THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

By

RIAAN VAN WYK

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PROMOTER: Prof M.J. Labuschagne
CO–PROMOTER: Prof G. Joubert

DECLARATION

I, Riaan van Wyk, declare that the Philosophiae Doctor's research thesis that I herewith submit for Philosophiae Doctor in Health Professions Education at the University of the Free State, is my independent work and that I have not previously submitted it for qualification at another institution of higher education.

R van Wyk — **1 Feb 2021**

Date

I, Riaan van Wyk, declare that I am aware that the copyright is vested in the University of the Free State.

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Date

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TABLE OF CONTENTS

CHAPTER 5: RESULTS OF THE DELPHI SURVEY

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

LIST OF ACRONYMS

CPD	Continued Professional Development
CSSU	Clinical Simulation Unit
FoHS	Faculty of Health Sciences
HPS	Human Patient Simulators
HSREC	Health Sciences Research Ethics Committee
ISL	Immersive simulation-based learning
PC	Personal computer
SBHE	Simulation-Based Health Education
SoBMS	School of Biomedical Sciences
SP	Standardised patient(s)
UFS	University of the Free State
UPS	Uninterrupted power supply

CLARIFICATION OF CONCEPTS

Accredited

Refers to the educational programmes accredited by the South African professional councils of the various health education institutions. These councils are the Health Professions Council of South Africa (HPCSA), the South African Nursing Council (SANC) and the South African Pharmacy Council (SAPC) (HPCSA 2020:online; SANC 2020:online & SAPC 2020:online).

Fidelity

The level of realism of a simulation. Higher fidelity means a higher level of realism. The dimensions involved in fidelity are the physical factors, psychological factors, social factors, the culture of the group and the participants' modes of thinking (Lopreiato, Downing, Gammon, Lioce, Sittner, Slot & Spain 2016:11).

High-technology simulation

Simulation activities where there is student interaction with equipment that has software or firmware that can be pre-programmed or controlled by a student or operator (Lopreiato *et al,* 2016:39).

Integrated systems approach

Different interdependent elements (subsystems) integrated in such a way to move to a common purpose (Kapp, Simoes, DeBiasi & Kravet 2016:2).

***In situ* simulation**

A simulation in an authentic space (patient care environment), for example in an actual hospital (Kyle & Murray, 2008:565).

Lecturers and facilitators - another department

Lecturers and facilitators that are part of another department will be content experts in their particular field (or department) and will be used on an *ad hoc* basis for simulation activities within the department or simulation facility (Labuschagne 2012:35).

Lecturers and facilitators – stand-alone simulation facility

Lecturers and facilitators dedicated to a stand-alone simulation facility will be focused on simulation educational activities within the facility (Labuschagne 2012:35).

Public facilities

Public facilities refer to facilities at government funded, non-profit institutions (Cambridge Dictionary 2020:online).

Role

"The position or purpose that someone or something has in a situation, organization, society, or relationship" (Cambridge Dictionary 2020:online).

Simulation

The Society for Simulation in Healthcare (2017:online) defines simulation as follows: "Simulation is the imitation or representation of one act or system by another."

Simulation-based medical education

A training and feedback method where learners practise tasks and processes in lifelike circumstances using models or virtual reality, with feedback from observers, peers, actor-patients, and video cameras to assist improvement in skills (Eder-Van Hook 2004:4).

Sustainable

Long-term, ongoing financial support for staff, equipment maintenance and capital expenses (Calzada 2015:268).

SUMMARY

Key terms: simulation, clinical simulation, high-technology simulation, high-fidelity simulation, operational approach, systems, integrated approach, management, funding, staff, staff development, curriculum integration, simulation rooms, physical environment, research, health education, COVID-19, quantitative, questionnaire, Delphi, survey, challenges, recommendation, guidelines

Simulation-based health education is used as a training and feedback method, and its modalities can broadly be divided into two, namely low-technology and high-technology. Due to its higher complexity, high-technology simulation has some added challenges for implementation and day-to-day operations.

The aim of the study was to illustrate the role of and determine how to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa in order to ensure long-term success.

To achieve the aim of the study, a sequential approach was followed to pursue the objectives.

- The objectives were: To conceptualise the various operational subsystems of high-technology clinical simulation and determine the best practices and challenges to high-technology clinical simulation and this was achieved with a literature review.

- To establish the current operational approach to and challenges regarding high-technology clinical simulation experienced by the simulation facilities of South African public, accredited health professions training institutions.

- To reach consensus amongst simulation experts on best practices for a sustainable integrated systems approach to high-technology clinical simulation in South Africa.

- To explain and illustrate the integration of the operational subsystems with each other and to set out recommendations and guidelines needed to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa.

A quantitative descriptive study was performed. Data were collected using an online, web questionnaire (Education Survey Automation Suite (EvaSys)) with representatives of public, South African simulation facilities. Forty-two health professions training institutions, representing 12 health professions were identified and approached for the survey. The questionnaire was completed for 17 facilities, of which 14 utilised high-technology simulation. Challenges were identified through the quantitative data and comments in each subsystem across the facilities. The approaches followed by the facilities are in line with the recommended approach in the literature. The challenges faced by the facilities are typically the challenges described in the literature.

An electronic Delphi survey was also conducted with simulation experts. The data from the questionnaire survey were used to inform the Delphi survey. The Delphi survey was conducted with eight simulation experts over three rounds. Four hundred and one statements emerged from the Delphi survey, and on 230 (57.4%) of these, consensus was reached. The results from the questionnaire survey and the Delphi survey were used to identify challenges and provide recommendations to address these challenges. Guidelines were drafted to illustrate how the recommendations could be achieved, and how multiple subsystems overlap and are integrated with each other.

The conclusion was that high-technology simulation consists of various operational subsystems that integrate with each other to ensure long-term sustainability. These subsystems are management, funding, staff and staff development, curriculum integration, physical environment, and research. Utilising an integrated systems approach can lead to sustainable, high-technology simulation in South Africa.

THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

CHAPTER 1
ORIENTATION TO THE STUDY

1.1 INTRODUCTION

In this research project, a quantitative descriptive study was performed with the aim of illustrating the role of and determining how to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa.

The Cambridge Dictionary (2020:online) defines "**role"** as the position or purpose of "something" or "someone" in an organisation, situation, society or relationship. In this research project, the role refers to the positioning and purpose of different elements needed to achieve successful high-technology simulation. In an integrated systems approach, these different elements (subsystems) are interdependent and **integrated** in such a way to move to a common purpose (Kapp *et al,* 2016:2). The integration of subsystems should also be **sustainable** to ensure the long-term ongoing success of high-technology simulation. It refers to, amongst others, the ongoing financial support for staff, equipment maintenance and capital expenses (Calzada 2015:268).

To provide the necessary context, the researcher determined the current operational approach to and challenges experienced regarding high-technology clinical simulation by public, accredited South African simulation facilities. Public facilities refer to facilities at governmental, non-profit institutions, and exclude any privately owned, for-profit institutions. Accreditation in this context is the South African professional councils that accredit the educational programs of the various institutions. These councils are the Health Professions Council of South Africa (HPCSA), the South African Nursing Council (SANC) and the South African Pharmacy Council (SAPC) (HPCSA 2020:online; SANC 2020:online; SAPC 2020:online).

Operational activities are defined as activities involved in doing or producing something (Cambridge Dictionary 2020:online). A multi-method approach was used to determine whether the established best practices regarding high-technology simulation from the literature is indeed followed by facilities in South Africa. Another aspect included determining the challenges they face with regards to high-technology simulation. The methods used included a questionnaire survey together with the consensus of various simulation experts by means of a Delphi survey.

1.2 BACKGROUND TO THE RESEARCH PROBLEM

Simulation-Based Health Education (SBHE) is used as a training and feedback method (Eder-Van Hook 2004:4). The Society for Simulation in Healthcare (2017:online) adds that the four main purposes of healthcare simulations are education, assessment, research, and health system integration in facilitating patient safety.

Deliberate practice, where the student can return again and again to improve his/her proficiency, will eventually lead to mastery of learning and skills acquisition (Kim, Rattner & Srinivasan 2004:228). To facilitate deliberate practice and achieve mastery of learning, simulation education modalities can be utilised. These modalities can be broadly divided into two main groups, namely high-technology and low-technology simulation (Ziv 2009:217).

High-technology simulators consist of computer-based software programs that train, enhance and assess clinical knowledge and reasoning, cognitive knowledge, and decision-making skills (Østergaard & Dieckmann 2014:208). High-technology simulation modalities consist of flat-screen simulation, virtual and augmented reality, and Human Patient Simulators (HPS).

Penn State Hershey (2017:online) describes flat-screen simulation as cognitive simulators used to train didactic information or steps in procedural tasks without the physical performance of the task. An example of a flat-screen simulator is the Advanced Cardiovascular Life Support (ACLS) simulation from ANESoft©.

A clinical setting or procedure can be replicated with virtual reality simulators. An example where students can interact with a virtual environment or procedure is when using laparoscopic surgery trainers. Procedures or courses can be loaded and simulated with software and haptic (sense of touch) feedback, and the progress of the student will be monitored, and feedback provided by the simulator.

Augmented reality is when a headset, smartphone or tablet is used to overlay digital information over real-world objects. An example of augmented reality is the VimedixAR© system, which displays anatomy in real-time (CAE Healthcare 2017:online).

Human Patient Simulators (HPS) can be utilised to simulate various clinical conditions and are controlled by computer-based software. These simulators are also referred to as high-fidelity simulators or interactive patient simulators. They can be pre-programmed and controlled (wired or wireless) by an educator or technician. The advantage of an HPS is that it provides students with a computer-based simulated patient that breathes, responds to drugs, talks, and controls clinical monitors such as blood pressure and O_2 rates (Milkins, Moore & Spiteri 2014:29).

The second modality of simulators is low-technology simulators, and some examples include plastic manikins, simple skills trainers or part-task trainers (Weller, Nestel, Marshall, Brooks & Conn 2012:594). Standardised patients (SP) are actors or volunteers that can be trained to act as patients (Østergaard & Dieckmann 2014:208) to simulate a set of symptoms or problems used for healthcare education and evaluation (Lopreiato *et al,* 2016:32).

Simulators are not the only elements needed for the optimum operational functioning of a high-technology simulation facility. Palaganas, Maxworthy, Epps and Mancini (2015), Labuschagne (2012) and Kyle Jr and Murray (2008) identify additional operational subsystems needed for best practices in high-technology simulation to achieve optimum operational functioning (various authors added details on the different subsystems):

- Management

  The management subsystem includes elements such as the needs analysis, a mission and vision, as well as all pertinent documentation and governance including policies and procedures (Feaster & Calzada 2015:353; Dongilli, Shekhter & Gavilanes 2015:355; Kyle Jr & Murray 2008:25).
- Funding

  The subsystem related to funding includes the strategies to be used to fund the simulation activities, and include decisions on sustainable business model(s) (Bar-on, Yucha & Kinsy 2013:e532; Calzada 2015:268).
- Staff and staff development

  The staff and staff development subsystem relates to decisions on allocation, designation and training of high-technology staff members (HETI 2014:6; Thomas, Kern, Howard & Chen 2016:6; Canales & Huang 2015:584).
- Curriculum integration

  The subsystem concerned with curriculum integration relates to decisions and strategies on how to implement high-technology simulation in the existing curriculum (Gaba 2007:126; Ziv 2009:221; Jeffries 2005:97).
- Physical environment

  The physical environment subsystem relates to the layout of simulation rooms and equipment used for high-tech simulation activities (Labuschagne 2012:108; Seropian 2008:179; Milkins *et al.* 2014:22).
- Research

  The research subsystem relates to the decision on whether to utilise high-technology simulation only for teaching and learning, or for research purposes as well. In the case where research will be conducted as well, the type(s) of research activities that will be focused on, should be identified (White & Peterson 2015:604; Kardong-Edgren, Dieckmann & Phero 2015:615).

Even though the best practices are already well established, thorough planning and execution are not always done by simulation facilities (Calzada 2015:269). This is also evident from the challenges in using high-technology simulation as described by Al-Ghareeb and Cooper (2016:284).

1.3 PROBLEM STATEMENT AND RESEARCH QUESTION

High-technology simulators are sometimes obtained by training institutions without a clear goal or plan on how to use them optimally. There are, in some cases, no clear long-term strategic approach to implementing the high-technology simulation into the curriculum, nor how to support it in the institution (Labuschagne 2012:124, Calzada 2015:269). This thesis will attempt to determine the current operational approach and challenges of clinical simulation facilities in South Africa towards the use of high-technology clinical simulation. Phillips (2014:55) identifies technical and logistical issues (time in schedule and number of trained staff) as challenges of high-technology clinical simulation in South Africa. Labuschagne (2012:122) and Swart, Duys and Hauser (2019:12) re-iterated these challenges in South Africa, especially with regards to the cost of technical support and the lack of technical support staff in South Africa. Labuschagne, Nel, Nel and Van Zyl (2014:142) focus on the importance of utilising simulation to expand the teaching platform as student numbers increase. Due to the specific South African training platform, case mix and resources, the local operational approaches and challenges may differ from those established in developed countries.

From the background above the following research question was formulated:

How can a sustainable integrated systems approach to high-technology clinical simulation in South Africa be achieved?

1.4 OVERALL GOAL, AIM AND OBJECTIVES OF THE STUDY

1.4.1 Overall goal of the study

The overall goal of this study is to support and enhance high-technology clinical simulation in South Africa.

1.4.2 Aim of the study

The aim of the study is to illustrate the role of and determine how to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa in order to ensure long-term success.

1.4.3 Objectives of the study

To achieve the aim and address the research question of the study, a sequential approach was followed to pursue the objectives:

1. To conceptualise the various operational subsystems of high-technology clinical simulation and determine the best practices and challenges to high-technology clinical simulation (literature review).
2. To establish the current operational approach to and challenges regarding high-technology clinical simulation experienced by the simulation facilities of South African public, accredited health professions training institutions (questionnaire survey with health simulation facility representatives).
3. To reach consensus amongst simulation experts on best practices for a sustainable integrated systems approach to high-technology clinical simulation in South Africa (Delphi survey with South African and international simulation experts).
4. To explain and illustrate the integration of the operational subsystems with each other and to set out recommendations and guidelines needed to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa (by analysing and interpreting the results from 1, 2 and 3 above).

