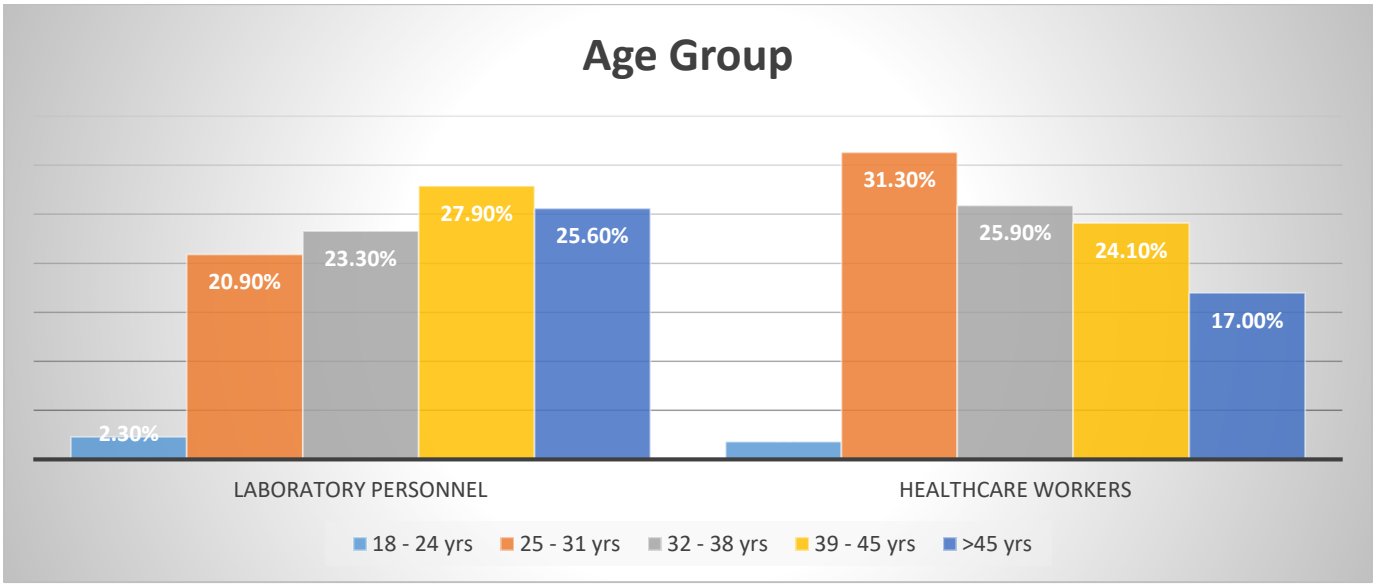


Figure 4-2: Age

The age of the participants in this study is illustrated in figure 4.2. The majority of the participants from laboratory personnel are between the age of 39 – 45 years (27.9%). They were followed by those who are greater than 45 years of age (25%) and between the age of 32 – 38 years old (23.3%). Another group of participants are between the age of 25 – 31 years old (20.9%), followed by a small portion between the age of 18 – 24 years old (2.3%).

On the contrary, the results indicate that the majority of the participants from healthcare workers are between the age of 25 – 31 years (31.3 per cent), followed by those who are between the age of 32 -38 years (25.9 per cent) and the age of between 39 – 45 years (24.1 per cent). Furthermore, a handful of participants (17 per cent) are older than 45 years, followed by a small portion (1.8 per cent) who are between the age of 18 – 24 years. It is fascinating to note that most of the participants from healthcare workers are between 25 – 31 years, whereas the majority (27.9 per cent) from laboratory personnel are between the age of 39 – 45 years.

4.2.3 Education level of participants

Table 4-1: Percentage illustration of participants' level of education

Educational Level	Laboratory Personnel		Healthcare Workers	
	Frequency (*f*)	**Percent (%)**	**Frequency (*f*)**	**Percent (%)**
Up to Grade 11	2	4.7	0	0
Matric or Equivalent	6	14.0	0	0
Certificate	13	30.2	7	6.3
Diploma	15	34.9	31	27.7
Degree	6	14.0	51	45.5
Honours	1	2.3	14	12.5
Masters	0	0	9	8.0
Total	**43**	**100.0**	**112**	**100**

Source: Data from the survey (2020)

Table 4.1 shows that most laboratory personnel have a Diploma (34.9%), followed by those who have a certificate qualification (30.2%). It is thought-provoking to note that only 14% of the participants from laboratory personnel obtained a degree. In comparison, the healthcare workers make up most of the participants (45.5). The second-highest level of education from healthcare workers' participants is a diploma (27.7%), followed by 12.5% who have an honours degree. However, it is pretty fascinating to note that 8% of the participants from healthcare workers have achieved masters' degrees. None of the participants from laboratory personnel has a master's degree. This suggests that participants from healthcare workers have a high level of education than their counterparts from the laboratory personnel. The lowest percentage further confirms this in the number of participants (2.3%) who have post-graduate degrees from laboratory personnel, compared to 24% of participants from healthcare workers who have honours and master's degree.

From this information, the healthcare workers who are directly or indirectly involved in patient care as per the selection criteria for participants in this study have higher

qualifications than just matric or equivalent qualification. This statement is supported by further revelations from these results that the lowest qualification in the hands of participants from healthcare workers is a certificate (6.3%). None of them has a secondary qualification as their highest qualification compared to their counterparts from laboratory personnel (14%).

4.2.4 Occupation of participants

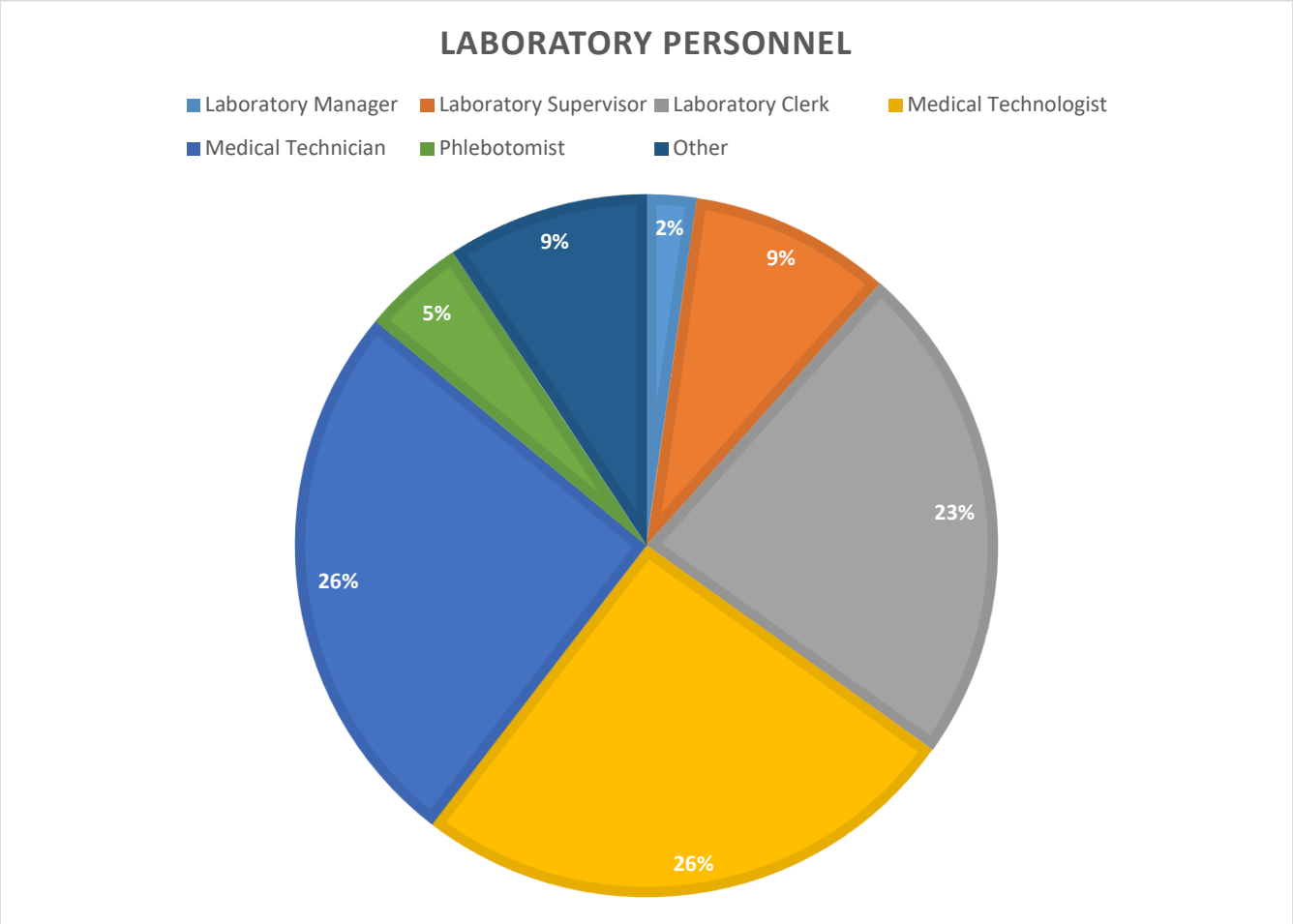


Figure 4-3: Occupation

This section gives a snapshot of the responsibilities bestowed on participants and the kind of work they perform. Figure 4.3 depicts that majority of the participants are medical technologists (26%) and medical technicians (26%). They were followed by laboratory clerks with 23% and laboratory supervisors (9%) and a small portion of phlebotomists who makes up 5%, followed by laboratory managers (2%). This indicates that laboratories

are dominated by medical technologists and medical technicians, who are primarily the ones performing tests on patient's samples, and laboratory clerks who register patient samples on laboratory information system (LIS) in the pre-analytical phase of the laboratory. In a study conducted by Rutledge and Simpson (2010), most employees in a core laboratory comprised of more medical technologists qualified to perform different kinds of cross-disciplinary testing. Besides, laboratory assistants were primarily staffed for specimen processing and nothing else.

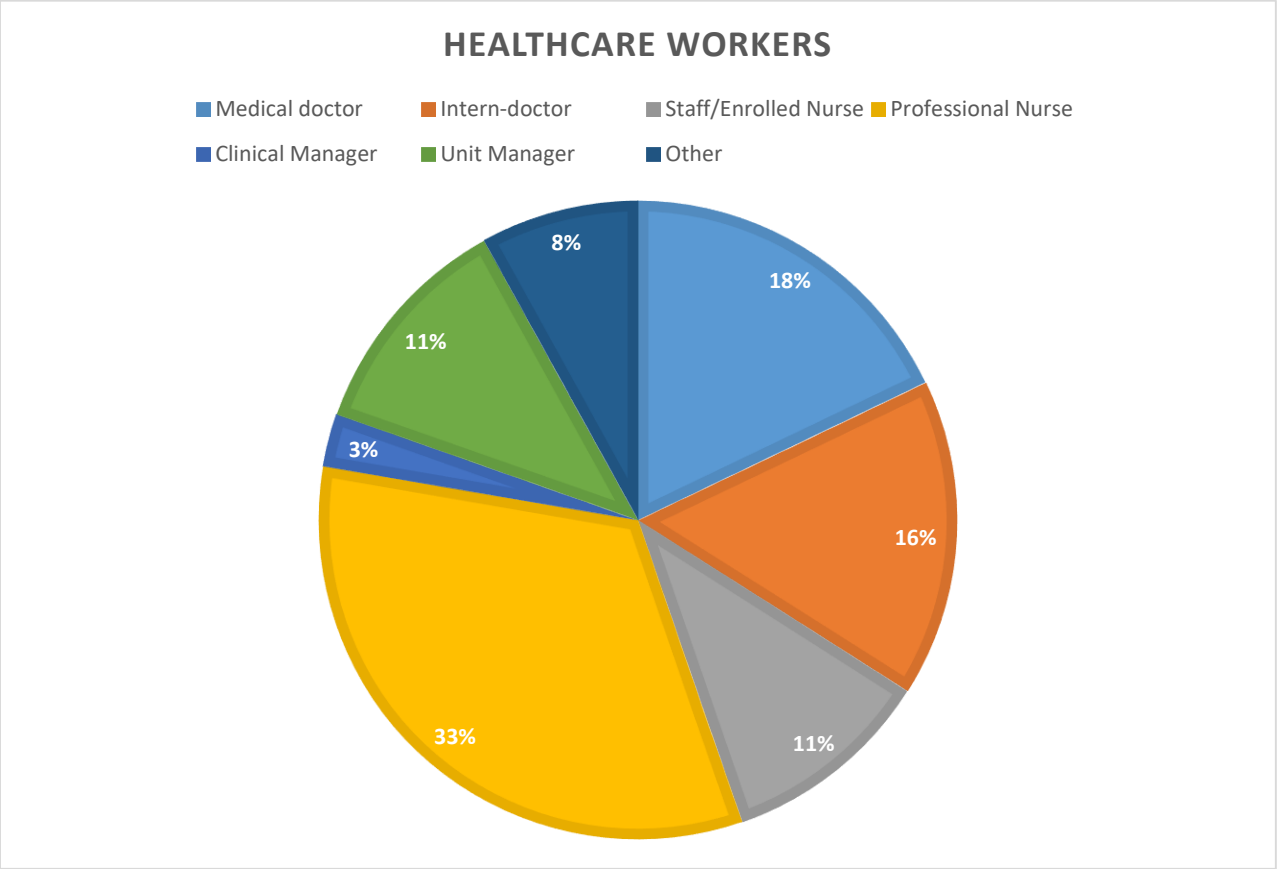


Figure 4-4: Position of Healthcare Workers

On the other hand, figure 4.4 shows that majority of participants in this study are professional nurses (33%), followed by medical doctors (18%) and Intern-doctors (16%). It is an ordinary course to note that a small portion of unit managers (11%) and clinical managers (3%). This is because one person per unit or facility ordinarily occupies these positions.

