Application of Project Management Methodologies in the Execution of Medical Gases Installations to Improve Synergy within South African Hospitals

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Abstract

This minor dissertation studies the application of project management methodologies in the execution of medical gases installations within South African hospitals. This was done in order to improve synergy during the execution of the medical gases installation with the rest of the hospital build programme. Medical gases installation in general as a gas reticulation system is made up of a combination of equipment that together or as individually are used to transmit medical gases for medicinal use in hospitals. These are gases that are regarded as life supporting within the hospital operations. They are not only used for healing or curing diseases but are used to support processes/machines that perform such functions. The installations are expected to be designed, installed and commissioned to meet the minimum requirements of SANS 7396-1/2, SANS 10260, EIGA guides and SANS 347-PER.

South African National Standards (SANS) 7396 part 1 deals with the pipeline system for compressed medical gases and vacuum and part 2 deals with Anaesthetic gas scavenging disposal system. SANS 10260 deals with the supply and storage of cryogenic gases in South Africa, HTM and EIGA describes the general scientific considerations of gas behaviour and what to consider during designing of a safe gas system. The supplied gas is produced as a cryogenic gas in a liquid form from atmospheric air through an air separation unit process of distillation. It is however packaged in a vapour form in cylinders or directly in a bulk liquid storage tank and using a vaporizer is converted into vapour. According to SANS requirements, three sources of supply are required for each gas reticulation supply system in a hospital.

Medical gases installations by their nature are projects and should follow project management doctrines in order to execute them in a manner that is acceptable and satisfies customer requirements. According to PMBOK, a project is not a fixed endeavour that gets to be undertaken, it is a short term activity that is aimed to create a unique product, service or end result. As this principle applies with the type of installations carried out in supplying and installing reticulation systems that transmit medical gases to the hospitals point of use such as theatres, ICU's, wards etc. As result of the nature of the medical gases reticulation system, the study aims to bring to the sector project management principles to ensure this critical task is always executed safely and within acceptable best practice.

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Nomenclature

ANSI - American National Standards Institute

APMbok - Association for Project Management body of Knowledge

Ar - Argon

ASU – Air Separation Unit

CAPEX – Capital Expenditure

DF - degrees of freedom

EIGA – European Industrial Gases Association

Etc - Etcetera

GMP - Good Manufacturing Practice

HTM - Health Technical Memorandum

ICU - Intensive Care Unit

ISBN - International Standard Book Number

MCC - Medicines Control Council

MSA - Measure of Sampling Adequacy

NBP - Normal Boiling Point

N_2O – Nitrous Oxide

O_2 – Oxygen

PER - Pressure Equipment Regulation

P&ID - Process & Instrument Diagram

PMBoK – Project Management Body of Knowledge

PMI – Project Management Institute

PMO - Project Management Office

PS – Project Success

SACGA - Southern Africa Compressed Gases Association

SANS – South African National Standards

SD – Sustainable Development

Sig - Significant

SPSS - Statistical Package for the Social Science

Std - Standard

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CHAPTER 1: INTRODUCTION

1.1. Background

Medical gases are used by hospitals on patients for various medicinal purposes, functions and applications. These gases are in the main manufactured by cryogenic companies through a process of natural air distillation. The natural air distillation takes place in an air separation unit (ASU) where the main components of air are broken down to individual gas molecules such as O_2, N_2, Ar etc. Some of the gases are further processed through blending of two or more gas molecules in order to make medical gases such as N_2O etc. These gases are then supplied to hospitals either in a liquid or packaged gaseous form. They are then connected and transmitted for patient use or equipment through hospital piping network reticulation system. The medical gases are manufactured following a strict GMP process and in compliance with MCC regulations.

Installation in general as a reticulation system is made up of equipment that transmits the gas to the hospital gas network. This gas transmission is mainly carried and distributed to different user outlet points in the hospital through a medical grade copper pipe network. These gases are regarded as life supporting, as they are not only used in the process that contributes to the healing or curing of diseases but are also used to support processes/machines that perform such functions. The installations are required to be designed, installed and commissioned to meet the minimum requirements of SANS 7396-1/2, 10260 and 347 (PER), HTM and EIGA guidelines.

SANS 7396 part 1 deals with medical grade copper pipeline systems for compressed medical gases and vacuum and part 2 of the standard deals with anaesthetic gas scavenging disposal system. SANS 10260 provides guidance on the supply and storage of cryogenic gases in South Africa. HTM describes the design parameters and the specification on the type of system to be used in the design of the hospital gas system and EIGA describes the general scientific considerations of the gas behaviour and what to consider to safely providing a design for a cryogenic gas system. The gas that is supplied to the hospital is produced as a cryogenic in a liquid form from atmospheric air. It is however supplied to the hospital use in a packaged form in cylinders or directly in bulk liquid storage tank. The bulk supply is then connected to the vaporiser which transforms the liquid to a gaseous state. According to (SABS, 2009) three sources of supply are required for each gas reticulation supply system.

Despite the SANS specification, certain installations do not necessarily comply with the standard and best practice. The application of project management principles and tools aims to contribute in closing the current gaps and assist in improving compliance. It is expected that the considerations for compliance to standards and best practice would be incorporated as part of the preparations plans of executing the installation. The project manager as part of his/her function would ensure the correct gas is identified and specified during the design phase. It is expected that the project manager would ensure that medical gases are clearly defined and the requirements are included in the project scoping and ensure that the scope is understood and signed off by project relevant stakeholders.

In South Africa medical gases are manufactured and packaged by three main companies. These companies are referred to as cryogenic/air gas producers and manufacture this gases from the primary source, which is the natural air. Medical gases producing company has to apply for a manufacturing license from the medicines control council in order for it to be acceptable as Pharmacopeia compliant. A certificate is issued by the council for each product to be manufactured and classified as a drug.

Medical gases installations by their nature are projects and should follow project management doctrines for ease of execution and to meet customer expectations and requirements. As a result of the nature of the medical gases reticulation system, the study aims to bring to the sector project management principles to ensure this critical task is always undertaken and executed safely and within acceptable best practice.

It is the belief of the research that following a structured project management format and outlined principles during execution of installations, would improve safety of patients.
In particular, the study aims to identify gaps in the planning, coordination and the execution of the medical gases installations in order to improve the process. This will be achieved through the use project management recommended domains of focus in the project life cycle process. The identified domains that are implementable in the medical gases installations would be recommended as standard for application. The study, through the use of these domains will identify the current gaps in the sector and recommend adoption of best practices by the sector for application in the sector. However, the study will not be able to prescribe solutions to all existing challenges that exist in the execution of installations projects. It targets to highlight best practices and recommend them for possible adoption by the sector.

The intention is that once the recommended best practices have been highlighted by this research, project managers in the sector would gradually adopt and apply these principles.

The study would lay a foundation and contribute to future studies on the application of project management practices in the medical gases sector. This, in my opinion could represent an important added value to the sector. In fact, despite this sector having the potential to affect both positively and negatively people's lives, not enough attention has been given to guide its application of project management principles during the execution of the installations. It is against this background, that the study is conducted in order to produce literature for further future studies. Currently there is limited literature available in order to get a balanced assessment of the sector as far as project management principles adherence in the sector is concerned. In this prospective, the present research could represent an original contribution to the generation of knowledge and insight into the subject.

The overall objective of this study is worth attention since as highlighted above, the examined sector has not received the required focus that would monitor it's adherence to basic project methodologies. The purpose and aim of the research is to consolidate best practice that would be applicable to the medical gases installations sector. This would be done with the view to formulate what could be a standard approach in the execution of medical installations in South Africa. Doing so would ensure similarity and more predictability of installations by all players in order to improve the overall standard and improve compliance to regulations of installations across the sector.

1.2. Problem Statement

Medical gases installations do not have a standardized project execution template which could be used to plan and execute installations consistently. As a result this leads to individual supplier/installer to define how to execute medical gases installations with minimum structured way of anticipating possible delays or interruptions to the schedule. This often happens with limited or no participation from the customer/user of the product. This also creates an impression that medical gases in the hospital build programme an afterthought during a plenary phase. The medical component of the overall hospital build or upgrade tends to be forgotten during the major planning of the new hospital or during the initial phase of the project, as it is usually a smaller component from the cost and limited understanding from the project managers. This is mainly due to the fact that the planning is carried at times by the hospital appointed PMO/consulting company with no or limited background of medical gases and its unique requirement. The case in point, would typically the required consideration to comply with minimum safety distances as prescribed by SANS 7396-1/2. This is to ensure that the oxygen as it is heavier than air would settle and accumulates creating an oxygen enriched environment. Oxygen enriched environment could lead to potential instantaneous fire. This is also to ensure road tankers used to deliver gases to the facility in order are being considered to ensure the facility is able to transmit the medical gas molecule safely and complies with all relevant standards and regulations.

1.3. Research Rationale

Medical gases installation as a sector has not received the required focus that would monitor its adherence to basic project methodologies. This creates an opportunity to establish and develop a standardized format for the execution of project installations. This is despite the potential risk these installations pose to the patient's lives. For instance, in the event an incorrect gas gets to be transmitted to a patient, due to the incorrect gas being connected to the hospital supply line i.e. medical O_2 being connected to the N_2O piping line, this could result to fatality as these gases serves different purposes in the hospital. Proper coordination of resources is required in order to effectively execute the installations with minimum impact to the operations of the hospital. The standardized format would guide the actual planning, management and execution of installation projects by various role players in the medical installations. The coordination, planning and management of available resources should be done in a manner that ensure that installations are completed within the available budget, limited time and within the required regulatory and industry standards compliance.
These are generally the principles found in different project management literature, hence the need to formalize the application of these principles for the sector. This would ensure a standardized approach in the execution of the installations, rather the current ad-hoc approach.

Despite this sector having the potential to impact both positively and also negatively on people's lives, not enough attention has been given to guide its application of project management principles during execution of the installations. It is against this background, that the study is conducted in this sector to produce literature for future studies.
Currently there is limited literature available in order to get balanced assessment of the sector as far as project management is concerned. This is more evident in the South African context, however, from hospital information point of view, countries such as United Kingdom, Europe and USA have developed a detailed medical gases installation framework which can be used as an existing literature. However, even this literature focuses mainly on the design and

specifications required for a medical gases facility within the hospital supply system. It comes short in terms of outlining and emphasising the application of project management doctrines during the execution.

Thus the research will contribute to the generation of this new required body of knowledge in order to assist focusing the execution phase of an installation to apply acceptable project management doctrines.

1.4. Research Purpose and Aim

Medical gases installations typically follow SANS to guide the quality and specifications of medical gases installations to ensure its safety. However despite the SANS guidance, there are no specific project management standards that are being applied during the planning and execution of installations. This results to poorly planned installations and at times not coordinated with the main hospital build programme, resulting to unnecessary delays and frustrations. It is against this backdrop that a need to establish through the existing project management principles and best practice a set of generally acceptable guidelines for medical gases installations. The application of project management principles and tools aims to ensure these gaps are closed. It is expected that in the process of executing the medical gases installations, a project manager who is familiar with the medical gases reticulation system should identify the gas in the design phase and ensure it is included in the project scoping. The purpose and aim of the research is to consolidate best practice that would be applicable to the medical gases installations sector. This would be done with the view to formulate what could be a standard approach in the execution of installations in South Africa. This would ensure similarity and more predictability of installations by all players improve the overall standard and compliant to regulations of installations across the sector. Consolidate best practice that would be applicable to the medical gases installations sector. It would aid in the process of ensuring similarity and predictability of installations by all players improve the overall standard and compliance to regulations of medical gases installations across the sector.

It further aims to gather data from key stakeholders in the sector in order to contribute to the understanding of what the stakeholders in the sector view as of value as far as the medical gases installation is concerned. This will lead to the generation of new body of knowledge in terms of incorporating project management principles in the sector. At the end, the improvement in the application of project management principles should result to an improvement of better coordination of installation activities and customer satisfaction. The customer satisfaction would be due to minimum frustration as a standard format of executing the installations would be agreed upon and understood from the word go. The understanding of the format should form part of the customer awarding the contractor the order to undertake and execute an installation.

The understanding of these principles by all involved stakeholders in the installations is an important element to be instilled as part of the research outcome. As such, this study will also heighten and enhance the general understanding of the medical gases and its applications to the key stakeholders that facilitates the distribution of the gas to the patient.

1.5. Research Questions and Objectives

The primary Objectives of the research is to establish:

- The general views and understanding of the role of the medical gases in the sector
- The extent in which the application of project management principles is perceived within the medical gases application
- Whether it would be valuable to have specific project management methodologies followed to aid the execution of medical gases installations.
- Critical components of project management principles that can be applicable to the medical gases installations.

1.6. Research Limitations

The study will not be able to identify solutions to all existing challenges that exist in the execution of medical gases installation projects. It will focus on the bulk tank, gas manifolds, vacuum pumps and medical air supply system. It will aim to highlight best practices and recommend them for possible adoption by the sector. The intention is that once the best practice approach has been highlighted, project managers in the sector would gradually adopt and apply these principles. The study would lay a foundation for future studies that would be undertaken on the subject of project management practices in the medical gases installation sector. As this stands at the current juncture there is limited literature available in order to get balanced assessment of the sector as far as project management is concerned.

1.7. Conclusion

The lack of following a structured method in the executing of medical gases installations within the medical gases sector is due to a lack of emphasis on the application of project management methods. This is notwithstanding that the size of medical gases installation within the hospital built programme, may not require the application of the entire recommended principles by PMI. However a reasonable application of the critical principles would guide and streamline the approach and make the installations more predictable to the customer. Currently the execution approach is mainly left to the discretion of the medical gas supplier or the installer appointed by the medical gases supplier with minimum input from the customer. As such the process would be left to the experience of the project manager of the installation who may not have formal project management qualification and solely rely on experience. In that case there is no predictability or early indicators to potential delays on the project or a means to formally track progress and identify deviations especially on the scope and quality. The customer would only realise the delay later within the project progress, yet having followed an agreed and structured approach would highlight these risks timeously and allow for early interventions. This lack of agreed method in executing medical gases installations exposes the medical gases supplier also to risks in the event that the experienced project manager leaves the employment of the company as there would not have a formal handover of projects in progress.

In the context of this research, there was a limited literature available specifically dealing with the medical gases installation as a subject. There is quite a range of literature available on project management application and its methodology for standard and familiar projects, however not much has been written about these principles being applied in the medical gases installations.

A questionnaire with a likert data scale was developed and sent out to an identified number of stakeholders that plays a key role within the medical gases sector. This was done with the intention of soliciting their experiences as far as what may be viewed as critical elements that could assist in the development of a template. As a result of the collected data evidence, a qualitative research method was used to conduct the research with an element of a case study for the medical gases sector as a case.

It is the belief of this research that following a structured project management format and outlined principles in preparation and the execution of the medical gas, installations would contribute towards the improvement of safety of patients. The responses from the key stakeholders involved in the medical gases strongly agreed with the project management principles as important for the sector. The principles that came out as important from the research were project initiation, project attributes and project knowledge and approach. These attributes were specifically selected to ensure that they are narrowed down in order to be applicable to the medical gases sector. The respondent's views from the questionnaire for medical gases as a product that should be safe to use and an acceptable quality of the installations came out as important and highly in agreement with the spirit of the questionnaire.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The realization of benefits from projects is a growing concern for organizations that rely on projects for innovation, change and value creation. (Rolstadås, Tommelein, Morten Schiefloe & Ballard, 2014:638-660) states that according to PMI fewer projects are meeting business objectives and realizing benefits. The need for organizations to successfully execute strategy, realize business objectives and deliver benefits through their projects has been highlighted in professional reports and academic studies (Badewi, 2016:761-778) (Laursen and Svejvig, 2016:736-747) (Serra and Kunc, 2015a:53-66) (Winter, Smith, Morris & Cicmil, 2006:638-649).

Within the organizations portfolio management and project management are being used as a basis of selection in order to contribute to the achievement of organizational strategy and objectives. This is done through streamlining and selecting projects that are aligned to the strategy at the right time. This is done in line with the overall project management doctrine of delivering the projects on time, within budget and meeting customer expectations (PMBOK, 2013). According to (Knutson, 1991), project management is a set of methods that are aimed at advancing specific principles, containing certain tools and techniques for the effective management of project objective. These project objectives by their selection ought to be oriented work that fit a specific and unique organizational environment. (Kerzner, 2014) emphasize that project management as "the art of creating the illusion that an outcome is as a result of a series of predetermined deliberate acts, when in actual fact it is pure luck. (Havranek, 2017) defines project management as a means and technique used to enhance planning, organizing, integrating, directing, and keeping in check resources that have been allocated throughout the life of a project. This art is developed in order to guide the process of achieving the predetermined project objectives as clearly defined in the scope.

(Meredith and Mantel, 2012a) argues that by its formation a project is temporal in nature and as such, it has a definite beginning and end. This is the case about medical gases installations projects, they have a start date and an expected completion date, as agreed between the project team, medical gas company appointed by the customer and the customer. Although repetitive elements in project objectives and tasks are inevitable, this will not alter the fundamental unique characteristic nature of the project activities. This is equally relevant to the installations projects, as some of the equipment and the kind of installations may be repetitive of a previous installation, as the design is similar. However, there may be some unique characteristics from customer to customer requiring an installation that the project execution would have to consider, for example different stakeholders would have to be treated differently, cost and size of the project would also typically be different for each installation. According to (Winter, Smith, Morris & Cicmil, 2006:638-649) project management literature has noted the difficulty of linking projects to business benefits and the limitation and challenges posed by the short-term consideration of project outputs which have impeded strategic improvements (Bryde, 2005:119-131).

According to (Badewi, 2016:761-778) the measure of project success has evolved over time, at the beginning in the 1970's it focused mainly on the application of project management tools. Over time and till recently, it has shifted its focus and integrated satisfying of stakeholder needs in its yardstick (Davis, 2014:189-201). The new focus requires more from project managers beyond the usual focus of delivering projects on time, in budget and within acceptable quality standards. However, project sponsors/funders have become stricter in their demand for favourable return on investment. This project demand is usually linked with the intention of realizing strategic benefits for the organisation's shareholder value. Therefore, project success is now being viewed with a different perspective than before. This change in perspective may be that of overall project efficiency, team and customer influence and satisfaction. These factors are meant to contribute to the overall business success or its ability to contribute in gearing the business for the future (Mir and Pinnington, 2014:202-217).

2.2 Project Management Principles

According to (PMBOK, 2013), PMI is a recognized and accredited standards developer by the American National Standards Institute (ANSI). This is one of the standards that were used as a guide to the Project Management Book of Knowledge development. The standard found its formation in 1987 with the intention to standardise the information and practices of project management. These standardisations were ought to be generally accepted as good practice within the community of project managers. This is the important approach that the study would like to formalise as a standard template within the medical gases installations. Within the medical gases installations industry, one is aware that not every principle within the project management books would be applicable for the installations. This is on the basis that medical gases installations varies from a mere replacement of an oxygen gas manifold which is a small task and to a full medical gases reticulation system, as such it may be unreasonable to expect every principle to be applicable. In this regard, these best principles aid as a guide to the project manager to select the basic and relevant tools that may be suitable to any size of project. This is on the basis that a project is a temporary in nature aimed at creating a unique product or service offering (PMBOK, 2013). Being temporal means a project has a definite start and finishing date, unique means that the product or service is different or is able to distinguish itself from similar products or service already available. (Andersen, Grude & Haug, 2009a) suggest that projects differ in size, scope, cost and time and this could range from mega to small.

2.2.1. Project Initiation

(PMBOK, 2013) defines project initiation as a means to assist in formally acknowledging that a new project has been created, or that an existing project can now move to its next phase. According to (Meredith, Mantel & Shafer, 2016) project initiation relates to the context of the project. It starts with the judicious process of selecting the organisation's projects and aligns them with the organisation's overall strategy. As a result, it creates a platform for evaluating and selecting projects that are aligned and contributes to the organisations strategy. It further provides a platform to discuss the information needed and the management of risks during this process.

2.2.2. Project Planning

(Andersen, Grude & Haug, 2009) argues that the planning process does not only establish what needs to be done, but also smoothens the manner in which it happens. The planning process communicates planning information to the project team and stakeholders. It enforces all the stakeholders to sign-on and pledge support to the project.

(Kerzner, 2014) suggests that most projects due to their nature of being typically short in duration and often being used in the control of prioritized resources available, a formal and detailed planning is critical. Planning can be best defined as the function of selecting the enterprise objectives, setting up appropriate policies and procedures required to drive programmes required enhance attainment the selected business objectives. Equally planning in a project environment may be regarded as the establishment of predetermined course of action in a forecasted environment. An important objective of project planning is to make sure the work required is clearly defined and it is readily available to each member of the project team.