1.5 DOMAIN OF THE STUDY

The domain of the study is Health Professions Education and Clinical Simulation, with the focus on the use of high-technology clinical simulation in South African public, accredited health professions training institutions.

The researcher, is chief technical expert at the Clinical Simulation Unit (CSSU), School of Biomedical Sciences (SoBMS), Faculty of Health Sciences (FoHS), University of the Free State (UFS), and holds a master's degree in Health Professions Education (HPE). He became interested in the topic of this thesis after observing that operational elements with regard to high-technology simulation were still very challenging to most staff involved with it.

The study was conducted between September 2017 and July 2020, with the empirical research phase taking place between February 2018 and March 2020.

1.6 RESEARCH METHODOLOGY

1.6.1 Study design and methods of investigation

The research paradigm used for this study was post-positivism, as the researcher acted separately from the data (Creswell 2018:7). The research approach was deductive in nature as it would test the current theory (Trafford & Lesham 2010:97) of high-technology simulation against how it is implemented in South African public, accredited health professions training institutions.

Three methods were used to gather data, namely a literature review, a questionnaire survey and a Delphi survey.

According to De Vos, Strydom, Fouche & Delport (2011:134), the literature review is aimed at contributing a clearer understanding of the nature and meaning of the identified problem. A literature review was done to determine the best practices and challenges of high-technology clinical simulation education and training.

A questionnaire survey was conducted to gather data about the current operational approach to and challenges experienced by high-technology clinical simulation at South African public, accredited health professions training institutions. The survey was quantitative in nature, and some open-ended questions allowed for qualitative answers. These questions were however coded into themes and analysed quantitatively (Mouton 2001:108).

A Delphi survey was conducted amongst simulation experts to determine the best practices regarding high-technology clinical simulation in South Africa.

The research methodology will be discussed in detail in Chapter 3.

1.6.2 Schematic overview of the study

Figure 1.1 is a schematic overview of the study

Preliminary literature study
Protocol
Evaluation Committee
Health Sciences Research Ethics Committee (HSREC)
Approval: Vice-rector: Academic
Approval: Dean: Health Sciences
Extensive literature study
Pilot study: questionnaire survey
Conduct questionnaire survey
Data analysis of questionnaire survey and discussion
Use questionnaire survey results to inform Delphi survey
Delphi survey: three rounds with data analysis after each round
Illustrate the role of a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa
Finalisation of the thesis

Figure 1.1: Schematic overview of the study

1.7 ARRANGEMENT OF THE THESIS

Reporting on the topic, the methods used and the results of the study will be arranged as follows:

In this chapter, ***Chapter 1: Orientation to the study***, the background to the study was provided as well as the problem statement and research question. The overall goal, aim and objectives were also stated. The domain of the study were defined. The research design was provided, with a full explanation following in Chapter 3.

In ***Chapter 2: The contextualisation of high-technology simulation-based clinical education,*** the contextualisation of the operational subsystems of high-technology simulation will be discussed. This chapter serves as the theoretical framework of the study. The discussion focuses on six operational subsystems regarding best practices of high-technology simulation in South Africa.

Chapter 3: Research Methodology is the detailed description of the research design and methodology.

Chapter 4: Results of the questionnaire survey encompasses the presentation of the results of the questionnaire survey.

Chapter 5: Results of the Delphi survey encompasses the presentation of the results of the Delphi survey.

In ***Chapter 6: High-technology clinical simulation in South Africa: The role of a sustainable integrated systems approach and achieving it,*** the results of the questionnaire survey and Delphi survey will be discussed against the background of the literature review. The aim of the discussion is to illustrate and explain the subsystems and their inter-relationship to each other, and to set out recommendations and guidelines needed to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa

In ***Chapter 7: Overview, conclusions and contributions of the study*** an overview of the study will be provided.

1.8 CONCLUSION

Chapter 1 provided the introduction, overview and background to the research problem. In the next chapter, ***Chapter 2: The contextualisation of high-technology simulation-based clinical education***, the contextualisation of the operational subsystems of high-technology simulation will be discussed, which will serve as the theoretical framework of the study.

CHAPTER 2

THE CONTEXTUALISATION OF THE OPERATIONAL SUBSYSTEMS IN HIGH-TECHNOLOGY SIMULATION-BASED CLINICAL EDUCATION

2.1 INTRODUCTION

Simulation in its broadest sense is “an imitation of some real thing, state of affairs, or process” (Rosen 2008:157). Simulation-Based Health Education (SBHE) can be defined as “a training and feedback method where learners practise tasks and processes in lifelike circumstances using models or virtual reality, with feedback from observers, peers, actor-patients, and video cameras to assist improvement in skills” (Eder-Van Hook 2004:4).

Simulation-based education utilises different modalities for education, and according to Ziv (2009:217), these modalities can be divided into two main groups, namely high-technology simulation, and low-technology simulation. Huang, Rice, Spain and Palagas (2015:xxviii) define low-technology simulation as the use of modalities that are not computerised or electronic, and are not controlled or programmed by someone external to the learner. Both low- and high-technology simulation modalities can be used by learners to facilitate deliberate practice and to achieve mastery of learning (Ziv 2009:217). Deliberate practice is defined as: “A systematically designed activity that has been created specifically to improve an individual’s performance in a given domain” (Ericsson, Krampe & Tesch-Römer 1993). Deliberate practice allows students to practise procedures or certain steps of a procedure until they have mastered the skill (Kim *et al.* 2004:228). Mastery of Learning is defined as: “An instructional philosophy that highlights individualised feedback and adequate time, allowing the learner to progress through the subject in a customised manner, generally in smaller units, to master the subject matter.” This philosophy states that nearly all learners can achieve subject or skill mastery utilising this method (Palaganas *et al.* 2015).

This chapter gives an overview of high-technology simulation, the South African perspective and the integrated systems approach. It also describes the operational subsystems and operational challenges of high-technology simulation.

2.1.1 High-technology simulation

High-technology simulation refers to using some form of a high-technology simulator(s) during a simulation experience (Østergaard & Dieckmann 2014:208). These simulators are computerised in some form and program-controlled by someone external to the learner (Huang *et al*. 2015: xxvii). Examples of high-technology simulators include Human Patient Simulators (HPS) or realistic patient simulators (Milkins *et al*. 2014:29), a flat-screen simulation which is not a manikin but a program running on a personal computer (PC), smartphone or tablet to train didactic information (Penn State Hershey 2017:online).

Another example is augmented reality, where a digital overlay over real-world objects is created (CAE Healthcare 2017:online), and virtual reality, where a headset is used to create a digital environment and scenario. Students can interact with this virtual procedure. An example is laparoscopic surgery trainers, where an exercise or procedure is loaded by the student and practised. A student's ability and progress will be automatically monitored, and feedback will be given by the software (Surgical Science 2018:Online).

Online virtual simulation is also possible. A virtual patient or scenario is presented to the students, which can be accessed remotely through a web browser. Students can participate in managing a virtual patient and thus increase their knowledge retention and clinical reasoning (Padilha, Machado, Ribeiro, Ramos & Costa 2019:2).

2.1.2 South African perspective

Research has been published on the application of high-technology clinical simulation as a training tool for specific clinical scenarios in South Africa as illustrated in articles by Swart *et al.* (2019:12), Labuschagne (2013:147), Botma (2014:1) and Nel and Stellenberg (2015:176). However, little has been published on the operational approach and challenges when creating and running a high-technology clinical simulation facility in South Africa. Swart *et al.* (2019:17) state that financial constraints to obtain simulators, and a lack of dedicated simulation technicians, trained educators, and time in the programme for simulation activities are the major barriers for simulation implementation. The importance of utilising simulation to expand the teaching platform as student numbers increase in South Africa is the focus of the research by Labuschagne *et al.* (2014:142). Phillips (2014:55) concludes that the high human and financial investment of a simulation facility in South Africa should mandate effective utilisation of the facility.

2.1.3 Sustainability and integrated systems approach

Sustainability refers to the quality of being able to endure over a period of time (Cambridge Dictionary 2020:online), and in the context of high-technology simulation, sustainability refers to, amongst others, financial support for staff, equipment maintenance and capital expenses to ensure its long-term, ongoing success (Calzada 2015:268).

Apart from the actual simulators, other operational subsystems are needed for best practices to achieving the optimum operational functioning in high-technology simulation. Palaganas *et al*. (2015), Labuschagne (2012) and Kyle Jr and Murray (2008) identify these additional subsystems as management, funding, staffing and staff development, curriculum integration, physical environment considerations and research outputs. Huang and Dongili (2016:29) state that the core of simulation facilities are their people, processes and products.

These different operational subsystems interact with each other, and continually affect each other and operate as a whole to move to a common purpose (Kapp *et al,* 2016:2). Meadows (in Kapp *et al.* 2016:1) adds that changing the relationships between subsystems usually changes the overall system behaviour. A framework for the literature study is represented in Figure 2.1.

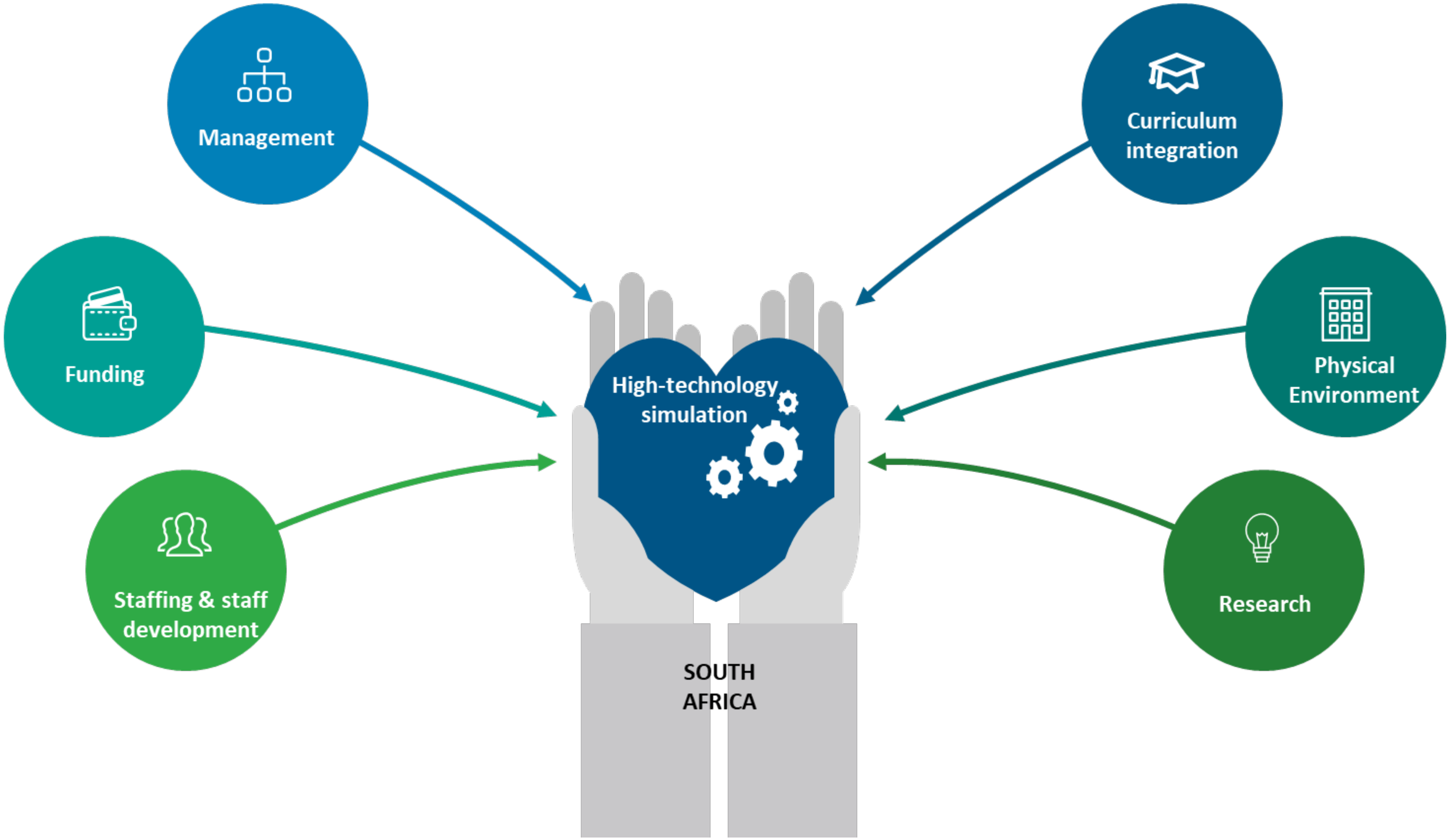

Figure 2.1: Framework for the literature study

2.2. MANAGEMENT OF HIGH-TECHNOLOGY SIMULATION

The management subsystem refers to the strategic and operational planning that should be in place. David and David (2017:33) define strategic planning as: “The formulation, implementation and evaluation of cross-functional decisions to enable an organisation to gain and sustain a competitive advantage.” Terwindt and Rajan (2016:9) state that strategic management should translate the vision, objectives and priorities of the leadership into robust documents that ensure successful implementation of activities, as well as the efficiency and sustainability of activities.

According to Calzada (2015:269), healthcare simulation is currently experiencing an international rise in usage, but thorough planning is not always done. An accepted mission, vision and supporting documents are essential for the successful implementation and running of a simulation facility (Calzada 2015:269).

2.2.1 Strategic plan

A strategic plan can also be defined as how the highest-level goal of the organisation will be achieved (Allison & Kaye 2015:5). Barry (2007:99) defines a strategic plan as a process of determining what the organisation should accomplish and how and which resources should be directed towards accomplishing those goals. Johnson and Augustson (2015:366) state that a strategic plan for a simulation facility should include the mission statement, goals and strategies, the vision and performance indicators (Figure 2.2).