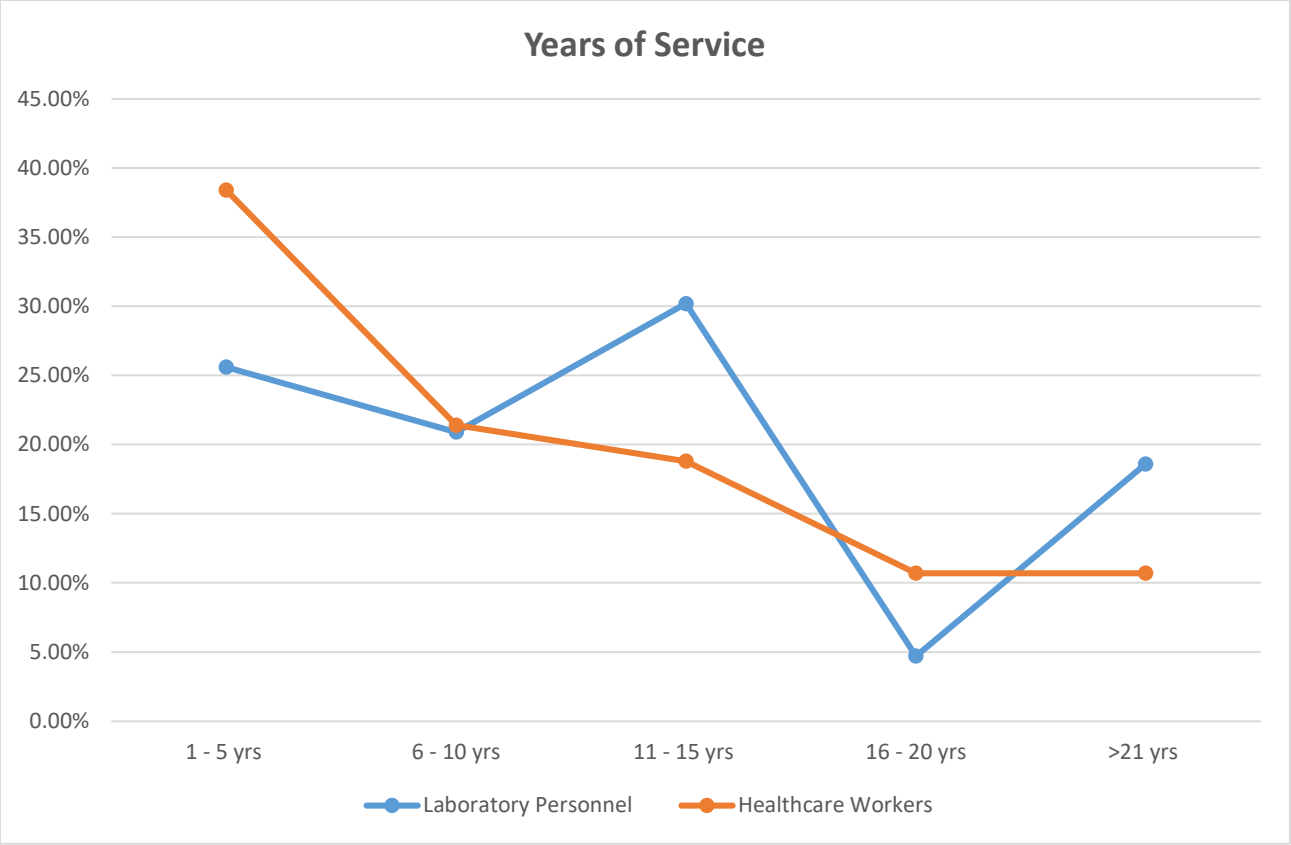


Figure 4-5: Duration of service

4.2.5 Years of service in the departments

The number of years that the participants have worked in their respective departments are illustrated in figure 4.6. Which show that most of the participants (30%) from the laboratory site have worked in the laboratory for years in between 11 – 15 years, followed by junior staff members (26%) who have worked in the laboratory for years in between 1 – 5 years and those who worked for NHLS for more than 6 – 10 years (21%). It is worth noting that a tiny portion of participants has worked in the laboratory for more than 16 – 20 years (5%). However, more experienced laboratory personnel worked in the laboratory for more than 21 years (19%). This implies a generational mix of employees from laboratory personnel in the chosen area of this study.

On the other hand, figure 4.5 depicts that most of the participants (38%) from the healthcare workers have only worked for the department for between 1 and 5 years. It is also worth noting that the more years of service in the department, the lesser the

percentage depiction of participants. Those who worked for 6 – 10 years make up 21% of the participants, followed by individuals (19%) with more than 11 – 15 years and 16 – 20 years of experience in their respective departments (11%). Equally, there is a generational mix of participants from healthcare workers, which is advantageous for this study because it means data was collected from individuals with different experiences.

4.2.6 Location of workplace

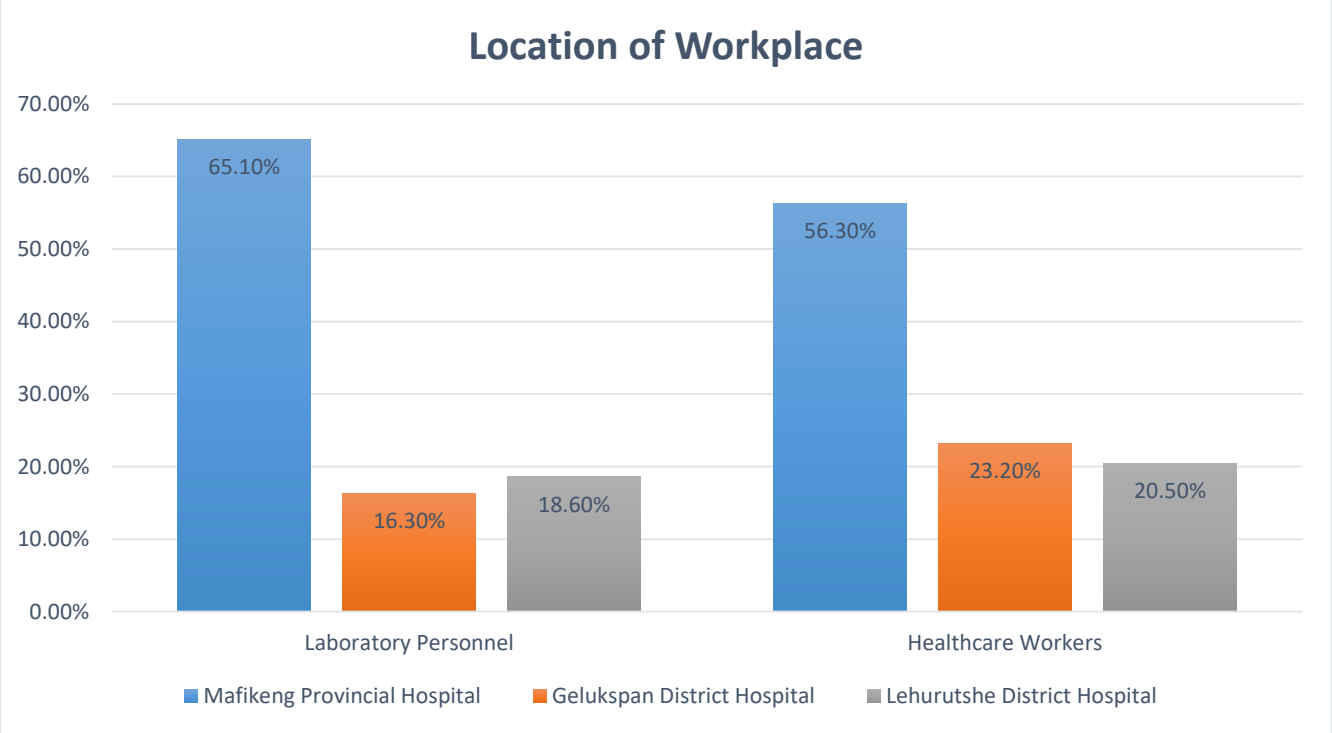


Figure 4-6: Participants' place of work

Percentages about the site where participants are working are illustrated in figure 4.6. Collected data indicates that most of the participants from both laboratory personnel and healthcare workers are from Mafikeng provincial hospital, 65.1% and 56.3% respectively. The second-highest number of participants (18.6%) working for the laboratory came from Lehurutshe district hospital, followed by 16.3 of the participants from Gelukspan district hospital. Similarly, the second largest number of participants (25.5%) from healthcare workers came from Lehurutshe district hospital and then Gelukspan district hospital making up 23.2% of the sample. This suggests that Mafikeng provincial hospital-employed more workers and is the biggest hospital in the district.

4.3 THE INFLUENCE OF INVENTORY MANAGEMENT SYSTEM IN MEDICAL LABORATORY ON HEALTHCARE SERVICE DELIVERY

This section intends to interpret the results, including details concerning the influence of the inventory management system in medical laboratories on healthcare service. The questions on a questionnaire were designed so that they would address the primary research question and objectives of the study. The analysis will first be on data collected from laboratory personnel (section 4.3.1 – section 4.3.6), and the last section 4.3.6 of this chapter, will analyse data collected from healthcare workers.

4.3.1 Knowledge of Inventory Management System

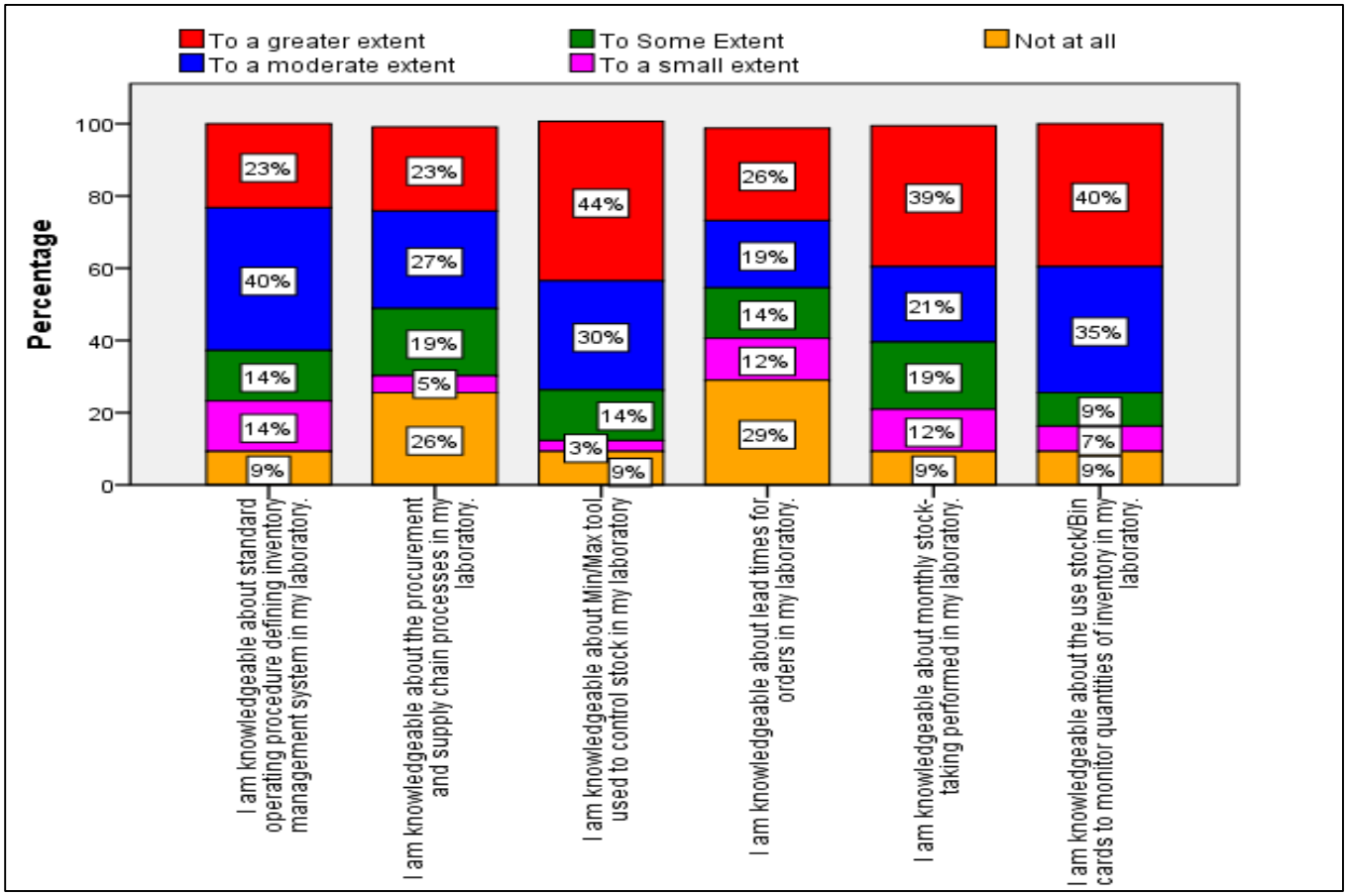


Figure 4-7: Medical laboratory inventory management knowledge

Percentages about the extent to which laboratory personnel are knowledgeable about the inventory management system are illustrated in figure 4.7. The results demonstrate that majority of the participants are familiar with inventory management systems in their

laboratories. 40% of them showed that they are known to a moderate extent about standard operating procedures (SOPs) defining inventory management system in their laboratory, with only 23% indicating that they are known to a great time. Furthermore, data suggest that only the minority (14%) of the participants are not familiar with an SOP defining inventory management system. They revealed that they are familiar with the SOP to a certain degree.

A study conducted by (Ahmad & Zabri, 2018:85) recommended that institutions give adequate training to prominent workers to improve their understanding of the stock control framework. The findings from this study suggest that more needs to be done in terms of training employees on inventory management system and SOPs. This statement is supported by outcomes of this study, which indicate that only a handful of participants (23%) were knowledgeable about the inventory management system, and 9% were not familiar with SOPs defining inventory management system in their laboratory.

The results further depicted that 26% of the participants are not at all knowledgeable on issues of procurement and supply chain processes in their respective labs, 27% of them are known to a moderate extent, as compared to the minority (23%) who are knowledgeable about these processes to a great time. This insinuates that most of the laboratory personnel are not so knowledgeable about supply chain management. According to Attia and Salama (2018:3), knowledge sharing of supply chain management amongst employees yields an improved supply chain practices and thus lead to enhanced performance of the organization.

Although the results are indicating that most of the participants (44%) are familiar with utilized tools such as Min/Max and stock/Bin cards to control and monitor quantities inventory to a greater extent as compared to 9% who are not at all knowledgeable, overwhelming majority (29%) of them are equally not at all knowledgeable about lead times for orders in their laboratories. It is pointless to know how to control and monitor stock quantities if you are uncertain about a period when new stock will arrive. According to (Ahmad & Zabri, 2018:85), the productive way and the frequency of reviewing buffer stock and lead times possess countless significance for performance planning of Material

Requirement Planning (MRP) techniques. Meanwhile, the purpose and order points review, frequency of this review and deletion events were imperative for re-order point approaches. This suggests that for new stock orders to be placed, one ought to know when to re-order and be familiar with lead times for those orders. This will allow them to make an informed decision.

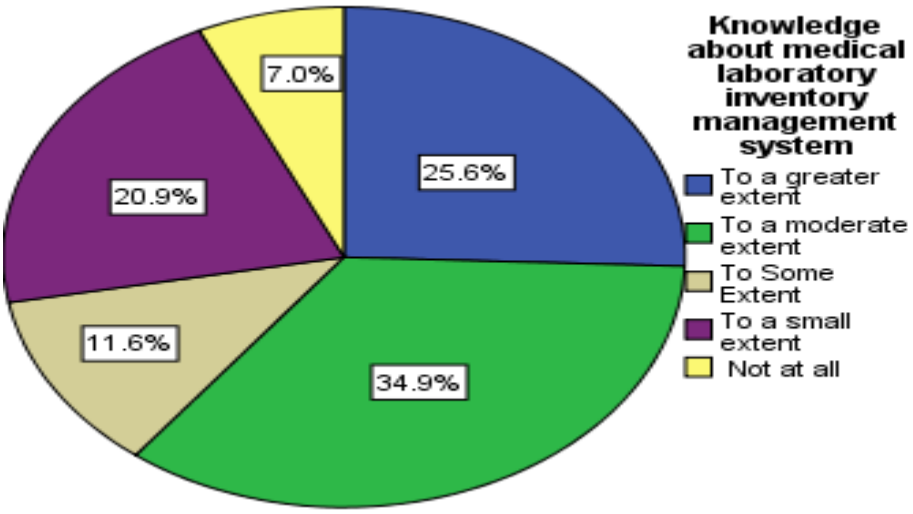


Figure 4-8: Aggregate knowledge on medical laboratory inventory management systems

Figure 4.8 illustrates percentage aggregate scores for the cluster bar chart (figure 4.7). It indicates that most participants (34.9%) are moderately familiar with the medical laboratory inventory management system compared to the 25.6% who are extraordinarily knowledgeable. It is evident from these findings that more training is needed to empower employees with relevant knowledge on inventory management system and supply chain processes in the laboratory. According to (Attia & Salama, 2018:2), one of the essential strategic resources for the survival, stability, growth and enhancement of any organization is knowledge. Therefore, equipping employees with knowledge on supply chain processes will be beneficial to them and the entire organization.

4.3.2 Influence of medical laboratory processes

Having demonstrated to what extent laboratory personnel are knowledgeable about medical laboratory inventory management system, the subsequent section will provide

an insight on the influence of laboratory processes on inventory management system and turnaround time (TAT). Gupta *et al.* (2018) defined turnaround time as a time-lapse from when a test is requested to receive a report. The researcher utilized a 4-point Likert scale to measure the participants' responses in this study. Respondents were asked to choose options ranging from 1 = Strongly disagree to 5 = Strongly agree.