(Meredith and Mantel, 2012) suggests that project planning is about coordinating the activities, create budgets and develop schedule for the project. It is about dealing with various activities of the project and by putting in place mitigation measures on identified project risks. It is also about presenting useful tools in order to organise and allocate appropriate resources to various tasks that should be executed within the project.

2.2.3. Project Life Cycle

(Andersen, Grude & Haug, 2009) suggests that the classic project life cycle only considers a project from concept to handover. He further argues that most projects passes through a four phase life cycle, as outlined below:

- ***Concept and Initiation Phase:*** These are the first phases that kick start the project by establishing a need or an opportunity for the product, service or facility. This allows for investigation on the feasibility study of the project and when the proposal has been acceptable, and then it can move to the next phase.
- ***Design and Development Phase:*** This is the second phase which takes cue from the guidelines coming out of the feasibility study undertaken to ensure the product design, outline manufacturing method, and develops a detailed schedule for the plans of developing the product.
- ***Implementation or Construction Phase:*** This is the third phase which execute the implementation of the project as guided by the developed plans outlined in the second phase of the project life cycle
- ***Commissioning and handover:*** This is the fourth and final phase of the project. This phase of the project confirms that the project has been implemented in line with the design parameters as set out in the project scope and terminates the project.

(PMBOK, 2013) defines project life cycle as a series of phases that a product undertakes in its evolution. The phases start from a concept, product delivery, maturity and all the way to retirement. This can be viewed as a sequence of phases that a project follows starting from its initiation and ending to its closure.

A typical project phase is comprised of the following characteristics:

- Sequential: In this case, one phase must end before the other starts
- Like a mini project: In this instance, each phase has all process groups consideration, from project initiation through to closure

Figure 1 below is a typical graphical representation of a project life cycle. The graph represents the cost of changes and the stakeholder influence, risk and uncertainty during a typical project life cycle.

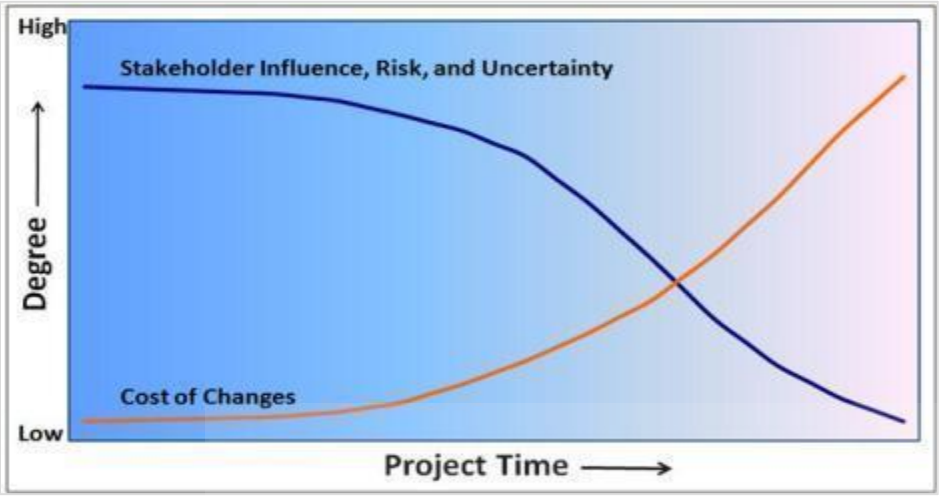

Figure 1: Project Life Cycle Graph (Source: leadinganswers.typepad.com)

2.2.4. Project Management Process

(PMBOK, 2013) suggests that a project management process is a means of ensuring the effective flow of project activities throughout its life cycle. As part of this flow, it suggests five project management process groups, ten knowledge areas and 47 logical project management processes. These project management process groups are Initiating, Planning, Executing, Monitoring and Controlling, and Closing. The knowledge areas are Project Time Management, Project Scope Management, Project Integration Management, Project Cost Management, Project Procurement Management, Project Quality Management, Project Risk Management, Project Communications Management, Project Human Resource Management and Project Stakeholder Management.

(Badewi, 2016:761-778) states that project planning is perceived to have a direct impact on project efficiency. This perception is based on delivering the project output on time, within the budgeted cost; and the issue of effectiveness, in terms of project performance and customer satisfaction (Zwikael and Globerson, 2006:688-700) (Zwikael, Pathak, Singh & Ahmed, 2014:435-441). However, planning which takes no account of changes in the environment and goals is probably useless (Dvir and Lechler, 2004:1-15). This addresses the issue of sustainability, which an increasing important factor to future projects.

2.2.5. Project Integration

According to (Dilkov, 2013:49-66) integration management is a system that must be in place to ensure that different activities and functions of a project are coordinated in an effective manner. This requires trade-offs that are made between competing project objectives and alternatives in order to sufficiently meet or exceed stakeholder requirements and expectations. These are mainly comprised of:

- **Development of the Overall Project Plan:** this is about the integration and coordination of all project plans in order to create a consistent and coherent document.
- **Development of Project Execution Plan:** this is about ensuring the execution of the project plan is done in line with the overall business strategy. This is measured and assessed through project activities and deliverables.
- **Designing of Integrated Change Control System:** this ensures the coordination of changes during the project are monitored and are implemented across the project life

2.2.6. Project Scope Management

(Dilkov, 2013:49-66) purports that the ability to effectively manage the project scope is one of the key factors that guides a project to its successful conclusion. He further adds that a failure to accurately interpret and understands the client's needs or problem would lead to misleading scope and a perception that the project is not complete. (Dilkov, 2013:49-66) describes a scope as project boundaries that define which project tasks should be completed during project life cycle. These include the identification of work that was not initially considered during the first phase of product/service delivery agreement. While on the planning phase of the project, specific outputs are created to identify and define the work that needs to be completed during this phase of the project. The controlling and monitoring phase of the project is concerned with managing scope creep, by ensuring the documentation is up to date, tracking and approving/disapproving project deviations. The closing process includes an audit of project deliverables and assesses project outcomes against the original scope. Project scope includes business requirements, project requirements and performance requirements. Product scope is about technological requirements, security requirements and performance requirements.

Figure 2 below represents a typical scope of a project for ease of avoiding and managing scope creep.

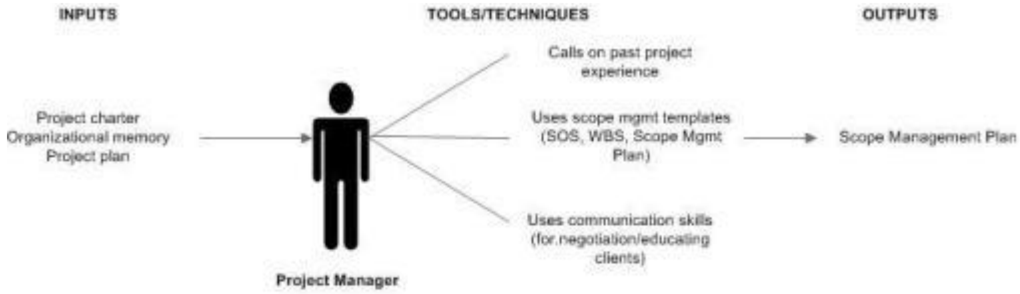

Figure 2: Scope Management Inputs, Outputs: Tools & Techniques (Source: Michael Crowe)

2.2.7. Project Stakeholder Management

Stakeholder inclusiveness makes the multiplicity of stakeholders evident to the project and (Eskerod, Huemann & Savage, 2015:6-14) explicates a pluralistic context for projects where power is diffused among the players and the project team and where there are diverse points of view. Stakeholder inclusiveness enables more engaged and satisfied stakeholders and opens up greater information for improving the identification and consideration of options for benefits creation (Eskerod and Huemann, 2013:36-50).

It is important for project managers to consider improving access to stakeholder's engagement initiatives which would lead to greater information transparency and eventual co-creation process. Engagement can be affected by organizational identity which influences whether the organization will seek self-serving interests or seek mutually beneficial partnerships and coalitions around a common agenda (Shelley L. Brickson, 2005:576-609). Traditional project stakeholder engagement has been project centred as it focuses on "the people and groups affected by the project or in a position to influence it" and subject them to project priorities in an effectively one way relationship where the issues originate from project interest (Eskerod and Huemann, 2013:36-50).

Project stakeholder engagement approaches would need to accommodate values of diverse stakeholders through project routines and conversation. (Denis, Langley & Rouleau, 2007:179-215) routines could include appropriate project plans, meetings, workshops, and focus groups that would reflect the SD principles of participation and transparency (Keeys and Huemann, 2017:1196-1212). Project managers need to use collaboration methods that enable them to adapt, learn and create with different actors and accommodate different perspectives without having complete information which is often the case in the project context regarding SD. The quality of the stakeholder engagement will influence understanding of stakeholder value perceptions, benefits determination, and ultimately the extent and nature of co-creation with stakeholders.

(Andersen, Grude & Haug, 2009b) argues that the purpose of a project is to meet stakeholder requires and satisfy their expectations and needs. He further argues that, as a result of this need, it is a fundamental requirement for the project manager to identify and understand who other stakeholders beside the client are. The understanding of the needs of the stakeholders would assist the project manager to analyse each stakeholder expectation which would assist in defining the purpose, scope of work, and the objectives of the project from the beginning.

2.3 Conclusion

On the backdrop of this argument outlined in the literature, the successful implementation and execution of customer installations within the hospitals, has an added benefit to both the hospital and the executing the installation. For a new hospital, it implies that the hospital can be opened timeously with no added cost and ensure public benefit realization. For the company responsible for the installation, it implies that the company would recover quicker the invested CAPEX and move resources to the next project. This certainly improves the reputation of the supplier towards its ability to execute projects. The specific activity of medical gases installation is unique as in the case of the hospital medical gases cannot be used for anything else other than what they are prescribed to and the installation should comply with a specific SANS standard i.e. SANS 7396 part 1 and 2, SANS 10620 etc.

APMbok defines project management as an efficient way of bringing in change within the organisation and this change can be achieved by:

- Clearly defining what needs to be achieved with respect to time, cost and applicable technical and quality performance indicators
- Developing a plan of action than states how the above indicators will be to achieve. This includes following through the plan to ensure it is effectively implemented by monitoring progress in line with project objectives
- Identifying appropriate management techniques and tools to be used to check on the viability of the plan and constantly monitor progress

- Employing skilled personnel relevant to the project needs to manage the project with the authority to introduce the desired change and accountable for the successful accomplishment of this desired change

These are critical factors to the medical gases installations, as the change of any existing infrastructure is considered critically due the life support nature of the medical gases. The understanding of these principles by all stakeholders that play a role in the medical gases installations is an important element to be instilled as part of the research outcome.

The idea of projects creating benefits takes the project into the strategic realm, linking it to organization strategy and business objectives (Dilkov, 2013:49-66). This realm is a hierarchical one where goals and objectives traditionally cascade from organizational strategy to portfolio, program and then projects in a linear planned fashion (Turner, 2009). Similarly, benefits realization has been conceptualized as proceeding from a hierarchy of objectives in a "chain of benefits" states (Serra and Kunc, 2015b:53-66). This chain begins with organizational strategic objectives at the highest level, followed by end benefits, intermediary benefits, and desired outcomes as a result of business changes, projects that facilitate business changes and those that can contribute as well to intermediary results. Projects are linked to this change through the business case which establishes the reason for the project justification in terms of alignment with business objectives and the benefits intended to create value for the organization, states (Serra and Kunc, 2015:53-66). Benefits have been considered as a concept related to the end of the project, where the outputs are delivered to the project owner for business change. This backend project thinking concerning benefits is in line with the hierarchical view of the benefits chain where the project is conceptually far from benefits. This does not facilitate a project's long term view and realization of business benefits and its role as strategic in the realization process, further emphasises (Serra and Kunc, 2015:53-66).

The identification of project benefits is considered the first step in making the business case for the project, linking it to achievement of the hierarchy of business objectives (Zwikael and Smyrk, 2012:S22) (Turner, 2009:) and makes projects central to benefits realization. Project benefits identification and formulation are essential features of the front end investment decision making phase of the investment life cycle of the organization (Turner, 2009).

The success of a project is assessed its ability to demonstrate efficiency by effectively attaining expected business results within the medium and the long term trajectory (Müller and Jugdev, 2012:757-775). The value of the project can be sufficiently measured and understood by its ability to satisfy and meet customer needs. It ought to align the project output with the organisation's strategy and provide an acceptable return on invested capital. Traditional PM does not accept scope creep, going over budget and project going beyond project timelines (Atkinson, 1999:337-342). Project management success is measured through the achievement of all project targets (Zwikael and Smyrk, 2012:S22) or internal project performance (Golini, Kalchschmidt & Landoni, 2015:650-663). However, the ability of the project's output to deliver the expected return on invested capital is important in judging the project as a success from a business point of view (Wikström, Artto, Kujala & Söderlund, 2010:832-841). As such, a successful project is used to demonstrate the ability to generate the project's return on invested capital (Zwikael and Globerson, 2006:688-700). Project successfully returning an acceptable value on invested capital is more challenging than project management successfully executing the project scope. Project investment success needs a system thinking mind-set within the organisation in order to understand and to manage the non-static internal and the external environment (Fortune, White, Jugdev & Walker, 2011:553-572). For instance, (Cserháti and Szabó, 2014:613-624) have found that relational oriented success factors such as communication, cooperation and leadership are more critical than a task oriented success factors.

CHAPTER 3: THEORY AND RESEARCH REVIEW

3.1 Introduction

Medical gases as a sector in South Africa is mainly used by hospitals as a form a drug following pharmacopoeia principles and as guided by medicines control council. The installations are normally conducted by contractors on behalf of the hospital who ought to be registered installer with the SACGA. On new hospital build these may be subcontractors by the principal contractor responsible for the construction of the hospital. As a result very little knowledge of medical gases is available from the construction sector, as this is a specialised product offering on its own. As a result, the construction team would rely from the small contractor to specify and install the medical reticulation system. This becomes a gap from the normal build programme as the contractors may not be familiar with formalised project management principles or its application.

3.2 Medical Gases Sector

In South Africa the medical gas is manufactured and packaged by three dominant air gases companies. These companies are referred to as cryogenic/air gas producers and manufacture this gases from the primary source, which is the natural air. They are Air Liquide South Africa (owned by Air Liquide Group, a French company), Afrox (owned by Linde, a German company) and Air Products South Africa (owned by Air Products International, an American company). These companies use a process known as air separation unit (ASU), which distils normal atmospheric air into its major components. The gases are manufactured in a cryogenic state.

(Marquardt, E. Le, J. Radebaugh, R, 2002) suggests that cryogenics is the science of production and effects of very low temperatures. The sector uses extremely low temperatures in the production of gases for various processes. These low temperatures can go as low as -196 degrees Celsius for liquid nitrogen and for medical oxygen they go as low as -183 degrees Celsius. The permanent gases post the distillation process (i.e. O_2) changes state from gas to liquid at atmospheric pressure and specific temperature. This state of change is referred to as normal boiling point (NBP).The medical gas producing company has to apply for a manufacturing license from the medicines control council in order for it to be acceptable as Pharmacopeia Company.

3.3 Medical Gases Installations

In a typical hospital set-up, an installation refers to oxygen, medical air, medical nitrous oxide manifolds, medical air plant, scavenging and vacuum plant.

As per the medicines control council all medical equipment in South Africa must be registered as medical devices and implement and maintain a documented quality management system which is relevant to one or more stages of the life cycle of the medical device. This is a regulatory requirement and falls under section 5 of the medical devices regulation. As such all the installations ought to meet the MCC requirements as the medical gases are classified as drugs. This requirement also contributed to the rationale behind the research. In order to have smooth compliance with this regulation requires a formal approach to medical installations.

Figure 3 below demonstrates a standard P&ID with three sources of supply of medical oxygen as per SANS 7396. The diagram demonstrates a bulk tank (which is the primary source with a vaporizer and regulating train), two cylinder manifolds which makes up the second and third source of supply.

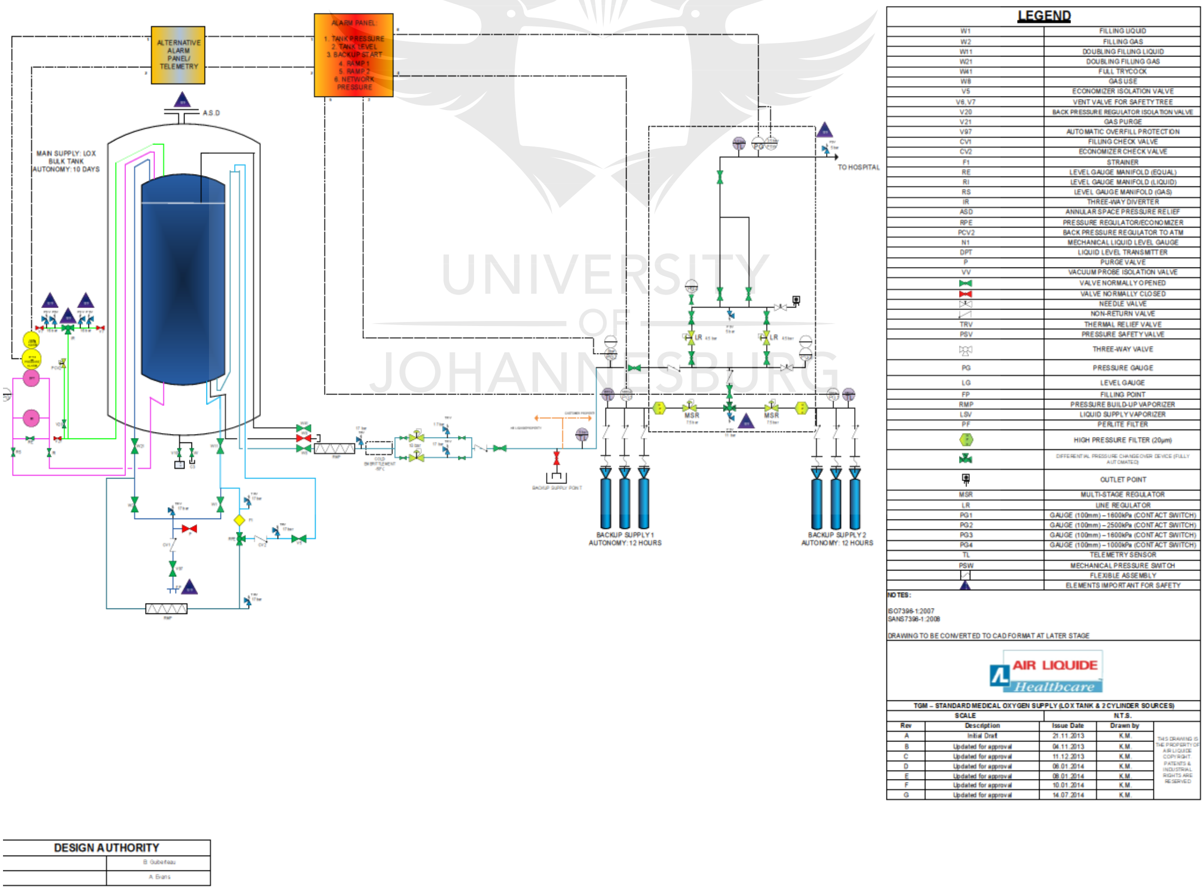

Figure 3: Standard Hospital Oxygen Gas Supply P&ID (Source: Air Liquide)

Figure 4 below demonstrates a typical hospital compressor layout in compliance with medical devices requirements and SANS 7396. As a requirement two compressors are supplied with an air receiver and a cylinder manifold acting as a third source of supply.