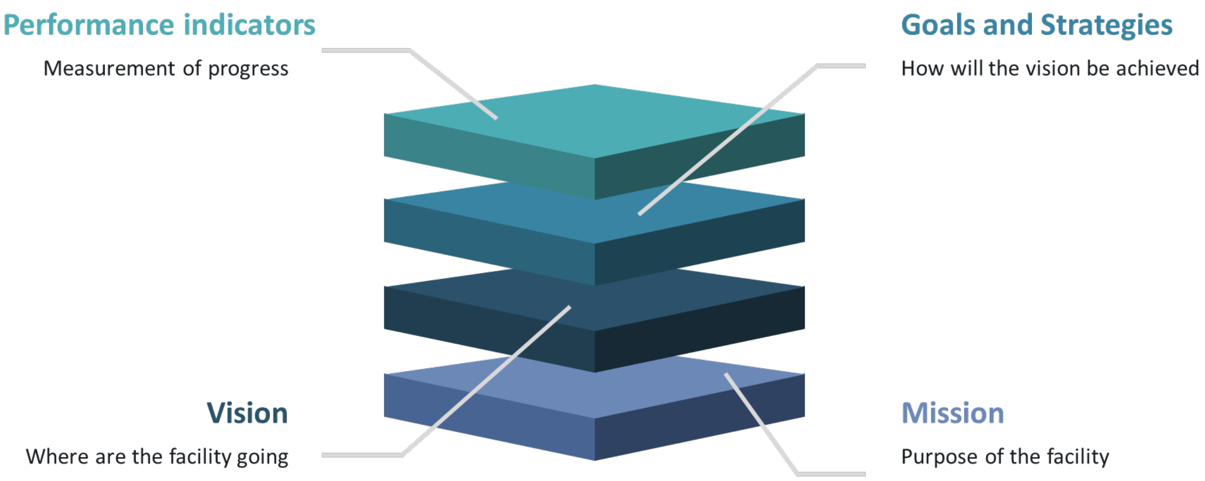

Figure 2.2: Contents of strategic plan (adapted from Johnson and Augustson 2015)

A mission statement should summarise the purpose of an organisation (Johnson & Augustson 2015:366), and becomes a good starting point for the Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis to follow (Gantt 2010:310). An example of a mission statement is: *"The mission of the Clinical Simulation Center is to improve patient outcomes with effective programs that promote and enhance practitioner skills, clinical competence, teamwork, and interdisciplinary collaboration"* (Penn State Hershey 2020:online).

The vision statement should be forward-thinking - what should be achieved in the future (Crelinsten 2019:801) - and should indicate where an organisation or program sees itself in the future (Johnson & Augustson 2015:366). An example of a vision statement is: "*Our vision is to fully integrate clinical simulation as a transformative learning strategy that ensures patient safety and facilitates optimum patient outcomes*" (University of Maryland, School of Nursing 2020:online).

Goals refer to the priorities that an organisation sets itself in order to achieve the mission and vision across different themes, and strategise the way that this will be achieved (Johnson & Augustson 2015:367). These should be realistic and within the organisation's capacity (INACSL Standards Committee 2017:682). An example of goals across different themes can be illustrated by the goals set by the Center for Immersive and Simulation-based Learning at the Stanford School of Medicine (Stanford School of Medicine 2020:online) listed in Table 2.1.

Table 2.1: Strategic goals of the Center for Immersive and Simulation-based Learning (Stanford School of Medicine 2020:online)

Theme:	Goal:
Education and Training of Students and Clinical Trainees	Improve the education and training of Stanford students (undergraduate, medical and graduate) and Medical Center trainees (residents, clinical fellows and postdoctoral scholars) using Immersive Simulation-based Learning (ISL).
Healthcare Systems Improvement	Improve care delivery and operational outcomes throughout Stanford Medicine, Stanford Health Care, Stanford Children's Health, the VA Palo Alto, and Stanford University Medical Indemnity and Trust Insurance Company (SUMIT) by improving the individual and teamwork skills of healthcare personnel.
Assessment/Testing	Use ISL techniques for explicit assessment/testing of skills, knowledge, and performance of students, trainees, and experienced personnel.
Research	Promote, support and conduct fundamental research and evaluation about ISL and to use the ISL techniques as a research tool.
Provide Immersive Learning to External Experienced Clinicians	Improve the clinical skills (both "technical" and "non-technical") of healthcare personnel, as individuals and in teams, through ISL.
Community Outreach	Develop and conduct outreach programs for local community and lay groups, as well as public safety and public health organisations, and healthcare providers, exposing them to the benefits and potential of ISL.
Leadership and Advocacy	Provide leadership in advocating the future vision of immersive and simulation-based learning in healthcare for the nation and the world.

Table 2.1: Strategic goals of the Center for Immersive and Simulation-based Learning (Stanford School of Medicine 2020:online) (continued)

Theme:	Goal:
Faculty Development	Recruit, train and sustain faculty to become effective ISL educators.
Management	Create management infrastructure and procedures that effectively coordinate and integrate the Center's priorities, activities and resources among its constituent units and within the School and University.

To measure the success of the achieved progress, performance indicators linked to each goal should be used (Olsen 2011), and can be focused on quality, efficiency, or be project-based (Johnson & Augustson 2015:368).

2.2.2 Needs and SWOT analysis

When moving forward with a strategic plan, a needs analysis is crucial in order to ascertain the goals and strategies that should be pursued (Kim, Hewitt, Buis & Ross 2015:84). Table 2.2 lists the questions that should be asked during a needs analysis related to a simulation facility. This will ensure that financial resources are spent on the correct assets for optimal return on investment (Feaster & Calzada, 2015:353).

Table 2.2: Questions to ask during the needs analysis (Feaster & Calzada, 2015:348)

Question:	Considerations:
Who?	Learners Customers Stakeholders Vendors
What?	Education Training Assessment Certification

Table 2.2: Questions to ask during the needs analysis (Feaster & Calzada, 2015:348) (continued)

Question:	Considerations:
When?	Hours of support Weekends Evenings
Where?	Stand-alone centre Part of the healthcare facility *In situ* simulation
Why?	Learners' training and assessment Certification Generating third stream revenue Education for health facility Team training
How?	Funding source Financial management

A SWOT analysis is a tool to compare the organisation to others using a list of strengths (S), weaknesses (W), opportunities (O), and threats (T) (Teoli & An 2019). It is an important tool to identify organisational (internal) and environmental (external) factors (Gürel 2017:995). According to Johnson and Augustson (2015: 370), this analysis should be used to identify positives and negatives, with strengths and weaknesses being internal to the simulation facility, and opportunities and threats being external aspects. The elements of a SWOT analysis are presented in Figure 2.3.

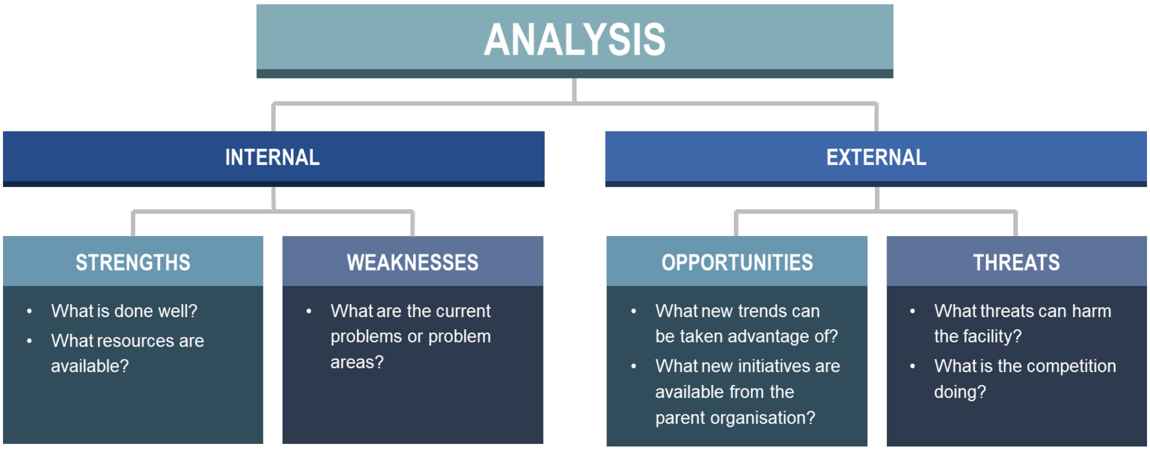

Figure 2.3: Elements of a SWOT analysis (adapted from Gürel 2017 and Johnson & Augustson 2015)

2.2.3 Positioning of simulation facility within a larger organisation

Typically, high-technology simulation will occur within an educational environment or organisation (Lewandowski 2008:477). Based on the strategic plan, needs analysis and SWOT analysis, a simulation unit can be a stand-alone unit, a sub-division of a department, or based on-site (*in situ*) (Bajaj, Meguerdichian, Pohlman, & Walker 2018:113). Peets and Ayas (2013:530) state that an advantage of a stand-alone unit is the centralisation of resources. Furthermore, if such a stand-alone unit is situated in a clinical (*in situ)* setting, the *in situ* simulation will have a higher level of fidelity or realism.

2.2.4 Operational policies and procedures

Operational planning is used to achieve the strategic vision, goals and objectives, and is typically focused on the short term, dealing with the day-to-day implementation (Shuey, Bigdeli, & Rajan 2016:1).

Policies and procedures should be in place to ensure stability and consistency, and will serve as a basis for future growth and expansion (Cox & Acree 2008:25). According to Dongilli *et al*. (2015:355), a policy contains the rules that govern the operations of an organisation, while procedures are the operational processes. As simulation facilities might exist within a larger organisation such as a university or medical school, it is important that the simulation facility's policies are aligned with organisational policies (Dongilli *et al*. 2015:355).

2.3 FUNDING OF HIGH-TECHNOLOGY SIMULATION

High-technology simulation facilities can be expensive to start and run, as equipment, maintenance of equipment and staff costs might be high (Calzada 2015:268). Funding is a critical element to run a successful high-technology simulation facility (Bar-on *et al.* 2013:e532).

2.3.1 Funding models

Calzada (2015:268) proposes two business models in approaching funding for a simulation facility. The first is solely internal funding from the institution, as training by the simulation facility will be for the institution's own learners. This internal funding should be high enough to cover not only initial setup costs but also day-to-day operational costs. These operational costs include expenses such as staffing salaries, supplies, and maintenance needs. Provision should also be made for growth and changes in the programme to accommodate new equipment. For sustained funding, a facility should demonstrate its continued success (CAE Healthcare 2013:online). An advantage of having institutional funding is that it relieves the financial pressure on a facility and its management, freeing it up to focus on the teaching and learning activities. A potential disadvantage can be that internal institution funding is only guaranteed for internal training, and when an external partnership presents itself, a facility might not be allowed to pursue it (Calzada 2015:271).

The second is being solely or partially funded by external sources. This is typically generated from continued professional development (CPD) courses for private individuals or organisations, and these courses can either be non-certified or certified courses (Calzada 2015:277). An advantage of this approach could be that courses that are well marketed and advertised, especially at a facility with an established reputation, could be well attended, and for certified CPD courses the income can also be higher (Calzada 2015:277). Disadvantages of external funding could be a lack of focus on the institution's core mission (Denning, Jewett Johnson, Johnson, Loen, Patow & Brannen 2008:341). The costs to the facility's resources (staff time, wear and tear on equipment and increased maintenance) to host these courses could result in high prices for the courses that might discourage individuals from attending.

A combination of the two approaches can be followed, called a hybrid funding model, where a simulation facility has multiple sources of income. This ensures diversity in funding sources, but could however lead to conflicts regarding who has priority access rights to the facility (Calzada & Leland 2019:63), and a lack of focus on what/who the primary customer is (Denning *et al.* 2008:341).

Another proposed model to reduce costs and increase revenue is the consortium model (or collaborative model), where different simulation facilities can combine resources by establishing an academia-service partnership. This could lead to shared resources and reduced costs. Some of the challenges with this model is that there might not be a well-defined, common framework for training students, scheduling conflicts may develop, and different expectations could exist between the members (Jeffries & Battin 2012:6). Although these facilities reside in different organisations, they typically have a common mission and seek to gain benefits difficult or impossible to achieve separately (Maxworthy & Waxman 2015:424).

2.3.2 Creating a fee structure

To create a fee structure, Jamal, Wallin and Arnold (2015: 293) propose a five-phased approach (Figure 2.4). The five phases are the evaluation of current operations, the understanding of the broader environment within which it operates, deciding on a strategic approach to pricing, and generating the financial model. This will lead to the finalisation of the analysis and fee structure.

Figure 2.4 visually represents this process. Information from all four initial phases are used to inform the final decision. Information can flow in both directions between each phase to inform the decisions made at each phase (Jamal *et al.* 2015: 299).

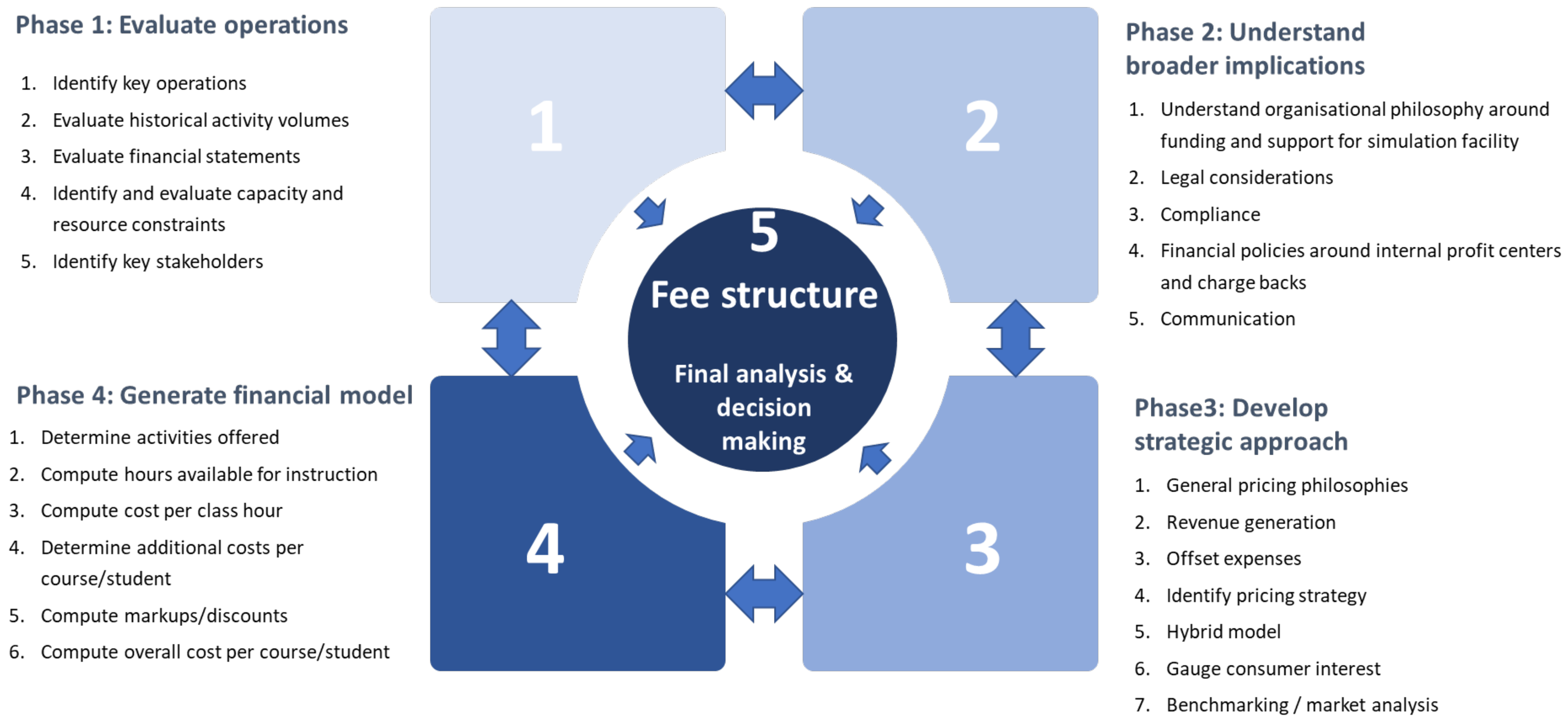

Figure 2.4: Five phased approach to creating a fee structure (adapted from Jamal *et al.* 2015)

Confirmed, long-term revenue sources are vital for the continued sustainability of a simulation facility (Barrott, Sunderland, Micklin & Smith 2013:174; CAE Healthcare 2013:online). Financial planning is essential for sustainability as the long-term operational cost might be more expensive than the initial setup (Sekandarpoor, Luevano & Crawford 2019:135).