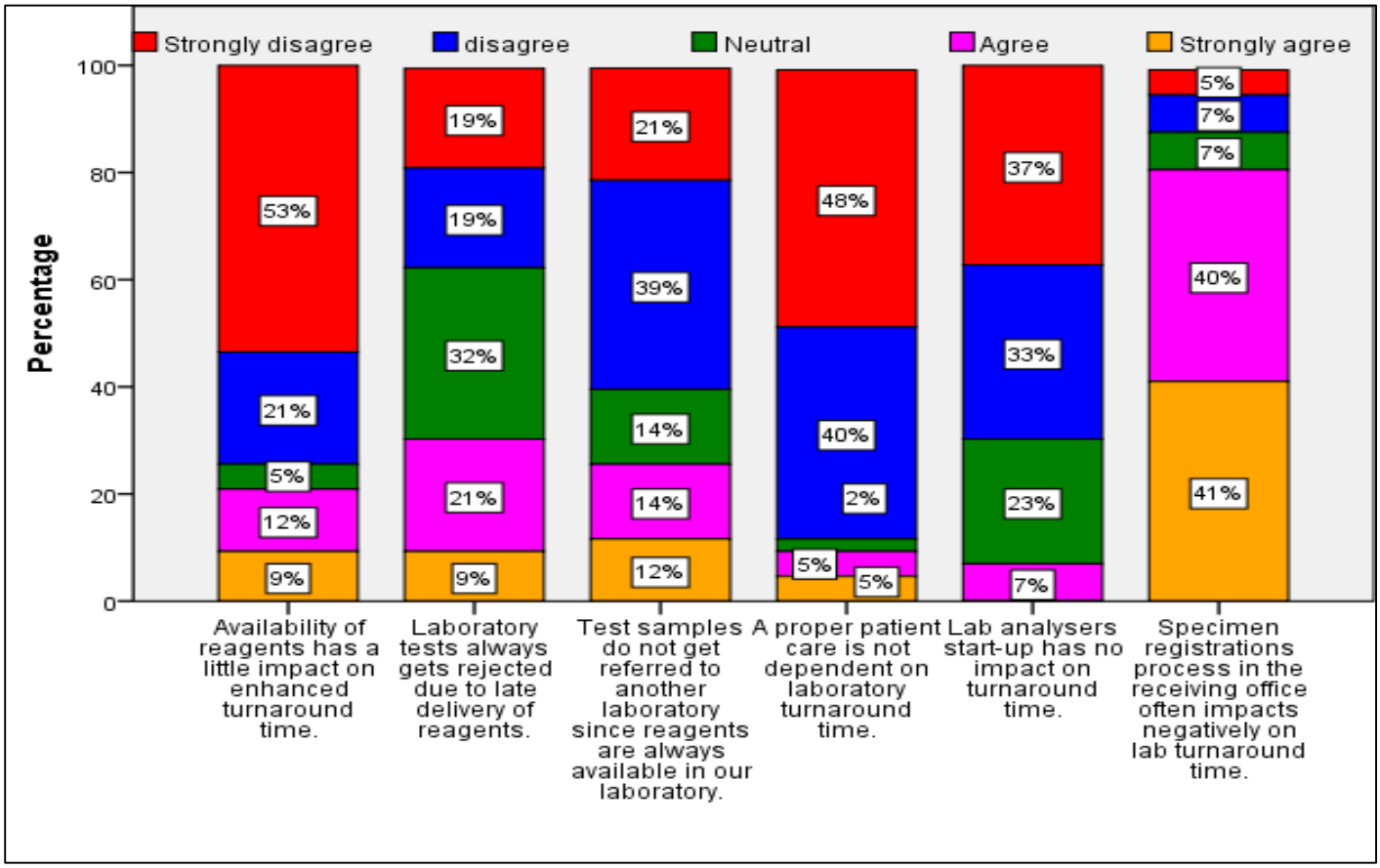


Figure 4-9: Influence of laboratory processes on inventory management and turnaround time

Figure 4.9 indicates that most participants (53%) strongly disagree that availability of reagents has little impact on enhanced turnaround time compared to the 9% who strongly agree with the statement. This implies that most of the participants believe that when reagents are available to run the test, laboratory TAT will be enhanced. This is following a study conducted by Sinishaw *et al.* (2015) which found that wellbeing habitats that did not satisfy the compelling circulation of TB lab reagents models were representing a great

test to the nonstop stockpile of reagents and consumables, which would probably be related with weak diagnosis finding of TB and follow up on laboratory services.

The results are further reflecting that most of the participants (38%) are not in agreement with a perception that laboratory tests get rejected due to late deliveries of reagents, compared to 30% of the participants who disagree. The results from this study further indicate that majority of the participants (60%) disagree with the notion that test samples do not get referred to another laboratory since reagents are always available in their laboratory, as compared to 28% who agree with this statement. The opposite of this statement is that laboratories refer samples to other laboratories as they sometimes run out of reagents. This indicates that the vast majority of laboratories experience stock-outs and referring samples to another laboratory serves as there is a contingency plan.

On the issue of turnaround time TAT, the results show that a vast number of participants (88%) disagree with the notion that proper patient care is not dependent on laboratory TAT, as compared to only 10% who agree with the statement. This is a confirmation of the literature review that states that any clinical laboratory considers TAT as one of the most important parameters to measure performance. Besides, proper and quick conveyance of results aids clinicians with precise analysis and early treatment (Gupta *et al.*, 2018:297). Other laboratory processes, such as the start-up of analyzers, impacts TAT. This is confirmed by the overwhelming majority of the participants (70%) who disagree with a perception that lab analyzers have no impact on TAT compared to only 7% who agree with this statement.

Lastly, it is also evident from the results that there are deficiencies at the pre-analytic phase of the laboratory. This statement is supported by the results from this study, which revealed that the vast majority of participants (81%) believe that specimen registrations at the pre-analytic phase negatively impact laboratory TAT compared to 12% who are opposing this statement.

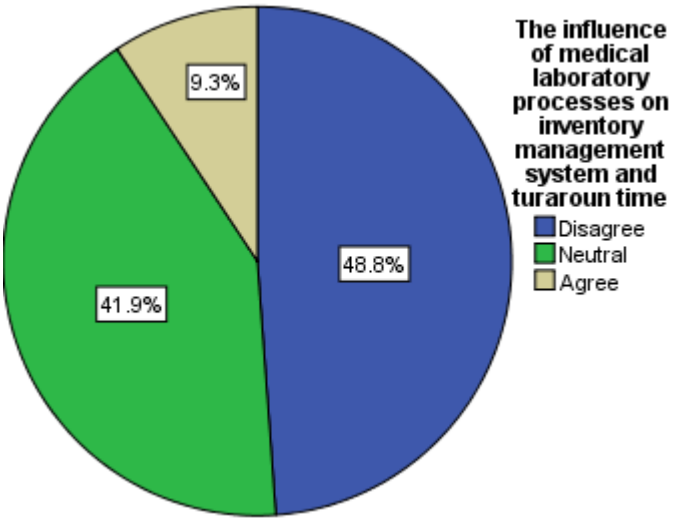


Figure 4-10: Aggregate scores on medical laboratory influence on inventory management and turnaround time

Figure 4.10 indicates that almost half of the participants (48.8%) disagree with the statements made in figure 4.9 above, against only 9.3% who hold a different perspective. This attests to the fact that medical laboratory processes influence inventory management system and turnaround time.

4.3.3 Effectiveness of inventory management system

For the laboratories to produce good quality results and render an excellent service delivery to the members of the public, an effective inventory management system ought to be in place. This section seeks to establish how effective is the current inventory management system on the performance of laboratories. According to Isack *et al.* (2018:134), most healthcare organizations are pressurized to improve medical laboratory's operational performance. Furthermore, the unavailability of the right inventory items on hand may lead to delays in (TAT) and misdiagnosis of patients. Therefore, it is essential to manage inventory in the laboratory because not having sufficient inventory items on hand could lead to an inability of the laboratory to perform specific tests needed by the physician and the patient (Menhardt, 2017:41).

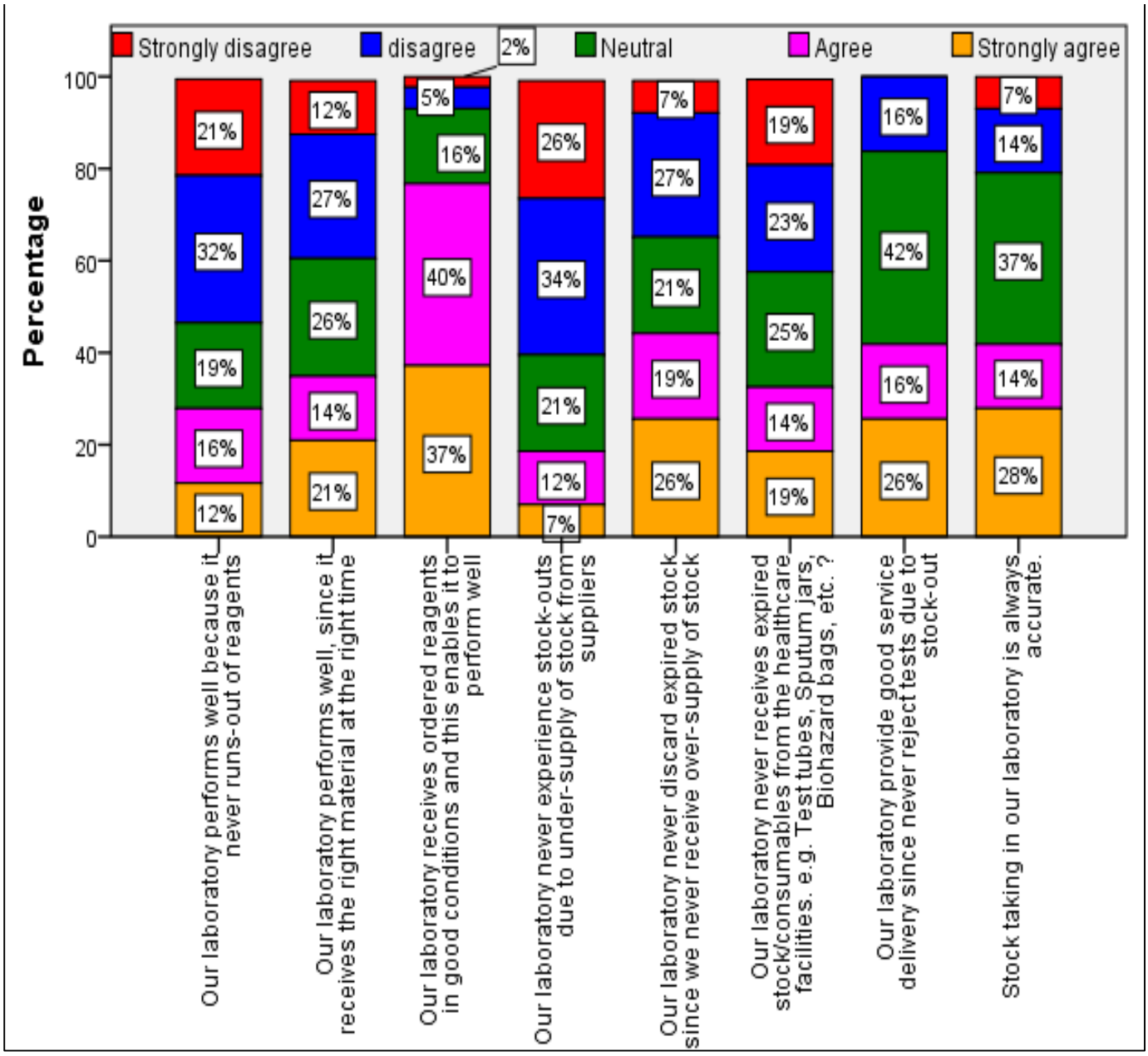


Figure 4-11: Effectiveness of inventory management on laboratory performance

Figure 4.11 provides an insight on the effectiveness of the current inventory management system employed by NHLS laboratories in the area study. The results indicate that 53% of the participants disagree that their laboratories perform well because they never run out of reagents, whereas 28% agree with the statement. This reflects deficiencies concerning the inventory management system in most laboratories because participants are disputing that their laboratories never run out of reagents.

Furthermore, the results indicate that most of the participants (37%) do not agree with the notion that their laboratories perform well because they receive correct material at the right time, against 35% who indicated that they do receive accurate material at the right time. These findings call for an improvement in supply chain and inventory management. It was discovered in the literature review that ordering the suitable material and quantities of stock at the right time yields good customer service (Nemtajela & Mbohwa, 2017:701).

Although the results are indicating that most participants (77%) argue that their laboratories receive ordered reagents in good conditions and this enables them to perform well, as compared to 21% who disagree with this proclamation, the results are indicating that the majority of the participants (60%) acknowledged the fact that their laboratories do experience stock-outs due to under-supply of stock from suppliers, as opposed to the 19% who are having a different experience and perception. This is a confirmation of findings that some of the laboratories do not receive the suitable material at the right time.

It is evident from the results that oversupply and undersupply of stock comes with different implications on inventory management, such as stock-outs and wastage. However, in this case, the results indicated that most participants (45%) agree that their laboratories never discard expired stock since they never receive an over-supply of stock compared to 33% who is having a different view on this statement. To address such issues, Attia and Salama (2018:9) suggest that there should be a close relationship between the organization and customers to apprehend their needs and fulfil these needs by delivering the right products to them.

This study further revealed that most participants (42%) do not agree with a declaration that their laboratories never receive expired stock/consumables from the healthcare facilities, whereas 33% agree with this declaration. This is another indication that inventory management systems employed by different laboratories are unable to effectively control stock and curb wastage of consumables in healthcare facilities.

In determining the influence of medical laboratory inventory management system on test rejections or cancellation, it was discovered that most of the participants (42%) are of the

view that their laboratories provide good service delivery since they never reject tests due to stock-outs, as opposed to only 16% of the participants who are holding a different view. This suggests that when their laboratories experience stock, they opt for a contingency plan instead of rejecting the samples. It is a standard requirement for all laboratories to have a contingency plan in the event of a delay in reagents delivery or stock-outs (Bouchet, 2015:2).

Finally, the results from this study revealed that most of the participants (42%) are confident of stock-taking in their laboratories, as they indicated that stock-taking in their laboratories is always accurate, as compared to only 23% who disagree with this statement and 37% could not give a clear indication of whether they agree or not.

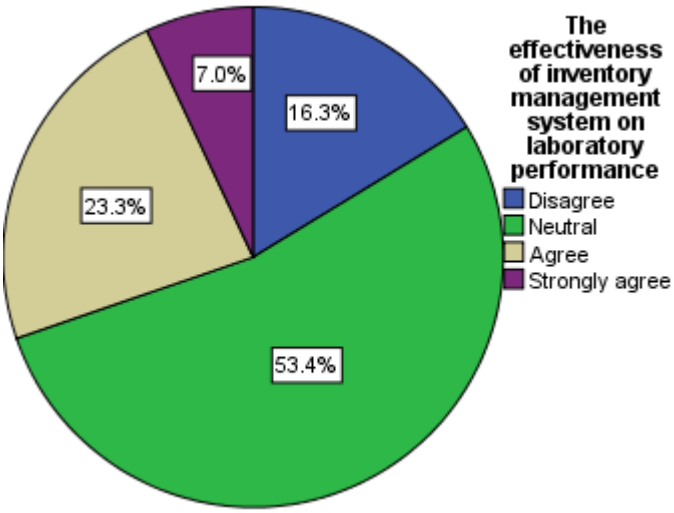


Figure 4-12: Aggregate scores on effectiveness of inventory management on laboratory performance

Figure 4.12 below depicts aggregate scores for the effectiveness of the inventory management system on laboratory performance. Even though it would appear that the vast majority of participants (53.4%) were neutral on most of the question asked and statements made in figure 4.11 above. The results show that most of the participants agreed with the statements made in this section compared to 16.3% who disagreed with most views. One can conclude from these findings that there are deficiencies in the effectiveness of the inventory management system on laboratory performance.