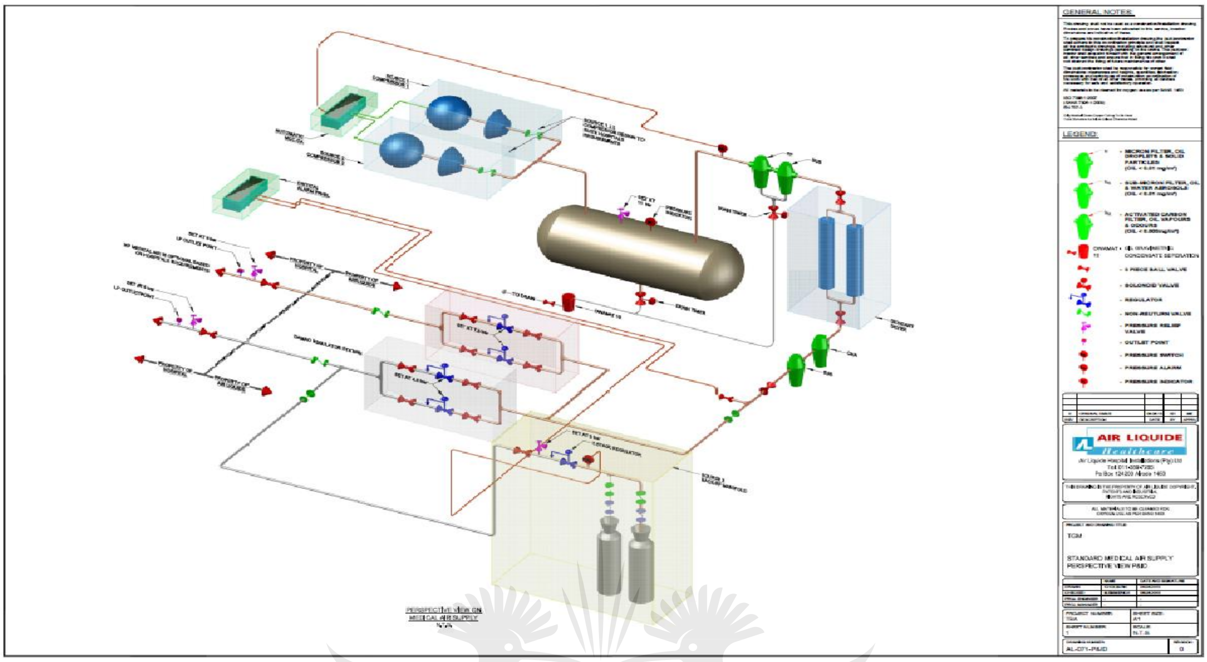

Figure 4: Hospital Medical Compressor Layout (Source: Air Liquide)

Figure 5 below demonstrates a typical hospital Vacuum pumps layout in compliance with SANS 7396 three sources of supply and medical devices requirement. In this instance, three vacuum pumps are supplied with a receiver.

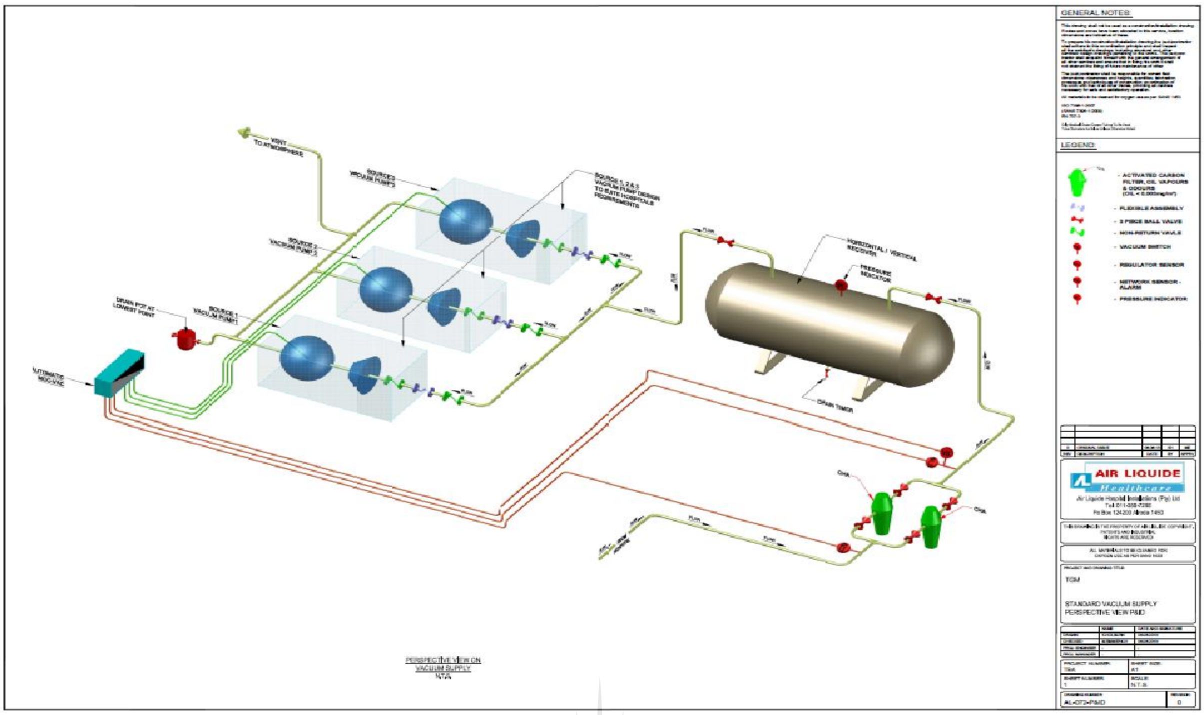

Figure 5: Hospital Vacuum Pumps Plant Layout (Source: Air Liquide)

Figure 6 below demonstrates a typical medical gases alarm system for a hospital installation. The selected alarm system is an example of a Meditek combined Main Technical and Clinical alarm fascia which complies with SANS 7396.

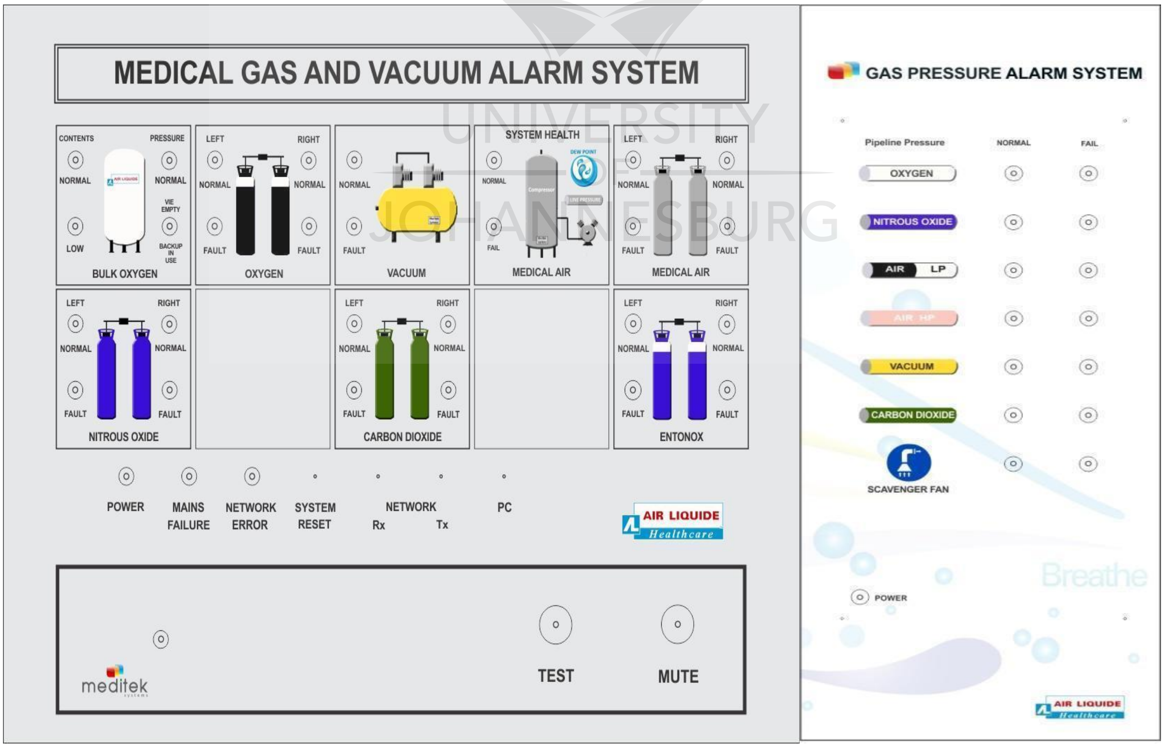

Figure 6: Master & Slave Alarm Fascia Design Configuration (Source: Air Liquide)

3.4 Project Management

According to (Payne, 1999:55-59) project management practices differ considerably from one project type to another. Indeed this is relevant as installations would have certain applications of project approaches. Specific tools, techniques or approaches are required in different types of projects within the hospital build programme despite their vastness. As a result of that difference, a need to adopt PM methods on each installation in hospitals is recommended (Crawford, 2005:7-16).

(Crowe and Sheppard, 2011) suggest that the fundamental purpose of embarking on a project is to accomplish specific organisational goal. In the case of medical gas reticulation system, the goal is to ensure a safe, compliant and reliable installation that would ensure continuous supply of medical gases to various outlet points of the hospital.

Project success (PS) is viewed as a multidimensional construct with the expectations for a project team to be multidimensional in approaching and executing projects. Traditionally a project is viewed to be successful if it fully complied and addressed scope requirements as defined at the initiation phase of the project. It must also be in accordance with set timelines and cost limits (de Wit, 1988:164-170). As such, according to (Shenhar and Dvir, 2014) project success can be deployed into more strategic dimensions of the business such as, project efficiency, impact on the team, value add to the customer, contribution to the overall business strategy. This is coupled with its ability to demonstrate contribution to the direct success of the business and its long term sustainability. These principles equally apply to the execution of projects within the installation of medical gases facility in the hospital, as these installations have an overall benefit to the life of the hospital and its patients.

3.5 Projects in Organisations

According to (Marcelino-Sádaba, González-Jaen & Pérez-Ezcurdia, 2015:1-16) organisations and society in general acknowledges that projects play a significant role in contributing to their long term sustainability. The sustainability aspect of organisations is closely linked to the improvement of perceived project value contribution to the business. The project value and its contribution to the overall business would typically include, improved organisational quality output, increase in productivity, increase in business profitability, reduction to product life cycle cost.

This argument assists in justifying the rationale behind the need to apply the project management principles in the execution of medical gases installations. This is so in order to allow hospitals to be more efficient in its medical gases operations. The efficient use of medical gases within the hospitals would contribute to cost containment. As such the project manager must manage the project in the most efficient and effective manner with respect to sustainability. This could be achieved by applying basic principles of project management in the overall planning, costing and execution of the installations projects. (Maltzman and Shirley, 2012) mentions that the project manager plays a pivotal role in project success. (Bryde, 2005:119-131) concludes that the project manager has a lot of influence on the application of sustainability principles in or to the project.

According to (Meredith and Mantel, 2012b) organizations worldwide continue to have issues with delivering services on time, on budget and meeting high customer satisfaction. This is also a concern in the construction and installation of medical gases for hospitals resulting to increased cost for hospitals and ultimately increasing the cost of providing health care. Traditionally, project management has been the key to delivering professional services. (Meredith and Mantel, 2012) argues that with the continued poor performance seen in industry, it is difficult to see how project management will improve its performance to deliver services efficiently and effectively with high customer satisfaction. This is the reason why the recommendation of applying project management principles in medical gases installations in order to curb and remedy the situation.

3.6 Projects Contribution to Organisational Strategy

According to (PMBOK, 2013) an effective business strategy would be measured by its ability to provide a clear path on how the organisation would achieve its development and growth trajectory. This is in addition to the organisation's defined performance metrics. In order to close a gap between organizational strategy and business success through value actualisation, the use of portfolio, program, and project management techniques is highly recommended. Also it is argued that portfolio management aligns strategic components such as projects, programs, or operations to the overall organizational strategy. In addition, it is stated that within programs and portfolios, projects make a special contribution as a means of achieving organizational objectives. This contribution can be achieved by the selection of appropriate projects and getting the timing of such selection correct.

The realization of benefits from projects is a growing concern for organizations that rely on projects for innovation, change and value creation. According to (Rolstadås, Tommelein, Morten Schiefloe & Ballard, 2014:638-660) there are fewer projects that are meeting business objectives resulting to businesses not realizing expected benefits. The need for organizations to successfully execute strategy, realize business objectives and deliver benefits through their projects has been highlighted in professional reports and academic studies (Badewi, 2016:761-778) (Serra and Kunc, 2015:53-66).

At the same time, organizations and the projects are challenged to sustainably manage their enterprises and to deliver benefits that go beyond individual organization value concerns or short-term temporal or even geographic interest. Project management literature has noted the difficulty of linking projects to business benefits and the limitation and challenges posed by the short-term consideration of project outputs (Winter, Smith, Morris & Cicmil, 2006:638-649) which have impeded strategic improvements (Bryde, 2005:119-131). The project creates benefits through stakeholder collaboration (Wikström, Artto, Kujala & Söderlund, 2010:832-841).

3.7 Projects Benefits

The idea of projects creating benefits takes the project into the strategic realm within the organisation, linking it to organization strategy and business objectives (Denis, Langley & Rouleau, 2007:179-215). This realm is a hierarchical one where goals and objectives traditionally cascade from organizational strategy to portfolio, program and then projects in a linear planned fashion. Similarly, benefits realization has been conceptualized as proceeding from a hierarchy of objectives in a “chain of benefits” (Turner, 2009). This chain begins with organization’s strategic objectives at the highest level, followed by end user benefits, intermediary benefits, desired outcomes as a result of business changes and projects that facilitate business changes and that can contribute as well to intermediary results. Projects are linked to this change through the business case as it justifies the rationale for the project. The alignment of projects with business objectives is meant to create value to the organization. Benefits have been considered as a concept related to the end of the project, where the outputs are delivered to the project owner for business change (Serra and Kunc, 2015:53-66). This backend project thinking concerning benefits is in line with the hierarchical view of the benefits chain where the project is conceptually far from benefits. This does not facilitate a project's long term view and realization of business benefits and its role as strategic in the realization process.

The identification of project benefits is considered the first step in making the business case for the project, linking it to achievement of the hierarchy of business objectives (Müller and Jugdev, 2012:757-775) makes projects central to benefits realization. Project benefits identification and formulation are essential features of the front end investment decision making phase of the investment life cycle of the organization (Atkinson, 1999:337-342).

3.8 Conclusion

On the backdrop of this argument outlined in the literature, the successful implementation and execution of customer installations within the hospitals, has an added benefit to both the hospital and the executing the installation. For a new hospital, it implies that the hospital can be opened timeously with no added cost and ensure public benefit realization. For the company responsible for the installation, it implies that the company the recover quicker the invested CAPEX and move resources to the next project. This certainly improves the reputation of the supplier towards its ability to execute projects. (PMBOK, 2013) describes a project as “a temporary endeavour undertaken to create a unique product, service, or result.” Customer installations fit perfectly this definition, as its activities in the customer site are linked purely to deliver that service for the duration of the installation. The specific activity is unique as in the case of the hospital medical gases cannot be used for anything else other than what they are prescribed to and the installation should comply to a specific SANS standard i.e. SANS 7396-1/2 and SANS 10620. Given the nature of medical gases installations projects, it is important that the critical stakeholders understand these principles and is instilled as part of their installations execution process.

CHAPTER 4: METHODOLOGY

4.1 Introduction

In preparing this research, a questionnaire was developed and circulated to key stakeholders that have a significant interaction in the preparation of usage of medical gases. These key stakeholders included medical gases producers, users of the gas such as hospitals, installers of the devices and consultants that generally render design and advice services to the hospitals. Hospitals such as Life Healthcare, Netcare, Mediclinic, Advanced Health and Busamed were targeted as part of data gathering. In the medical gases product suppliers, Air Liquide and Afrox were targeted to collect data. On the medical equipment manufacturing (such as gas manifolds and pressure regulating stations) point of view, Lewthwaite Engineering and Air Liquide Medical systems were targeted for data collection. On the side of the consulting company's point of view, Spoormaker and Aecom were targeted for data collection. Given the nature of the format followed to source the required data to prove the hypothesis of the research, a qualitative method with an integration of some case study principles was adopted for this research.

(Leedy and Ormrod, 2013) defines methodology as a study of a particular method, it is a continuous process. This process is meant to be followed in its entirety for the research to achieve an objective end. This desired end with the type of methodology adopted is highly dependent on the nature of the collected data while conducting the research. Equally the nature of the data and manner of collecting it would be formulated and informed by the problem that is being researched. In this research, a qualitative research method was adopted and used as its approach resonates with the description provided. This was supported by the questionnaire that was developed and circulated to the respondents to collect empirical evidence to formulate the research data. The research questions had a scaling measure of 1 to 5. The scales were merely used to categorise the statement contained in the question. The categorisation of the statements made it easy to upload them in a statistical modelling tool for analysis purposes.

According to (N. Burns, 1989:44-52) a qualitative research methodology should have the following attributes:

- Be an alternative to the experimental method
- Consider words as the elements of data
- Be primarily an inductive approach to data analysis

- Results in theory development as an outcome of data analysis

These points are relevant to the type of method selected for this study, as there was no experiment conducted in this research. As a way of executing the data collection, words formed the construction of statements on the questionnaire. The developed questions/statements were scaled for the ease of capturing to the SPSS data analysis tool. This resulted to the analysed data output being used as a basis for recommendation of future research in order to expand further on this phenomenon. The recommendations coming out of the gaps identified by this research, are aimed to enhance the current research findings through further future test on this hypothesis in order to enhance the research objectives.

4.2 Outline and Critique of the Research Method

According to (Smagorinsky, 2008:389-411) methodology is the way in which knowledge is generated and is closely related to epistemology, which is the philosophical theory of knowledge. It can be a useful idea to establish an organized discussion on the principles and methods of a research. A principle informs the underlying philosophy of the research and it is appropriate to regard them in such a manner. The research approach can be made of a combination of the qualitative and quantitative method. This combination is referred to as a mixed approach. In this regard, the research approach will consist of a comprehensive literature review accompanied by questionnaire that was distributed to targeted key stakeholders that have an insight on the medical gases sector. The identified stakeholders have a specific role in the sector as outlined in the category of the distributed questionnaire. The category of sampling the specific respondents on the identified stakeholders was on a random basis, yet with some level of targeting. This means the technique will be on a personal judgment (purposive), experience and convenience of their direct interaction with the medical gases, in a specific capacity as categorized in the questionnaire. The targeted audience approach was a selective one, as specific individuals in the identified stakeholder companies received the questionnaire. The views were sought in order to enrich the study and assist the study to be able to identify practical gaps in the sector and provide appropriate recommendations. The primary data collection will be qualitative one in nature. To an extent, this will subject the response to subjective views of the respondents, in terms of their personal opinion of the medical gases and how they view the integration of project management doctrines to the installations. This is also being dependent on the respondents understanding of these project management principles and their experience in implementing them in projects of different nature.

Due to limited empirical and quantifiable data in the domain of medical gases installations within the existing body of knowledge, a purely qualitative method with a case study approach has been adopted for this research. This limit in the available literature is exacerbated by the small number of role players in the South African medical gas production space.

4.3 Research Design and Method

(Yin, 2009) suggests that the research design helps to avoid a situation where the empirical or theoretical evidence received as an outcome of the study does not talk to the actual research questions. The research design is the meant to be a logical sequence of steps that connects the empirical data to the study's initial research questions. It leads the research outcome to its logical conclusion. This is important for the exploratory nature of this research to ensure the appropriate design method is selected.

(Benito, Petersen & Welch, 2011:803-820) suggests that a research design focuses on the end product of the research. As such this principle would help to guide the design of the questionnaires to address the research objectives. It is aimed at defining the kind of study that is being conducted and the results expected. It focuses on the kind of evidence that is required to address the research question adequately. They further suggest that a research design is the blueprint or a plan that describe the path to be undertaken in conducting the research.

The design would cover the following points:

- The actual procedure to be followed in conducting the inquiry
- Description of the specific method to be used in the collection of the data
- The method of analysing the received data
- The interpretation of received data

The study adopted a qualitative research method by getting participants observation on their views about the medical gases sector and project management principles in the form of a questionnaire. (Heppner, 2004) suggests a qualitative study as an activity that locates the observer of the research in the world. The qualitative research method is made of a set of interpretive material practices that make the world visible. It involves the study and collection of variety of empirical materials such as case study, personal experience, interviews etc.

Qualitative research mainly starts from a premise that people understand and can relate to things cognitively. (Roy Horn, 2012) states that a qualitative method relate to people in ways that allow them to express their beliefs, assumptions, desires and understanding. A qualitative research mainly uses words, using open-ended questions, qualitative case studies. This type collects predominantly numerical data and opinion and often relies on reasoning. Deductive reasoning often forms a view about the likely nature of a thing and then test whether the view is correct. In this case, a view about the medical gases sector is being solicited by using the different key stakeholders on their views about project management in the execution of medical gases installations projects. This was done through the use of a questionnaire which was circulated for completion and be returned back.