2.4 STAFFING AND STAFF DEVELOPMENT FOR HIGH-TECHNOLOGY SIMULATION

According to Andreatta (2019:47), simulation facilities, irrespective of size, need at least three staff roles. These are executive administration, educational assistance and technical operations. Depending on the size of a facility, these designations, might be further divided into more functions. An example is that the technical operations role could be further divided into the roles of technical co-ordinator, technologist and technician.

The executive administration is responsible for the management of the facility, and typically includes designations such as the head, director of a facility, or a similarly named designation. Management tasks typically constitute the financial and strategic decisions and communication, and liaise with other stakeholders. Although not part of the facility's staff, an institution can also have a simulation steering committee that oversees and guides strategic, financial, staffing and programme-related decisions, and ensures that the needs of all relevant stakeholders are addressed (Andreatta 2019:49).

The educational assistance includes designations such as facilitator, debriefing facilitator, and content expert. These staff members are responsible for the educational content, alignment and execution of the simulation programme and activities (Andreatta 2019:50).

Technical operations refer to designations such as operations director, operational and technical support, information technologist and simulation technologist. Depending on the size of a facility, some of these designations might be combined or even more diversified. The responsibilities of the technical operations staff are to ensure the day-to-day operations of a facility. They are involved in the technical programming of simulations, the maintenance of equipment and general coordination of activities (Andreatta 2019:50). Labuschagne (2012:243) proposes that the educational assistance be performed by lecturers (subject matter experts) who are not directly situated in the simulation facility, but who utilise it from their respective departments on an *ad hoc* basis.

Canales and Huang (2015:584) state that people are the greatest resource of a simulation program, but may also be the greatest barrier to a successful simulation scenario. One of the main reasons for this is the lack of training for staff, educators, and simulated patients. Staff and educators who are unavailable, sick or late can also be a barrier to effective simulation, according to Canales and Huang (205:243).

2.4.1 Staff development regarding technical aspects

With high-technology simulation being logically reliant on the use of computer hardware and software, it is important that skilled technical staff are part of a simulation team. These technical staff members should also understand and be trained in the clinical and educational components of simulation (Zigmont, Oocumma, Szyld & Maestre 2015:555).

The Health Education and Training Institute (HETI) (2014:6) conducted a survey on the training needs of simulation professionals in New South Wales, Australia. The top two activities identified were the development of simulation scenarios and the use of manikin simulators. The skills identified by HETI that needed the most training was the use of computer-based simulation. Koh and Dong (2018:190) describe the situation where simulation facilities struggle with a high turn-over rate of simulation technicians in Southeast Asia. This is mainly because there are very little career path possibilities, and it is not a recognised specialist role. This turn-over of simulation technicians has a negative effect on the facility and staff, which in some cases may lead to the postponement of simulation experiences. This was addressed by creating a simulation technician/specialist development programme to train newly hired technicians.

When creating a training program for simulation staff, it is important to follow standard curriculum design principles (Zigmont *et al*. 2015:547). Thomas *et al*. (2016:6) outline six steps, all integrated, to curriculum design. The six steps are:

1. Problem identification and general needs assessment.
2. Targeted needs assessment.
3. Setting goals and objectives.
4. Deciding on education strategies.
5. Implementation.
6. Evaluation and feedback.

Koh and Dong (2019:194) state that the development of competent simulation technicians, with scope for further professional development, is essential for uninterrupted and successful simulation operations.

2.5 CURRICULUM INTEGRATION OF HIGH-TECHNOLOGY SIMULATION

For sustained and goal-directed usage of simulation, it is important to determine which elements of a curriculum could be enhanced by using simulation. This approach leads to better resource planning. It also allows for review of how a curriculum is administered and which modalities are available to achieve learning objectives (Motola, Devine, Chung, Sullivan & Issenberg 2013:e1512).

Resistance to change can occur when integrating simulation training into a health education programme for the first time. Awareness and the management of this resistance should not be neglected. It should be kept in mind that simulation is, in fact, not a technology, but an educational technique (Gaba 2007:126). The same principles that apply for simulation apply for high-technology clinical simulation.

2.5.1 Simulation principles and models

One approach for delivering skills training, as set out by Walker and Peyton (1998:175), is called “Peyton’s four-step approach”. The four steps are:

1. Demonstration – A demonstration by the teacher takes place without any narration or explanation.
2. Deconstruction – The procedure is repeated by the teacher, adding all the needed narration and explanation.
3. Comprehension – The student explains each step while the teacher follows the student’s instruction.
4. Performance – The student performs the skill on their own.

George and Doto (2001:77) amended these steps and added a fifth step at the start, where the teacher explains the importance of the skill and contextualise it to the students. This step is called the “Overview”.

Jeffries (2005:97) developed a model for simulation (Figure 2.5) to demonstrate the relationships and interactions between the relevant factors (students, teachers, educational practices, simulation design and outcomes) and processes when developing simulation experiences. Because simulation is student-centred and not teacher-centred, a large part of the success or failure of a simulation experience will depend on the students taking responsibility for their training. Setting out the ground rules and expectations for an activity, will ease the acceptance of the students and lead to greater success of the simulation experience (Jeffries 2005:97).

For successful integration of simulation into a curriculum the simulation design should be done with the learning objectives in mind. These objectives will guide how complex a simulation experience will be, as well what needs to be added for increased realism or fidelity. The debriefing should allow for reflective learning where the students can link theory to practice (Jeffries 2005:100).

The role of the teacher will depend on the type of activity. For teaching and learning, it will be a facilitator role, and for assessment it will be an observer. Staff development should allow for teachers to feel comfortable in their roles during a simulation experience (Jeffries 2005:98).

Active learning is the act of learning where students are directly involved in a hands-on capacity of a topic and receive immediate feedback. Student and teacher interaction is more prevalent, as simulation facilitates more interaction between students and teachers. Collaborative learning is also more prevalent as the group of students experience shared decision-making and teamwork to achieve a goal (Jeffries 2005:98).

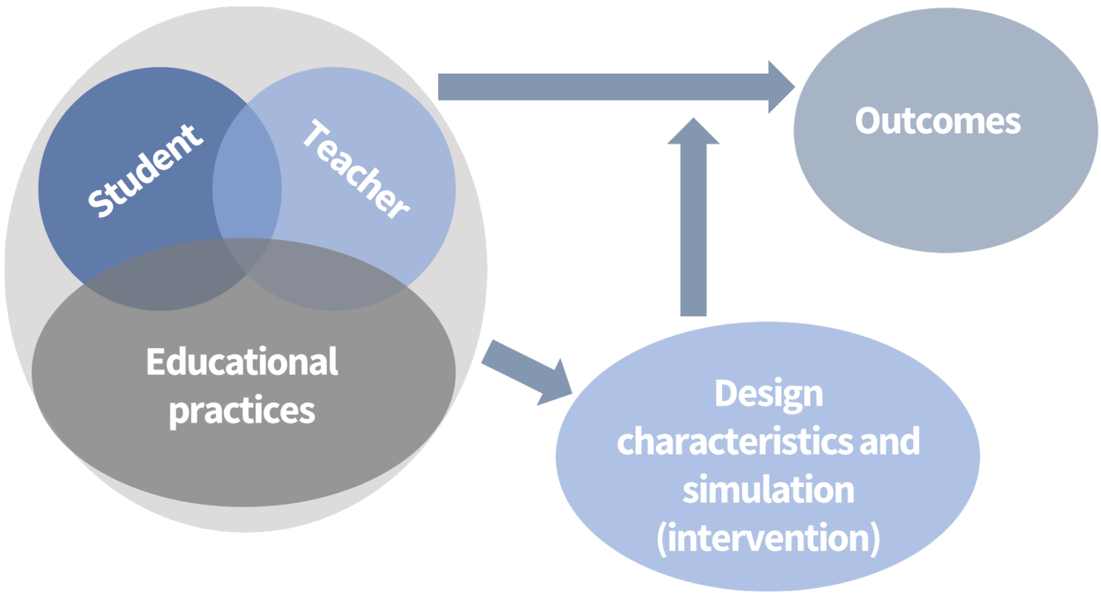

Figure 2.5: Jeffries' simulation model (adapted from Jeffries 2005)

Learning theories inform the design of a simulation experience and should be seen as guides rather than being prescriptive. Behaviourism can broadly be defined as learning that focuses on achieving a certain standard through demonstrated behaviours. In simulation-based education, behaviourism can be used where skills need to be demonstrated without much thinking about it, such as psychomotor skills in suturing. Deliberate practice, which is focused, repetitive practice, draws from behaviourism and is an important aspect of simulation and skills education (Bearman, Nestle & McNaughton 2018:9).

Constructivist theories can be defined as those theories that recognise the role of the learner to construct their own meaning from experiences. This includes cognitive constructivism (their learning experiences, knowledge and learning styles) and social constructivism (how their meaning derives from social encounters) (Bearman *et al.* 2018:11). When designing a simulation experience, the students' prior knowledge should be considered, and the new knowledge or skills scaffolded as the next step. Care should be taken not to overload students with too much new information or expectations, but rather to gradually scaffold the experiences towards more and more complex outcomes (Reedy 2015:355). The learning experience should be an up-and-down spiral movement between theory, simulation and clinical training, increasing in complexity (scaffolding) as the student becomes more competent, as illustrated in Figure 2.6 (Labuschagne 2012:20). The principles of blended learning where online instruction (theory overview) and face-to-face learning (simulation activity and clinical training) (Hrastinski 2019:564) take place, can be utilised for simulation experiences.

Although simulation can be used to achieve the knowledge and skills performance outcomes of a particular session, it can also lead to increased critical thinking by the students as well as an increase in their self-confidence (Jeffries 2005:102). Flores, Bez, Respício and Fonseca (2012:59) state that simulation can also contribute to the students' decision making and reasoning skills.

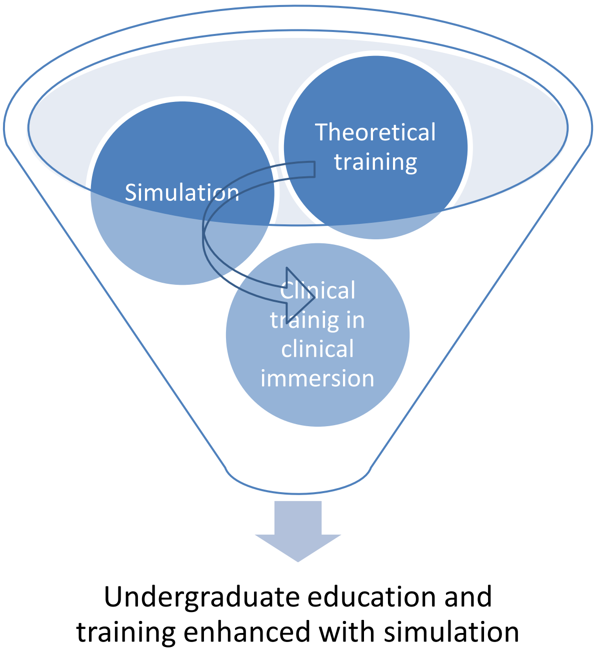

Figure 2.6: Spiral movement between theory, simulation, and clinical training (adapted from Labuschagne 2010)

The effective integration of simulation, which consists of the simulation experience and debriefing, can also lead to better training of professional attributes in a safe environment. These attributes include, among others, interprofessional collaboration, professionalism, communication and leadership (Labuschagne *et al*. 2014:140).

According to Steadman, Rudolph, Myo-Bui and Matevosian (2013:136), simulation is suitable to be used for either formative or summative assessment. It is important, however, to consider that with the use of a high-technology simulator for assessment, the students must be familiar with the technology and must have used it during the teaching and learning phase (Van Wyk 2016:88).

2.5.2 Practical considerations when using high-technology simulation in a curriculum

Van Wyk (2016:90) states that specific aspects should be taken into account when considering the use of simulation to enhance a particular part of a module. These are:

- Whether simulation is applicable to address the content.
- Whether the students' background level of the theory is adequate.
- Whether there are ethical benefits to the students and patients.
- Whether there are staff resource and financial costs.
- Whether staff have adequate training in simulation facilitation and debriefing.
- Whether the scheduling of small groups has an impact on the time constraints of the students and facilitators.

The Covid-19 lockdown and social distancing guidelines starting in March 2020 have implications for health education, and, by extension for simulation education. In some cases, face-to-face teaching has been suspended, or due to social distancing rules, the groups of students allowed in a physical space have been severely curtailed (Arandjelovic, Arandjelovic, Dwyer & Shaw 2020:1; Khan 2020:2).