4.3.4 Factors affecting medical laboratory performance

Many factors tend to affect laboratory performance on supply chain and inventory management, such elements comprise but not limited to the following: storage facilities for commodities, forecasting tools for stock replenishment or Material Planning requirement (MPR), approval hierarchy for orders, communication channels between suppliers and the laboratory, top management involvement on supply chain issues and stock count. This section of the study seeks to determine which factors affect the performance of laboratories on supply chain and inventory management system.

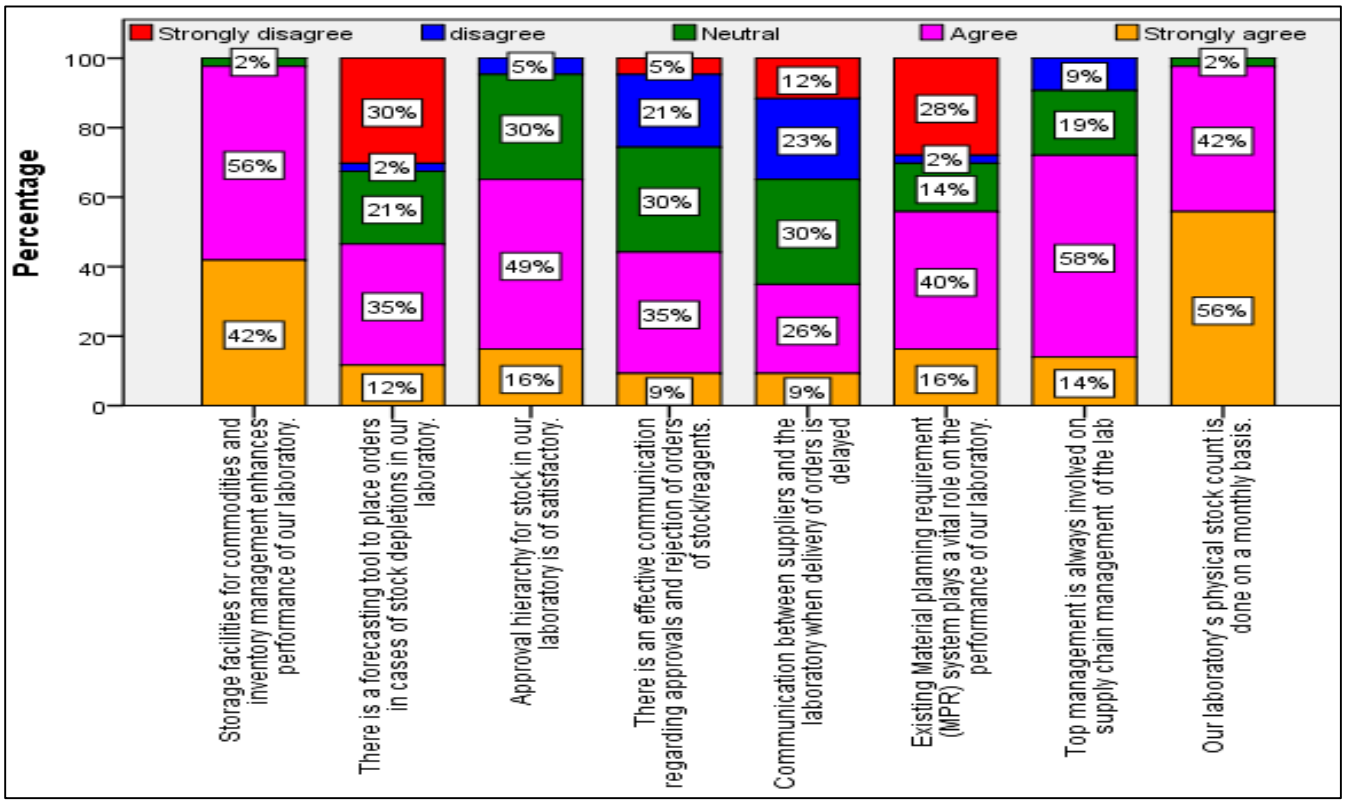


Figure 4-13: Factors on medical laboratory's supply chain and inventory management performance

Figure 4.13 depicts that most of the participants (98%) agree that storage facilities for commodities and inventory management enhance the performance of their laboratories. This is a clear indication that facilities utilized for storage purposes are in good conditions, and there are no challenges experienced. Therefore, laboratories around this study are

not at the risk of encountering losses caused by possible damages caused by storage under unfavourable/uncontrollable room temperatures in the storeroom. Just as the case at ten health centres in Ethiopia was storage for TB laboratory consumables and reagents were exposed to a direct sunlight, others mixed with other chemicals and temperatures in the store room were not monitored (Sinishaw *et al.*, 2015).

Furthermore, the results have shown that 47% of the participants agree that there is a forecasting tool to place orders in stock depletions in their laboratories, whereas 32% disagree. According to (Ahmad & Zabri, 2018:84), vendors with sophisticated systems for forecasting demand and enhanced inventory management had the upper hand over their rivals regarding profitability.

Bureaucracy in the approval of orders is sometimes hindering the timeous delivery of stock due to miscommunication. Studies revealed that implementing a successful supply chain management relies on various factors such as a sound support system and leadership from top management, which are essential tool for altering business processes and organizational culture to accomplish amalgamation of supply chain partners (Attia & Salama, 2018:9). The results indicate that most participants (64%) agree that the approval hierarchy for orders/stock in their respective laboratories is satisfactory, against the minority (5%) who disagree with this statement. Furthermore, the results depict that most of the participants (58%) believe top management is always involved in supply chain management of their laboratories, whereas 9% of them are not sharing the same sentiments. These findings suggest that there is good communication between end-users and approvers of orders in supply chain practices, and top management do provide support and leadership to improve performance and accomplish competitive advantage, just as Attia and Salama (2018:3) rightfully stated that companies need a well-integrated supply chain to compete in the global markets.

Communication is one of the critical factors that play a prominent role in enhancing the organisation's performance, and adopting information technology (IT) continuously improves this fundamental aspect. According to Attia and Salama (2018:8), IT selection is significant for inner assimilations, correspondence, coordination and commitment

between individuals in the supply chain. The results in this quantitative study depict that most of the participants (44%) agree that there is effective communication regarding approvals and rejections of orders for stock/reagents, whereas 27% are not in agreement with this statement. However, the results are inconclusive in terms of communication between suppliers and end-users. They indicate that an equal number of participants agree (35%) and disagree (35%) with the notion that there is good communication between suppliers and the laboratory when delivery of orders is delayed. The remaining 30% are neutral on the question of communication between the supplier and the laboratory.

These findings illustrate that the organization needs to improve communication, knowledge and cooperation amongst employees to increase business performance and remain competitive. This statement is supported by (Attia & Salama, 2018:12), who writes that all role players in companies should team up and construct long haul associations with upstream and downstream accomplices in the supply chain, with the end goal of the organization to improve their performance and make due in a severe climate.

More discoveries made from this study are that most of the participants agree that the existing Material Planning Requirement (MRP) system plays a vital role in the performance of their laboratory. Also, 98% of the participants agree that physical stock count at their respective laboratories is done monthly. None of them disagreed with this statement, except for 2% who could not comment on it. It is evident from these findings that most laboratories in the area of study do take the initiative of conducting a stock take monthly.

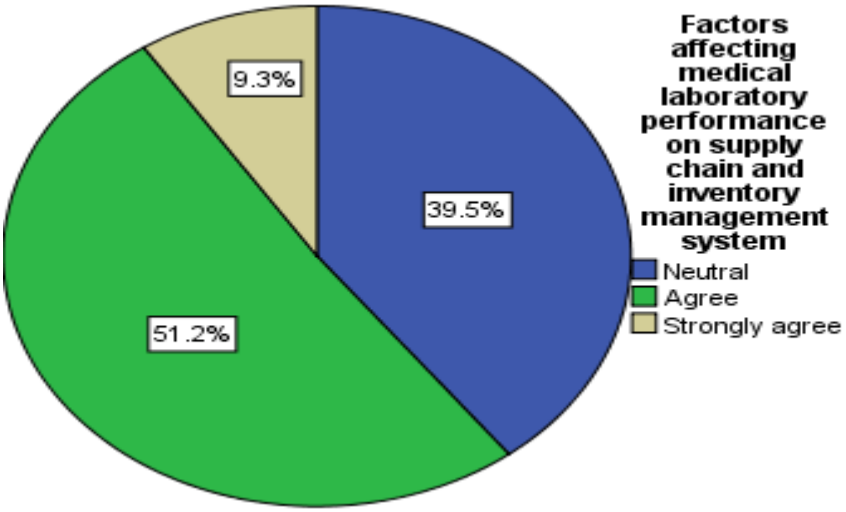


Figure 4-14: Aggregate scores of medical laboratory performance on supply chain and inventory management

Figure 4.14 displays a summary of responses from participants on questions related to factors affecting laboratory performance on the supply chain and inventory management system. The results suggest that the majority of the participants (51.2%) agree with statements made in figure 4.13 and 9.3% of them have a strong view of what has been discussed in this section. In comparison, 39.5% of the participants could not comment on many statements and chose to remain neutral. These findings illustrate that there ought to be a holistic view of inventory management, not only the system, as there are other elements that influence medical laboratories' performance on supply chain and inventory management system.

4.3.5 The influence of laboratory analysers on the inventory management system, turnaround time and healthcare service delivery.

Analysers used to perform patients' tests are constantly checked if they are producing accurate and reliable results before running patients' samples. This is usually done by running control material and running calibrations if any abnormalities are discovered (Goswami *et al.*, 2017:2). This section seeks to determine how impactful a laboratory inventory management system is on turnaround time and healthcare service delivery, the effect of repeated tests, frequent re-runs of control, and calibration materials stemming from poor laboratory performance.

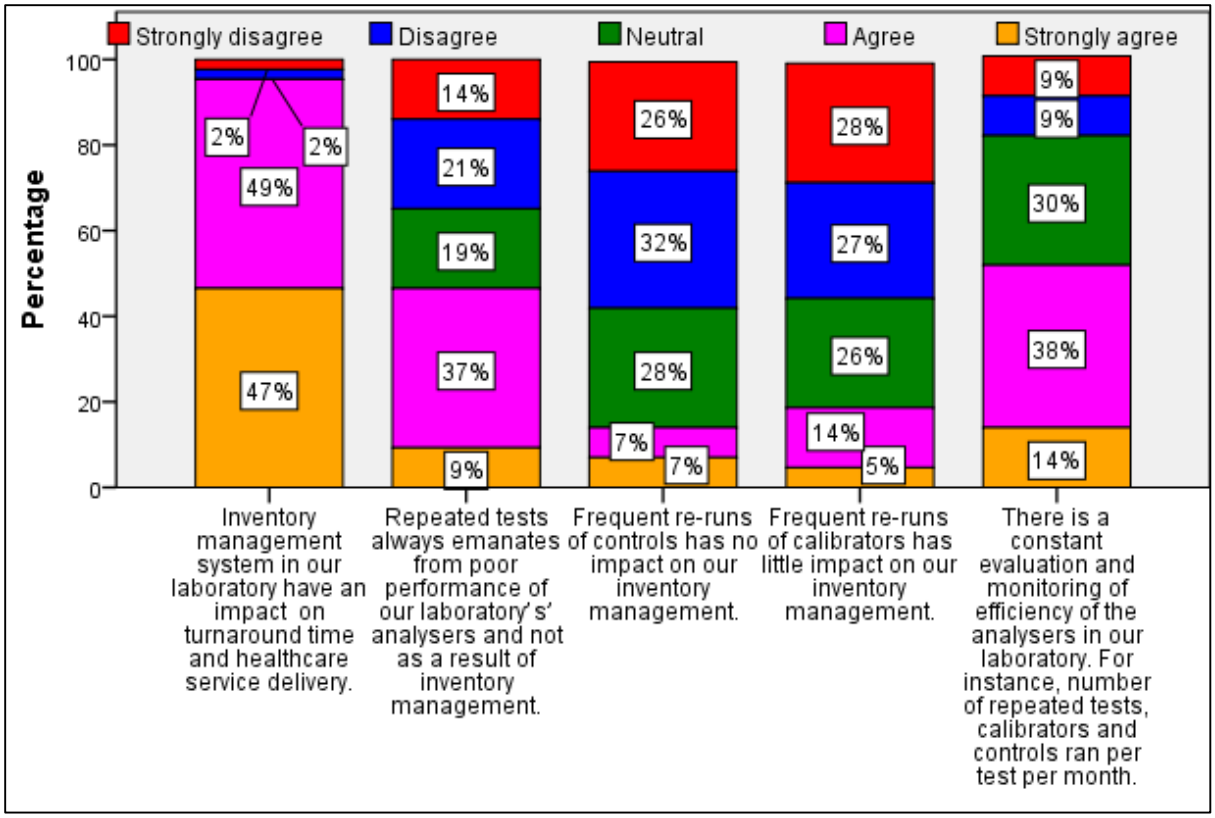


Figure 4-15: Laboratory analysts' effectiveness on inventory management turnaround time and service delivery

Figure 4.15 indicated that most of the participants (96%) agree with the concept that inventory management system impacts turnaround time and service delivery, compared to 4% who disagree with this statement. This suggests that failure to manage laboratory inventory negatively impacts patient care and service delivery. According to Nemtajela and Mbohwa (2017:701), poor inventory management always comes with financial implications to the company. It has the potential of causing customers to lose interest in the company's service and opt for assistance from the competitors.

The results further indicated that most of the participants (46%) believe that repeated tests in the laboratory emanates from the poor performance of the laboratory's analysers and not because of inventory management, as opposed to the 35% who disagree with this statement. It is also interesting to note that the most significant number of participants (52%) indicated a constant evaluation and monitoring of the efficiency of analysers in their laboratories, against 18% who disagree with this statement. This suggests that from this

evaluation and monitoring of the analyser's efficiency, most of the participants (58%) and (55%) realized that frequent re-runs of controls and calibrations negatively impact inventory management, just as Goswami *et al.* (2017:2) have alluded that the ever-changing parametric tests in chemistry require relatively expository assessments of analysers, techniques, adjustment and accuracy testing of controls, both normal and abnormal before an analyser can be introduced into the clinical testing laboratory framework.