(Richards and Morse, 2007) suggests that a qualitative research assist in the exploration, interpretation on the meaning individuals or groups puts to a social or human problem. He further suggests that quantitative research assist in the process of testing objective theory by examining the relationship among a set of variables. The different sets of variables are measured in such a manner that the numbered data can easily be analysed through the use of statistical test method.

(Yin, 2003a) defines a case study as a phenomenon which exists within a real life context. This context is when boundaries between the phenomenon and context are not clearly defined and in which different sources of evidence have been used. As (Yin, 2003b) points out, case studies often use quantitative measures, yet they more often tend to take a qualitative perspective, concerned with exploring, describing and explaining a phenomenon. This is relevant in this study approach, as it was mainly a qualitative method that was used. According to (Richards and Morse, 2007) a qualitative research gives insight to various perspectives of a phenomenon, on behaviours and feelings, and it also allows a deep exploration of different experiences. (Smagorinsky, 2008:389-411) also attests that qualitative methods involve trying to understand a particular phenomenon of interest without formulating hypothesis.

(Holloway and Brown, 2016:) give an overview on the type of questions that require a qualitative approach, for instance seeking knowledge in an area where little is known, where you wish to explore participant’s understanding in depth, or when you are generating a theory or theoretical ideas. The typical approach to qualitative research is outlined on the illustration below. The researcher followed the guide in preparing the setup of the one on one interviews and reporting of the outcomes to ensure it is as comprehensive as possible. More importantly the researcher demonstrated the generation of new knowledge within the industrial expansion phenomena and the possible link technology transfer has in assisting its expansion.

Table 1: Qualitative Research Method

Aim	To understand, explore and describe participant's experiences and world generation of theory
Approach	• Focused broadly at the beginning • Process oriented • Context bound • Mostly natural settings allowed and getting close to the data
Sampling	• Participants, • Sources of information, • Sampling units (place, time, concepts) • Purpose driven and theoretical sampling • Flexible sampling that can develop during the research
Data collection	• In-depth non-standardized interviews • Participant observation/field work • Documents, diaries, photographs, videos
Analysis	• Constant comparative analysis (Thematic), • latent content analysis, • Ethnographic, • Narrative analysis
Outcome relationships	• A theory, story and ethnography • Direct involvement of researcher • Research relationship close
Rigor	• Trustworthiness and authenticity • Typicality and transferability • Validity

In this research a combination of an empirical and theoretical re-evaluation was done together with the reconstruction of the themes as a basis of analysis. This means conducting a sector based survey combined with a case study evaluation and the non-empirical study comprise of theory building and literature review.

(Creswell, 2009) parallels the idea of using a quantitative and qualitative data together with a case study method makes explaining of both the process and outcome of a phenomenon easy. This becomes so through complete observation, reconstruction and analysis of the cases under investigation. (Simons, 2009) suggests that this phenomenon is more plausible for a case study of contemporary event that is being investigated over which the investigator has no control. It can be considered as a robust research approach particularly when a holistic, in-depth investigation is required. Finally according to (Scholz and Tietje, 2002) a case study research is an in-depth analysis of an individual unit such as a person, group, or event. It is so as it brings to evidence the developmental factors in relation to the context. A critical case can be viewed as having a strategic link to the general problem that is being investigated. Critical case in this research leads to the type of generalization that suggests 'If it is valid for this case, it is valid for all (or many) other cases. The inverse of the generalisation also applies in that, if it is not valid for this case, then it is not valid for any or only on few cases.

The main advantage of a case study in this research is that it provides in-depth information about the medical gases than what is available through other methods, such as surveys. This is so as it provides this through the study of the sector by involving the critical stakeholders that has a role in the sector. This is supported by (Yin, 2005) stating that the use of case study method present an in-depth understanding of the situation. The situation in this regards has to do with the sector being able to adopt project management principles when executing medical gases installations. This approach aid in the provision of detailed information that is relevant in the production of detailed results addressing the research question. Case studies also allow one to present data collected from multiple methods (i.e. surveys, interviews and document review) in order to paint a complete story of the research interest. The richness of such different cases provides both literal and theoretical replication of the research outcomes (Yin, 1994:283-290). As a result of the fact that case studies, in contrast to experiments do not change/alter developments or behaviours of the phenomenon. Thus, case studies are particularly useful in examining temporal organizational/sector developments requirements (Yin, 2003). This will be viewed to establish this possible area of improvement at Air Liquide Healthcare and some of its medical gas customers. Various literature studies will be reviewed to learn on how other countries execute their installations projects and what standards they follow. The literature will help to identify best practice methods from other countries and see if some of those best practices can be adopted and adapted to suit the South African context.

In keeping up with the spirit of simplicity in this research, five research design groups were used for qualitative designs despite these groups can be as many as sixteen, suggest (Patton, 2002:261-283). In research design phase, the synthesis research group is not viewed as part of the traditional research design group. This is mainly because the data collected typically is not collected directly from participants. Research synthesis has become an important technique for gathering secondary sources of research and pooling the data to gain a better understanding of a topic (Cooper, Hedges & Valentine, 2009). As a result, a research synthesis when completed in a systematic and thorough manner can be a valuable source of knowledge generation and is considered a research design. On the types of research synthesis, there are difference between a systematic review and a critical review. A systematic review requires at least two reviewers whereas a critical review does not require such. Besides this difference, they otherwise follow the same process (Cooper, Hedges & Valentine, 2009). The two most widely reported qualitative research synthesis methods are thematic synthesis and meta-ethnography (Dixon-Woods, Sutton, Shaw, Miller, Smith, Young, Bonas, Booth & Jones, 2007:42-47). It is important to note that in research synthesis a meta-analysis is often incorrectly used as a synonym for systematic review. It is typically not listed because it is a statistical technique form of research which may be used in the data analysis part of a research synthesis.

4.4 Theory Building of the Method

(Kumar, 2014) suggests that a methodology pays attention on the adopted research process, tools and procedures used during the research. It mainly focuses on the specific steps and procedure to be deployed in getting objective research outcomes. Depending on the statistical technique that has been adopted, some of the questions may need to be asked in a certain manner, or provide different response formats. Most questions can be classified into two groups such as a closed or open-ended question. A closed question involves offering respondents a number of defined response choices and an open ended question allows the respondents to formulate his or her response. The typical response of the open ended questions is informed by the respondent’s views on the matter. The respondents are asked to mark their response using a tick, cross, circle etc on each question provided in the questionnaire.

In the interest of making it easy to capture the received data from the respondents, (Glatthorn, 2005) suggests that closed questions are usually easy to convert to the numerical format. Typically a Yes can be coded as 1, No can be coded as 2; males can be coded as 1 and females coded as 2. In the education question shown above, the corresponding number to the response ticked by the respondent would be entered. By creating numbering for each of the possible responses helps with the coding process. For data entry purposes, it is important to decide on a convention for the numbering (e.g. in order across the page, and then down), and stick with it throughout the questionnaire. Sometimes you cannot guess all the possible responses that respondents might make, it is therefore necessary to use open-ended questions. The advantage here is that respondents have the freedom to respond in their own way and not restricted to the choices provided by the researcher. Responses to open-ended questions are able to be summarized into a number of different categories. These categories are usually identified by looking through the range of the actual responses received from the respondents. Certain possibilities could be raised from an understanding of previous research outcome in the subject area of focus.

(Mason, 2011) states that at certain instances, a combination of a closed and open-ended questions works best to structure the questions. This is normally dependent on the topics that are being addressed by the questionnaire. This involves providing respondents with a number of defined responses, including an additional category such as other in the event that the response they wish to give is not listed. A line or two is provided so that they can write in detail to rationalise the response they wish to provide. In asking respondents a question, the researcher decides on a response format that would address the objectives of the research. The type of response format chosen can have implications when conducting statistical analysis on the results. This is mainly due to the fact that some analysis test (e.g. correlation) requires scores that are continuous, from low to high and allows for a wide range of scores.

According to (Crowe and Sheppard, 2011:) each branch on the mind map as illustrated in figure 7 represents a distinct aspect of a research method with branches that form part of the seven individual mind maps components. He further suggest that, although branches act independently from each other, each decision made in a branch ted to have an influence or persuade decisions that are made by other branches.

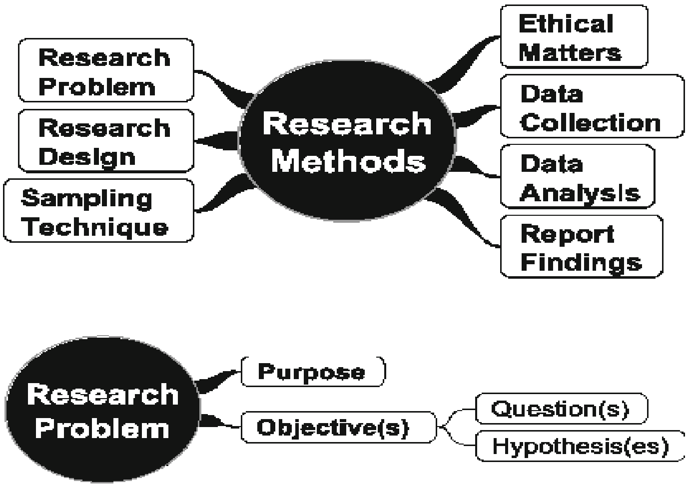

Figure 7: Research Method & Research problem Structure (Source: Michael Crowe)

4.5 Case Study Method

(Kumar, 2014) suggest that the case that has been selected becomes the basis of a thorough, holistic and in depth exploration of the aspect that the research want to discover. In the case of this study, it is about the effects of applying project management principles/methodology in the medical gases installations. According to (R. B. Burns, 2000) for a research to qualify as a case study, it ought to be a bounded system, an entity in itself. For the purpose of this research, the medical gases installations within the South African hospitals are treated as an entity. (Kumar, 2014) attest that it becomes a useful design to apply when exploring an area where little is known or where one wants to have a holistic understanding of the situation or phenomenon. This point applies in this study, as it has already been mentioned on study limitations that there is very little literature of academic acceptance available exploring the application of project management principles in the medical gases within hospitals. One is aware that these installations normally forms part of the bigger hospital build programme, with no specific focus on the medical gases. (Kumar, 2014) continues to suggest that the design is very useful when the focus of a study is on extensively exploring and understanding rather than confirming and quantifying. The principle found resonance with this study as it appreciates that given the limited available literature needed the findings to be more exploratory in order to understand the general sentiments of the stakeholders within the medical gases sector.

(Yin, 2014) argues that case study as a method is used in many situations to contribute to existing knowledge on groups, organisations or sectors. Accordingly it is an exploratory and descriptive approach that allows in-depth insights into the research objective. It is against this background that the case study method is used for the study in order to bring new knowledge to the medical gases installation's sector through the project management principles. This new knowledge came through the identified key stakeholders in the sector through the completion of the questionnaire. This was done in order to gain insight to the sector, so that through their input, their views and opinions can be considered to contribute in the improvement of executing of medical gases projects in the sector. Case study method is normally preferred due to its ability to provide an in depth study to an identified matter for investigation. It can be conducted for a particular situation rather than a sweeping statistical survey. In a broader theme, a case study can be used to narrow it to a reasonable and manageable theme. This is precisely the case for the medical gases in South Africa the research will provide an opportunity to allow the stakeholders to enhance the understanding of the project management concept relevant to it.

(Scholz and Tietje, 2002) argues that the case study research, through reports of past research, allows the exploration and understanding of complex issues. The principle applies in this context, as the exploration of the formulation of a template to be used in medical gases installation project principles. (Simons, 2009) suggests that it is through the analysis and interpretation of how people think, feel and act that many of the insights of the case study are understood. (Hancock and Algozzine, 2011) also argues that qualitative case study values the multiple perspectives of the stakeholders and participants in the sector, observation in naturally occurring circumstances and the interpretation in context. In the context of this research, the developed questions were meant to bring this insight to illustrate the point as far as the application of project management principles/methodologies within the medical gases sector. The interest is the in-depth study of a single case using a qualitative method within a naturalistic paradigm. The outcome of the interpreted data from these targeted stakeholders meant to strongly bring the sector insights as far as how these stakeholders feel about the medical gases and how the execution using the project management principles in installations could be of value to the sector.

(Simons, 2009) parallels the idea that by including both quantitative and qualitative data, case study helps to explain both the process and outcome of a phenomenon through complete observation. This can be achieved by the reconstruction of data and analysis of the cases that are being investigated. He further asserts that it is particularly suitable for the case of contemporary events being studied that the investigator may have control or influence on the matter. It can be considered a robust research method especially when a holistic and in-depth investigation is being adopted.

(Hancock and Algozzine, 2011) adds that a case study research as a method is a systematic and in depth investigation of a particular matter in its context for the purpose of generating new knowledge. The new knowledge that has been in this instance would mean understanding the key stakeholders within the medical gases installations sector as to their views in the application of project management principles and their attitudes towards medical gases as a sector.

This is relevant as project management principles are adopted and applied by major companies operating within the medical gas supply sector would lead to the sector being developed for the benefit of the key stakeholders. (Kerzner, 2014) states that the developmental nature in the project management domain, has emerged as an important of the contemporary society. This developmental nature forces evolvement that should lead to the development of new methods of management. There are three paramount of these developmental that principles have emerged with great intensity. These are the exponential expansion of human knowledge, the growing demand for a broad range of complex, sophisticated, customized goods and services, and finally the evolution of worldwide competitive markets for the production and consumption of goods and services (Czuchry and Yasin, 2003:39-46).

4.6 Advantages of Case Studies

According to (Yin, 2003) the fundamental advantage of case studies is the provision of detailed information than what is available through other research methods. This is particularly relevant given limited literature around this subject. This argument is supported by (Simons, 2009) who states that the use of case study method can make available in depth understanding of the situation that is being investigated, relevant information and detailing of the analysis test results. Case studies also allow one to present a collected data from multiple methods. These methods ranges from surveys, interviews and document review in order to provide the complete story of the phenomenon. The richness of such different cases provides both literal and theoretical replication to similar phenomenon (Byrne and Ragin, 2009). This is due to the fact that case studies, in contrast to experiments, do not affect developments or behaviours of the researched subject matter. As such, case studies are particularly useful in examining of temporal organizational developments. This principle contributes to the spirit of this study as the outcomes must contribute to the overall contribution of developing an appropriate identification of the relevant project management principles in the medical gases sector.

4.7 Measure/Material

For the purpose of this research, a descriptive survey method, sometimes called the normative survey method would be adopted in order to process the data that would come out from the collected questionnaire. This type of data is referred to as discrete data, coming from the written questionnaire and distributed for completion by the respondents. Through the completion of the questioner by the respondents, this allows some level of observation to be derived, as the questions are structured in such a manner that allows for such an observation.

(Leedy and Ormrod, 2013) suggests that a research method that looks with intensity at the phenomena of the moment and then describes precisely what the researcher sees is referred to as a descriptive survey or a normative survey. This implies that whatever is being observed at a particular time is normal and it could be observed similarly under the same conditions in the future. This is so as such an approach would mean the phenomena usually follow a common pattern or norm. In the case of this research, the questions would test the observation of the individuals operating within the medical gases installations in terms of their beliefs in the current execution of installations approach and whether application of project management principles would make a difference in the installations. (Leedy and Ormrod, 2013) further suggests that, data lies buried deep within the attitudes, feelings and reactions of people. Hence the common instrument for observing data beyond a physical reach of the observer the questionnaire is able to achieve.

A questionnaire with a likert data scale was designed for this research in order to gather evidence about the medical gases sector. It aimed to assess and gain an insight on some of the primary influences of project execution within medical installations. The questions were divided into three logical sections and these sections were: personal information, general information, and industry information. Personal information section contained questions about the company in which the participant work for and his/her position in the company and his/her general profile. The general information will include questions pertaining to the respondent's and the industry/company they work for. The third section will include the participant's opinion on the medical gases sector. The last section pertains to the respondent's opinion on the application of project management principles in the execution of medical gases. This section aims to draw out specific views that could contribute to the implementation of specifics project management nodes to contribute to the improving and success rate of projects. The questionnaire will be sent to the respondents via email to the identified stakeholders for the purpose of getting their views of the sectors practitioners in their ability to safely execute installations projects. A design of a questionnaire with specific questions to support this point was distributed to a selected sample of specific stakeholders that have a direct involvement within the medical gases installation sector. In the preparation of the questionnaire, there was an enormous consideration on how the information would be used to assist in achieving the research objectives.

4.8 Research Method Justification

(Leedy and Ormrod, 2013) puts up an argument that a qualitative research approach is concerned with humans, that is; interposal relationships, personal values, meanings, beliefs, thoughts and feelings. This is the case in this research, as one wants to get thoughts on the application of project management principles within the medical gas installations. The respondents, identified as key stakeholders within this sector, went through a guided approach in the form of a questionnaire indicate whether they are of the opinion that the application of project management principles would add value to the execution of installations and contribute positively. Through the structured questions, the responses would henceforth contribute to the research objectives of identifying the critical components of a project management approach within the medical gases installations, and use that to advocate of the standard template development.

4.9 Data Collection Preparation

The study will use the distributed questionnaire as its primary data which will be received from the targeted population within the medical gases production and utilisation. The data will be analysed by the same researcher with the assistance from data analysis specialists provided by Statkon. A computerised IBM SPSS programme was used to capture the received completed questionnaire from the respondents for interpretation and ease of analysis. The questions in the questionnaire were grouped together through the tool according to the category and scale of the questions. The questions were then rated according to the research objectives to establish the validity of the questions to the research objective. On the initial category various test ran on the tool questionnaire such as factor analysis, reliability test etc.

in order to establish the outcome of the research. Subsequently, from the original categories, subthemes were created in order to align each question with the scale to improve the reliability of the results.

4.10 Conclusion

In the context of this research, there was a limited literature available specifically dealing with the medical gases installation as a subject. There is quite a range of literature available on project management application and its methodology for standard and familiar projects, however not much has been written about these principles being applied in the medical gases installations. As a result, a primary source approach was applied to evaluate the validity of the research question and purpose. The distributed questionnaire and received feedback from the respondents from the identified stakeholders within the sector became the primary source of evidence for analysis.

(Badenhorst, Rosales, Moloney, Dyer & Murray, 2012) states that research methods are based on two premises, which are:

- New research builds on previous research. In the case of this study, there was limited literature available that was addressing the specific area of medical gases installation. As such, this research would create the basis for further future research and contribute to the new generation of information as far as the medical gases sector is concerned.
- Evidence is the source of truth, the stronger the evidence, the more “truthful” the claims becomes. This principle formed the critical part of this research, as it was founded on the basis of a questionnaire which was circulated to relevant stakeholders that plays a key role within the medical gases installations in South African hospitals. Primary evidence is the first step of research and collecting data. In an academic context, primary data as a source of evidence is top of the hierarchy. It carries the authority of the ‘real world’ and it provides empirical proof. This is the reason why, primary data for this study was sought in the form of the questionnaire.

(Badenhorst, Rosales, Moloney, Dyer & Murray, 2012) further puts an emphasis that in an academic context, previously published research is also accepted as valuable evidence because of procedure of peer review. For relevance of this statement within the context of this research, a number of peer reviewed papers were used as a source of evidence to support this research within the available literature.

CHAPTER 5: RESULTS AND DISCUSSION

5.1 Introduction

The result were initially analysed based on the original questions that were circulated to the different stakeholders that plays a role in the availability of medical gases to the patients in hospitals. These included the producers of the medical gases companies, the hospitals that provides/administer the gas to patients, medical gases equipment installers and consulting companies that assists hospital during the construction phase and acts as project managers on behalf of the hospitals.

The questionnaire had three factors that categorised the specific themes of focus. The factors had different questions that were addressing what the themes were aiming to unpack. There were a total of 120 questionnaires that were distributed to the identified population. 98 of the 120 were received back from the respondents, making it 81.6% response rate.

The factor analysis was not conducted as there was no consistency expected on the results due to the type of the questions. Following the first analysis outcome, the questionnaires were further grouped according to their relevance to the stakeholders that had responded. Out of the regrouping, subthemes were developed to make the grouping to be relevant and for ease of performing reliability test on the themes. The results were discussed using the original empirical themes and also on theoretical analysis these that were further developed for secondary analysis.