In cases where reduced face-to-face simulation and skills activities are still allowed, it will still have an impact on logistics and scheduling as the size of student groups allowed in a facility at a time will be greatly reduced, which might mean that some activities will have to be re-written for reduced team members. This will also have an impact on the number of simulations that will have to be repeated to ensure that each student is part of a simulation experience (CSUM 2020:4).

Another option would be to shift some simulation activities to utilise online virtual reality, where simulations will be performed by the students from home on a remote platform. A hybrid form of simulation can also be utilised where a remote camera and microphone is used in the simulation room to stream information to home-based students. Simulation staff in the simulation room can be remotely directed by the students on the tasks to be completed (M Simulation 2020:4; CSUM 2020:4).

2.6 PHYSICAL ENVIRONMENTAL CONSIDERATIONS FOR HIGH-TECHNOLOGY SIMULATION

Students must be able to immerse themselves as fully as possible during a simulation practice within a setting resembling their actual workplace as closely as possible. This setting must also include the consumables, patient documentation and medical equipment required for the specific simulation experience (Milkins *et al.* 2014:22).

2.6.1 Typical types of rooms to consider

It is important to define the functional needs and plan the rooms/spaces according to those needs. Typically the rooms include areas where the simulation experience takes place, for example, a mock theatre room, a control room, area where debriefing can take place, lecture rooms (Horley 2016:17) as well as computer area for flat screen simulation (Seropain 2008:182).

During the planning of the physical environment, care must be taken to consider technical elements of possible high-technology equipment such as cabling, installation of gasses and Wi-Fi range. Other considerations could include acoustics, heating and lighting specifications and audio-visual equipment (Seropian, Alinier, Hssain, Driggers, Brost, Dongilli & Lauber (2015:436).

During the design of the rooms/spaces, it is also important to take into account what type of simulation will take place, possible future plans, the available budget (Seropian 2008:179) and what the student flow should be between the rooms (Labuschagne 2012:108) to ensure separation of learners and simulated patients (SPs), or evaluators and other groups of students (especially during assessment) (Brost, Thiemann, Belda & Dunn 2008:189). Flexibility is key, and rooms should be designed with this in mind as well as making the rooms larger than its real-world counterpart to accommodate student groups (Sekandarpoor *et al*. 2019:117).

Additional rooms to consider are breakout rooms with beverage facilities, change rooms and lockers (Horley 2016:23). Offices and reception area for simulation staff

(Labuschagne 2012:236) and an area for technical training and maintenance of the simulators (Ahmed, Hughes, Friedl, Figueroa, Brito, Frey, Birmingham & Atkinson 2016:3) are also important to consider. Storage areas and room(s) for IT infrastructures such as network, A/V and servers should not be neglected (Seropian, Driggers & Gavilanes 2013:617).

The Covid-19 social distancing guidelines will also impact the effective use of rooms. Depending on the modality used, there might be a need for additional equipment to stream simulation or skills sessions to remote students. In other cases, the number of students in the room allowed will have to be minimised, and waiting students will have to be accommodated in spaces where social distancing can be observed (M Simulation 2020:4; CSUM 2020:4; Khan 2020:2).

2.7 RESEARCH OUTPUTS WHEN UTILISING HIGH-TECHNOLOGY SIMULATION

Simulation-based health education research should follow accepted research methods (White & Peterson 2015:604; Vincent-Lambert & Bogossian 2017:48). Gaba (in White & Peterson 2015:607) states research associated with simulation can either be research about simulation, or research that utilises simulation as a tool to study key health concepts. He continues to elaborate on the adaptation of translational research (“T-levels”) for simulation-based research. These levels are summarised in Table 2.3.

Table 2.3: T-levels for simulation-based research (Gaba 2015)

T-Level:	Description:
T0	Basic biomedical research
T1	Studies of clinical performance as measured during simulation
T2	Performance observed during actual clinical care
T3	Whether patient outcomes were actually changed
T3'	Whether the above change was cost-effective
T4	How innovation was disseminated
T5	Whether the outcomes were adopted in the workplace
T6	Whether the outcomes yielded widespread changes in population health

As in any other field of research, research within simulation should be robust and generate trustworthy findings that may change policy or practice (Garden 2016:278).

Kardong-Edgren *et al*. (2015:615) suggest some initial steps to use when deciding on research within a simulation environment:

1. Research the idea – use the literature review, personal experience and available resources to decide what type of studies are reasonable to pursue.
2. Use a theoretical theory as a guide.
3. Decide between research *on* or research *with* simulation.
4. Consider a possible “hot topic”.

Kahol (2013:634) states that the creation of a solid program of research will sustain funding for the facility. He adds that facilities should focus research on two areas, namely larger, multicentre research, and multidisciplinary aspects. This typically leads to large-scale grant funding.

2.8 OPERATIONAL CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

When considering high-technology simulation, there are operational challenges and obstacles that might cause staff members to question the use of high technology in clinical simulation. These challenges include a lack of time, fear of technology, lack of human resources, inadequate space and equipment, lack of trained staff (computer literacy), lack of financial support, insufficient technology, lack of maintenance of technology, additional workload and lack of applicability to the curriculum (Al-Ghareeb & Cooper 2016:284; King 2018:237). Due to the Covid-19 protocols, an additional challenge with regards to maintenance and time allocation is the fact that the equipment and rooms need to be sanitised between each student or groups of students after use (CSUM 2020:4; Arandjelovic *et al*. 2020:1). The lack of time and human resources leads to staff multi-tasking. Patel (2016:88) asserts that as an individual's concentration is stretched across various tasks, the quality will be negatively impacted.

Young (2016:10) states that from a staff point of view, a major challenge is the breadth of the professional healthcare culture as viewed from the technician point of view and *vice versa,* where clinicians have challenges navigating IT related-issues and cultures and understanding the role of simulation and the operations of the simulation space and its technology. Patel (2016:78) adds that the integration and operationalisation of simulation technology are challenging, as it necessitates an understanding not only of the role of simulation but also of the operations and of the simulation space and its technology.

2.9 CONCLUSION

High-technology simulation refers to any simulator that has some form of computerised control. Due to the high human and financial cost of high-technology simulation in South Africa, the effective utilisation of high-technology simulation is important. For sustainable high-technology simulation, six operational subsystems are needed that operate as a whole.

The management and funding of operational subsystems are closely related, as management decisions and documents are important on how to generate income and where expenses should be located. Human resources are crucial to the successful implementation and day-to-day operations of a high-technology simulation facility. Not only are the staff designations important, but also the development of staff to ensure that the technical aspects of high-technology simulation are addressed.

Considerations regarding the physical environment of where high-technology simulation takes place should take into account the types of simulation as well as potential future expansion of a facility. Integration of high-technology simulation into a curriculum should follow accepted educational principles and should contribute to achieve the relevant educational outcomes. Likewise, research utilising high-technology simulation should follow accepted research principles, and could lead to income for a facility.

Even though operational best practices are already well established, thorough planning and execution are sometimes neglected by simulation facilities (Calzada 2015:269). This is also evident from the challenges in using high-technology simulation that Al-Ghareeb and Cooper (2016:284) describe.

Little has been published on this operational approach to high-technology clinical simulation in South Africa The question arises as to whether thorough operational planning and execution, utilising all six subsystems, are happening in simulation facilities in South Africa, and if it does, to what extent.

In the next chapter, ***Chapter 3: Research Methodology,*** a detailed description of the research design and methodology will be given.

CHAPTER 3
RESEARCH METHODOLOGY

3.1 INTRODUCTION

In chapter 2 an overview was given on high-technology simulation, the South African context and the six operational subsystems. This context is vital, as it is used as a framework in the research design to address the research questions.

In this chapter, the research design and methods will be discussed. A literature study was done, a questionnaire survey conducted at South African public, accredited health professions training institutions, and a Delphi survey was conducted amongst simulation experts to determine the best practices for high-technology clinical simulation in South Africa. Appendices A to K provide the documentation used in the study.

3.2 RESEARCH PARADIGM, APPROACH AND DESIGN IN THIS STUDY

A research paradigm (also called a worldview) is the way of looking at natural phenomena and a general perspective on the complexities of the world (Polit & Beck 2017:9). It influences the approach taken regarding a research problem (Botma, Greeff, Mulaudzi & Wright 2010:39).

Creswell (2018:7) and Mertens (2015:56) describe four research paradigms or worldviews. The first is positivism or post-positivism, which is a traditional form of research that focuses on cause and effect. Here the researcher acts objectively with relation to the data, and this paradigm is associated with a quantitative design. Secondly is the constructivism worldview, where there is an interactive link between the researcher and participants, and typically an approach used in a qualitative design. The third paradigm is called the transformative paradigm. This is used to address issues of power and trust, and rejects cultural relativism. It utilises a qualitative design and is used with historical and contextual factors. Lastly is pragmatism, in which knowledge is gained in the pursuit of desired ends. The process is influenced by the researcher's values. This paradigm matches different methods to specific questions, and mixed methods can be used.

The research paradigm followed in this study was post-positivism, as the researcher acted objectively and detached from the data (Figure 3.1).

Following the paradigm, a decision must be made on which research approach to follow (Trafford & Lesham 2010:97).

According to De Vos *et al.* (2011:48), the research approach can be deductive or inductive in nature. The deductive approach "moves from a pattern that should be logically expected, to physical observations that test whether the expected pattern actually occurs." It is used in quantitative design (Creswell 2018:4). The inductive approach moves from concrete observations to a theoretical explanation and is used in qualitative research (Creswell 2018:3).

The research approach that was followed was deductive in nature as it tested the existing theory (Trafford & Lesham 2010:97) of high-technology simulation against how it is implemented in South African facilities (Figure 3.1).

A multi-method approach was used in this study to determine how to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa. A descriptive, quantitative design was used for this study. This non-experimental design was used because there was no manipulation of the variables (De Vos *et al*. 2011:158).

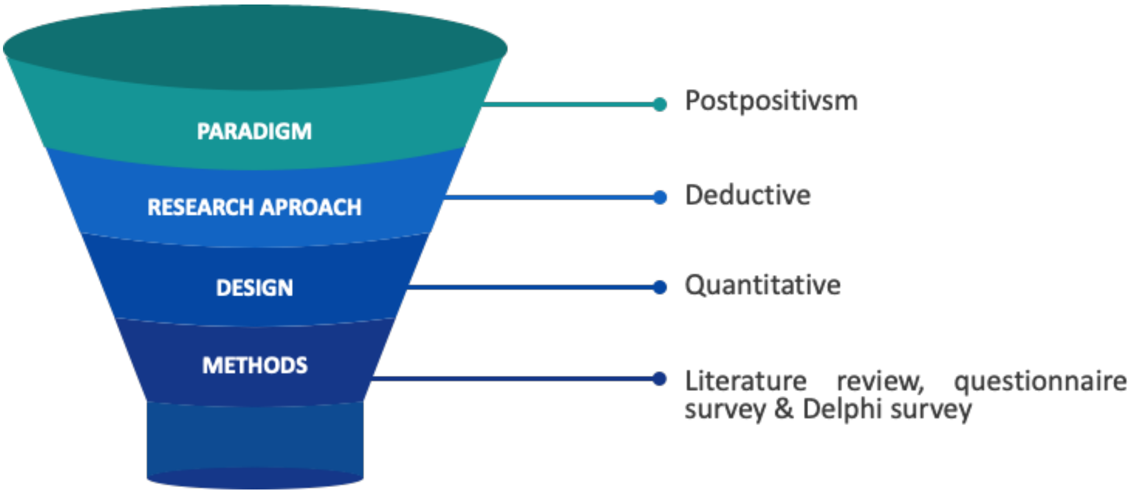

Figure 3.1: Research paradigm, approach, design and methods used (adapted from Trafford & Lesham 2010:94)

Three methods were used to gather data, which included a literature review, a questionnaire survey and a Delphi survey (Figure 3.2).

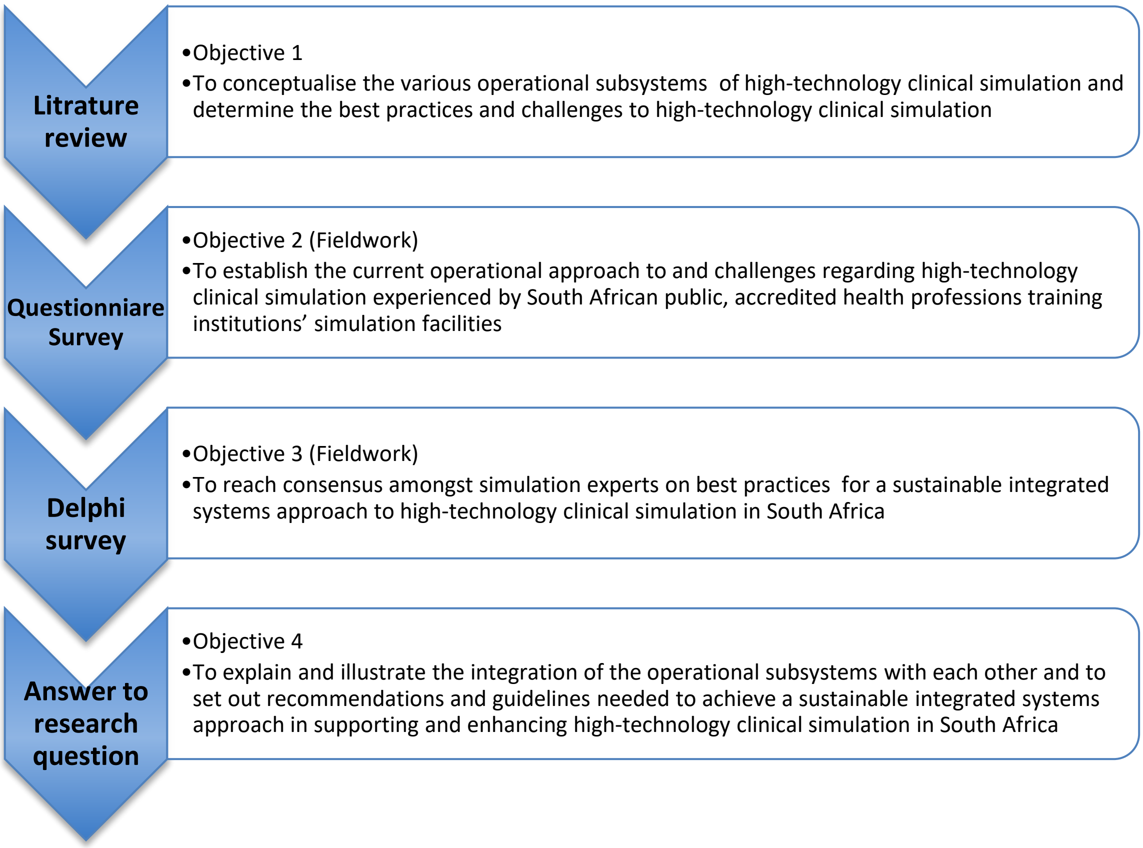

Figure 3.2: Sequential approach, utilising a multi-method research design

3.3 DESCRIPTION OF THE METHODS

3.3.1 Literature review

A literature review was used to gather initial information on the approach and possible operational challenges when using high-technology simulation. This focused on current best practice and challenges. The online search portal of the UFS Library and Information Services was used. This portal has access to a wide range of scholarly journals and resources. Keywords used include high-technology clinical simulation, high-fidelity simulation, operational approach, management of high-technology clinical simulation facilities, funding models for high-technology clinical simulation, curriculum integration of clinical simulation, research outputs from high-technology clinical simulation, physical considerations of high-fidelity simulation, staff development for clinical simulation, challenges of high-fidelity clinical simulation, high-fidelity clinical simulation in South Africa and high-technology clinical simulation in South Africa. The searches focused on journal articles from the last 23 years (1997 onwards) published in English. In addition, textbooks on simulation, high-technology simulation and its operational aspects were used and recent publications were scrutinised for relevant information.