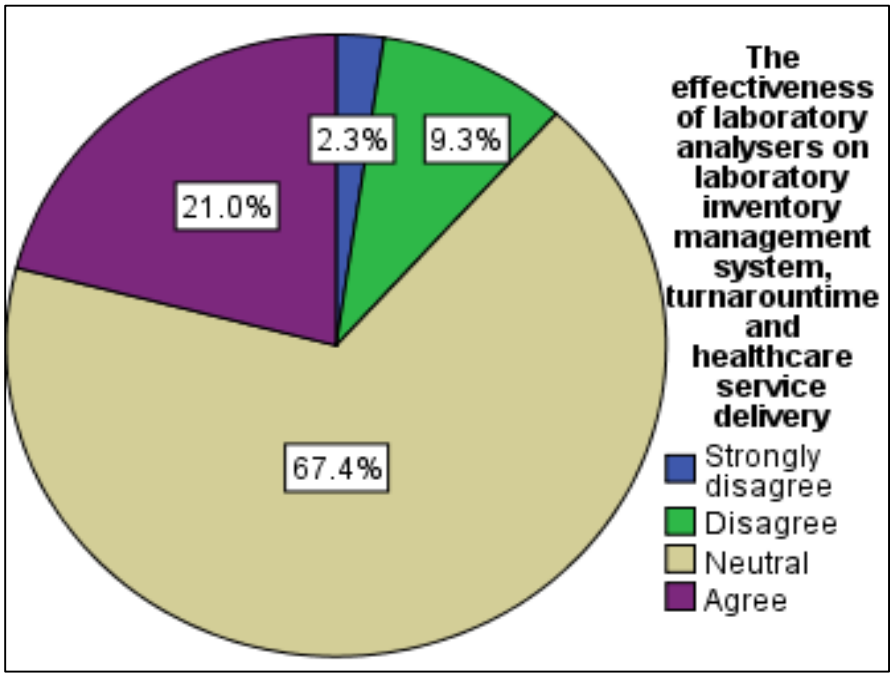


Figure 4-16: Aggregate on effectiveness of analysts on inventory management, turnaround time and service delivery

Although the results indicate that the majority of participants (67.4%) are neutral on the statements mentioned above, more revelations indicate that majority of the participants (30.3%) agree with most of the statements made, as compared to the minority of 2.3% who are strongly holding different view regarding these statements.

4.3.6 Influence of laboratory inventory management system on healthcare service delivery

Management of stock in business operations is one of the fundamental vital functions in meeting customers' demands. Therefore, there should be a balance between meeting customers' needs and keeping an adequate supply of products (Ahmad & Zabri, 2018:83). Moreover, research indicated that clinical laboratory services form part of essential constituents of good quality healthcare service delivery (Archetti *et al.*, 2017:31). As a result, this section seeks to assess the effect of the laboratory inventory management system on healthcare service delivery by analysing data collected exclusively from healthcare workers in the chosen area of this study.

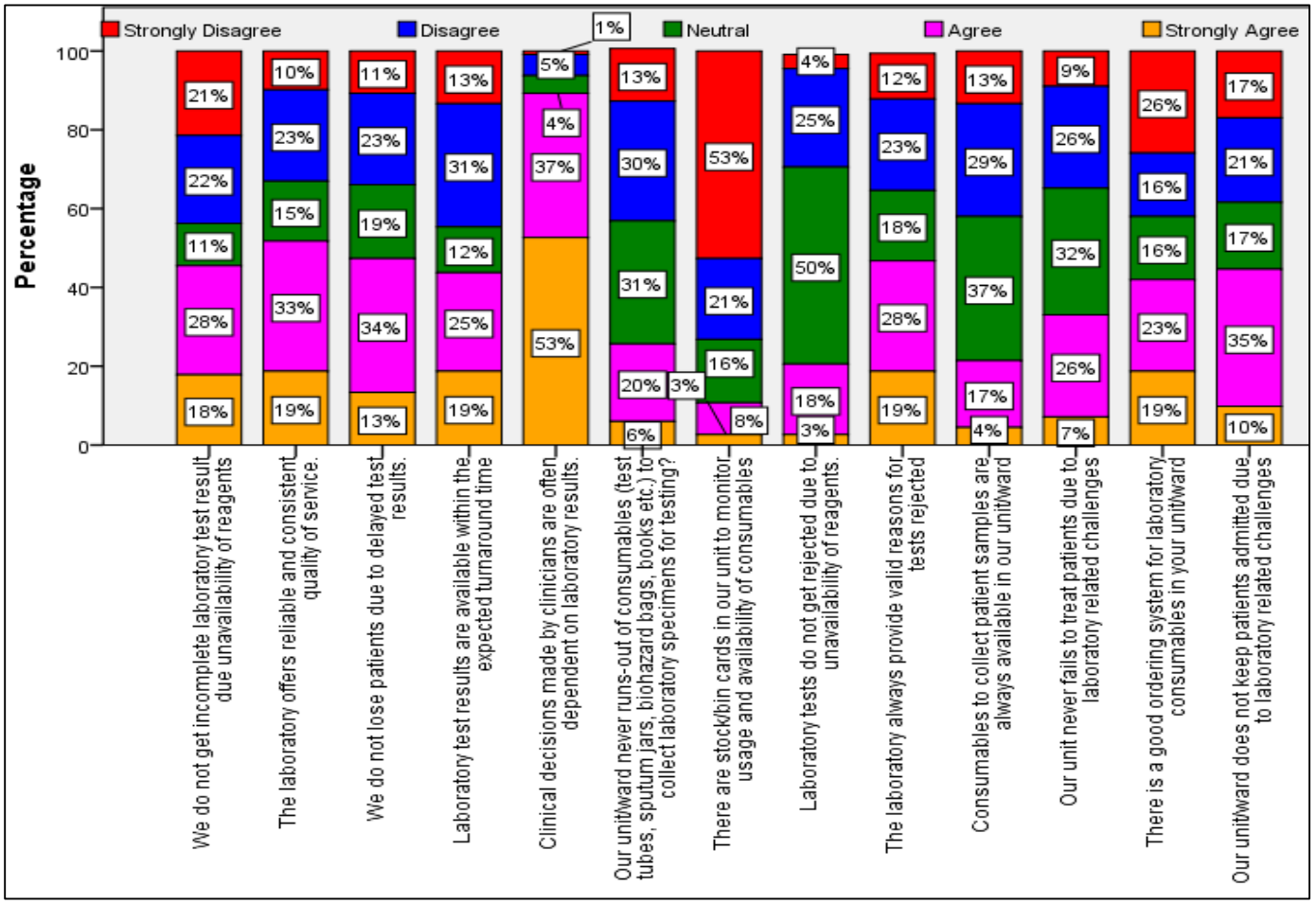


Figure 4-17: Influence of laboratory inventory management system on service delivery

When there are no reagents in the laboratory, it means specific tests cannot be performed. For instance, if 8 Liver function tests (LFT) are requested and one reagent is

missing to run one of the tests, not all 8 LFT will be performed. The results in figure 4.17 indicate that most participants (46%) view that they do not get incomplete laboratory results due to unavailability of reagents, as compared to 43% of them who agree that preliminary results are frequently due to the unavailability of reagents to perform tests. This implies that laboratories are sometimes unable to perform specific tests due to stock-outs. According to Ehrenthal and Stölzle (2013:59), stock outs directly impact retailers' financial performance because they lead to losses on sales when customers decide to buy those unavailable items somewhere else or entirely cancel their shopping trip. This suggests that when laboratories can not perform tests, customers might choose to seek these services from the organizations' rivals. However, it is interesting to notice that most participants (52%) believe that the laboratory offers reliable results and consistent quality of service compared to 33% of the participants who have a different view.

Furthermore, the results illustrate that most of the participants (47%) are satisfied with service quality. They indicated that they do not lose patients due to delayed tests results instead of the other 34% of the participants not sharing the same sentiments. This is an indication that the problem is not the quality of laboratory results or services but quantity.

There are mixed or inconclusive reactions on the question of availability of results within the expected turnaround time (TAT) because the works depict that an equal number of participants agree (44%) and disagree (44%) that laboratory test results are available within the expected TAT, against a portion of the participants (12%) who could not comment on this statement. The TAT is customarily utilized as a pointer of the performance of the laboratory about the level of service given to the patients (Archetti *et al.*, 2017:31).

According to the literature, laboratory medicine is one of the branches of medicine that provides clinicians and healthcare workers with objective data to make appropriate clinical decisions (Adeli, 2017:5). It is not surprising to note from the results that most participants (90%) agree that clinicians' clinical decisions are often dependent on laboratory tests. This is a clear indication that laboratory results play a prominent role in inpatient care. This statement is supported by Krasowski *et al.* (2015:1), who writes that laboratory test

report impact findings, visualization and the board of infections as lab testing are an indispensable portion of medicine nowadays.

The results in figure 4.17 further indicated that most of the hospital units do not have monitoring tools for their consumables, as it is illustrated from the effects that the majority of the participants (74%) do not have stock/bin cards to monitor usage and availability of consumables in their hospital units, in comparison to only 11% who indicated opposite to this statement. It is therefore not surprising to note that most of the hospital unit/wards are often faced with stock-outs on a collection of material for specimens, as it is illustrated from the results that the majority of the participants (43%) often run out of consumables such as test tubes, sputum jars, request forms and biohazard bags to collect specimens for testing, against 26% who are experiencing the opposite. These findings are further emphasized by 42% of the participants who do not agree that consumables to collect patient samples are always available in their hospital wards compared to only 21% of them who agree with the statement, which explains the discovery made in this study that most of the participants (26%) strongly disagree that there is a sound ordering system for laboratory consumables in their hospital unit/wards, against a handful of the participants (19%) who strongly agree to this statement.

Although the results are showing that a massive number of participants (50%) did not want to comment on the question of whether lab tests get rejected due to unavailability of reagents or not, the majority (29%) of those who expressed their view indicated that they disagree with an impression that laboratory tests do not get rejected due to unavailability of reagents, as compared to the 21% who agree with this proclamation. Therefore, it is evident that unavailability of reagents to perform tests leads to the cancellation/rejection of tests requested by clinicians. Nemtajela and Mbohwa (2017:325) support this statement and argue that cancellation/rejection of test orders typically emanates from stock depletion in some instances. Participants would know if the reason for cancellation/rejection of their requested tests originate from the unavailability of reagents because findings from this study revealed that laboratories always provide valid reasons. This statement is supported by the results, which shows that most participants (47%) indicated that their laboratories always offer good reasons for tests rejected compared to

the 35% who disagree with this notion. This implies that if tests were dismissed due to the unavailability of reagents, this would be stated in the report given to the requesting healthcare worker.

In conclusion, the results indicate that most of the participants (35%) do not agree with the statement that their units never fail to treat patients due to laboratory-related challenges, as compared to 33% who approve. This implies that laboratories' challenges do impact patient care and cost related to healthcare service delivery. It is interesting to note that most participants (45%) agree with a narrative that their units/wards do not keep patients admitted due to laboratory-related challenges, as compared to 38% of the participants who disagree with this proclamation. One of the implications of delays in TAT or rejections of tests is that the hospital is compelled to wait longer than agreed TAT for patients results, meanwhile keeping patients in the hospital and incurring more costs due to this extended stay.

According to Archetti *et al.* (2017:31), the expected TAT for each test report is typically established by clients of the service. The laboratory must stick to this agreement or inform the clients if there are any deferral. Therefore, shortening TAT does not only help healthcare workers make clinical decisions timeously, but it also minimizes the average length of patient's stay in the wards and costs related to this extended stay. This view is supported by Rutledge *et al.* (2010:24), who stated that medical laboratories are generally pressurized to give test results faster; meanwhile, it is expected of them to improve quality and decrease costs.

4.4. CONCLUSION

Clinical laboratories play a prominent role in patient care and healthcare service delivery. Laboratory performance is somehow affected by challenges relating to inventory management. The focal aim of this chapter was to determine different challenges faced by healthcare facilities and medical laboratories in Ngaka Modiri Molema district municipality. And also to determine how well inventory management system is implemented in the selected area of this study. The next chapter summarises the findings from this study, including revision of theoretical and empirical objectives outlined in

chapter 1 to establish whether those objectives were met or not. The succeeding chapter also gives recommendations concerning challenges experienced by healthcare facilities and laboratories in the chosen area of this study.

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Inventory management appears to be a challenge for many NHLS laboratories around the selected area of this study. The kind of inventory management system employed by any organization relies on numerous variables: economic strength of the place, storage facilities available, supply chain practices, and many more, which are called imperatives. Furthermore, the Inventory management system is one of the critical aspects in ensuring that businesses are well managed, customer's needs are met, and the organization remains competitive and profitable by minimizing losses. This chapter will begin by giving an overview of the study, discussing and summarizing the findings, and providing recommendations and conclusion to this study.

5.2 OVERVIEW OF THE STUDY

This study aims to assess the influence of inventory management system in medical laboratories on healthcare service delivery. The primary purpose of chapter 1 was to introduce this study topic and outline the primary objectives of the study. An introduction was provided in section 1.1 of chapter 1, followed by a background of the study in section 1.2 and the research problem in section 1.3, together with the study's objectives in section 1.4.

5.3 SUMMARY OF MAIN FINDINGS AND DISCUSSION

This section aims to highlight the study's main findings concerning the eight empirical objectives outlined in chapter one (1). A descriptive analysis of data collected from the chosen area of this study was conducted. To confirm the reliability of results the Cronbach's alpha coefficiency was used, and the values were all greater than 0.7, which implies that results are reliable. The primary objective was to determine how the current medical laboratory's inventory management system influences public healthcare service

delivery in the NMM district municipality. The results indicated that healthcare facilities in the chosen area of this study do get incomplete results, which negatively influences patient care and healthcare service delivery. According to (Menhardt, 2017:41), not having sufficient inventory items on hand could lead to the inability of the laboratory to perform specific tests needed by physicians and the patients. The results further show that the availability of reagents has a significant influence on enhanced TAT and healthcare service delivery. Furthermore, proper patient care is dependent on a good laboratory TAT. To address the primary objective of this study, the following secondary research objectives were identified and analyzed in more details:

5.3.1 Evaluate the impact of laboratory reagents depletion

The first secondary research objective was to evaluate the impact of laboratory reagents depletions on healthcare service delivery. The results show that most laboratories do experience stock-outs. Consequently, healthcare workers argue that laboratory tests get rejected due to the unavailability of reagents. Keeping adequate inventory helps sustain confidence in the healthcare system. Therefore, should there be frequent stock-outs, patients and healthcare workers might lose faith in the system (Saha & Ray, 2019:2).

5.3.2 Determine the influence of inventory management system on TAT

The second empirical objective of the study was to determine the influence of inventory management system on laboratory TAT. According to Isack *et al.* (2018:134), TAT is usually used by many healthcare institutions as a key performance indicator for laboratory services. The results in this study are inconclusive of whether healthcare worker receive laboratory tests within expected TAT or not. However, healthcare workers argue that laboratories provide reliable test results and consistent quality of service. Furthermore, healthcare workers are satisfied with service quality as they do not lose patients due to delayed test results.

5.3.3 Assess effectiveness of the current inventory management system

The third empirical objective was identified to assess the current inventory management system employed by NHLS laboratories in Ngaka Modiri Molema district municipality. The

results depict that the current inventory management system is moderately effective because most laboratories do experience stock-outs and are not constantly receiving the suitable material at the right time. However, reagents are always obtained in good conditions when delivered, and there has never been an oversupply of stock. Also, they never discard stock because of expiry dates. This suggests that there is some element of reasonable inventory control at most laboratories around the study. Inventory control is when goods and services are supplied at the right time in the required quantity and quality (Ogbo & Ukpere, 2014:111).

5.3.4 Determine the influence of laboratory inventory management system on rejections

The fourth empirical objective was identified with the sole purpose of determining the influence of the laboratory inventory management system on rejections or cancellation of tests requested by clinicians. The results show that healthcare workers believe that laboratory tests get rejected due to the unavailability of reagents. However, laboratory personnel indicated that they never leave tests due to stock-outs and late deliveries of reagents. If there are no reagents, test samples get referred to another laboratory to avoid losing revenue. Rejection of tests According to Ullah and Kang (2014:2448), the essential target of any service association is to meet the needs of its customers at fewer expenses.

Inventory management has been identified as one of the critical role players in reducing costs related to the product or service. Nemtajela and Mbohwa (2017:702) defined stock out as an event where customer's demand cannot be achieved. For instance, when a laboratory experience stock-out, some tests get rejected if they could not be processed within a certain period. An alternative to test rejection is the referral of that test to another laboratory, and this is usually causing delays associated with prolonged TAT, and this alternative has its disadvantages. Isack *et al.* (2018) argue that prolonged TAT in most cases is linked to many factors, including specimen referral system, serious stock-outs and instrument downtime, among other things. The results further indicated that poor performance on laboratory analyzers is also a contributing factor towards inventory management, as they sometimes run controls and calibrators repeatedly.