Below are the methods used in the interpretation of the collected responses from the population and its brief explanation and relevance to the analysis of the results:

- **Extraction Method:** This is the method that was used in the analysis and interpretation of the results from the data received. For these results a principal axis factoring was applied. This meant the use of likert scale data which is not limited to normal distribution.
- **Rotation Method:** This is the method that was used to rotate the factors in order to get the best fit of the factors within the scales. It applied two orders in trying to achieve this. The first order that was applied in the analysis was a varimax rotation. This yields a simplified structure and this method makes factors not to correlate too high and avoid different themes. The second order was the direct oblimin rotation which allows higher factors to correlate.

5.2 Analysis of the Original Set of Questions

5.2.1 Section A - Background Information (Biographic)

Table 2 below shows gender split from the respondents on the data received which was used for results analysis. The received questionnaires from the respondents were captured on the SPSS analysing tool/software. 72 percent of the respondents were males and 27 percent were females. These percentages are a total sum from all the categories of the questionnaire received and analysed. For the purposes of analysis the gender split category was coded as A1.

Table 2: Gender Split (A1)

A1 Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	71	72.4	72.4	72.4
	Female	27	27.6	27.6	100.0
	Total	98	100.0	100.0	

Table 3 below demonstrate the different occupational levels the respondents occupied in their respective organisations during the time of completing the questionnaire. 14.3% formed the skilled/semi-skilled personnel, 10.2% made-up of supervisors, with 50% consisting of middle management and 24.5% being senior/executive management. For the purposes of analysis the participant's occupational level was coded as A2.

Table 3: Occupational Levels

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Skilled/Semi-Skilled	14	14.3	14.3	14.3
	Supervisor	10	10.2	10.2	24.5
	Middle Management	49	50.0	50.0	74.5
	Senior/Executive Management	24	24.5	24.5	99.0
	Other	1	1.0	1.0	100.0
	Total	98	100.0	100.0	

Table 4 below demonstrates the experience in which the respondents have in the sector during the time of completing the questionnaire. This is the section of the questionnaire that required the respondents to define the number of years they have spent in the medical gases sector regardless of their nature of participation. 7.1% had less than 1 year, 13, 3% had between 1 to 2 years, 31.6% had 2 to 5 years, 30.6% had 5 to 10 years and 17.3% had more than 10 years. For the purposes of the analysis, this was coded as A3.

Table 4: Number of Years in the Medical Gases Sector

A3: How many years of experience do you have in the medical gases sector?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 1 year	7	7.1	7.1	7.1
	Between 1-2 years	13	13.3	13.3	20.4
	Between 2-5 Years	31	31.6	31.6	52.0
	Between 5-10 Years	30	30.6	30.6	82.7
	More than 10 Years	17	17.3	17.3	100.0
	Total	98	100.0	100.0	

Table 5 below demonstrate the level of education the respondents had during the completion of the questionnaire, while working in any of the categories described in the questionnaire within the medical gases sector. 5.1% had grade 12 or lower, while 32.7% had diploma/certificate, with 30.6% having a bachelor's degree, 22.4% had honors degree/post graduate diploma and with 9.2% having a Masters/PHD degrees. For the purposes of the analysis, the highest educational qualification category was coded as A4.

Table 5: Highest Educational Qualification

A4: What is your highest educational qualification?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Grade 12 or lower	5	5.1	5.1	5.1
	Diploma/Certificate	32	32.7	32.7	37.8
	Bachelor Degree (s)	30	30.6	30.6	68.4
	Honors Degree / Post Graduate Diploma	22	22.4	22.4	90.8
	Masters/PHD	9	9.2	9.2	100.0
	Total	98	100.0	100.0	

Table 6 describes the split of the specific area in which each respondent function within the medical gases value chain during the time of completing the questionnaire. This addressed the section of the questionnaire that asked for the role the respondent played within the medical gases products or devices.35.7% were working for the medical gases products supplier, with 35.7% working for the medical gases product end user, 14.3% working for the medical gases installer companies, with 3.1% working for medical equipment/devices supplier companies and 11.2% working for consulting companies. For the purposes of the analysis, this section was coded as A5.

Table 6: Primary Role within the medical gases sector

A5: Your Primary role with the Medical Gases Products or devices?		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Medical Gases Products Supplier	35	35.7	35.7	35.7
	Medical Gases product user (Hospital)	35	35.7	35.7	71.4
	Medical Gases Installer	14	14.3	14.3	85.7
	Medical Equipment/devices Supplier	3	3.1	3.1	88.8
	Consulting company	11	11.2	11.2	100.0
	Total	98	100.0	100.0	

5.2.2 Section B - Medical Gases Products

Table 7 below shows the split of respondents on how they expressed their views for each item addressing medical gases products in accordance with the scale. A majority of the respondents had responses that had a combined tally above 50% between agree and strongly agree. There were some that were on neutral side of the scale such as B1.3 (1.%), B1.4 (6.1%), B1.5 (30.6%), B1.6 (14.3%), B1.7 (2%), B1.8 (2%) and smaller percentage on disagree such as B1.4 (1%), B1.5 (7.1%), B1.6 (16.3%) and one item on strongly disagree which is B1.6 (5.1%). The results suggest that the items addressed by this factor are relevant to the execution of medical gases installations and the stakeholders in the sector believe that the items addressed by this factor are relevant and in support.

Table 7: General views about the medical gases products

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
B1.1 Medical gases products plays an important role in the hospital operations	Count	0	0	0	10	88	98
	Row N %	0.0%	0.0%	0.0%	10.2%	89.8%	100.0%
B1.2 Medical gases products sustain vulnerable lives	Count	0	0	0	15	83	98
	Row N %	0.0%	0.0%	0.0%	15.3%	84.7%	100.0%
B1.3 Medical gases products are regarded as life supporting	Count	0	0	1	14	83	98
	Row N %	0.0%	0.0%	1.0%	14.3%	84.7%	100.0%

B1.4 Registering medical gases products with the medicines control council ensures safe use of gases	Count	0	1	6	28	63	98
	Row N %	0.0%	1.0%	6.1%	28.6%	64.3%	100.0%
B1.5 Different countries have the same approach to the use of medical gases in hospitals	Count	0	7	30	37	24	98
	Row N %	0.0%	7.1%	30.6%	37.8%	24.5%	100.0%
B1.6 South African hospitals should not rely on one supplier of medical gases products	Count	5	16	14	25	38	98
	Row N %	5.1%	16.3%	14.3%	25.5%	38.8%	100.0%
B1.7 It is important for the hospital business that medical gas companies continually improve its product offering	Count	0	0	2	30	66	98
	Row N %	0.0%	0.0%	2.0%	30.6%	67.3%	100.0%
B1.8 Bringing in new medical device products would aid hospitals to be innovative	Count	0	2	9	34	53	98
	Row N %	0.0%	2.0%	9.2%	34.7%	54.1%	100.0%

Results Analysis of Statistics table 8 below:

- **B1.1 -** the mean value and standard deviation was 4.90 and 0.304 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **B1.2 -** the mean value and standard deviation was 4.85 and 0.362 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.
- **B1.3 -** the mean value and standard deviation was 4.84 and 0.398 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.
- **B1.4 -** the mean value and standard deviation was 4.56 and 0.659 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.
- **B1.5 -** the mean value and standard deviation was 3.80 and 0.896 respectively. This means the response rate from the respondents was between neutral and agree, leaning more on the agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.

- **B1.6 -** the mean value and standard deviation was 3.77 and 1.267 respectively. This means the response rate from the respondents was between neutral and agree, leaning more on the agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.
- **B1.7 -** the mean value and standard deviation was 4.65 and 0.520 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.
- **B1.8 -** the mean value and standard deviation was 4.41 and 0.744 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.

In summary, a majority of the responses on these factors were mainly learning towards the strongly agree side of the scale. There was also a good spread around the mean based on the standard deviation values, suggesting that the scale was used widely and not concentrated in one part of the scale. On some factors, the responses were mainly on the agree side of the scale.

Table 8: Statistics on General views about medical gases

	Valid	Missing	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
B1.1	98	0	4.90	5.00	5	0.304	4	5
B1.2	98	0	4.85	5.00	5	0.362	4	5
B1.3	98	0	4.84	5.00	5	0.398	3	5
B1.4	98	0	4.56	5.00	5	0.659	2	5
B1.5	98	0	3.80	4.00	4	0.896	2	5
B1.6	98	0	3.77	4.00	5	1.267	1	5
B1.7	98	0	4.65	5.00	5	0.520	3	5
B1.8	98	0	4.41	5.00	5	0.744	2	5

Table 9 below shows the split of respondents on how they expressed their opinion on the application of medical gases for each item in accordance with the scale. A majority of the respondents had responses that had a combined tally above 50% between agree and strongly agree. There were some that were on neutral such as B2.1 (33.7%); B2.6 (18.4%), B2.8 (38.8%) and smaller percentage on disagree such as B2.1 (13.3%), B2.6 (2%), and B2.8

(7.1%). The results suggest that the items addressed by this factor are relevant to the execution of medical gases installations and the stakeholders in the sector believe that the items addressed by this factor in the main found them to be relevant and are in support.

Table 9: Opinion on the application of medical gases

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
B2.1 Different countries have the same approach to the use of medical gases in hospitals	Count	0	13	33	32	20	98
	Row N %	0.0%	13.3%	33.7%	32.7%	20.4%	100.0%
B2.2 Using suitable qualified installers improves the safety of the installations for medical gases	Count	0	1	3	14	80	98
	Row N %	0.0%	1.0%	3.1%	14.3%	81.6%	100.0%
B2.3 Registering medical equipment as medical devices would compel suppliers to improve their product offering to hospitals	Count	0	0	6	40	52	98
	Row N %	0.0%	0.0%	6.1%	40.8%	53.1%	100.0%
B2.4 It is important for the hospital's' business that medical gas companies continually improve their product offering	Count	0	0	4	39	55	98
	Row N %	0.0%	0.0%	4.1%	39.8%	56.1%	100.0%
B2.5 Using medical equipment registered as medical devices increase safety of patients	Count	0	0	4	31	63	98
	Row N %	0.0%	0.0%	4.1%	31.6%	64.3%	100.0%
B2.6 Multinational companies investing in medical gases products bring in new technology that benefits hospitals' operations	Count	0	2	18	48	30	98
	Row N %	0.0%	2.0%	18.4%	49.0%	30.6%	100.0%
B2.7 Imported medical device technology by local firms improves the quality and reliability of the product	Count	0	7	38	36	17	98
	Row N %	0.0%	7.1%	38.8%	36.7%	17.3%	100.0%

Results Analysis of Statistics table 10 below:

- **B2.1 -** the mean value and standard deviation was 3.60 and 0.960 respectively. This means the response rate from the respondents was between neutral and agree, leaning slightly on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **B2.2 -** the mean value and standard deviation was 4.77 and 0.552 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.
- **B2.3 -** the mean value and standard deviation was 4.47 and 0.613 respectively. This means the response rate from the respondents was between agree and strongly agree,

leaning slightly on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.

- **B2.4 -** the mean value and standard deviation was 4.52 and 0.578 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning slightly on the strongly agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **B2.5 -** the mean value and standard deviation was 4.60 and 0.570 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the agree side of the scale. This means the majority of the respondents believe this item is important for medical gases installations.
- **B2.6 -** the mean value and standard deviation was 4.08 and 0.755 respectively. This means the response rate from the respondents was between agree and strongly agree, learning more on the agree side of the scale. This means the majority of the respondents believe this item is important for medical gases installations.
- **B2.7 -** the mean value and standard deviation was 3.64 and 0.853 respectively. This means the response rate from the respondents was between neutral and agree, leaning more on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.

In summary, a majority of the responses on the factors were mainly on the strongly agree side of the scale. There was also a good spread around the mean based on the standard deviation values, suggesting that the scale was used widely and not concentrated in one part of the scale. On some factors, the responses were mainly on the agree side of the scale.

Table 10: Statistics on opinion about medical gases application

	Valid	Missing	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
B2.1	98	0	3.60	4.00	3	0.960	2	5
B2.2	98	0	4.77	5.00	5	0.552	2	5
B2.3	98	0	4.47	5.00	5	0.613	3	5
B2.4	98	0	4.52	5.00	5	0.578	3	5
B2.5	98	0	4.60	5.00	5	0.570	3	5
B2.6	98	0	4.08	4.00	4	0.755	2	5
B2.7	98	0	3.64	4.00	3	0.853	2	5

5.2.3 Section C - Project Management

Table 11 below shows the split of respondents on how they expressed their opinion on the application of medical gases for each item in accordance with the scale. A majority of the respondents had responses that had a combined tally above 50% between agree and strongly agree. There were some items that the respondents were neutral in their response such as C1 (3.1%), C2 (1%), C3 (3.1%), C4 (1%), C5 (13.3%), C6 (5.1%), C7 (16.3%), C8 (9.2%), C9 (13.3%), C10 (4.1%), C11 (7.1%) and smaller percentage on disagree such as C9 (5.1%), C11 (3.1%) and one item on the strongly disagree side of the scale such as C7 (1%). The results suggest that the items addressed by this factor are relevant to the execution of medical gases installations and the stakeholders in the sector believe that items addressed by this factor are relevant and in the main are in support.

Table 11: Applying project management in the execution of medical gas installations

		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Total
C1: Project Planning is critical in the successful execution of medical gases installations.	Count	0	0	3	19	76	98
	Row N %	0.0%	0.0%	3.1%	19.4%	77.6%	100.0%
C2: Accurate identification of project activities is important for successful project execution of medical gases installations.	Count	0	0	1	27	70	98
	Row N %	0.0%	0.0%	1.0%	27.6%	71.4%	100.0%
C3: Accurate project budgeting and cost estimation is important for project success.	Count	0	0	3	34	61	98
	Row N %	0.0%	0.0%	3.1%	34.7%	62.2%	100.0%
C4: Project scheduling plays an important role in the successful execution of projects.	Count	0	0	1	30	67	98
	Row N %	0.0%	0.0%	1.0%	30.6%	68.4%	100.0%
C5: Project process groups are aimed to guide the smooth execution of projects.	Count	0	0	13	42	43	98
	Row N %	0.0%	0.0%	13.3%	42.9%	43.9%	100.0%
C6: The basic purpose of initiating a project is to accomplish a specific organizational goal.	Count	0	0	5	39	54	98
	Row N %	0.0%	0.0%	5.1%	39.8%	55.1%	100.0%
C7: The temporal nature of projects influences project start and end dates.	Count	1	0	16	43	38	98
	Row N %	1.0%	0.0%	16.3%	43.9%	38.8%	100.0%
C8: Technical competency of the project manager contributes to the achievement of project success.	Count	0	0	9	30	59	98
	Row N %	0.0%	0.0%	9.2%	30.6%	60.2%	100.0%
C9: Attaining project management skills by hospital personnel would improve medical gas management in the hospitals.	Count	0	5	13	38	42	98
	Row N %	0.0%	5.1%	13.3%	38.8%	42.9%	100.0%
C10: Applying a systematic approach	Count	0	0	4	38	56	98

towards project management encourages the completion of projects on time	Row N %	0.0%	0.0%	4.1%	38.8%	57.1%	100.0%
C11: Applying a systematic approach towards project management supports the completion of projects within the budget	Count	0	3	7	36	52	98
	Row N %	0.0%	3.1%	7.1%	36.7%	53.1%	100.0%

Results Analysis of Statistics on table 12 below:

- **C1 -** the mean value and standard deviation was 4.74 and 0.504 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **C2 -** the mean value and standard deviation was 4.70 and 0.481 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale This means the majority of the respondents believe this item as important for medical gases installations.
- **C3 -** the mean value and standard deviation was 4.59 and 0.553 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **C4 -** the mean value and standard deviation was 4.67 and 0.493 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the strongly agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **C5 -** the mean value and standard deviation was 4.31 and 0.695 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **C6 -** the mean value and standard deviation was 4.50 and 0.596 respectively. This means the response rate from the respondents was between agree and strongly agree. This means the majority of the respondents believe this item as important for medical gases installations.
- **C7 -** the mean value and standard deviation was 4.19 and 0.782 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.

- **C8 -** the mean value and standard deviation was 4.51 and 0.662 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **C9 -** the mean value and standard deviation was 4.19 and 0.857 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **C10 -** the mean value and standard deviation was 4.53 and 0.578 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning slightly more on the strongly agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.
- **C11 -** the mean value and standard deviation was 4.40 and 0.756 respectively. This means the response rate from the respondents was between agree and strongly agree, leaning more on the agree side of the scale. This means the majority of the respondents believe this item as important for medical gases installations.

In summary, a majority of the responses on the factors were mainly on the strongly agree side of the scale. There was also a good spread around the mean based on the standard deviation values, suggesting that the scale was used widely and not concentrated in one part of the scale. On some factors, the responses were mainly on the agree side of the scale.

Table 12: Statistics on the application of project management principles

	Valid	Missing	Mean	Median	Mode	Std. Deviation	Minimum	Maximum
C1	98	0	4.74	5.00	5	0.504	3	5
C2	98	0	4.70	5.00	5	0.481	3	5
C3	98	0	4.59	5.00	5	0.553	3	5
C4	98	0	4.67	5.00	5	0.493	3	5
C5	98	0	4.31	4.00	5	0.695	3	5
C6	98	0	4.50	5.00	5	0.596	3	5
C7	98	0	4.19	4.00	4	0.782	1	5
C8	98	0	4.51	5.00	5	0.662	3	5
C9	98	0	4.19	4.00	5	0.857	2	5
C10	98	0	4.53	5.00	5	0.578	3	5
C11	98	0	4.40	5.00	5	0.756	2	5

5.3 Development of Sub-Themes and Regrouped Questions

As an outcome of the initial analysis of the factors, new groups of the themes were created as detailed below:

- A2.1 - was compared with B1 & B2 themes from the original questions on the questionnaire.
- A2.2 - was compared with B1, B2 and C themes from the original questions on the questionnaire.
- A3.1 - was compared with B1, B2 & C themes from the original questions on the questionnaire.
- A3.2 - was compared with B1, B2 & C themes.
- A4.1 - was compared with B1 & B2 themes from the original questions on the questionnaire.
- A4.2 - was compared with B1, B2 & C themes from the original questions on the questionnaire.
- A4.3 - was compared with B1, B2 & C themes from the original questions on the questionnaire.

5.3.1 Construction of Sub-Themes and Grouping

This was done in order to create items with similarity on scale and combined them together in order to improve reliability of the factors. The questions were re-grouped based on better correlation and the underlying tone of addressing similar factor. Out of their similarity on their undertone, a new identity was created to cover each item. From the new themes, another analysis test was conducted to measure the reliability of the factors. This led to the results being interpreted using empirical and theoretical based evidence.

Below are the new grouped factors with questions that were re-arranged:

B.1: GENERAL VIEWS ABOUT MEDICAL GASES PRODUCTS

1. Medical Gas as Life Supporting - 1.1, 1.2 and 1.3
2. Safe Use of Medical Gas - 1.4, 1.5 and 1.6
3. Variety of Product Offering - 1.7 and 1.8

B.2: OPINION ON APPLICATION OF MEDICAL GASES

1. Product Use - 2.1 and 2.6
2. Product Safety - 2.2 and 2.5
3. Product Quality - 2.3, 2.4 and 2.8

C: APPLYING PROJECT MANAGEMENT IN THE EXECUTION OF MEDICAL GASES INSTALLATIONS IN HOSPITALS

1. Project Initiation - 1, 2, 3 and 4
2. Project Attributes - 5, 6 and 7
3. Project Knowledge - 8 and 9
4. Project Approach - 10 and 11

5.3.2 Empirical and Theoretical Reliabilities

This section tests for the reliability of the analysed factors from the received data. This is confirmed by having a Cronbach alpha of a value greater than 0.7. In the case where the Cronbach alpha value is smaller than 0.7, an Inter-item correlation test is conducted. For the reliability test performed the mean score of a value greater than 0.2 makes the factor reliable. This results to the factor being accepted. In the event also that the mean value is less than 0.2, an Item Total Statistics test is further conducted. In this test, a corrected Item-Total correlation value is required to improve the reliability of the factor, where the weaker item gets to be omitted in order to improve the factor reliability. This test gives an indication of the degree to which each item correlates with the total score. Low values that are less than 0.3 indicate the item is measuring something different from what the scale was aiming for. It must also be noted that due in this research, grouped items were lower than 10, hence having to further conduct the item-total statistics test to identify the weaker item for omission. For scales with a smaller number of items, such as lower than 10, it is often difficult to get a decent Cronbach alpha value. As such, mean inter-item correlation was conducted for such and is shown under Summary Item Statistics. By weaker item, it means an item that does not work together with the others or that seems to address something different to what other items are addressing in the questionnaire.