3.3.2 Empirical study - questionnaire survey

Babbie (2011:246) describes a questionnaire as a document to solicit information appropriate for analysis. Bryman (2012:232) adds that a questionnaire is a research instrument which the respondents can complete themselves. De Vos *et al.* (2011:186) state that the objective of a questionnaire is to obtain facts and opinions from informed persons on a phenomenon. Online surveys can be used to reach a larger population quickly and with lower costs (Toepoel 2016:3).

An online, web questionnaire was developed using the EvaSys (Education Survey Automation Suite) at www.surveys.ufs.ac.za. The aim of the questionnaire was to obtain the current approach followed, as well as challenges faced at South African clinical simulation facilities with regard to the use of high-technology simulation.

3.3.2.1 Target population

The term population can be described as the universe of units from which the sample can be selected (Bryman 2012:714). The target population was South African public, accredited (South African Nursing Council, Health Professions Council of South Africa and the South African Pharmacy Council) health professions training institutions. The details of these institutions were obtained from the relevant councils' websites. Private training institutions were excluded as well as the Clinical Simulation and Skills Unit, School of Medicine at the University of the Free State, as the candidate is affiliated to this facility.

3.3.2.2 Description of sample and sample size

Table 3.1 summarises the target population.

Table 3.1: Public, accredited health professions training institutions (HPCSA 2018, SANC 2018 & SAPC 2018)

Profession	Accreditation	Total
Biokinetics	HPCSA	12
Dental Therapy and Oral Hygiene	HPCSA	9
Dietetics and Nutrition	HPCSA	10
Emergency care (Colleges)	HPCSA	7
Emergency care (Universities)	HPCSA	4
Medicine	HPCSA	9
Nursing (Colleges)	SANC	12
Nursing (Universities)	SANC	21
Occupational Therapy	HPCSA	9
Optometry	HPCSA	5
Pharmacy	SAPC	8
Physiotherapy	HPCSA	9
Radiography	HPCSA	7
Speech, Language and Hearing Professions	HPCSA	6

The total number of institutions that qualified for the questionnaire survey was 42, as some institutions train more than one profession. However, each profession was contacted separately in case the institution has different simulation facilities. In cases where a facility is used to train multiple disciplines, a questionnaire was only sent out once as the data pertains to a facility and not to a discipline.

3.3.2.3 Description of questionnaire schedule

The questionnaire was developed using the EvaSys online system and was in English. The questionnaire in appendix A was the final version that was submitted to the Health Sciences Research Ethics Committee (HSREC) of the UFS for approval (appendix B) and sent to the participants.

The questionnaire comprised eight parts.

1. Demographics of the facility.
2. Management elements.
3. Financial planning and funding model.
4. Staffing and staff development.
5. Curriculum integration of high-technology simulation.
6. Environmental considerations.
7. Research outputs of the simulation facility.
8. Challenges of high-technology simulation at the facility.

These operational subsystems were derived from Palaganas *et al*. (2015), Labuschagne (2012) and Kyle Jr and Murray (2008). The layout of the questionnaire was created according to the best practices and visual design of Artino, La Rochelle, Dezee and Gehlbach (2014:269).

3.3.2.4 The pilot study

The pilot study was conducted with representatives of two facilities that utilise simulation as a teaching tool. The purpose of the pilot study was to determine whether the questions were well designed, clear and in the correct order. Feedback on the design, clarity and correctness of the questionnaire by the two representatives was obtained telephonically. The responses from the pilot study were used in the main study as there were no changes to the questions or other methodology.

3.3.2.5 Data gathering

Using the contact details obtained from the relevant council's website, the listed representative of the institution was contacted. Where no contact details were listed for an institution's representative, the institution's website was used to obtain the relevant contact details. This initial correspondence was done telephonically, and in cases where that failed, e-mails were used to ascertain whether simulation is part of the training platform at a specific institution, who the contact person for the simulation facility is and what the procedure to obtain permission for the questionnaire to be distributed at the relevant institution (appendices C and D) would be. Each institution where no feedback was received was approached three more times over a 3-month period.

If simulation is not part of the training platform, the institution was removed from the target population for that specific profession. In cases where simulation is part of the training platform, the contact details for the simulation facility's representative were obtained from the council-listed representative.

Once permission was obtained, the representative of the simulation facility was contacted by e-mail by the researcher as introduction and to explain the purpose of the study. The representative was also asked to participate, and an indication of how much of their time would be needed was given. An introduction letter (appendix E) and an informed consent form (for a signature) (appendix F) were sent out using e-mail. When the persons approached indicated that they would participate, a pdf copy of the questionnaire (for the purpose of preparing for the completion of the online questionnaire) was e-mailed to them, as well as the link to the online questionnaire. The questionnaire was tracked via the EvaSys online status pages.

The researcher followed up with respondents who had not completed the survey via e-mail. Follow-ups were sent out via e-mail every two weeks to the representatives of specific simulation facilities. All correspondence was in English.

3.3.2.6 Data analysis

The data were collected and collated into a blinded Microsoft Excel sheet by the researcher. The data were sent to and analysed by a biostatistician from the Department of Biostatistics (UFS) in terms of frequencies and percentages. Answers to open questions were coded into themes by the researcher and analysed quantitatively (Mouton 2001:108).

3.3.3 Empirical study – the Delphi survey

Grove, Burns and Gray (2013:435) describe the Delphi survey as a tool to measure the judgment of a group of experts to make decisions and assess priorities. The purpose of the Delphi survey, according to Yousuf (2007:online) is to elicit judgments in a specialised field by expert opinions.

The Delphi method involves multiple rounds of surveys with a panel of experts with feedback derived from earlier responses to elicit consensus on a particular topic (Arthur, Levett-Jones & Kable 2013:1358). The Delphi technique that was applied is based on Brewer's (2011:243) flow chart (Figure 3.3). This approach to the Delphi technique is the reactive method (Brewer 2011:247). In this study the researcher acted as monitor. The Delphi survey terminated after round 3 and feedback was given to the participants.

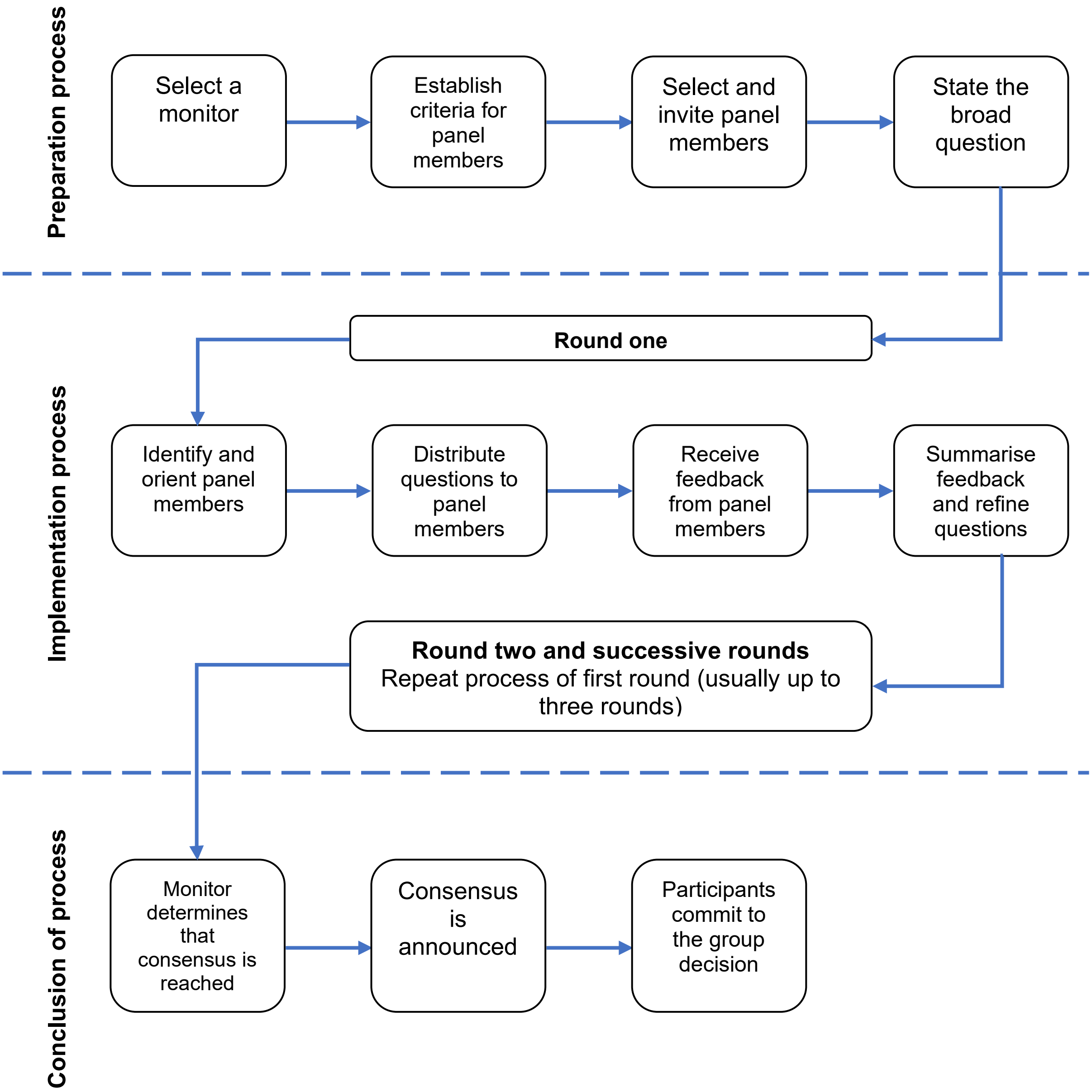

Figure 3.3: Flowchart of Delphi Technique (adapted from Brewer 2011:243)

Hsu and Sandford (2012:345) state that three rounds are usually sufficient to collect the needed information, but a fourth round might be needed to obtain consensus or stability amongst the participants. Holey, Feeley, Dixon and Whittaker (2007) define consensus as agreement, and that agreement can be determined by the aggregate of judgements of the participants, while stability is "the consistency of answers between successive rounds".

3.3.3.1 Target population

The population for the Delphi survey was simulation experts using high-technology simulation. Criteria for inclusion were a minimum of five years' experience of simulation-based health education, as well as being the head of a department where high-technology simulation is used. Participants had to either work in South Africa or have some relevant experience of high-technology clinical simulation in South Africa. Staff from the Clinical Simulation and Skills Unit, School of Medicine at the University of the Free State were excluded, as the candidate is affiliated to this facility. Only one participant per institution was considered.

3.3.3.2 Description of sample and sample size

Experts were purposefully selected to include persons from different health professions' simulation institutions. The number of experts chosen for the panel was 10, with seven based in South Africa and three internationally. An invitation letter (appendix G) was sent out using e-mail to all of them, and eight responded and indicated that they would participate.

3.3.3.3 The Delphi questionnaire

The Delphi questionnaire consisted of six themes with an option for the participants to add any additional topics. These six themes are:

1. Management
2. Funding
3. Staffing and staff development
4. Curriculum integration
5. Physical environment
6. Research

Each theme comprised of two parts. In the first general part the participants could give their opinions on statements based on principles set out in the literature. In the second part their opinions on possible solutions to the challenges identified by the questionnaire survey conducted in the South African facilities were recorded.

A 3-point Likert scale was used during the Delphi survey in order for the participants to rank each item. Ranking terms were: 1 - "essential", 2 - "optional", and 3 - "not necessary".

Surveys for the rounds were developed as a Word document that could be completed using Microsoft Word (appendix I). The first round of the Delphi survey was a structured questionnaire (appendix I), and was informed by the results from the questionnaire survey sent out to the high-technology simulation facilities as well as the findings from the literature review. This questionnaire was used as a platform in subsequent rounds (Hsu & Sandford 2012:344) with statements reaching consensus being removed. During each round (after round one), participants could revise their judgement on remaining statements and make further clarification where needed (Hsu & Sandford 2012:344).

3.3.3.4 The pilot study

The Delphi questionnaire was circulated for evaluation to two UFS simulation experts, who were excluded from the study. The purpose of the evaluation was to determine whether the questions were well designed, clear, and in the correct order. Feedback on the design, clarity and order of the questionnaire by the experts were obtained telephonically, and no adjustments were needed.

3.3.3.5 Data gathering

The researcher sent out an e-mail to all members of the sample introducing and explaining the purpose of the study. In the e-mail they were requested to participate, and an indication was given on how much of their time would be needed. It was also stated that an informed consent form (appendix H) would be sent out for signature approval. The round one survey, as well as an informed consent form (for signature), were sent out to the eight participants that agreed to take part in the Delphi survey.

The researcher tracked the completion of the survey every two weeks, and followed up via e-mail with respondents who had not yet completed the survey.