5.3.5 Determine the influence of inventory management system on clinical decisions

The fifth secondary research objective of this study was to determine whether a laboratory inventory management system has an influence on making clinical decisions for patients. The results in this study indicated that clinical decisions made by clinicians are often dependent on laboratory tests. Besides, healthcare workers are sometimes failing to treat patients due to laboratory-related challenges. However, their hospitals do not keep patients admitted due to the difficulties related to the laboratory. According to a study conducted by Moyo *et al.* (2015), clinicians use more than 90% of laboratory results to diagnose or plan patient management such as admission or discharge of patients, monitor treatment and rule out diseases. In the same vein, Mboera *et al.* (2015:2) stated that health laboratories remain the backbone of the healthcare system because confirmation of any diagnosis is essential for identifying specific diseases, determining drug resistance, and guiding treatment.

5.3.6 Assess the effectiveness of supply chain and inventory management system

The sixth and seventh identified secondary objectives of this study was to assess the effect of supply chain management of laboratory consumables in public health hospitals and determine how effective is the inventory management system for laboratory consumables at the public hospitals in the chosen area of this study. The results revealed that there is a sound ordering system for laboratory consumables. However, there are no monitoring tools for consumables/stock in the hospital wards. As a result, most healthcare facilities in this study do run out of consumables. It was also interesting to note that most of the facilities keep too much stock/consumables in their wards/units until they expire and return this stock to the laboratory when this happens. This indicates an ineffective inventory management system for laboratory consumables and an inability to control laboratory stock and curb wastage. It is worth noting that inventory management systems in healthcare are multifaceted systems associated with various inducing factors. Therefore, to improve accessibility and affordability of services in healthcare, there ought

to be a continuous improvement in the performance of their inventory management system (Saha & Ray, 2019:2).

5.3.7 Assess effectiveness of supply chain management for NHLS

This study's last secondary research objective was to assess the effectiveness of the supply chain management system for NHLS laboratories in the chosen area of this study. The results have shown that only a few laboratory personnel are incredibly knowledgeable about procurement and supply chain processes. Most of them are not at all knowledgeable about lead times of orders in their laboratories. Furthermore, there is no forecasting tool to place orders in cases of stock depletions. However, the approval hierarchy for orders is satisfactory, and top management is always involved in supply chain practices by providing support and leadership to improve performance in the laboratories. Besides, there is good communication between end-users and approvers of orders and good communication regarding approvals and rejections of orders for stock/reagents. However, the results are inconclusive on communication between suppliers and the laboratory when delivery of orders is delayed. This indicates that there are deficiencies in the supply chain management of laboratory consumables at the hospitals.

5.4 RECOMMENDATIONS

Inventory is one of the most essential and costly assets in any organization. Thus, an effective inventory management system plays a pivotal role in ensuring no stoppages of production or service due to stock depletion. This also helps organizations stay afloat in business and meet customers' demand. There are areas of improvement identified from the findings, and the following are suggested recommendations to the organization.

5.4.1 Improve inventory management system

The results indicated that laboratories around this study do experience stock-outs. A well-organized, improved and controlled laboratory inventory management system that will assist laboratories in performing tests without delays and avoids situations of stock-outs must be implemented. On the contrary, inefficient stock control leads to various critical

issues such as giving healthcare workers incomplete laboratory results, which causes a hindrance to patient care and service delivery. However, it is a mammoth task to effectively manage laboratory inventory due to the uncertainty of demands for laboratory tests. To address this problem, it is recommended that an ideal inventory management policy that will make it possible to captivate these uncertainties be developed. Alternatively, the organization must invest in an automated inventory management system and do away with manual counting and stock monitoring in the laboratories.

5.4.2 Avoid laboratory tests rejections

The findings from this study indicate that tests often rejected to the unavailability of reagents. Since it is difficult to predict the influx of patients into the hospital, what medical conditions are they coming with, the kind of treatment they need, and the number of laboratory tests to be requested, it is recommended that laboratories always keep a buffer stock to address the sudden increase of tests ordered and identify a contingency plan if there are no reagents to perform tests or any other challenge that may cause stoppage to laboratory service and stick to it. This plan should be tested occasionally to determine if it works, and the process of trying this plan should be documented and improved as and when a need arises.

5.4.3 Improve expected laboratory turnaround time (TAT)

The majority of healthcare facilities measure the performance of their laboratory services by using TAT as a key performance indicator. Even though the results from this study indicated that laboratories provide reliable products and consistent quality of service, there was no confirmation on whether healthcare workers receive laboratory tests within expected TAT. The results from this study further revealed that proper patient care is dependent on a good laboratory TAT. It is therefore essential for laboratories to enhance TAT because a shortened period for the provision of the test result is helpful to clinicians in making diagnoses, treating and discharging their patients early from the hospital wards or shortening the length of stay for patients at the hospital and reducing costs related to their admission in the hospital. Therefore, it is recommended that the laboratory and users of its services agree upon the expected TAT for each test that is frequently requested,

and the laboratory must abide by this agreement or inform its users if there will be any deferral.

5.4.4 Clarify lead times for delivery of reagents/stock

It is not an easy task in service facilities such as laboratories to predict future customers' future demands. This is because there is uncertainty as to when and how many patients will require laboratory tests. To mitigate this situation, laboratory managers must closely monitor their stock to keep it as near as possible to the maximum level. This can be achieved by assigning store clerks or an individual who will constantly monitor how much available reagents is on hand and alert managers whenever an item in the store is running low. This study shows that one of the contributing factors to stock-outs is that laboratories do not always receive the right quantities of material at the right time. It is therefore recommended that laboratories define lead times for every reagent used in the laboratory. If the supplier is unable to deliver a specific item on time, then laboratories must be informed right on time to resort to an available contingency plan. The quantity of reagents laboratories can keep in-store must rely on how long it takes for that reagent to be delivered when ordered. It also recommended that laboratories classify their stock in terms of ABC classification. This implies that items will be marked according to how quickly they get finished. Those moving fast will be classified as A items, class B will be moving moderately quick, and class C will be moving slowly in the storeroom. This will help laboratory management predict or forecast monthly usages of each item.

5.4.5 Improve laboratory equipment to address laboratory challenges

Clinical laboratories are expected to produce good quality results at all times. Consistency in rendering good services and meeting customer’s demands enhances confidence in the quality management system implemented by the organization. The results revealed that frequent re-runs of controls and calibration materials on analyzers harm inventory management. Therefore, laboratories must avoid inundated and unnecessary re-runs of control materials, repeat tests, and instrument breakdowns, leading to wastage of reagents. This can be achieved by replacing old equipment that has exceeded its life span and sticking to service schedules of the available equipment.

5.4.6 Improve supply chain management of laboratory consumables in the wards

Laboratories around this study are compelled by service level agreement between DoH and NHLS to supply healthcare facilities with consumables to collect patients' samples. These consumables get purchased by the laboratory and provided to the facility free of charge. The results revealed that there is a sound ordering system in place for the supply of these consumables. However, there are no monitoring tools for the usage of these consumables in the hospital wards. As a result, facilities tend to keep excessive stock in their wards/units until they expire and returning them to the laboratory when this happens. This is yet another confirmation that there are deficiencies in the inventory management system for consumables in the wards. Therefore, it is recommended that each healthcare facility reach an agreement with laboratory personnel on a specific day of the week in which they will place orders for consumables.

There must also be a well-established inventory control system that is aligned with this agreement. On the other hand, laboratories must keep optimal stock of consumables to distribute to individual facilities and different units/wards in the hospital. The unit managers' responsibility is to keep inventory costs at their lowest level to avoid wastage. Therefore, they are required to order the suitable material and quantities of stock at the right time to meet their client's demands. This can be achieved by implementing automated inventory optimization tools to generate consistent ordering items for the service. Alternatively, they assign store clerks who will take full control of consumables replenishment of the chain and use public demand and cost information to decide how much stock to re-order.

5.4.7 Invest in training and skills development

Companies base their competitiveness on their capabilities and available resources at their disposal. Resources are described as any tangible or intangible thing the company owns or acquired. In contrast, capacity can effectively and efficiently use available resources to achieve the organisation's set objectives. One of the prominent strategic resources for the success and survival of the organization is knowledge. Knowledge can

help organizations enhance their key competencies and gain a competitive advantage and improve performance. The results in this study revealed that only a few laboratory personnel are knowledgeable and familiar with procurement and supply chain processes. Besides, most of them are not knowledgeable about lead times for orders in their respective laboratories. Therefore, it is recommended that the organization invest in employees' training and skills development to enhance their knowledge on supply chain and inventory management. Knowledge management aims to establish channels to get appropriate knowledge and skills at a suitable time to the right people. Furthermore, the organization must have an excellent working relationship with upstream and downstream associates in the supply chain to survive in the competitive environment and improve service delivery.

5.5 DELIMITATIONS OF THE STUDY

All objectives identified in this study were achieved. However, the researcher acknowledges that there were limitations. Firstly, the study focused only on three healthcare facilities in one district, North West province, where there is a fully functional medical laboratory. The preference was on the participation from all healthcare facilities that are using the laboratory services. Secondly, the research approach employed in this study was a quantitative research method. A preferred methodology would have been a mixed method. Specific individuals, such as procurement officers and finance managers, can be interviewed on a one-on-one session to get their perspective regarding the inventory management system employed in their laboratories. Lastly, although participants' demographic data were collected, results were not compared based on demographic information received. It would have been better if results were compared based on demographics to establish who is more involved with inventory management in their respective facilities.

5.6 FUTURE STUDIES

To mitigate the limitations of this study, the following areas can be explored for future studies:

- The scope of the study may be extended to other districts of the North West province and cover all healthcare facilities, including those that are not having medical laboratories on the premises. This will help determine how inventory management systems influence healthcare service delivery even in facilities that do not have clinical laboratories on their beliefs and get a clear perspective of other healthcare workers and laboratory personnel on the inventory management system.
- Top management did not take part in this study. Therefore, it is recommended that future studies make use of a mixed research methodology. This will allow the researcher to draft hard questions specific to one-on-one interviews with procurement officers and top management.
- Lastly, compare the findings of the future study based on the demographics of the participants. This will enable researchers to get an idea of who amongst the participants is knowledgeable and involved in daily management and control of inventory at their workplace. Besides, the researchers will determine who amongst the participants were neutral on the questions asked.

5.7 CONCLUSION

This study aimed to determine the effectiveness and influence of inventory management system in clinical laboratories on healthcare service delivery in Ngaka Modiri Molema district municipality. Clinical laboratories are generally the cornerstone of healthcare services in providing laboratory tests for patients' diagnoses, treatment and management. However, due to stock-out challenges encountered by healthcare facilities and laboratories in the chosen area of this study, they are struggling to keep up with effective inventory management and consistent provision of laboratory tests promptly. The research established that these challenges emanate from various factors ranging from lack of knowledge towards inventory management and control system by staff members in general, late delivery of reagents ordered, and ineffective management of laboratory consumables to collect patient's specimens in the hospital wards. Also, it was established that clinical decisions are primarily dependent on laboratory tests.

An effective management and control systems for the stock are perceived as components where managers of the organization should acquire expertise and capabilities. The capability of any entity to create a compelling stock control management framework will depend upon how much it sees the focal points it stands to profit from it. The results from this study have generally revealed organizations stand to benefit from a successful stock control management system greatly. A portion of this advantage incorporates ideal utilization of assets, cost containment, elimination of waste, maximum profit, accountability, shortened patient's length of stay at the hospital wards, improved turnaround time, improved service delivery, and service stoppage, simple stockpiling and recovery of the stock, maximum usage of inventory and reduction of stock depletion amongst other things. In any case, to accomplish every one of these, the organization needs to keep up adaptable stock control. Along these lines, this study discovered that the medical laboratory inventory management system influences healthcare service delivery and the organisation's performance.

BIBLIOGRAPHY

Acharya, A.S., Prakash, A., Saxena, P. & Nigam, A. 2013. Sampling: Why and how of it. *Indian Journal of Medical Specialties*, 4(2):330-333.

Adeli, K. 2017. Laboratory medicine-A hidden treasure in healthcare. *Clinical biochemistry*, 50(12):645.

Ahmad, K. & Zabri, S.M. 2018. The mediating effect of knowledge of inventory management in the relationship between inventory management practices and performance: The case of micro retailing enterprises. *Journal of Business and Retail Management Research*, 12(2):83-93.

Alvi, M. 2016. A manual for selecting sampling techniques in research.

Archetti, C., Montanelli, A., Finazzi, D., Caimi, L. & Garrafa, E. 2017. Clinical laboratory automation: a case study. *Journal of Public Health Research*, 6(1).

Attia, A. & Salama, I. 2018. Knowledge management capability and supply chain management practices in the Saudi food industry. *Business Process Management Journal*.

Biddle, C. & Schafft, K.A. 2015. Axiology and anomaly in the practice of mixed methods work: Pragmatism, valuation, and the transformative paradigm. *Journal of Mixed Methods Research*, 9(4):320-334.

Bouchet, N. 2015. ISO 15189: 2012: What changes for African laboratories? *African Journal of Laboratory Medicine*, 4(1):1-3.

Bryman, A. 2012. Social research methods. New York: Oxford University Press Inc.
Carvalho, H., Silva, L. & Tavares, J. 2013. Automated Planning Applied in Inventory Management. *IFAC Proceedings Volumes*, 46(24):147-152.

Çelebi, D. 2015. Inventory control in a centralized distribution network using genetic algorithms: A case study. *Computers & Industrial Engineering*, 87:532-539.

Choy, L.T. 2014. The strengths and weaknesses of research methodology: Comparison and complimentary between qualitative and quantitative approaches. *IOSR Journal of Humanities and Social Science*, 19(4):99-104.

Cresswell, J.W. 1994. Research design qualitative and quantitative approaches: Sage Publications.

Creswell, J.W. & Creswell, J.D. 2017. Research design: Qualitative, quantitative, and mixed methods approaches: Sage publications.

Drotz, E. 2014. Lean in the public sector: Possibilities and limitations. Linköping University Electronic Press.

Ehrenthal, J.C. & Stölzle, W. 2013. An examination of the causes for retail stockouts. *International Journal of Physical Distribution & Logistics Management*, 43(1):54-69.

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.

Goswami, K., Mookhrjee, S. & Mazumdar, I. 2017. Comparative precision analysis of precision controls on automated chemistry analysers. *International Journal of Biomedical and Healthcare Science*, 2(1):1-13.

Groenevelt, R.B.R., Opalach, A., Fano, A. & Linaker, F. 2014. Detection of stock out conditions based on image processing: Google Patents.

Groenewald, T. 2004. A phenomenological research design illustrated. *International journal of qualitative methods*, 3(1):42-55.

Guba, E.G. & Lincoln, Y.S. 1994. Competing paradigms in qualitative research. *Handbook of qualitative research*, 2(163-194):105.

Gupta, S., Kapil, S. & Sharma, M. 2018. Improvement of laboratory turnaround time using lean methodology. *International journal of health care quality assurance*, 31(4):295-308.

Heale, R. & Twycross, A. 2015. Validity and reliability in quantitative studies. *Evidence-based nursing*, 18(3):66-67.

Healy, M. & Perry, C. 2000. Comprehensive criteria to judge validity and reliability of qualitative research within the realism paradigm. *Qualitative market research: An international journal*.

Hickner, J., Thompson, P.J., Wilkinson, T., Epner, P., Shaheen, M., Pollock, A.M., Lee, J., Duke, C.C., Jackson, B.R. & Taylor, J.R. 2014. Primary care physicians' challenges in ordering clinical laboratory tests and interpreting results. *The Journal of the American Board of Family Medicine*, 27(2):268-274.