According to (Briggs & Cheek, 1986) Cronbach alpha values are quite sensitive to the number of items; it is common to find quite low Cronbach values. In this instance, it may be more appropriate to report the mean inter-item correlation for those items. The reliability of a scale vary depending on the sample with which it is used and the paired questions.

5.4 Empirical Results Analysis

5.4.1 Scale: Section B1 - Factor 1

On the table 13 below, the Cronbach alpha is 0.595 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 14 below. The result of the mean value for this factor is 0.296. This makes the factor reliable, as this mean value is greater than the recommended value of 0.2. For the purpose of the study, this means the general questions in this scale received positive feedback from the respondents.

Table 13: Reliability Statistics for section B1 - Factor 1

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.595	0.678	5

Table 14: Summary item statistics for factor 1

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.296	0.116	0.512	0.396	4.402	0.014	5

5.4.2 Scale: Section B2 - Factor 1

On the table 15.below, the Cronbach alpha is 0.777 which is above the required minimum value of 0.7 for a factor to be considered reliable and as such no further tests were required.

For the purpose of the study, this means, the respondents had positive opinion about the specific questions addressed by this theme and regards it as important factor to consider in the medical gases installations in South African Hospitals.

Table 15: Reliability statistics for section 2 - B1

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.777	0.789	5

5.4.3 Scale: Section C - Factor 1

On the table 16 below, the Cronbach alpha is 0.835 which is above the required minimum value of 0.7 for a factor to be considered reliable and as such no further tests were required.

For the purpose of the study, this means the respondents find these themes addressed by this scale as an important factor to consider in the medical gases installations in South African Hospitals.

Table 16: Reliability statistics for section C - Factor 1

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.835	0.837	4

5.4.4 Scale: Section C - Factor 2

On the reliability statistics table 17 below, the Cronbach alpha is 0.672 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 18 below. In the summary item statistics table below, the mean value for this factor is 0.355. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 17: Reliability statistics for section c - Factor 2

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.672	0.688	4

Table 18: Summary item statistics for section C - Factor 2

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.355	0.186	0.550	0.364	2.963	0.017	4

5.4.5 Scale: Section C - Factor 3

On the reliability statistics table 19 below, the Cronbach alpha is 0.707 which is above the required minimum value of 0.7 for a factor to be considered reliable and as such no further tests were required.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 19: Reliability statistics for section C - Factor 3

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.707	0.716	3

5.4.6 Scale: Section C - 2nd Order Factor 1 & Theoretical

5.4.6.1 Project Management Application in the Medical Gases Installations

On the reliability statistics table 20 below, the Cronbach alpha is 0.844 which is above the required minimum value of 0.7 for a factor to be considered reliable and as such no further tests were required. For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 20: Reliability statistics for section C- 2nd order Factor 1

Cronbach's Alpha	N of Items
0.844	11

5.4.6.2 Scale: General Views about Medical Gases Products

On reliability statistics table 21 below, the Cronbach alpha is 0.557 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 22 below. In the summary item statistics table below, the mean value for this factor is 0.193. The value is below the required minimum of 0.2. As a result of the lower mean value, Item-Total Statistics Test was conducted, and a corrected Item-Total Correlation values performed in order to establish the weaker item for elimination. Items with values lower than 0.2 were considered to be weak items and were eliminated. In this case, in the item-total statistics results table, B1.6 had a value of 0.121. This means the item does not fit with the rest of the items in the same factor.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 21: Reliability statistics for general views on medical gases

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.557	0.656	8

Table 22: Summary item statistics for A1

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.193	-0.096	0.512	0.608	-5.346	0.027	8

Table 23: Item total statistics for A1

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
B1.1	30.87	7.436	0.220	0.361	0.546
B1.2	30.92	7.127	0.328	0.443	0.526
B1.3	30.93	6.892	0.403	0.259	0.508
B1.4	31.20	5.917	0.481	0.330	0.454
B1.5	31.97	5.618	0.346	0.221	0.493
B1.6	32.00	5.567	0.121	0.100	0.655
B1.7	31.11	7.049	0.208	0.277	0.542
B1.8	31.36	5.799	0.430	0.457	0.464

5.4.6.3 Scale: Application of Medical Gases

On reliability statistics table 24 below, the Cronbach alpha is 0.719 which is above the required minimum value of 0.7 for a factor to be considered reliable and as such no further tests were required. For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 24: Reliability statistics for application of medical gases

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.719	0.753	7

5.5 Additional Theoretical Reliabilities: Sub-Scales

5.5.1 Scale: Medical Gas as Life Supporting (A3)

On reliability statistics table 25 below, the Cronbach alpha is 0.601 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 26 below. In the summary item statistics table below, the mean value for this factor is 0.342. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 25: Reliability statistics for A3

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.601	0.609	3

Table 26: Summary item statistics for A3

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.342	0.116	0.512	0.396	4.402	0.033	3

5.5.2 Scale: Safe Use of Medical Gas (A4)

On reliability statistics table 27 below, the Cronbach alpha is 0.353 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 28 below.

In the summary item statistics table below, the mean value for this factor is 0.186. The value is below the required minimum of 0.2. As a result of the lower mean value, Item-Total Statistics Test was conducted as shown in figure 29, and a corrected Item-Total Correlation values performed in order to establish the weaker item for elimination. Items with values lower than 0.2 were considered to be weak items and were eliminated. In this case, in the item-total statistics results table 29, B1.6 had a value of 0.178. This means the item does not fit with the rest of the items in the same factor.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 27: Reliability statistics for A4

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.353	0.407	3

Table 28: Summary item statistics for A4

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.186	0.121	0.266	0.145	2.199	0.004	3

Table 29: Item total statistics for A4

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
B1.4	7.56	2.682	0.278	0.090	0.205
B1.5	8.33	2.325	0.215	0.076	0.247
B1.6	8.36	1.552	**0.178**	0.036	**0.405**

5.5.3 Scale: Safe Use of Medical Gas (B1.6 Omitted)

On reliability statistics table 30 below with B1.6 being omitted due to it being a weaker item from this factor, the Cronbach alpha is 0.405 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 31 below. In the summary item statistics table below, the mean value for this factor is 0.266. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 30: Reliability statistics on Safe use of medical gases (B1.6 omitted)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.405	0.420	2

Table 31: Summary item statistics for safe use of med gases (B1.6 omitted)

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.266	0.266	0.266	0.000	1.000	0.000	2

5.5.4 Scale: Variety of Product Offering

On reliability statistics table 32 below, the Cronbach alpha is 0.569 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 33 below. In the summary item statistics table below, the mean value for this factor is 0.423. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2. For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 32: Reliability statistics for variety of product offering

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.569	0.595	2

Table 33: Summary item statistics on variety of product offering

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.423	0.423	0.423	0.000	1.000	0.000	2

5.5.5 Scale: Product Use

On reliability statistics table 34 below, the Cronbach alpha is 0.419 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 35 below. In the summary item statistics table below, the mean value for this factor is 0.273. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 34: Reliability statistics on product use

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.419	0.428	2

Table 35: Summary item statistics on product use

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.273	0.273	0.273	0.000	1.000	0.000	2

5.5.6 Scale: Product Safety

On reliability statistics table 36 below, the Cronbach alpha is 0.654 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 37 below. In the summary item statistics table below, the mean value for this factor is 0.486. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 36: Reliability statistics on product safety

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.654	0.654	2

Table 37: Summary item statistics on product safety

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.486	0.486	0.486	0.000	1.000	0.000	2

5.5.7 Scale: Product Quality

On reliability statistics table 38 below, the Cronbach alpha is 0.489 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 39 below. In the summary item statistics table below, the mean value for this factor is 0.288. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2. As the mean value was still slightly low, item B2.7 was omitted in order to improve the factor as shown in figure 40.

For the purpose of the study, this means the respondents view this factor as important to consider in the medical gases installations in South African Hospitals.

Table 38: Reliability statistics on product quality

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.489	0.549	3

Table 39: Summary item statistics on product quality

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.288	0.068	0.584	0.516	8.623	0.057	3

Table 40: Item total statistics on product quality

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
B2.3	8.16	1.272	0.350	0.344	0.331
B2.4	8.11	1.173	0.498	0.371	0.121
B2.7	8.99	1.124	**0.156**	0.051	**0.736**

5.5.8 Scale: Product Quality (Omitted B2.7)

On reliability statistics table 41 below with B2.7 being omitted due to it being a weaker item from this factor, the Cronbach alpha is 0.736 which is higher than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, the factor is reliable as the Cronbach alpha improved after removing the weaker item from the factor.

For the purpose of the study, this means the key stakeholders believes product quality is an important factor to consider in the medical gases installations in South African Hospitals.

Table 41: Reliability statistics on product quality (B2.7 Omitted)

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.736	0.737	2

5.5.9 Scale: Project Initiation

On reliability statistics table 42 below, the Cronbach alpha is 0.835 which is above the required minimum value of 0.7 for a factor to be considered reliable and as such no further tests were required. For the purpose of the study, this means following a formal process or structure of project initiation is an important factor to consider in the medical gases installations within South African Hospitals.

Table 42: Reliability Statistics on Project Initiation

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.835	0.837	4

5.5.10 Scale: Project Attributes

On reliability statistics table 43 below, the Cronbach alpha is 0.707 which is above the required minimum value of 0.7 for a factor to be considered reliable and as such no further tests were required. For the purpose of the study, this means understanding of project attributes by key stakeholders is an important factor to consider in the medical gases installations within South African Hospitals.

Table 43: Reliability Statistics on Project Attributes

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.707	0.716	3

5.5.11 Scale: Project Knowledge

On reliability statistics table 44 below, the Cronbach alpha is 0.379 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 45 below. In the summary item statistics table below, the mean value for this factor is 0.242. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2.

For the purpose of the study, this means that being knowledgeable about installations project is an important factor to consider in the medical gases installations within South African Hospitals.

Table 44: Reliability Statistics on Project Knowledge

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.379	0.389	2

Table 45: Summary Statistics on Project knowledge

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.242	0.242	0.242	0.000	1.000	0.000	2

5.5.12 Scale: Project Approach

On reliability statistics table 46 below, the Cronbach alpha is 0.693 which is less than the required minimum value of 0.7 for a factor to be considered reliable. In this instance, Inter-item correlations test was performed and the results are shown in the summary item statistics table 47 below. In the summary item statistics table below, the mean value for this factor is 0.550. The value result to the factor becoming reliable, as this mean value is greater than the minimum required value of 0.2.

For the purpose of the study, this means that the key stakeholders are of the view that following a formal project approaches an important factor to consider in the medical gases installations in South African Hospitals.

Table 46: Reliability Statistics on Project Approach

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.693	0.709	2

Table 47: Summary Item Statistics on Project Approach

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Inter-Item Correlations	0.550	0.550	0.550	0.000	1.000	0.000	2

5.6 Frequencies for New / Recoded Variables

This section of the results was reorganised in order to create a bigger or larger groups for the statistics to be able to make meaningful comparison of the results. There were new categories created to create the grouping of the items and make similar sizing in performing the hypothesis testing.

Table 48 below targeted respondents according to their level of occupation within their respective companies and were grouped in order to create a number that will be large enough to test the hypothesis. As a result, skilled and semi-skilled respondents were grouped with the supervisors and analysis was then performed as a group. Middle management and Senior/Executive management each had a reasonable acceptable number separately and as such were not grouped and analysis was performed as per the questionnaire. There was one respondent that did not specify. This resulted to three groups were the hypothesis was tested.

Table 48: rA2 - Best Describes Occupational Level (re-coded)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Skilled/Semi-Skilled & Supervisor	24	24.5	24.7	24.7
	Middle Management	49	50.0	50.5	75.3
	Senior/Executive Management	24	24.5	24.7	100.0
	Total	97	99.0	100.0	
Missing	System	1	1.0		
Total		98	100.0		

Table 49 below targeted respondents according to the number of years they have been in the employment of their respective companies during the time of completing the questionnaire. A grouping of a reasonable number was created in order to perform the hypothesis test. As a result of the grouping, less than 1 year, between 1 to 2 years and between 2 to 5 years was grouped together as one. 5 years and older was left on its own as it had a reasonable number of respondents that allowed the hypothesis to be tested. This resulted to two groups where the hypothesis was tested.

Table 49: rA3 - Years of Experience in the Medical Gases Sector (re-coded)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 5 years	51	52.0	52.0	52.0
	5 years or more	47	48.0	48.0	100.0
	Total	98	100.0	100.0	

Table 50 below reported on the respondents according to their highest educational qualification. A grouping of a reasonable number was created in order to perform the hypothesis test. As a result of the grouping, grade 12 or lower and diploma/certificate were grouped together, honors/post graduate diploma and masters/PHD were grouped together, and bachelor's degree was left a single group. This resulted to three groups where the hypothesis was tested.

Table 50: rA4 - Highest Educational Qualification (re-coded)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Diploma/Certificate or lower	37	37.8	37.8	37.8
	Bachelor Degree (s)	30	30.6	30.6	68.4
	Post Graduate Diploma or Degree	31	31.6	31.6	100.0
	Total	98	100.0	100.0	

Table 51 below targeted respondents according to their company's role in within the medical gases sector. A grouping of a reasonable number was created in order to perform the hypothesis test. As a result of the grouping, medical gases installer, medical equipment/devices supplier and consulting companies were grouped to one category and were renamed as complimentary service providers. This resulted to three groups where the hypothesis was tested.

Table 51: rA5 – Primary Role in the Medical Gases Services (re-coded)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Medical Gases Products Supplier	35	35.7	35.7	35.7
	Medical Gases product user (Hospital)	35	35.7	35.7	71.4
	Complimentary Service Providers	28	28.6	28.6	100.0
	Total	98	100.0	100.0	

5.7 Descriptive results Analysis on Sub-Scales

Table 52 below gets the scores to work together instead of individual scores in order to get the overall scoring of the responses. The report will focus on the mean value and standard deviation of the response rate and is detailed as below:

- On Medical gas as a life supporting, the mean value is 4.86 and standard deviation is 0.266. This meant the responses leaned more to strongly agree, which meant they strongly agreed with this factor.
- On Safe use of medical gases, the mean value was 4.179 with the standard deviation of 0.6228. This meant the responses leaned more to agree with this factor.
- On variety of product, the mean value was 4.53 with the standard deviation of 0.536. This meant the responses leaned more between agree and strongly agree. This means on average, the respondent are in agreement with this factor.
- On product use, the mean value was 3.84 with the standard deviation of 0.687. This meant that averaged responses were between neutral and agree, leaning more on the agree part of the scale. This means most of the respondents agreed with this factor
- On product safety the mean value was 4.68 with the standard deviation of 0.484. This meant the averaged responses were between agree and strongly agree, leaning more on strongly agree part of the scale. This meant majority of the respondents felt strongly in agreement with this factor.
- On product quality the mean value was 4.495 with the standard deviation of 0.53. This meant the averaged responses were between agree and strongly agree, leaning more on strongly agree part of the scale. This meant majority of the respondents felt strongly in agreement with this factor.
- On product quality the mean value was 4.495 with the standard deviation of 0.53. This meant the averaged responses were between agree and strongly agree. This meant majority of the respondents agreed with this factor.

- On project attributes the mean value was 4.6786 with the standard deviation of 0.41555. This meant the averaged responses were between agree and strongly agree, leaning more on strongly agree part of the scale. This meant majority of the respondents felt strongly in agreement with this factor.
- On project initiation the mean value was 4.333 with the standard deviation of 0.55199. This meant the averaged responses were between agree and strongly agree, leaning more on agree part of the scale. This meant majority of the respondents were in agreement with this factor.
- On project knowledge and approach the mean value was 4.4082 with the standard deviation of 0.51195. This meant the averaged responses were between agree and strongly agree, leaning more on agree part of the scale. This meant majority of the respondents were in agreement with this factor.

In summary, a majority of the responses on the factors were mainly on the strongly agree side of the scale. There was also a good spread around the mean based on the standard deviation values, suggesting that the scale was used widely and not concentrated in one part of the scale. On some factors, the responses were mainly on the agree side of the scale.

Table 52: Descriptive Results on Sub-Scales

	Valid	Missing	Mean	Median	Mode	Std deviation
Medical Gas as Life Supporting	98	0	4.8605	5	5	0.26617
Safe Use of Medical Gas	98	0	4.1786	4	4	0.62281
Variety of Product Offering	98	0	4.5306	4.5	5	0.53639
Product Use	98	0	3.8418	4	3	0.68713
Product Safety	98	0	4.6837	5	5	0.48369
Product Quality	98	0	4.4949	4.5	5	0.53
Project Initiation	98	0	4.6786	4.75	5	0.41555
Project Attributes	98	0	4.3333	4.3333	5	0.55199
Project Knowledge and Approach	98	0	4.4082	4.5	5	0.51195

5.8 Hypothesis testing (Checking for distribution - normal or not)

On this section, the results were checked for differences between the groups on the scores that were calculated. This was done in order to test the distribution of the results for each variable or scores of each factor to confirm the distribution type of the results for each scale. This was done because the test on the factors was based on the distribution type.

A comparison between the scales was done in order to determine whether the respondents had different opinions on each factor according to their profile or categorization. A test for the distribution of each variable was done based on the score of the factors.

A test for Hypothesis was conducted to determine whether there were differences between the groups on the scores that have been calculated. On this test, a check for comparison between groups to determine whether respondents according to the outlined categories have different opinions on each factor was performed. Prior to conducting the hypothesis, a distribution test on each variable was performed informed by the actual scoring per group.

On normal distributed factors, parametric test was used to check for comparison between the factors and those that were not normally distributed (having a lot of outliers) nonparametric test was used. A p-value test was used to interpret the factors based on the calculated value on the analysed results. The calculated p-value from the analysis results is tested against a 0.05 value which represents a 5 percent error significant margin.

Where a p-value was bigger than 0.05 the hypothesis (not reject) was accepted and it is normally distributed. This means there is difference on the responses. If the p-value is less than 0.05, the hypothesis is rejected and the analysis is not normally distributed. This means there is difference in the responses and when it is less than 0.05 reject the hypothesis. Shapiro Wilk test was used as there as the group had less than 50 people on each.

On table 53 below a test for normality was conducted on the factors. Most of the factors had a p-value of less than 0.005 and thus the hypothesis was accepted. This means all these variables were normally distributed. With the exception of Senior/Executive management on project attributes which had a p-value of 0.09 which is greater than 0.05. Also under project knowledge and approach the senior/executive management had a p-value of 0.56. For these two factors the hypothesis was rejected as they were normally distributed.

Table 53: Test for Normality - rA2

Shapiro-Wilk				
rA2		Statistic	Df	Sig. (p-value)
Medical Gases as Life Support	Skilled/Semi-Skilled & Supervisor	0.640	24	0.000
	Middle Management	0.566	49	0.000
	Senior/Executive Management	0.514	24	0.000
Safe Use of Medical Gases	Skilled/Semi-Skilled & Supervisor	0.900	24	0.021
	Middle Management	0.909	49	0.001
	Senior/Executive Management	0.900	24	0.021
Variety of Product Offering	Skilled/Semi-Skilled & Supervisor	0.759	24	0.000
	Middle Management	0.779	49	0.000
	Senior/Executive Management	0.860	24	0.003
Product Use	Skilled/Semi-Skilled & Supervisor	0.902	24	0.023
	Middle Management	0.866	49	0.000
	Senior/Executive Management	0.882	24	0.009
Product Safety	Skilled/Semi-Skilled & Supervisor	0.663	24	0.000
	Middle Management	0.710	49	0.000
	Senior/Executive Management	0.618	24	0.000
Product Quality	Skilled/Semi-Skilled & Supervisor	0.830	24	0.001
	Middle Management	0.781	49	0.000
	Senior/Executive Management	0.817	24	0.001
Project Initiation	Skilled/Semi-Skilled & Supervisor	0.806	24	0.000
	Middle Management	0.756	49	0.000
	Senior/Executive Management	0.754	24	0.000
Project Attributes	Skilled/Semi-Skilled & Supervisor	0.869	24	0.005
	Middle Management	0.873	49	0.000
	Senior/Executive Management	0.928	24	0.090
Project Knowledge and Approach	Skilled/Semi-Skilled & Supervisor	0.887	24	0.011
	Middle Management	0.888	49	0.000
	Senior/Executive Management	0.919	24	0.056

5.8.1 Descriptive Results Analysis for rA2

Table 54 below gets the scores to work together instead of individual scores in order to get the overall scoring of the responses. The report will focus on the mean value and standard deviation of the response rate and is detailed as below:

- On Medical gas as a life supporting under skilled/semiskilled with supervisors, the mean value is 4.819 with a standard deviation is 0.278. On middle management, the mean value was 4.864 with a standard deviation of 0.271. For senior/executive management the mean value is 4.889 with a standard deviation of 0.254. For all these factors the responses leaned more to strongly agree side of the scale, which means the respondents strongly agreed with this factor.