During round one, feedback from the experts was also obtained and used to refine and add questions for round two. Statements on which consensus was reached during round one were omitted for round two. The adapted questionnaire was sent out for round two, and the process was repeated. After round three stability was reached in the remaining statements. No more rounds followed.

All data gathering was confidential, and all correspondence was in English.

3.3.3.6 Data analysis

In this study, eight experts participated in the Delphi study, and it was decided that at least six of the eight needed to agree before it would be considered as consensus. This determined the level of consensus at 75%. Collected data were captured in Microsoft Excel and analysed by the researcher. Questions where consensus (75%) was reached, were removed for the following round. For each successive round, results of statements where consensus was reached were summarised and sent to each participant as feedback. Comments made by the participants were incorporated as refined or additional questions in the subsequent round. Where consensus was not reached, the questions were repeated in the following round, and stability (when the results have not changed from the previous round) was reached in round three.

3.4 VALIDITY AND RELIABILITY

3.4.1 Validity

Validity is defined as the extent to which the instrument measures what it purports to measure (Leedy & Ormond 2010:28).

According to Sue and Ritter (2012:56), the validity of questionnaire answers can be compromised when the wording of a question is faulty or when the response options are inadequate or inappropriate. The design of the questionnaire was according to best practices and visual design principles (Artino, *et* alL, 2014:269) and was tested and confirmed in the pilot study. Using both national and international literature contributed to validity during the literature review. The literature review served as a guide for the development and content of the questionnaire.

The use of open-ended questions in the questionnaire survey coded into themes also increased validity, as these were based on the participants' responses rather than themes created beforehand by the researcher. The Delphi survey was informed by the results of the questionnaire. A high response rate further enhances validity. To facilitate a high response rate, the participants were contacted personally and followed up regularly.

3.4.2 Reliability

Reliability is the extent to which a measurement procedure can produce the same results when repeated. It is therefore an indication of consistency (Punch 2000:98). To enhance reliability in this study, a questionnaire survey and Delphi survey, which are structured research instruments, were used. A specific target population had been selected.

The pilot study of the questionnaire and the evaluation of the Delphi questionnaire also enhanced the reliability of this study, as adjustments to the questionnaire and Delphi questionnaire could be made before the main study commenced.

3.5 ETHICAL CONSIDERATIONS

3.5.1 Approval

Approval for the research project was obtained from the Health Sciences Research Ethics Committee (HSREC) of the UFS (appendix B). Permission from the Dean (Faculty of Health Sciences) and the Vice-Rector, Research, at the UFS was obtained for the project. Permission to conduct the survey with the relevant simulation facility representative was requested from the various health professions training institutions in the target population. In most cases (10), approval from the relevant dean or department head was sufficient to complete the questionnaire, while others had an institutional or faculty ethics committee or a research gatekeeper committee which had to approve participation. In all cases the UFS HSREC approval letter, a copy of the protocol, a copy of the questionnaire, informed consent form and invitational letter were sufficient for approval. The Delphi questionnaire was submitted for approval to the HSREC once it had been finalised after the results of the questionnaire survey had been processed.

3.5.2 Informed consent

An informed consent form was sent out to the target population. Follow-up emails were sent one week later for those that did not respond and participants had the opportunity to decline participation. The form was signed and sent back to the researcher, either in hard copy or as a scanned e-mail. Participation was voluntary, and participants had the right to withdraw from the study at any stage. Participants did not receive any remuneration, nor did they incur any costs. The contact details of the researcher were available. Guarantees of information confidentiality of all respondents were given. Information was only used for research purposes and was not released for any academic and/or employment-related performance evaluation, promotion and/or disciplinary purposes.

3.5.3 Right to privacy

All data collection and reporting were done in a confidential method. No names or personal information was published. For the questionnaire survey, a separate list of simulation representatives of each institution was kept by the researcher. This list was used to track and follow up with the various representatives. The questionnaires were confidential. The Delphi participants were anonymous to one another.

3.6 CONCLUSION

Chapter 3 provided a detailed description of the research design and methodology, as well as the data collection methods and analysis. The questionnaire survey and Delphi survey methods, which were applied in the study, were described, including the construction of both the survey questionnaire survey and Delphi questionnaire and the processing of the data.

In the next chapter, ***Chapter 4: Results of the questionnaire survey,*** the results from the questionnaire survey will be presented.

CHAPTER 4
RESULTS OF THE QUESTIONNAIRE SURVEY

4.1 INTRODUCTION

In the previous chapter, the research methodology was described. In this chapter, the results of the questionnaire survey will be presented. The questionnaire survey was conducted at South African public, accredited health professions training institutions. The questionnaire consisted of eight parts (*cf*. 3.3.2.3) and was sent to all participating facilities that indicated the utilisation of simulation as part of their curriculum. Part one of the questionnaire included information on the characteristics of the facilities (called demographics in the questionnaire). One question was whether the facility utilises high-technology simulation. If a facility does not utilise high-technology simulation, no further data were collected for the subsequent seven parts of the questionnaire. The survey was conducted between September 2018 and April 2019.

4.2 PARTICIPATION AND RESPONSE RATE

A total number of 128 representatives from 12 health professions (*cf.* table 3.1*)* were contacted and represented 42 institutions. These institutions can be classified into three categories: Universities (n=23), nursing colleges (n=12) and emergency care colleges (n=7). Replies were received from 27 (64.3%) institutions, but four (which indicated that they utilise simulation) did not complete the survey, leaving 23 (54.8%) participating institutions. The 23 participating institutions consisted of 19 (82.6%) universities, two (16.7%) nursing colleges and two (28.6%) emergency care colleges. Seven (30.4%) of the 23 participating institutions indicated that no simulation is utilised. These seven institutions consisted of five (26.3% of respondents) universities and two (100% of respondents) nursing colleges.

Simulation was utilised at 16 (69.6%) of the participating 23 institutions. These were 14 universities and two emergency care colleges. The 16 institutions represented 17 simulation facilities, as one of the universities had two separate participating simulation facilities.

Fourteen of the participating facilities indicated that they have high-technology simulation. The 14 facilities that have high-technology simulation represented 14 institutions. Reasons listed for no high-technology simulation (n=3) was that there are no finances available for it (n=2), and there is no need for it in the curriculum (n=1).

The response from institutions is illustrated in figure 4.1

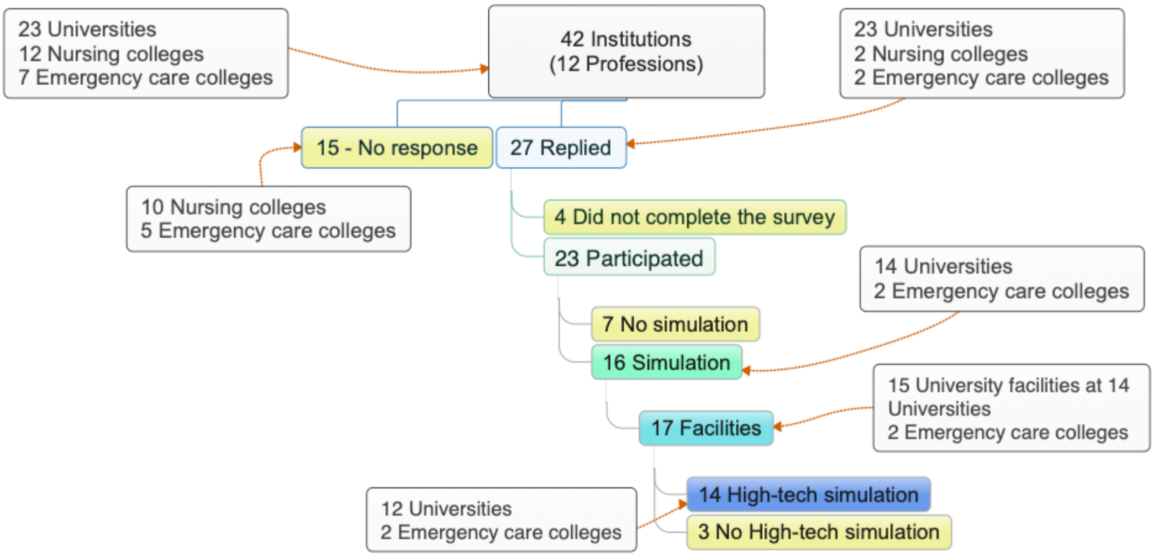

Figure 4.1: Response from institutions

4.3 CHARACTERISTICS OF FACILITIES

The median number of years that the 17 facilities have been in operation was 8.5 (range 2 – 52) (n=16). The roles of the respondents (n=17) were mostly defined as "Head of Unit" (8) or "Lecturer" (8). One respondent was "Clinical simulation co-ordinator".

Simulation is used in the facilities (n=17) across 11 professions (Table 4.1). Eleven (64.7%) of the facilities serve more than one profession.

Table 4.1: Simulation across professions (n=17)

Profession	Frequency	Percentage
Nursing	12	70.6%
Emergency care	10	58.8%
Physiotherapy	6	35.3%
Medicine	5	29.4%
Dietetics and nutrition	2	11.8%
Occupational therapy	2	11.8%
Pharmacy	2	11.8%
Radiography	2	11.8%
Biokinetics	1	5.9%
Dental therapy	1	5.9%
Optometry	1	5.9%
Speech and language therapy	0	0%

All 17 facilities utilise some form of low-technology simulation. Providing skills training with part-task trainers is the most popular method with almost all (94.1%) facilities making use of it (Table 4.2).

Table 4.2: Low-technology simulation modalities used (n=17)

Modality	Frequency	Percentage
Skills training (part-task trainers)	16	94.1%
Role-play (using SPs)	12	70.6%
Role-play (amongst students)	10	58.8%
Skills training (using animal tissue)	3	17.6%

Three (17.6%) of the 17 facilities does not utilise high-technology simulation. The majority (76.5%) of facilities, uses human patient simulators (Table 4.3).

Table 4.3: High-technology simulation modalities used (n=17)

Modality	Frequency	Percentage
Human patient simulators	13	76.5%
Flat-screen simulation	5	29.4%
None	3	17.6%
Virtual and/or augmented reality	2	11.7%

The median number of hours that high-technology simulation is utilised per week (n=11) is 10 (range 1 – 25) hours.

4.4 MANAGEMENT

Four of the fourteen facilities (28.6%) are stand-alone facilities with their own management systems in place (Figure 4.2).

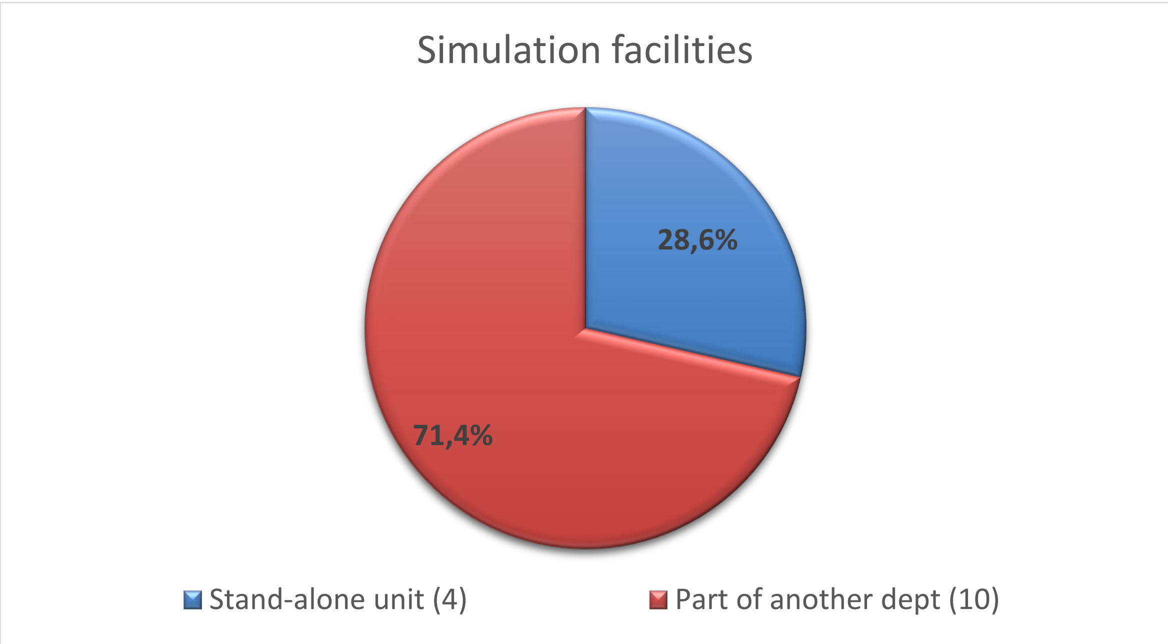

Figure 4.2: Stand-alone vs part of another department's simulation facilities (n=14)

Documentation in place at the simulation facilities utilising high-technology simulation is presented in Table 4.4.

Table 4.4: Documentation available at the simulation facilities (n=14)

Document	Frequency	Percentage
Student feedback forms	10	71.4%
Financial plan	9	64.3%
Policy document	9	64.3%
Mission statement	8	57.1%
Vision statement	7	50.0%
Staff development plan	7	50.0%
Goals and strategies	6	42.9%
Statistics of facility usage	6	42.9%
Organogram	5	35.7%
Needs analysis	5	35.7%
Performance indicators	4	28.6%
SWOT analysis	3	21.4%

When deciding which vendors to use for high-technology simulation, the representative of each facility was asked to list up to five aspects they considered important in their decision making. These were open-ended questions in the questionnaire. These five aspects were ranked (most important = 5 and least important = 1). The aspects were combined into themes, and are reported on in Table 4.5.

Table 4.5: Considerations when deciding which vendors to use (n=13)

Consideration:	N[1]	Median rank[2]	Range
The product must address training needs	9	5	3 – 5
Quality, durability, and latest technology	6	4.5	3 – 5
Usage across multiple disciplines	1	4	4 - 4
After-sales care, training, and support	13	3	1 – 5
Costs of equipment and maintenance	13	3	2 – 5
Availability of equipment	2	2.5	1 – 4
Adherence to financial regulations of the institution	5	2	1 – 5

Table 4.5: Considerations when deciding which vendors to use (n=13) (continued)

Consideration:	N[1]	Median rank[2]	Range
Ease of use and compatibility with current equipment	4	1.5	1 - 5

1: Number of responses for an aspect
2: Ranking were: most important = 5 and least important = 1

Additional comments about the management of a high-technology simulation facility included the fact that the facility needs more documents for effective strategic management (n=1).