Hoberg, K., Protopappa-Sieke, M. & Steinker, S. 2017. How do financial constraints and financing costs affect inventories? An empirical supply chain perspective. *International Journal of Physical Distribution & Logistics Management*, 47(6):516-535.

Hussain, M. & Malik, M. 2016. Prioritizing lean management practices in public and private hospitals. *Journal of Health Organization and Management*, 30(3):457-474.

Isack, H.D., Mutingi, M., Kandjeke, H., Vashishth, A. & Chakraborty, A. 2018. Exploring the adoption of Lean principles in medical laboratory industry: Empirical evidences from Namibia. *International Journal of Lean Six Sigma*, 9(1):133-155.

Isaksson, O.H. & Seifert, R.W. 2014. Inventory leanness and the financial performance of firms. *Production Planning & Control*, 25(12):999-1014.

Islam, M.S. 2015. Introducing modern technology to promote transparency in health services. *International journal of health care quality assurance*, 28(6):611-620.

Jonsson, P. & Mattsson, S.-A. 2016. Advanced material planning performance: a contextual examination and research agenda. *International Journal of Physical Distribution & Logistics Management*, 46(9):836-858.

Karim, N.A., Nawawi, A. & Salin, A.S.A.P. 2018. Inventory management effectiveness of a manufacturing company–Malaysian evidence. *International Journal of Law and Management*, 60(5):1163-1178.

Krasowski, M.D., Chudzik, D., Dolezal, A., Steussy, B., Gailey, M.P., Koch, B., Kilborn, S.B., Darbro, B.W., Rysgaard, C.D. & Klesney-Tait, J.A. 2015. Promoting improved utilization of laboratory testing through changes in an electronic medical record: experience at an academic medical center. *BMC medical informatics and decision making*, 15(1):11.

Krosnick, J.A. 2018. Questionnaire design. The Palgrave handbook of survey research. Springer. p. 439-455).

Maestre, J., Fernández, M. & Jurado, I. 2018. An application of economic model predictive control to inventory management in hospitals. *Control Engineering Practice*, 71:120-128.

Malhotra, N.K. 2010. An applied orientation. *Marketing Research*, 2.
Mataranyika, M.N. & Beukes, L.K. 2014. View from the top: Involvement of Namibia's health ministry in laboratory quality improvement. *African journal of laboratory medicine*, 3(2).

Mboera, L.E., Ishengoma, D.S., Kilale, A.M., Massawe, I.S., Rutta, A.S., Kagaruki, G.B., Kamugisha, E., Baraka, V., Mandara, C.I. & Materu, G.S. 2015. The readiness of the national health laboratory system in supporting care and treatment of HIV/AIDS in Tanzania. *BMC health services research*, 15(1):248.

McCusker, K. & Gunaydin, S. 2015. Research using qualitative, quantitative or mixed methods and choice based on the research. *Perfusion*, 30(7):537-542.

Mittal, S., Mittal, R., Singh, G. & Gupta, S. 2014. Inventory management in fertiliser industry of India: an empirical analysis. *Asia-Pacific Journal of Management Research and Innovation*, 10(4):291-303.

Mohajan, H.K. 2017. Two criteria for good measurements in research: Validity and reliability. *Annals of Spiru Haret University. Economic Series*, 17(4):59-82.

Morgan, D.L. 2007. Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of mixed methods research*, 1(1):48-76.

Mosissa, L., Kebede, A., Mindaye, T., Getahun, M., Tulu, S. & Desta, K. 2016. External quality assessment of AFB smear microscopy performances and its associated factors in selected private health facilities in Addis Ababa, Ethiopia. *The Pan African medical journal*, 24.

Moyo, K., Porter, C., Chilima, B., Mwenda, R., Kabue, M., Zungu, L. & Sarr, A. 2015. Use of laboratory test results in patient management by clinicians in Malawi. *African journal of laboratory medicine*, 4(1):1-8.

Mussap, M. 2014. An alternative perspective on how laboratory medicine can contribute to solve the health care crisis: a model to save costs by acquiring excellence in diagnostic systems. *Clinica Chimica Acta*, 427:202-204.

Nawawi, A. & Salin, A.S.A.P. 2018. Slow moving stock problem: empirical evidence from Malaysia. *International Journal of Law and Management*, 60(5):1148-1162.

Nemtajela, N. & Mbohwa, C. 2017. Relationship between inventory management and uncertain demand for fast moving consumer goods organisations. *Procedia Manufacturing*, 8:699-706.

Ogbo, A.I. & Ukpere, W.I. 2014. The impact of effective inventory control management on organisational performance: A study of 7up bottling company nile mile enugu, nigeria. *Mediterranean Journal of Social Sciences*, 5(10):109.

Paltriccia, C. & Tiacci, L. 2016. Supplying networks in the healthcare sector: a new outsourcing model for materials management. *Industrial Management & Data Systems*, 116(8):1493-1519.

Pandey, S.C. & Patnaik, S. 2014. Establishing reliability and validity in qualitative inquiry: A critical examination. *Jharkhand journal of development and management studies*, 12(1):5743-5753.

Paradis, E., O'Brien, B., Nimmon, L., Bandiera, G. & Martimianakis, M.A. 2016. Design: selection of data collection methods. *Journal of graduate medical education*, 8(2):263-264.

Prempeh, K.B. 2015. The impact of efficient inventory management on profitability: evidence from selected manufacturing firms in Ghana.

Price, C.P. & John, A.S. 2014. Innovation in healthcare. The challenge for laboratory medicine. *Clinica chimica acta*, 427:71-78.

Rahman, M.S. 2017. The Advantages and Disadvantages of Using Qualitative and Quantitative Approaches and Methods in Language" Testing and Assessment" Research: A Literature Review. *Journal of Education and Learning*, 6(1):102-112.

Roberts, T., Cohn, J., Bonner, K. & Hargreaves, S. 2016. Scale-up of routine viral load testing in resource-poor settings: current and future implementation challenges. *Clinical Infectious Diseases*, 62(8):1043-1048.

Rutledge, J., Xu, M. & Simpson, J. 2010. Application of the Toyota Production System improves core laboratory operations. *American Journal of Clinical Pathology*, 133(1):24-31.

Saha, E. & Ray, P.K. 2019. Modelling and analysis of inventory management systems in healthcare: A review and reflections. *Computers & Industrial Engineering*, 137:106051.
Samuel, L. & Novak-Weekley, S. 2014. Commentary: The Role of the Clinical Laboratory in the Future of Health Care: Lean Microbiology. *Journal of clinical microbiology*, 52(6):1812-1817.

Sedgwick, P. 2014. Cross sectional studies: advantages and disadvantages. *BMJ: British Medical Journal (Online)*, 348.

Sinishaw, M.A., Gebregergs, G.B. & Shiferaw, M.B. 2015. Distribution and Availability of Essential Tuberculosis Diagnostic Items in Amhara Region, Ethiopia. *PloS one*, 10(12):e0141032.

Strohhecker, J. & Größler, A. 2013. Do personal traits influence inventory management performance?—The case of intelligence, personality, interest and knowledge. *International Journal of Production Economics*, 142(1):37-50.

Taherdoost, H. 2016. Sampling methods in research methodology; how to choose a sampling technique for research. *How to Choose a Sampling Technique for Research (April 10, 2016)*.

Tavakol, M. & Dennick, R. 2011. Making sense of Cronbach's alpha. *International journal of medical education*, 2:53.

Transchel, S. 2017. Inventory management under price-based and stockout-based substitution. *European Journal of Operational Research*, 262(3):996-1008.

Ullah, M. & Kang, C.W. 2014. Effect of rework, rejects and inspection on lot size with work-in-process inventory. *International Journal of Production Research*, 52(8):2448-2460.

Wilson, V. 2016. Research methods: sampling. *Evidence Based Library and Information Practice*, 11(1 (S)):69-71.

Yao, K., Maruta, T., Luman, E.T. & Nkengasong, J.N. 2014. The SLMTA programme: Transforming the laboratory landscape in developing countries. *African journal of laboratory medicine*, 3(2).

Yu, C.H. 2009. Book review: Creswell, J., & Plano Clark, V.(2007). Designing and conducting mixed methods research. Thousand oaks, CA: sage. *Organizational Research Methods*, 12(4):801-804.

Appendix 1: A letter of permission to North West Department of Health.

12 Quigley Street
Golf view
Mafikeng
20 July 2020

Policy, Planning, Research Monitoring and Evaluation
North West Department of Health
Private bag 2068
Mmabatho
2745

Re: PERMISSION TO CONDUCT RESEARCH STUDY

Dear Sir/Madam

I hereby request permission to conduct a research study for Master of Business Administration degree at selected public hospitals in the North West province. I am a second year student studying Master's degree in Business Administration (MBA) at the North West University. I am also a permanent employee working as a laboratory manager for National Health Laboratory Service in Mafikeng.

The study seeks to determine the influence of medical laboratory inventory management system on healthcare service delivery, the impact of laboratory stock-outs on healthcare service delivery, implications associated with over-supply of laboratory consumables to healthcare facilities. Elements under investigation will include factors influencing laboratory turnaround time and clinical decisions on patient management. An inference made from the study will include recommendations which will address any gaps identified and highlight inefficiencies emanating from a lack of automated inventory management system in medical public health laboratories. A copy of the final document will be given to relevant policy makers on request, policy makers will be in position to disseminate the findings to the people at lower structures. The researcher will be under the supervision of Doctor Martha Matashu and Professor Jan Meyer, they can be reached at 018 389 2323 and I can be contacted at 082 882 5284 or 076 584 7423 for any questions.

Yours sincerely,

Thabo Simon Seale

Appendix 2: A letter of permission to National Health Laboratory Service.

12 Quigley Street
Golf view
Mafikeng, 2745
20 July 2020

Academic Affairs, Research and Quality Assurance
National Health Laboratory Service
1 Modderfontein Road
Sandringham
Johannesburg, 2000

Re: PERMISSION TO CONDUCT RESEARCH STUDY

Dear Sir/Madam

I hereby request permission to conduct a research study for my Master of Business Administration degree at selected National Health Laboratory Service (NHLS) laboratories in the Ngaka Modiri Molema district. I am a second year student studying Master's degree in Business Administration (MBA) at the North West University. The study seeks to determine the influence of medical laboratory inventory management system and the impact of laboratory stock-outs on healthcare service delivery, implications associated with over-supply of laboratory reagents and consumables supplied to healthcare facilities. Elements under investigation will include factors influencing laboratory turnaround time and clinical decisions on patient management. An inference made from the study will include recommendations which will address any gaps identified and highlight inefficiencies emanating from ineffective inventory management system in medical laboratories. A copy of the final document will be given to relevant policy makers on request, policy makers will be in position to disseminate the findings to the people at lower structures. The researcher will be under the supervision of Doctor Martha Matashu and Professor Jan Meyer, they can be reached at 018 389 2323 and I can be contacted at 082 882 5284 or 076 584 7423 for any queries.

Yours sincerely,
Thabo Simon Seale

APPENDIX 3: Consent letter

THE INFLUENCE OF INVENTORY MANAGEMENT SYSTEM IN MEDICAL LABORATORIES ON HEALTHCARE SERVICE DELIVERY IN NORTH WEST

My name is Thabo Seale and I am currently doing my Masters in Business Administration (MBA) at the North West University, Mafikeng campus. You are invited to partake in a research study that forms part of my studies. The purpose of my study is to establish how influential is inventory management system in medical laboratories on healthcare service delivery in Ngaka Modiri Molema district, North West province.

You are requested to take few minutes of your time to complete the questionnaire attached. The questionnaire should take less than 10 minutes to complete. The questionnaire is constructed in such a way that the measuring instrument induce less confusion to you. There are six sections on the questionnaire, questions asked seeks to gather information on your knowledge about medical laboratory inventory system, the influence of medical laboratory processes on inventory management system and turnaround times, the effect of inventory management system on laboratory performance, factors affecting medical laboratory performance on supply chain and inventory management system, and lastly efficiency of laboratory analysers on inventory management, turnaround time and healthcare service delivery.

Your participation in this study is entirely voluntary, participants have a right to choose not to participate or withdraw from participating in the survey at any moment. This is a completely voluntary and anonymous exercise with no incentives given towards the time taken to complete the survey. As a results, there will be no financial loss or gain from it.

Data collected for this study will be anonymous and confidential, and the results will be reported in aggregate not individually. Therefore, please do not write your name, surname or any identifying marks on your responses. This is an assurance that your participation in this study will remain anonymous and confidential throughout the entire duration of this study.

Your assistance in completing this questionnaire will be highly appreciated. should you have any queries please feel free to conduct the researcher on the below contact details.

Thank you in advance for your time and contribution to this important study.

Yours sincerely,

Thabo Seale

Cell: 082 882 5284 | Email: thibos.seale@gmail.com

Declaration by participant:

By completing this questionnaire, I (name)……. voluntarily agree to participate in this research.

Signed at (place)……. on (date)…….20…...

…….

Signature of participant

APPENDIX 4: Certificate of language editing



ABC LANGUAGE EDITORS
PRETORIA ESPERANTO
HEIGHTS
187 SKINNER STREET
PRETORIA 0002,
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PHONE: +277837975691
E-MAIL abceditors@gmail.com
Company Reg: k2016131410

2 December 2020

TO WHOM IT MAY CONCERN

CERTIFICATE OF EDITING

I Medicine Magocha, confirm and certify that I have read and edited the entire Dissertation. **The Influence of Inventory Management System in Medical Laboratories on Healthcare Service delivery in North West by Thabo Seale, Student number 28339274,** submitted for the fulfillment of the **Master of Business Administration (MBA) DEGREE** with the **NWU SCHOOL OF BUSINESS AND GOVERNANCE** at the **North-West University.**

Thabo Seale was supervised by **Prof Jan Meyer** and Core-supervised by **Dr. Martha Matashu from North-West University.**

I hold a bachelor's degree in languages and postgraduate degrees with a lot of research component and am qualified to edit such kind of academic work, aligning it to the requirements of scholarship. However, the views expressed in the study remain the onus of the researcher (s).

Yours Sincerely

APPENDIX 5: Ethical Clearance from NWU- NWU-Health Research Ethics Committee



Private Bag X6001, Potchefstroom
South Africa 2520

Tel: 018 299-1111/2222
Web: http://www.nwu.ac.za

Health Sciences Ethics Office for Research, Training and Support

North-West University Health Research Ethics Committee (NWU-HREC)
Tel: 018 299-1206
Email: Ethics-HRECApply@nwu.ac.za

20 July 2020

To whom it may concern

APPROVAL OF THE RESEARCH STUDY FROM THE NORTH-WEST UNIVERSITY HEALTH RESEARCH ETHICS COMMITTEE (NWU-HREC) OF THE FACULTY OF HEALTH SCIENCES

Ethics number: NWU-00324-20-S1

Kindly use the ethics reference number provided above in all future correspondence or documents submitted to the administrative assistant of the North-West University Health Research Ethics Committee (NWU-HREC).

Study title: The influence of inventory management system in medical laboratories of healthcare service delivery in North West

Study leader/supervisor: Prof JA Meyer

Student: TS Seale - 28339274

Application type: Single study

Risk level: Minimal

You are kindly informed that this application was reviewed at the meeting of the North-West University Health Research Ethics Committee (NWU-HREC), Faculty of Health Sciences, North-West University, held on 11/03/2020. Following review of the application, it has been decided that the study is approved. Approval in this letter means that **final ethics approval** was indeed granted for the **research methodology and the ethical aspects** of this study and that the NWU-HREC has **no further ethical concerns** relating to the research ethics process, except for the outstanding documentation indicated below, which must be provided to the NWU-HREC by the researcher. It is important to mention that this letter indicates that there are no further ethical concerns that exist, regarding the execution of the research. A final ethics letter will be issued upon the receipt of the following documentation:

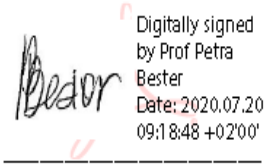
a. A copy of the approval letter from you as the provincial Department of Health, indicating that the study can proceed.
b. A copy of the approval letter from you as the management of the National Health Laboratory System, indicating that the study can proceed.