- On Safe use of medical gases, under skilled/semiskilled with supervisors, the mean value is 4.292 with a standard deviation of 0.550. On middle management, the mean value was 4.122 with a standard deviation of 0.689. For senior/executive management the mean value is 4.208 with a standard deviation of 0.550. For all these factors the responses were more to the agree side of the scale, which means the respondents agreed with this factor.
- On variety of product offering, under skilled/semiskilled with supervisors, the mean value is 4.583 with a standard deviation of 0.565. On middle management, the mean value was 4.570 with a standard deviation of 0.577. For senior/executive management the mean value is 4.479 with a standard deviation of 0.429. For all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On product use, under skilled/semiskilled with supervisors, the mean value is 3.729 with a standard deviation of 0.589. On middle management, the mean value was 3.806 with a standard deviation of 0.706. For senior/executive management the mean value is 4.042 with a standard deviation of 0.736. For all these factors the responses were between neutral and agree, yet leaning more on the agree side of the scale, which means the respondents agreed with this factor.
- On product safety, under skilled/semiskilled with supervisors, the mean value is 4.688with a standard deviation of 0.507. On middle management, the mean value was 4.694 with a standard deviation of 0.406. For senior/executive management the mean value is 4.667 with a standard deviation of 0.620. For all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On product quality, under skilled/semiskilled with supervisors, the mean value is 4.438 with a standard deviation of 0.577. On middle management, the mean value was 4.541 with a standard deviation of 0.519. For senior/executive management the mean value is 4.458 with a standard deviation of 0.530. For all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.

- On project initiation, under skilled/semiskilled with supervisors, the mean value is 4.625 with a standard deviation of 0.436. On middle management, the mean value was 4.679 with a standard deviation of 0.427. For senior/executive management the mean value is 4.719 with a standard deviation of 0.385. For all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On project attributes, under skilled/semiskilled with supervisors, the mean value is 4.444 with a standard deviation of 0.526. On middle management, the mean value was 4.408 with a standard deviation of 0.533. For senior/executive management the mean value is 4.069 with a standard deviation of 0.564. For all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On project knowledge and approach, under skilled/semiskilled with supervisors, the mean value is 4.479 with a standard deviation of 0.483. On middle management, the mean value was 4.423 with a standard deviation of 0.543. For senior/executive management the mean value is 4.292 with a standard deviation of 0.482. For all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.

Table 54: Descriptive Results for rA2

rA2		N	Mean	Std. Deviation	Mean Rank	Median
Medical Gases as Life Supporting	Skilled/Semi-Skilled & Supervisor	24	4.819	0.278	45.21	5.000
	Middle Management	49	4.864	0.271	49.60	5.000
	Senior/Executive Management	24	4.889	0.254	51.56	5.000
	Total	97				
Safe Use of Medical Gases	Skilled/Semi-Skilled & Supervisor	24	4.292	0.550	53.52	4.500
	Middle Management	49	4.122	0.689	46.65	4.000
	Senior/Executive Management	24	4.208	0.550	49.27	4.000
	Total	97				
Variety of Product Offering	Skilled/Semi-Skilled & Supervisor	24	4.583	0.565	52.75	5.000

	Middle Management	49	4.520	0.577	49.54	5.000
	Senior/Executive Management	24	4.479	0.429	44.15	4.500
	Total	97				
Product Use	Skilled/Semi-Skilled & Supervisor	24	3.729	0.589	45.46	4.000
	Middle Management	49	3.806	0.706	47.05	3.500
	Senior/Executive Management	24	4.042	0.736	56.52	4.000
	Total	97				
Product Safety	Skilled/Semi-Skilled & Supervisor	24	4.688	0.507	50.63	5.000
	Middle Management	49	4.694	0.406	47.12	5.000
	Senior/Executive Management	24	4.667	0.620	51.21	5.000
	Total	97				
Product Quality	Skilled/Semi-Skilled & Supervisor	24	4.438	0.577	46.63	4.500
	Middle Management	49	4.541	0.519	51.27	4.500
	Senior/Executive Management	24	4.458	0.530	46.75	4.500
	Total	97				
Project Initiation	Skilled/Semi-Skilled & Supervisor	24	4.625	0.436	45.35	4.750
	Middle Management	49	4.679	0.427	49.88	5.000
	Senior/Executive Management	24	4.719	0.385	50.85	4.875
	Total	97				
Project Attributes	Skilled/Semi-Skilled & Supervisor	24	4.444	0.526	54.10	4.667
	Middle Management	49	4.408	0.533	52.46	4.333
	Senior/Executive Management	24	4.069	0.564	36.83	4.167
	Total	97				
Project Knowledge and Approach	Skilled/Semi-Skilled & Supervisor	24	4.479	0.483	52.52	4.625
	Middle Management	49	4.423	0.543	50.61	4.500
	Senior/Executive Management	24	4.292	0.482	42.19	4.250

	Total	97				

5.8.2 Descriptive Results Analysis for rA3

Table 55 below gets the scores to work together instead of individual scores in order to get the overall scoring of the responses. The report will focus on the mean value and standard deviation of the response rate and is detailed as below:

- On Medical gas as a life supporting for less than 5 years, the mean value is 4.863 with a standard deviation is 0.251. On 5 years or more, the mean value was 4.858 with a standard deviation of 0.284. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On safe use of medical gases, for less than 5 years, the mean value is 4.216 with a standard deviation is 0.585. On 5 years or more, the mean value was 4.138 with a standard deviation of 0.665. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On variety of product offering, for less than 5 years, the mean value is 4.549 with a standard deviation is 0.577. On 5 years or more, the mean value was 4.511 with a standard deviation of 0.494. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On product use, for less than 5 years, the mean value is 3.716 with a standard deviation is 0.680. On 5 years or more, the mean value was 3.979 with a standard deviation of 0.675494. On all these factors the responses were between neutral and agree side of the scale, leaning more on the agree side of the scale which means overall the respondents agreed with this factor.
- On product safety, for less than 5 years, the mean value is 4.706 with a standard deviation is 0.460. On 5 years or more, the mean value was 4.660 with a standard deviation of 0.512. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On product quality for less than 5 years, the mean value is 4.480 with a standard deviation is 0.574. On 5 years or more, the mean value was 4.511 with a standard deviation of 0.483. On all these factors the responses were between agree and

strongly agree side of the scale, which means the respondents strongly agreed with this factor.

- On project initiation, for less than 5 years, the mean value is 4.721 with a standard deviation is 0.414. On 5 years or more, the mean value was 4.633 with a standard deviation of 0.417. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On projects attributes for less than 5 years, the mean value is 4.425 with a standard deviation is 0.574. On 5 years or more, the mean value was 4.234 with a standard deviation of 0.515. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On project knowledge and approach for less than 5 years, the mean value is 4.456 with a standard deviation is 0.499. On 5 years or more, the mean value was 4.356 with a standard deviation of 0.526. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.

Table 55: Descriptive Results for rA3

rA3		N	Mean	Std. Deviation	Mean Rank	Median
Medical Gases as Life Supporting	Less than 5 years	51	4.863	0.251	48.91	5.000
	5 years or more	47	4.858	0.284	50.14	5.000
	Total	98				
Safe Use of Medical Gases	Less than 5 years	51	4.216	0.585	50.75	4.000
	5 years or more	47	4.138	0.665	48.14	4.000
	Total	98				
Variety of Product Offering	Less than 5 years	51	4.549	0.577	51.42	5.000
	5 years or more	47	4.511	0.494	47.41	4.500
	Total	98				
Product Use	Less than 5 years	51	3.716	0.680	44.47	3.500
	5 years or more	47	3.979	0.675	54.96	4.000
	Total	98				

Product Safety	Less than 5 years	51	4.706	0.460	50.58	5.000
	5 years or more	47	4.660	0.512	48.33	5.000
	Total	98				
Product Quality	Less than 5 years	51	4.480	0.574	49.45	4.500
	5 years or more	47	4.511	0.483	49.55	4.500
	Total	98				
Project Initiation	Less than 5 years	51	4.721	0.414	52.45	5.000
	5 years or more	47	4.633	0.417	46.30	4.750
	Total	98				
Project Attributes	Less than 5 years	51	4.425	0.574	54.53	4.667
	5 years or more	47	4.234	0.515	44.04	4.333
	Total	98				
Project Knowledge and Approach	Less than 5 years	51	4.456	0.499	51.81	4.500
	5 years or more	47	4.356	0.526	46.99	4.250
	Total	98				

On table 56 below test for normality for rA3 was conducted using Kolmogorov-Smirnova and Shapiro-Wilk test. For both these test all these factors had a p-value of less than 0.005 and thus the hypothesis was accepted. This means all these variables were normally distributed.

Table 56: Test for Normality on rA3

rA3		Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig. (p-value)	Statistic	df	Sig. (p-value)
Medical Gases as Life Supporting	Less than 5 years	0.433	51	0.000	0.605	51	0.000
	5 years or more	0.457	47	0.000	0.558	47	0.000
Safe Use of Medical Gases	Less than 5 years	0.193	51	0.000	0.891	51	0.000
	5 years or more	0.196	47	0.000	0.896	47	0.001
Variety of Product Offering	Less than 5 years	0.312	51	0.000	0.770	51	0.000
	5 years or more	0.243	47	0.000	0.825	47	0.000
Product Use	Less than 5 years	0.187	51	0.000	0.898	51	0.000

	5 years or more	0.168	47	0.002	0.897	47	0.001
Product Safety	Less than 5 years	0.346	51	0.000	0.675	51	0.000
	5 years or more	0.321	47	0.000	0.691	47	0.000
Product Quality	Less than 5 years	0.268	51	0.000	0.816	51	0.000
	5 years or more	0.291	47	0.000	0.763	47	0.000
Project Initiation	Less than 5 years	0.293	51	0.000	0.708	51	0.000
	5 years or more	0.258	47	0.000	0.813	47	0.000
Project Attributes	Less than 5 years	0.214	51	0.000	0.865	51	0.000
	5 years or more	0.130	47	0.046	0.943	47	0.023
Project Knowledge & Approach	Less than 5 years	0.173	51	0.001	0.891	51	0.000
	5 years or more	0.166	47	0.002	0.916	47	0.002

On table 57 below test for normality for rA4 was conducted using Shapiro-Wilk test. For this test all these factors had a p-value of less than 0.005 and thus the hypothesis was accepted. This means all these variables were normally distributed.

Table 57: Test for Normality on rA4

Shapiro-Wilk				
rA4		Statistic	Df	Sig. (p-value)
Medical Gases as Life Supporting	Diploma/Certificate or lower	0.657	37	0.000
	Bachelor Degree (s)	0.466	30	0.000
	Post Graduate Diploma or Degree	0.581	31	0.000
Safe Use of Medical Gases	Diploma/Certificate or lower	0.909	37	0.005
	Bachelor Degree (s)	0.890	30	0.005
	Post Graduate Diploma or Degree	0.894	31	0.005
Variety of Product Offering	Diploma/Certificate or lower	0.725	37	0.000
	Bachelor Degree (s)	0.845	30	0.000
	Post Graduate Diploma or Degree	0.819	31	0.000

Product Use	Diploma/Certificate or lower	0.896	37	0.002
	Bachelor Degree (s)	0.923	30	0.032
	Post Graduate Diploma or Degree	0.857	31	0.001
Product Safety	Diploma/Certificate or lower	0.718	37	0.000
	Bachelor Degree (s)	0.569	30	0.000
	Post Graduate Diploma or Degree	0.689	31	0.000
Product Quality	Diploma/Certificate or lower	0.815	37	0.000
	Bachelor Degree (s)	0.798	30	0.000
	Post Graduate Diploma or Degree	0.778	31	0.000
Project Initiation	Diploma/Certificate or lower	0.782	37	0.000
	Bachelor Degree (s)	0.726	30	0.000
	Post Graduate Diploma or Degree	0.750	31	0.000
Project Attributes	Diploma/Certificate or lower	0.905	37	0.004
	Bachelor Degree (s)	0.840	30	0.000
	Post Graduate Diploma or Degree	0.910	31	0.013
Project Knowledge & Approach	Diploma/Certificate or lower	0.881	37	0.001
	Bachelor Degree (s)	0.872	30	0.002
	Post Graduate Diploma or Degree	0.938	31	0.074

5.8.3 Descriptive Results Analysis for rA4

Table 58 below gets the scores to work together instead of individual scores in order to get the overall scoring of the responses. The report will focus on the mean value and standard deviation of the response rate and is detailed as below:

- On Medical gas as a life supporting for diploma/certificate or lower, the mean value is 4.82 with a standard deviation is 0.290. On bachelor's degree, the mean value was 4.90 with a standard deviation of 0.250. On post graduate diploma or degree, the mean value is 4.87 with a standard deviation of 0.254. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.

- On safe use of medical gases for diploma/certificate or lower, the mean value is 4.18 with a standard deviation is 0.592. On bachelor's degree, the mean value was 4.23 with a standard deviation of 0.704. On post graduate diploma or degree, the mean value is 4.13 with a standard deviation of 0.591. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On variety of product offering for diploma/certificate or lower, the mean value is 4.62 with a standard deviation is 0.532. On bachelor's degree, the mean value was 4.43 with a standard deviation of 0.537. On post graduate diploma or degree, the mean value is 4.52 with a standard deviation of 0.540. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On product use for diploma/certificate or lower, the mean value is 3.74 with a standard deviation is 0.573. On bachelor's degree, the mean value was 3.87 with a standard deviation of 0.730. On post graduate diploma or degree, the mean value is 3.94 with a standard deviation of 0.772. On all these factors the responses were between neutral and agree side of the scale, leaning more on agree. This in the main the respondents agreed with this factor.
- On product safety for diploma/certificate or lower, the mean value is 4.61 with a standard deviation is 0.516. On bachelor's degree, the mean value was 4.78 with a standard deviation of 0.429. On post graduate diploma or degree, the mean value is 4.68 with a standard deviation of 0.492. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On product quality for diploma/certificate or lower, the mean value is 4.45 with a standard deviation is 0.497. On bachelor's degree, the mean value was 4.48 with a standard deviation of 0.565. On post graduate diploma or degree, the mean value is 4.56 with a standard deviation of 0.544. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On project initiation for diploma/certificate or lower, the mean value is 4.68 with a standard deviation is 0.376. On bachelor's degree, the mean value was 4.69 with a standard deviation of 0.424. On post graduate diploma or degree, the mean value is

4.66 with a standard deviation of 0.463. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.

- On project attributes for diploma/certificate or lower, the mean value is 4.31 with a standard deviation is 0.574. On bachelor's degree, the mean value was 4.47 with a standard deviation of 0.492. On post graduate diploma or degree, the mean value is 4.24 with a standard deviation of 0.572. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On project knowledge and approach for diploma/certificate or lower, the mean value is 4.46 with a standard deviation is 0.522. On bachelor's degree, the mean value was 4.42 with a standard deviation of 0.539. On post graduate diploma or degree, the mean value is 4.34 with a standard deviation of 0.481. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.

Table 58: Descriptive Results for rA4

rA4		N	Mean	Std. Deviation	Mean Rank	Median
Medical Gases as Life Supporting	Diploma/Certificate or lower	37	4.82	0.290	37	5.000
	Bachelor Degree (s)	30	4.90	0.250	30	5.000
	Post Graduate Diploma or Degree	31	4.87	0.254	31	5.000
	Total	98	4.86	0.266	98	
Safe Use of Medical Gases	Diploma/Certificate or lower	37	4.18	0.592	37	4.000
	Bachelor Degree (s)	30	4.23	0.704	30	4.500
	Post Graduate Diploma or Degree	31	4.13	0.591	31	4.000
	Total	98	4.18	0.623	98	
Variety of Product Offering	Diploma/Certificate or lower	37	4.62	0.532	37	5.000
	Bachelor Degree (s)	30	4.43	0.537	30	4.500
	Post Graduate Diploma or Degree	31	4.52	0.540	31	4.500
	Total	98	4.53	0.536	98	
Product Use	Diploma/Certificate or lower	37	3.74	0.573	37	4.000
	Bachelor Degree (s)	30	3.87	0.730	30	4.000

	Post Graduate Diploma or Degree	31	3.94	0.772	31	4.000
	Total	98	3.84	0.687	98	
Product Safety	Diploma/Certificate or lower	37	4.61	0.516	37	4.500
	Bachelor Degree (s)	30	4.78	0.429	30	5.000
	Post Graduate Diploma or Degree	31	4.68	0.492	31	5.000
	Total	98	4.68	0.484	98	
Product Quality	Diploma/Certificate or lower	37	4.45	0.497	37	4.500
	Bachelor Degree (s)	30	4.48	0.565	30	4.500
	Post Graduate Diploma or Degree	31	4.56	0.544	31	5.000
	Total	98	4.49	0.530	98	
Project Initiation	Diploma/Certificate or lower	37	4.68	0.376	37	4.750
	Bachelor Degree (s)	30	4.69	0.424	30	4.875
	Post Graduate Diploma or Degree	31	4.66	0.463	31	4.750
	Total	98	4.68	0.416	98	
Project Attributes	Diploma/Certificate or lower	37	4.31	0.574	37	4.333
	Bachelor Degree (s)	30	4.47	0.492	30	4.500
	Post Graduate Diploma or Degree	31	4.24	0.572	31	4.333
	Total	98	4.33	0.552	98	
Project Knowledge and Approach	Diploma/Certificate or lower	37	4.46	0.522	37	4.500
	Bachelor Degree (s)	30	4.42	0.539	30	4.375
	Post Graduate Diploma or Degree	31	4.34	0.481	31	4.500
	Total	98	4.41	0.512	98	

On table 59 below test for normality was conducted using Shapiro-Wilk test. For this test all these factors had a p-value of less than 0.005 and thus the hypothesis was accepted. This means all these variables were normally distributed.

Table 59: Test for Normality on rA5

Shapiro-Wilk				
rA5		Statistic	df	Sig. (p-value)
Medical Gases as Life Sup	Medical Gases Products Supplier	0.540	35	0.000
	Medical Gases product user (Hospital)	0.580	35	0.000
	Complimentary Service Providers	0.612	28	0.000
Safe Use of Medical Gases	Medical Gases Products Supplier	0.857	35	0.000
	Medical Gases product user (Hospital)	0.861	35	0.000
	Complimentary Service Providers	0.906	28	0.016
Variety of Product Offering	Medical Gases Products Supplier	0.728	35	0.000
	Medical Gases product user (Hospital)	0.801	35	0.000
	Complimentary Service Providers	0.851	28	0.001
Product Use	Medical Gases Products Supplier	0.905	35	0.005
	Medical Gases product user (Hospital)	0.888	35	0.002
	Complimentary Service Providers	0.869	28	0.002
Product Safety	Medical Gases Products Supplier	0.584	35	0.000
	Medical Gases product user (Hospital)	0.747	35	0.000
	Complimentary Service Providers	0.747	28	0.000
Product Quality	Medical Gases Products Supplier	0.759	35	0.000
	Medical Gases product user (Hospital)	0.788	35	0.000
	Complimentary Service Providers	0.843	28	0.001
Project Initiation	Medical Gases Products Supplier	0.752	35	0.000
	Medical Gases product user (Hospital)	0.730	35	0.000
	Complimentary Service Providers	0.813	28	0.000
Project Attributes	Medical Gases Products Supplier	0.887	35	0.002
	Medical Gases product user (Hospital)	0.862	35	0.000
	Complimentary Service Providers	0.917	28	0.029
Project Knowledge and Approach	Medical Gases Products Supplier	0.932	35	0.032
	Medical Gases product user (Hospital)	0.855	35	0.000
	Complimentary Service Providers	0.890	28	0.007

Post-Hoc Tests was performed to check if there were differences between Groups and where those differences could be. This was done through Bonferroni Adjustment / Correction to assist in identifying the possible differences. The following sequence was used to perform the test:

- Firstly a test of the smallest p-value against a significance level of 0.05 / 3 = 0.0167

- Secondly a test on the 2nd smallest p-value against a significance level of 0.05 / 2 = 0.025
- Lastly, a test on the largest p-value against a significance level of 0.05 / 1 = 0.05

5.8.4 Descriptive Results Analysis for rA5

Table 60 below gets the scores to work together instead of individual scores in order to get the overall scoring of the responses. The report will focus on the mean value and standard deviation of the response rate and is detailed as below:

- On Medical gas as a life supporting for product supplier of the medical gases, the mean value is 4.876 with a standard deviation is 0.244. On medical gases as a product user the mean value was 4.848 with a standard deviation of 0.295. On complimentary service providers the mean value is 4.857 with a standard deviation of 0.263. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents strongly agreed with this factor.
- On safe use of medical gases for product supplier of the medical gases, the mean value is 4.271 with a standard deviation is 0.573. On medical gases as a product user the mean value was 4.243 with a standard deviation of 0.711. On complimentary service providers the mean value is 3.902 with a standard deviation of 0.535. On all these factors the responses were between neutral and agree side of the scale, leaning more on the agree side of the scale which means the respondents agreed with this factor.
- On variety of product offering for product supplier of the medical gases, the mean value is 4.657 with a standard deviation is 0.416. On medical gases as a product user the mean value was 4.514 with a standard deviation of 0.562. On complimentary service providers the mean value is 4.393 with a standard deviation of 0.614. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On product use for product supplier of the medical gases, the mean value is 4.000 with a standard deviation is 0.664. On medical gases as a product user the mean value was 3.886 with a standard deviation of 0.665. On complimentary service providers the mean value is 3.589 with a standard deviation of 0.695. On all these factors the responses were between neutral and agree side of the scale, leaning more on the agree side of the scale, which means the respondents agreed with this factor.
- On product safety for product supplier of the medical gases, the mean value is 4.843 with a standard deviation is 0.291. On medical gases as a product user the mean value

was 4.657 with a standard deviation of 0.416. On complimentary service providers the mean value is 4.518 with a standard deviation of 0.673. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.