The mentioned document, as indicated above, should be submitted to Ethics-HRECProcess@nwu.ac.za by the researcher, for review before the ethics approval certificate can be provided. This approval is provided *for a year*, after which continuation of the study is dependent on receipt of an annual (or as otherwise stipulated) monitoring report and the concomitant issuing of a letter of continuation for another year.

Please note: Due to the nature of the study i.e. (self-administered questionnaires to be distributed by courier), this study will be able to proceed during the current alert level, following receipt of the approval letter. No additional COVID-19 restrictions have been placed on the study except that the researcher must ensure that before proceeding with the study that all research team members have reviewed the North-West University COVID-19 Occupational Health and Safety Standard Operating Procedure.

If you have any questions or need further assistance, please contact the Faculty of Health Sciences Ethics Office for Research, Training and Support at Ethics-HRECApply@nwu.ac.za.

Yours sincerely



Chairperson: NWU-HREC

Current details: (23239522) G:\My Drive\9. Research and Postgraduate Education\9.1.5.3 Letters Templates\9.1.5.3.6_Gatekeepers_Letter_HREC.docm
30 April 2018

File reference: 9.1.5.3.6

APPENDIX 6: Approval letter from North-West Department of Health

health
Department of
Health
North West Province
REPUBLIC OF SOUTH AFRICA

3801 First Street
New Office Park
MAHIKENG, 2735

Enq: Nthabiseng Mapogo
Tel: 018 391 4504
NMapogo@nwpg.gov.za
www.nwhealth.gov.za

RESEARCH, MONITORING AND EVALUATION DIRECTORATE

Name of researcher : Mr. T.S. Seale
North West University

Physical Address (Work/ Institution) NHLS - Mafikeng Provincial Hospital
Mareetsane / Vryburg road
Danville, 2745

Subject : Research Approval Letter- The influence of inventory management system in medical laboratories on healthcare service delivery in North West.

This letter serves to inform the Researcher that permission to undertake the above mentioned study has been granted by the North West Department of Health. The Researcher is expected to arrange in advance with the chosen facilities, and issue this letter as proof that permission has been granted by the Provincial office.

This letter of permission should be signed and a copy returned to the department. By signing, the Researcher agrees, binds him/herself and undertakes to furnish the Department with an electronic copy of the final research report. Alternatively, the Researcher can also provide the Department with electronic summary highlighting recommendations that will assist the department in its planning to improve some of its services where possible. Through this the Researcher will not only contribute to the academic body of knowledge but also contributes towards the bettering of health care services and thus the overall health of citizens in the North West Province.

Kindest regards

Dr. F.R.M. Reichel
Director: RM&E

31/07/2020
Date

31-07-2020

Researcher

03/08/2020
Date

1

Healthy Living for All

APPENDIX 7: Approval letter from National Health Laboratory Service

NATIONAL HEALTH LABORATORY SERVICE

Academic Affairs and Research
Modderfontein Road, Sandringham, 2031
Tel: +27 (0)11 386 6142
Fax: +27 (0)11 386 6296
Email: babatyi.kgokong@nhls.ac.za
Web: www.nhls.ac.za

07 December 2020

Applicant: Thabo Seale
Institution: National Health Laboratory Service
Department: Bophelong Laboratory – Mafikeng
Email: thabo.seale@nhls.ac.za
Tel: 018 383 3936
Cell: 082 882 5284

CC: Jone Mofokeng
Acting HR Executive

Re: Approval to conduct a study at the National Health Laboratory Service (NHLS) – North West

Your application to undertake a research project "**The influence of inventory management system in medical laboratories on healthcare service delivery in North West**", **ref no: PR20192** has been reviewed. This letter serves to advise that the application to conduct the proposed research in the NHLS premises has been approved.

Please note that the approval is granted on your compliance with the NHLS conditions of service and that the study can only be undertaken provided that the following conditions have been met.

- Ethics approval is obtained from a recognised SA Health Research Ethics Committee.
- Processes are discussed with the head of Human Resources (HR) and are agreed upon.
- Processes are discussed with the head of Human Resources (HR) and are agreed upon.
- Confidentiality is maintained at participant and institutional level and there is no disclosure of personal information or confidential information as described by the NHLS policy.
- A final report of the research study and any published paper resulting from this study are submitted and addresses to the NHLS Academic Affairs and Research office and the NHLS has been acknowledged appropriately.

Yours sincerely,

Dr Babatyi Malope-Kgokong
National Manager: AAR

Prof Koleka Mlisana
Executive Manager: AARQA

Dr Karmani Chetty
CEO

APPENDIX 8: QUESTIONNAIRE FOR LABORATORY PERSONNEL

RESEARCH TITTLE: The influence of inventory management system in medical laboratories on healthcare service delivery in North West.

SECTION A: DEMOGRAPHIC INFORMATION

Answer each question (for statistical purpose only). Please mark with an '**X**' in the box on the right in the number that best characterises your response. Your honest responses and complete participation are important to the ultimate success of this study. Thank you in advance for your participation.

Q1	Gender			Mark
		1	Female	
		2	Male	
Q2	Age group			
		1	18 – 24	
		2	25 – 31	
		3	32 – 38	
		4	39 – 45	
		5	46 and above	
Q3	Highest level of education completed			
		1	Up to Grade 11	
		2	Matric or Equivalent	
		3	Certificate	
		4	Diploma	
		5	Degree	
		6	Honours	
		7	Masters	
		8	PhD	
Q4	Please indicate your occupation			
		1	Laboratory Manager	
		2	Laboratory Supervisor	
		3	Laboratory Clerk	
		4	Medical Technologist	
		5	Medical Technician	
		6	Phlebotomist	
		7	Messenger / Cleaner	
		8	Other (please specify):	
Q5	The department you are employed?			
		1	Haematology	
		2	Microbiology + TB	
		3	Chemistry	
		4	Laboratory Support Service (Receiving)	
		5	Others (please specify):	
Q6	Years of service in the department?			
		1	1 – 5 years	
		2	6 – 10 years	
		3	11 – 15 years	
		4	16 – 20 years	
		5	21 years and above	
Q7	Please indicate your laboratory location			
		1	Mafikeng Provincial Hospital	

		2	Gelukspan District Hospital	
		3	Lehurutshe District Hospital	

RESEARCH QUESTION 1

SECTION B: KNOWLEDGE ABOUT MEDICAL LABORATORY INVENTORY MANAGEMENT SYSTEM

Listed below are several items, each anchored by a 5-point Likert-type scale. Using the scale below, please indicate the extent to which you agree or disagree with each of the statements. In responding to the items, please mark with an '**X**' the number that best characterises your response. **1 = To a greater extent, 2 = To a moderate extent, 3 = To some extent, 4 = To a smaller extent, 5 = Not at all.**

		To a Greater Extent	**To a Moderate Extent**	**To Some Extent**	**To a Small Extent**	**Not At ALL**
		1	**2**	**3**	**4**	**5**
1.1	I am knowledgeable about standard operating procedure defining inventory management system in my laboratory.					
1.2	I am knowledgeable about the procurement and supply chain processes in my laboratory.					
1.3	I am knowledgeable about Min/Max tool used to control stock in my laboratory					
1.4	I am knowledgeable about lead times for orders in my laboratory.					
1.5	I am knowledgeable about monthly stock-taking performed in my laboratory.					
1.6	I am knowledgeable about the use stock/Bin cards to monitor quantities of inventory in my laboratory.					

RESEARCH QUESTION 2

SECTION C: THE INFLUENCE OF MEDICAL LABORATORY PROCESSES ON INVENTORY MANAGEMENT SYSTEM AND TURAROUN TIME.

Listed below are several items, each anchored by a 5-point Likert-type scale. Using the scale below, please indicate the extent to which laboratory inventory management system and processes affects turnaround time. In responding to the items, please mark with an '**X**' the number that best characterises your response.
1 = Strong Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
2.1	Availability of reagents has a little impact on enhanced turnaround time.					
2.2	Laboratory tests always gets rejected due to late delivery of reagents.					
2.3	Test samples do not get referred to another laboratory since reagents are always available in our laboratory.					
2.4	A proper patient care is not dependent on laboratory turnaround time.					
2.5	Lab analysers start-up has no impact on turnaround time.					
2.6	Specimen registrations process in the receiving office often impacts negatively on lab turnaround time.					

RESEARCH QUESTION 3

SECTION D: THE EFFECTIVENESS OF INVENTORY MANAGEMENT SYSTEM ON LABORATORY PERFORMANCE

Listed below are several items, each anchored by a 5-point Likert-type scale. Using the scale below, please respond to each question according to your personal experience/s with laboratory reagents. Inventory. Please indicate the extent to which you experienced the below events: Please mark with an '**X**' the number that best characterises your experience. **1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Strongly Agree, 5 = Agree.**

		Strongly Disagree	Disagree	Neutral	Strongly Agree	Agree
		1	2	3	4	5
3.1	Our laboratory performs well because it never runs-out of reagents					
3.2	Our laboratory performs well, since it receives the right material at the right time					
3.3	Our laboratory receives ordered reagents in good conditions and this enables it to perform well					
3.4	Our laboratory never experience stock-outs due to under-supply of stock from suppliers					
3.5	Our laboratory never discard expired stock since we never receive over-supply of stock					
3.6	Our laboratory never receives expired stock/consumables from the healthcare facilities. e.g. Test tubes, Sputum jars, Biohazard bags, etc. ?					
3.7	Our laboratory provide good service delivery since never reject tests due to stock-out					
3.8	Stock taking in our laboratory is always accurate.					

RESEARCH QUESTION 4

SECTION E: FACTORS AFFECTING MEDICAL LABORATORY PERFORMANCE ON SUPPLY CHAIN AND INVENTORY MANAGEMENT SYSTEM

Listed below are several items, each anchored by a 5-point Likert-type scale. Using the scale below, please indicate how likely it is that any of the following could affect your laboratory performance on inventory management. Please mark with an '**X**' the number that best characterises your response. **1 = Strongly Disagree, 2 = Disagree, 3 = Neutral, 4 = Agree, 5 = Strongly Agree.**

4. The performance of the laboratory on inventory management are affected by the following:

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
4.1	Storage facilities for commodities and inventory management enhances performance of our laboratory.					
4.2	There is a forecasting tool to place orders in cases of stock depletions in our laboratory.					
4.3	Approval hierarchy for stock in our laboratory is of satisfactory.					
4.4	There is an effective communication regarding approvals and rejection of orders of stock/reagents.					
4.5	Communication between suppliers and the laboratory when delivery of orders is delayed					
4.6	Existing Material planning requirement(MPR) system plays a vital role on the performance of our laboratory.					
4.7	Top management is always involved on supply chain management of the lab					
4.8	Our laboratory's physical stock count is done on a monthly basis.					

RESEARCH QUESTION 5

SECTION F: THE EFFECTIVENESS OF LABORATORY ANALYSERS ON LABORATORY INVENTORY MANAGEMENT SYSTEM, TURNAROUNTIME AND HEALTHCARE SERVICE DELIVERY

Listed below are several items, each anchored by a 5-point Likert-type scale. Using the scale below, please indicate the extent to which you agree or disagree with each of the statements. In responding to the items, please mark with an '**X**' the number that best characterises your response. **1 = Strongly Disagree, 2 = Agree, 3 = Neutral, 4 = Disagree, 5 = Strongly Agree.**

5. The involvement of laboratory instruments on inventory management, turnaround time and healthcare service delivery include:

		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
		1	2	3	4	5
5.1	Inventory management system in our laboratory have an impact on turnaround time and healthcare service delivery.					
5.2	Repeated tests always emanates from poor performance of our laboratory's' analysers and not as a result of inventory management.					
5.3	Frequent re-runs of controls has no impact on our inventory management.					
5.4	Frequent re-runs of calibrators has little impact on our inventory management.					
5.5	There is a constant evaluation and monitoring of efficiency of the analysers in our laboratory. For instance, number of repeated tests, calibrators and controls ran per test per month.					

SECTION G: PARTICIPANT COMMENTS:

Do you have any comments, suggestions or recommendations regarding inventory management system in your laboratory? If yes, please specify:

APPENDIX 9: QUESTIONNAIRE FOR HEALTHCARE WORKERS

RESEARCH TITTLE: The influence of inventory management system in medical laboratories on healthcare service delivery.

QUESTIONNAIRE FOR HELATHCARE WORKER

SECTION A: DEMOGRAPHIC INFORMATION

Answer each question (for statistical purpose only). Please mark with an '**X**' in the box on the right in the number that best characterises your response. Your honest responses and complete participation are important to the ultimate success of this study. Thank you, in advance, for your participation.

Q1	Gender			Mark
		1	Female	
		2	Male	
Q2	Age group			
		1	18 – 24	
		2	25 – 31	
		3	32 – 38	
		4	39 – 45	
		5	46 and above	
Q4	Highest level of education completed			
		1	Up to Grade 11	
		2	Matric or Equivalent	
		3	Certificate	
		4	Diploma	
		5	Degree	
		6	Honours	
		7	Masters	
		8	PhD	
Q5	Please indicate your occupation			
		1	Medical Doctor	
		2	Intern- Doctor	
		3	Staff Nurse	
		4	Professional Nurse	
		5	Clinical Manager	
		6	Unit manager	
		7	Other (please specify)	
Q6	Years of service in the department			
		1	1 – 5 years	
		2	6 – 10 years	
		3	11 – 15 years	
		4	16 – 20 years	
		5	21 years and above	
Q7	Please indicate your hospital location			
		1	Mafikeng Provincial Hospital	
		2	Lehurutshe district hospital	
		3	Gelukspan district hospital	

RESEARCH QUESTION

SECTION B: THE INFLUENCE OF LABORATORY INVENTORY MANAGEMENT SYSTEM ON HEALTHCARE SERVICE DELIVERY.

Listed below are several items, each anchored by a 5-point Likert-type scale. Using the scale below, please indicate the extent to which you agree or disagree with each of the statements. In responding to the items, please mark with an '**X**' the number that best characterises your response. **1 = Strongly Disagree, 2 = Disagree, 3 = Neutral 4 = Strongly Agree, 5 = Agree.**

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
		1	2	3	4	5
1.1	We do not get incomplete laboratory test result due unavailability of reagents					
1.2	The laboratory offers reliable and consistent quality of service.					
1.3	We do not lose patients due to delayed test results.					
1.4	Laboratory test results are available within the expected turnaround time					
1.5	Clinical decisions made by clinicians are often dependent on laboratory results.					
1.6	Our unit/ward never runs-out of consumables (test tubes, sputum jars, biohazard bags, etc.) to collect laboratory specimens for testing?					
1.7	There are stock/bin cards in our unit to monitor usage and availability of consumables					
1.8	Laboratory tests do not get rejected due to unavailability of reagents at the laboratory.					
1.9	The laboratory always provide valid reasons for tests rejected					
1.10	Consumables to collect patient samples are always available in our unit/ward					
1.11	Our unit never fails to treat patients due to laboratory related challenges					
1.12	There is a good ordering system for laboratory consumables in your unit/ward					
1.13	Our unit/ward does not keep patients admitted due to laboratory related challenges					

SECTION C: GENERAL COMMENTS

Do you have any comments, suggestion or recommendations regarding laboratory services? If yes, please specify.

THANK YOU FOR YOUR PARTICIPATION

APPENDIX 10: TURNITIN REPORT