- Product quality for product supplier of the medical gases, the mean value is 4.657 with a standard deviation is 0.433. On medical gases as a product user the mean value was 4.471 with a standard deviation of 0.581. On complimentary service providers the mean value is 4.321 with a standard deviation of 0.530. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On project initiation for product supplier of the medical gases, the mean value is 4.750 with a standard deviation is 0.343. On medical gases as a product user the mean value was 4.657 with a standard deviation of 0.450. On complimentary service providers the mean value is 4.616 with a standard deviation of 0.454. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On projects attributes for product supplier of the medical gases, the mean value is 4.438 with a standard deviation is 0.477. On medical gases as a product user the mean value was 4.495 with a standard deviation of 0.446. On complimentary service providers the mean value is 4.000 with a standard deviation of 0.629. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.
- On project knowledge and approach for product supplier of the medical gases, the mean value is 4.314 with a standard deviation is 0.519. On medical gases as a product user the mean value was 4.521 with a standard deviation of 0.471. On complimentary service providers the mean value is 4.384 with a standard deviation of 0.542. On all these factors the responses were between agree and strongly agree side of the scale, which means the respondents agreed with this factor.

Table 60: Descriptive Results for rA5

rA5		N	Mean	Std. Deviation	Mean Rank	Median
Medical Gases as Life Supporting	Medical Gases Products Supplier	35	4.876	0.244	50.71	5.00
	Medical Gases product user (Hospital)	35	4.848	0.295	49.13	5.00
	Complimentary Service Providers	28	4.857	0.263	48.45	5.00
	Total	98				
Safe Use of Medical Gases	Medical Gases Products Supplier	35	4.271	0.573	54.09	4.500
	Medical Gases product user (Hospital)	35	4.243	0.711	52.71	4.000
	Complimentary Service Providers	28	3.982	0.535	39.75	4.000
	Total	98				
Variety of Product Offering	Medical Gases Products Supplier	35	4.657	0.416	54.81	5.000
	Medical Gases product user (Hospital)	35	4.514	0.562	49.04	4.500
	Complimentary Service Providers	28	4.393	0.614	43.43	4.500
	Total	98				
Product Use	Medical Gases Products Supplier	35	4.000	0.664	56.01	4.000
	Medical Gases product user (Hospital)	35	3.886	0.665	51.20	3.500
	Complimentary Service Providers	28	3.589	0.695	39.23	3.500
	Total	98				
Product Safety	Medical Gases Products Supplier	35	4.843	0.291	57.70	5.000
	Medical Gases product user (Hospital)	35	4.657	0.416	45.56	4.500
	Complimentary Service Providers	28	4.518	0.673	44.18	5.000
	Total	98				
Product Quality	Medical Gases Products Supplier	35	4.657	0.433	57.26	5.000
	Medical Gases product user (Hospital)	35	4.471	0.581	48.94	4.500
	Complimentary Service Providers	28	4.321	0.531	40.50	4.000
	Total	98				
Project Initiation	Medical Gases Products Supplier	35	4.750	0.343	52.71	5.000
	Medical Gases product user (Hospital)	35	4.657	0.450	49.40	5.000
	Complimentary Service Providers	28	4.616	0.454	45.61	4.750
	Total	98				

Project Attributes	Medical Gases Products Supplier	35	4.438	0.477	54.33	4.333
	Medical Gases product user (Hospital)	35	4.495	0.446	57.09	4.333
	Complimentary Service Providers	28	4.000	0.629	33.98	4.000
	Total	98				
Project Knowledge and Approach	Medical Gases Products Supplier	35	4.314	0.519	44.64	4.500
	Medical Gases product user (Hospital)	35	4.521	0.471	55.41	4.500
	Complimentary Service Providers	28	4.384	0.542	48.18	4.375
	Total	98				

CHAPTER 6: CONCLUSION

6.1 Summary of the Results

The developed scales for the specific factors of the questionnaire had items that were less than 10. This resulted to some of the Cronbach alpha values being less than the minimum recommended numerical value of 0.7. On the scales with this lower numerical Cronbach alpha value, a mean inter-item correlation test was performed. This test is another measure of testing reliability on the factors addressed by the questionnaire. Regardless of this test performed, there were some items that still remained to be weaker in the scale. This led to those items to be omitted completely in order to improve the reliability of the scale. In that case an item-total statistics test was performed and out of the test, a total item correlation value was taken which improved the reliability of the scale and as such the item accepted. Scales with fewer items are generally not reliability. The omitted items means would not form part of the standard template that is recommended for use in the sector.

On the original categorisation of the statements from the questionnaire, various statistical tests were performed on the SPSS analysis tool. These tests included factor analysis, reliability test, test for normality etc. in order to establish the un-biasedness of the research outcome. Following the first analysis of the results of the original data from the questionnaire, the questions were re-grouped. This was done to merge the items according to their similarity. The similarity was based on the underlying theme that was being addressed by the question. The regrouped questions were further tested for reliability as a secondary source of contribution to the study research questions and objectives. Subsequently, from the original categories, sub-themes were created in order to align each question with the scale to improve the reliability of the results. On the re-grouped questions, on section B1 and B2 of the questionnaire, the reporting was based on theoretical items. On section C of the questionnaire, reporting was based on empirical evidence.

It is against this background that the case study method was integrated into the study in order to bring new knowledge to the medical gases installation's sector through the project management principles. This new knowledge came through the identified key stakeholders in the sector through the completion of the questionnaire. This was done in order to gain insight to the sector, so that through their input, their views and opinions can be considered to contribute in the improvement of executing of medical gases projects in the sector.

A test for Hypothesis was conducted to determine whether there were differences between the groups coming out of the calculated scores. A check for comparison between groups was done to determine whether respondents have different views based on the outlined categories. Prior to conducting the hypothesis, a distribution test on each variable was performed and this was informed by the actual scoring per group.

On normal distributed items, a parametric test was used to check for comparison between the factors. On those factors that were not normal distributed due to the number of outliers in the distribution, a nonparametric test was used. A p-value test was used to interpret the factors based on the calculated value of the analysed results. The calculated p-value from the analysis results is tested against a 0.05 value which represents a 5 percent error significant margin. In the case where the p-value was bigger than the numerical value of 0.05 the hypothesis (not reject) was accepted and it resulted to normally distribution. This means there is difference on the responses. In the case where the p-value was less than the numerical value of 0.05, the hypothesis is rejected and the analysis is not normally distributed. This means there is difference in the responses and when it is less than 0.05 reject the hypothesis. Shapiro Wilk test was used as all the groups had less than 50 people.

On conducted test for normality on the factors, the majority of the factors had a p-value of less than 0.005 and the hypothesis was accepted. This means the factors were not normally distributed, as most responses were between agree and strongly agree section of the scale. This also means there were differences within the group and thus the hypothesis was accepted. With the exception of Senior/Executive management on project attributes which had a p-value of 0.09 which is greater than 0.05. On these, the hypothesis was accepted as there was no difference between the groups and as such was normally distributed. This also applied on project knowledge and approach as the senior/executive management had a p-value of 0.56. For these two factors the hypothesis was rejected as they were normally distributed.
The views were sought in order to enrich the study and assist the study to be able to identify practical gaps in the sector and provide appropriate recommendations. The primary data collection will be qualitative one in nature. To an extent, this will subject the response to subjective views of the respondents, in terms of their personal opinion of the medical gases and how they view the integration of project management doctrines to the installations. This is also being dependent on the respondents understanding of these project management principles and their experience in implementing them in projects of different nature.

The research provided an opportunity to allow the stakeholders that have an interaction with the medical gases to enhance the understanding of the project management concepts that are relevant to the sector. This was done by drawing out of the respondents specific views as far as their attitude and understanding of specific project management nodes that would contribute to the overall improvement and success rate of projects.

6.2 Results Outcomes in Relation to the Research Questions and Objectives

6.2.1 Views on Med Gas Products (Empirical)

On the factor addressing the general views about the medical gases products, responses on specific themes/questions of this factor demonstrated that a majority of respondents leaned more on the strongly agree side of the scale with a good spread of responses on the scale. This was both evident through the mean score and standard deviation values of the statistics analysis results. This was therefore in support of the hypothesis of the original factor. As an outcome of the analysis results, this factor is recommended for inclusion in the development of the standard template for projects tools on the sector.

Through this component of the questionnaire it addressed the part of the research objectives that were meant to seek “The general views and understanding of the role of the medical gases in the sector”. This section drew views form the key stakeholders that plays a critical role in the formation of the medical gases installations. These stakeholders range from the gas producers, the gas users, installers and consultants with the medical gases installations sector.

6.2.2 Application of Med Gases (Empirical)

On the factor addressing the application of medical gases within hospitals, responses on specific themes/questions of this factor demonstrated that a majority of respondents leaned more on the strongly agree side of the scale with a good spread of responses on the scale. This was both evident through the mean score and standard deviation values of the statistics analysis results. This was therefore in support of the hypothesis of the original factor. As an outcome of the analysis results, this factor is recommended for inclusion in the development of the standard template for projects tools on the sector.

6.2.3 Application of Project Management Principles (Empirical)

On the application of project management principles, responses on specific themes/questions of this factor demonstrated that a majority of respondents leaned more on the strongly agree side of the scale with a good spread of responses on the scale. This was both evident through the mean score and standard deviation values of the statistics analysis results. This was therefore in support of the hypothesis of the original factor. As an outcome of the analysis results, this factor is recommended for inclusion in the development of the standard template for projects tools on the sector.

These attributes on the questionnaire were specifically selected to ensure that they are narrowed down in order to be applicable to the medical gases sector.

The respondent's views from the questionnaire for medical gases from product safe use to installations meeting quality requirements were mainly in agreement with the spirit of the questionnaire. It became clear to note that medical gases as a product should be safe to use and an acceptable quality of the installations came out as important as important to the stakeholders. This strong agreement with the questions on the likert data scale of the questionnaire meant that the stakeholders agreed with the research hypothesis as it found expression in the questionnaire.

This section of the questionnaire assisted in formulating new knowledge with regards to how medical gases installation projects should be approached. This enriches the application of project management principles within the sector. As a result of the analysed data from the respondents, it assisted in addressing the following research objectives:

- The extent in which the application of project management principles is perceived within the medical gases application
- Whether it would be valuable to have specific project management methodologies followed to aid the execution of medical gases installations.
- Critical components of project management principles that can be applicable to the medical gases installations.

The results outcome from the analysed data further highlighted to define specific principles of project management that would be applicable to this sector. As a result of the respondents leaning more favourable to the strongly agree part of the questionnaire on most of the questions addressing project management principles, the research draws a conclusion that this principles addressed by the questionnaire are relevant and applicable to this sector.

The underlying spirit of this study was for the outcomes to contribute in the overall identification of appropriate principles of project management that can be used in the medical gases sector. The overall outcome of the results, with the exception of the omitted items on the themes/factors proved to be relevant to addressing and validating the relevance of the research objectives.

6.3 Recommendations

The overall outcome of the results on the themes/factors proved to meet the research objective. The sought views and opinions from the stakeholders led the research to recommend that the following principles should formulate the foundation of a standardised customer installations project format.

6.3.1 Section B - Medical Gases Products

Under General Views about Medical Gases Products, which was section B1 and B2 of the questionnaire, the analysis report was based on empirical reliability/scores of the items. Out of this reliability on B1, item B1.6 of the questionnaire was omitted due to its unsuitability to be grouped with the rest of the questions in this section. This led to the following themes to be recommended to be included as part of the proposed template:

- Medical Gas as Life Supporting
- Safe Use of Medical Gas
- Variety of Product Offering by medical gases suppliers

Under the section that was dealing with Opinion on Application of Medical Gases - All questions on these themes were acceptable with the exception of item 2.7. This item proved to be unsuitable as part of the standard template to be used in the sector. The research recommends that the following themes formulate the standard template and be part of the points that would link them with project management principles applicable to the sector. These themes are:

- Product Use (Medical Gases & Equipment)
- Product Safety (Medical Gases and Equipment)
- Product Quality - omitted question B2.7 which means the item did not fit with the rest of the items in this category.

Further research would be recommended in order to define how they can be integrated as a component of a project management structure in the medical gases sector.

6.3.2 Section C - Project Management

On the Application of Project Management principles in the Execution of Medical Gases Installations in Hospitals, the following themes were adopted for recommendation to the items that should be addressed by the proposed standard template. These project principles were identified as important to the medical gases installation sector.

- Project Initiation
- Project Attributes
- Project Approach and Knowledge - combined with to address a similar outcome.

These recommendations are done in order for the hospitals to be more efficient in its medical gases operations and increase project best practice approach. The efficient use of medical gases within the hospitals would contribute to cost containment and safety of patients. As such the project manager must manage the project in the most efficient and effective manner with respect to sustainability. This could be achieved by applying basic principles of project management in the overall planning, costing and execution of the installations projects.

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Annexure 1 - Research Questionnaire

FACULTY OF ENGINEERING AND THE BUILT ENVIRONMENT

May, 2017

Assistance in Research Study

Dear Sir/Madam,

I, Mr. Bangixhanti Gift Nyambe (student number 201235959), am registered for a Master of Philosophy, Engineering Management, at the University of Johannesburg, under the supervision of Professor Charles Mbohwa. I am writing to invite you to participate in my research project which is aimed to determine the importance of applying project management principles in the medical gases installations.

The title of my research project is: *"THE APPLICATION OF PROJECT MANAGEMENT METHODOLOGIES WOULD IMPROVE PROJECT SUCCESS ON CUSTOMER INSTALATIONS WITHIN THE MEDICAL GASES SECTOR".*

I kindly request that you complete the questionnaire and be assured that it remains anonymous.

Please note participation is voluntarily and you may withdraw from the research at any time.

Kindly return the completed questionnaire before the 15th of June 2017.

Yours sincerely

____

Nyambe Gift

083 992 2388

The Application of Project Management Methodologies would Improve Project Success on Customer Installations within Medical Gases Sector.

Section A: Background Information (Biographic)

1. Gender

Male	1☐
Female	2☐

2. Which of the following best describes your Occupational level?

Skilled/Semi-Skilled	1☐
Supervisor	2☐
Middle Management	3☐
Senior/Executive Management	4☐
Other (please specify)	5☐

3. How many years of experience do you have in the medical gases sector?

Less than 1 year	1☐
Between 1-2 years	2☐
Between 2-5 Years	3☐
Between 5-10 Years	4☐
More than 10 Years	5☐

4. What is your highest educational qualification?

Grade 12 or lower	1☐
Diploma/Certificate	2☐
Bachelor Degree (s)	3☐
Honors Degree / Post Graduate Diploma	4☐
Masters/PHD	5☐

5. Your Primary role with the Medical Gases Products or devices?

Medical Gases Products Supplier	1☐
Medical Gases product user (Hospital)	2☐
Medical Gases Installer	3☐
Medical Equipment/devices Supplier	4☐
Consulting company	5☐

Section B: Medical Gases Products

B1: Below are some statements that will measure your views about medical gases products. Please indicate your answer using the following 5-point scale, where:

1= Strongly Disagree

2=Disagree

3=Neutral

4=Agree

5=Strongly Agree

YOUR GENERAL VIEWS ABOUT MEDICAL GASES PRODUCTS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1.1 Medical gases products plays an important role in the hospital operations	1☐	2☐	3☐	4☐	5☐
1.2 Medical gases products sustain vulnerable lives	1☐	2☐	3☐	4☐	5☐
1.3 Medical gases products are regarded as life supporting	1☐	2☐	3☐	4☐	5☐
1.4 Registering medical gases products with the medicines control council ensures safe use of gases	1☐	2☐	3☐	4☐	5☐
1.5 Different countries have the same approach to the use of medical gases in hospitals	1☐	2☐	3☐	4☐	5☐
1.6 South African hospitals should not rely on one supplier of medical gases products	1☐	2☐	3☐	4☐	5☐
1.7 It is important for the hospital business that medical gas companies continually improve its product offering	1☐	2☐	3☐	4☐	5☐
1.8 Bringing in new medical device products would aid hospitals to be innovative	1☐	2☐	3☐	4☐	5☐

B2: Below are some statements that will measure your attitude towards the application of medical gases products. To what extent do you agree with the following statements?

YOUR OPINION ON APPLICATION OF MEDICAL GASES	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
2.1 Different countries have the same approach to the use of medical gases in hospitals	1☐	2☐	3☐	4☐	5☐
2.2 Using suitable qualified installers improves the safety of the installations for medical gases	1☐	2☐	3☐	4☐	5☐
2.3 Registering medical equipment as medical devices would compel suppliers to improve their product offering to hospitals	1☐	2☐	3☐	4☐	5☐
2.4 It is important for the hospitals' business that medical gas companies continually improve their product offering	1☐	2☐	3☐	4☐	5☐
2.5 Using medical equipment registered as medical devices increase safety of patients	1☐	2☐	3☐	4☐	5☐
2.6 Multinational companies investing in medical gases products bring in new technology that benefits hospitals' operations	1☐	2☐	3☐	4☐	5☐
2.7 Imported medical device technology by local firms improves the quality and reliability of the product	1☐	2☐	3☐	4☐	5☐

Section C: Project Management

Below are some statements to measure your views on the extent in which the application of Project Management Principles influences successful execution of medical gasses installations in hospitals.

APPLYING PROJECT MANAGEMENT IN THE EXECUTION OF MEDICAL GASES INSTALLATIONS IN HOSPITALS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1. Project Planning is critical in the successful execution of medical gases installations.	1☐	2☐	3☐	4☐	5☐
2. Accurate identification of project activities is important for successful project execution of medical gases installations.	1☐	2☐	3☐	4☐	5☐
3. Accurate project budgeting and cost estimation is important for project success.	1☐	2☐	3☐	4☐	5☐
4. Project scheduling plays an important role in the successful execution of projects.	1☐	2☐	3☐	4☐	5☐
5. Project process groups are aimed to guide the smooth execution of projects.	1☐	2☐	3☐	4☐	5☐

6. The basic purpose of initiating a project is to accomplish a specific organizational goal.	1☐	2☐	3☐	4☐	5☐
7. The temporal nature of projects influences project start and end dates.	1☐	2☐	3☐	4☐	5☐
8. Technical competency of the project manager contributes to the achievement of project success.	1☐	2☐	3☐	4☐	5☐
9. Attaining project management skills by hospital personnel would improve medical gas management in the hospitals.	1☐	2☐	3☐	4☐	5☐
10. Applying a systematic approach towards project management encourages the completion of projects on time	1☐	2☐	3☐	4☐	5☐
11. Applying a systematic approach towards project management supports the completion of projects within the budget	1☐	2☐	3☐	4☐	5☐