Documentation is also important for the continuation of what has been achieved. When staff members leave the institution, the new staff often needs to start from scratch (n=1).

4.5 FUNDING

Various funding sources are used by the high-technology simulation facilities. In some cases more than one source is used by a facility (Table 4.6). The most frequent sources are a combination of institutional budget allocation and a government education grant.

Table 4.6: Funding sources (n=14)

Funding source	Frequency	Percentage
Institutional budget allocation	11	78.6%
Government education grant	11	78.6%
Income from external training	8	57.1%
Government health grant	7	50.0%
CPD/certification courses	5	35.7%
Corporate donations (sponsors)	1	7.1%
Corporate grants	1	7.1%
Research grants	1	7.1%
Unsure	1	7.1%

Two (14.3%) of the high-technology simulation facilities have their own financial steering committee, while three (21.4%) have no financial committee. Nine (64.3%) facilities have their finance steering committee as part of another institutional committee.

Six (42.9%) of the high-technology simulation facilities have their own procurement policies and procedures, and five (35.7%) indicated that their procurement policies are governed by the institution. Three (21.4%) have no procurement policies in place.

4.6 STAFFING AND STAFF DEVELOPMENT

When considering the staffing allocation for stand-alone facilities, the medians, as indicated in Table 4.7, were obtained (n=3). One of the four stand-alone facilities did not answer this question.

Table 4.7: Staffing allocation for stand-alone facilities (n=3)

Designation	Median	Range
Full-time employees	5	1 - 9
Part-time employees	4	0 – 5
Unit head(s)	1	0 – 5
Lecturers	1	0 – 4
Administrative	1	0 – 1
Operational set-up staff	1	0 – 2
SP coordinator	1	0 – 1
Scenario facilitators	0	0 – 1
Debriefing facilitators	0	0 – 1
Technical	0	0 – 2

Staffing allocation for facilities that are part of another department (n=10) is listed in Table 4.8. It was indicated that in some instances, multiple roles are covered by the same staff member (n=3). Some facilities will make use of staff (content specialist) on an *ad hoc* basis to assist with simulations (n=2).

Table 4.8: Staffing allocation for facilities that are part of another department (n=10)

Designation	Median	Range
Full-time employees	2	0 – 13
Part-time employees	0	0 – 1
Unit head(s)	1	0 – 8
Lectures	1	1 – 8
Scenario facilitators	0.5	0 – 13
Debriefing facilitators	0	0 – 12
Administrative	1	0 – 3
Technical	0	0 – 1
Operational set-up staff	1	0 – 8
SP co-ordinator	0.5	0 - 10

Table 4.9 provides a breakdown of how many facilities have specific training plans in place for the various staffing allocations.

Table 4.9: Training plans in place (n=14)

Training plans in place	Frequency	Percentage
Lecturers	9	64.3%
Unit head	7	50.0%
Scenario facilitators	7	50.0%
Operational set-up staff	4	28.6%
Technical staff	4	28.6%
Administrative	4	28.6%
SP co-ordinator	4	28.6%
Sending staff on courses covering multiple aspects	3	21.4%
Debriefing facilitator	3	21.4%

The topics that are covered by the training plans are listed in Table 4.10. The topics most frequently covered are scenario planning and programming, as well as simulation facilitation (85.7%), followed by debriefing facilitation (71.4%).

Table 4.10: Topics covered in training plans (n=14)

Training plans in place	Frequency	Percentage
Scenario planning and programming	12	85.7%
Simulation facilitation	12	85.7%
Debriefing	10	71.4%
Physical planning	8	57.1%
Technical support	7	50.0%
Moulage	7	50.0%
Ethics	6	42.9%
Financial planning	6	42.9%
Management aspects	6	42.9%
SP co-ordination	4	28.6%

When asked about the approach used for running a successful simulation when some staff member(s) are not available, 46.2% of 13 representatives indicated that there is no backup plan in place, while 53.9% indicated that all staff members are part of the planning phase and will multi-task if a member is not available.

Additional comments about staffing and staff development were mostly focused on the need for additional, better-trained staff in some cases (n=3), planned training (n=3), and recurring refresher courses being attended on an annual basis (n=3). One challenge that was highlighted is that some lecturers do not attend simulation training as they feel overwhelmed with their current task allocation, and attending training takes a back seat. The need for broader training in high-technology simulation was also mentioned as a challenge. One respondent added that most lecturers are fine with the subject matter, but not with the management and technical elements of high-technology simulation. When a staff member is absent, simulation experiences might therefore be compromised.

4.7 CURRICULUM INTEGRATION

The type of student utilisation (mandatory vs voluntary) of high-technology simulation is shown in Table 4.11, and the median number of students per facility is shown in Table 4.12. The highest frequencies of high-technology simulation usage are amongst 3rd year (9), 4th (8) year and post-graduate (8) students. The number of students utilising high-technology simulation facilities is highest amongst the 5th (195) and 6th (21) years.

Table 4.11: Mandatory vs voluntary usage of high-technology simulation facilities (n=14)

Classification	None	Mandatory	Voluntary	Mandatory in some cases and voluntary in others	Usage per group
1st year	8 (57.1%)	3 (21.4%)	2 (13.3%)	1 (7.1%)	6 (42.9%)
2nd year	8 (57.1%)	5 (35.7%)	1 (7.1%)	0 (0.0%)	6 (42.9%)
3rd year	5 (35.7%)	8 (57.1%)	0 (0.0%)	1 (7.1%)	9 (64.3%)
4th year	6 (42.9%)	8 (57.1%)	0 (0.0%)	0 (0.0%)	8 (57.1%)
5th year[1]	10 (71.4%)	3 (21.4%)	1 (7.1%)	0 (0.0%)	4 (28.9%)
6th year[1]	12 (85.7%)	1 (7.1%)	1 (7.1%)	0 (0.0%)	2 (14.3%)
Post-graduate/Diploma	6 (42.9%)	7 (50.0%)	0 (0.0%)	1 (7.1%)	8 (57.1%)
CPD courses	9 (64.3%)	2 (13.3%)	0 (0.0%)	3 (21.4%)	5 (35.7%)
Other	9 (64.3%)	2 (13.3%)	0 (0.0%)	3 (21.4%)	5 (35.7%)

1: Only medicine has 5th and 6th year

Table 4.12: Student utilisation of high-technology simulation facilities (n=14)

Classification	N	Median number of students per facility	Range
1st year	4	45.6	30–108
2nd year	5	95.5	3–250
3rd year	9	165.6	74–320
4th year	8	156.1	55–320
5th year[1]	4	195	110–320
6th year[1]	2	210	100-320
Post-graduate/Diploma	8	67.8	10–200
CPD courses	5	111.8	15-300
Other	3	59.5	12-100

When considering the usage of high-technology simulation by the facilities, 13 (92.9%) use it for teaching and learning experiences. Half (seven) of the facilities also use it for summative assessment, and eight (57.1%) use it for formative assessment.

The majority of the facilities follow and incorporate the typical steps of a simulation session (Table 4.13). Five also indicated that a “dry-run” (or practice run) of the simulation experience would be done beforehand to make sure that everything works as expected, including all technical elements.

Table 4.13: Typical steps during a high-technology simulation (n=14)

Steps in high-technology simulation	Total	Percentage
Lesson/presentation	9	64.3%
Pre-briefing	9	64.3%
Simulation experience	12	85.7%
Debriefing	10	71.4%
Repeat the simulation	10	71.4%
Other - Programme still being developed	1	7.1%

In most cases, these high-technology simulation experiences are for skills training (Table 4.14). Comments added by respondents were that cases are developed either by or in conjunction with discipline experts (lecturers) (n=7), and these will be in line with their respective outcomes.

Table 4.14: Types of high-technology simulation used (n=14)

Types of high-technology simulation	Total	Percentage
Skills training	13	92.9%
Simulation (with facilitator guiding)	12	85.7%
Self-directed learning and feedback	7	50.0%
Simulation (without facilitator)	3	21.4%

General remarks about integration with the curriculum were that the use of high-technology simulation is already part of the curriculum, and aligned with the theory and outcomes (n=2). In some cases (n=4) the curriculum is in the process of being adapted to ensure the usage of simulation as a teaching modality.

4.8 PHYSICAL ENVIRONMENT

Nine (64.3%) of the facilities were custom built as simulation facilities, and the other five utilise pre-existing spaces allocated to them.

Table 4.15 indicates the physical spaces used by the facilities to conduct high-technology simulations. In most cases (12, 85.7%) dedicated rooms are available for simulations, but only three (21.4%) have separate, dedicated debriefing areas.

Table 4.15: Availability of physical spaces (n=14)

Classification	Frequency	Percentage	Median number where present	Range
Dedicated simulation rooms	12	85.7%	2.5	1 – 6
Skills training area	11	78.6%	3	1 – 8
Lecture halls	7	50.0%	3	1 – 8
Interchangeable rooms	6	42.9%	3	1 – 14
In situ rooms	4	28.6%	3.5	3 – 8
Dedicated debriefing rooms	3	21.4%	1	1 – 5
Flat screen (computer lab)	2	14.3%	1.5	1 – 2
Other – Cubicles with curtains around beds	1	7.1	4	4 – 4

Eight (57.1%) of the simulation facilities have control/observation rooms. Six (75%) use separate rooms than the areas where the simulation experience takes place. One (12.5%) has the control/observation area in the same room as the simulation area, and the others (12.5%) have a mix of separate and combined areas for control/observation.

With regards to audio-visual equipment, 11 (78.6%) facilities use it to stream or record some or all of the high-technology experiences in the facility. In ten (71.4%)

instances, these are recorded for later viewing, and four (28.6%) facilities also have the capabilities to stream the simulations to observers in a separate room.

Seven of the 14 (50%) facilities indicated that they have separate spaces for debriefing. The physical space used for debriefing by these seven is approached in three ways. These are debriefing in a separate space from the experience each time (utilised by four facilities), debriefing in the same room as the experience each time (not utilising the separate space) (utilised by four facilities), and utilising both a separate room and the same room as the experience (utilised by four facilities). The other seven debrief in the same room as the simulation experience.

Commenting on the physical space elements of their respective facilities, two respondents indicated that they are able to move their high-technology manikins around and as the need arises. One indicated that they are faced with technical difficulties such as poor sound quality in a new building. Another mentioned that they would be expanding to a new building in the near future.

4.9 RESEARCH OUTPUTS AND HIGH-TECHNOLOGY SIMULATION

Six (42.9%) of the facilities are utilised in support of the institution's research outputs. These research outputs can be divided into research "in a health profession discipline utilising high-technology simulation" and "about simulation or high-technology simulation". In both these cases, five (out of six) (83.3%) facilities are producing research outputs.

In the facilities with research outputs, the involvement of the simulation staff for research outputs is mainly as post-graduate examiners or post-graduate study leaders (five each). In four facilities, research outputs are via publication of research in journals, and in three instances, it is post-graduate students using high-technology simulation equipment for research.

One respondent commented that research is still on the *"to-do list*" for their facility and is being planned for the future.

4.10 CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

Four out of fourteen (28.6%) respondents were involved in their respective facility's initial setup. Each of these respondents (n=4) had to list up to five specific challenges (open question) they experienced with the initial setup of the facility. These five aspects were ranked (most important = 5 and least important = 1). The aspects were combined into themes and are reported on in Table 4.16.

Table 4.16: Specific challenges with initial setup (n=4)

Challenges	**N[1]**	**Median rank[2]**	**Range**
Sharing space with another department	1	5	5 - 5
Finding appropriate space, infrastructure issues and layout	4	4	1 - 5
Technical difficulties with PCs	3	4	3 - 5
Meeting educational goals and expectations	2	4	4 - 4
IT support not available	1	3	3 - 3
No discipline-specific programme available	2	2.5	2 -3
Budget constraints	3	2	1 – 3
Lack of trained staff		2	2 - 2

1: Number of responses for an aspect
2: Ranking: most important = 5 and least important = 1

Other general challenges experienced during the initial setup of the facilities (n=4) are listed in Table 4.17. These were given as a list to select from and not as an open question. They were also not ranked.

Table 4.17: General challenges experienced during initial setup (n=4)

Challenges	Frequency	Percentage
Lack of trained staff	4	100%
Lack of human resources	3	75%
Additional workload	2	50%
Lack of time	2	50%
Inadequate space and equipment	2	50%
Lack of financial support	2	50%
Applicability to curriculum	1	25%
Maintenance of technology	1	25%
Fear of technology	1	25%
Insufficient technology	1	25%

Each respondent was asked to list up to five specific challenges (open question) experienced with the day-to-day running of the facility. These five aspects were ranked (most important = 5 and least important = 1). The aspects were combined into themes and are reported on in Table 4.18. Two respondents did not complete the question.

Table 4.18: Specific challenges during day-to-day running (n=12)

Challenges	N[1]	Median rank[2]	Range
Large student groups	5	5	1 – 5
Lack of trained simulation staff	12	4	2 – 5
Lack of time	9	4	1 – 5
Complexity of technology	1	4	4 – 4
Cost of equipment and maintenance	5	4	1 – 5
Poor communication from lecture staff	2	3.5	3 – 4
Integration into curriculum	2	3.5	3 – 4
Lack of space	2	3	1 – 5
Lack of documentation (protocols)	1	2	2 – 2
Limited technical knowledge for setup and use	4	2	2 – 3

Table 4.18: Specific challenges during day-to-day running (n=12) (Continued)

Challenges	N[1]	Median rank[2]	Range
Lack of technical support	3	2	1 – 5
Lack of storage space	1	1	1 - 1

1: Number of responses for an aspect
2: Ranking: most important = 5 and least important = 1

Other general challenges experienced during the day-to-day operational running of the facilities (n=14) are listed in table 4.19. These were given as a list to select from and not as an open question nor ranking.

Table 4.19: General challenges experienced during day-to-day running (n=14)

General challenges	Frequency	Percentage
Lack of human resources	12	85.7%
Lack of time	11	78.6%
Lack of trained staff	10	71.4%
Lack of financial support	9	64.3%
Maintenance of technology	9	64.3%
Additional workload	7	50.0%
Fear of technology	6	42.9%
Applicability to curriculum	5	35.7%
Inadequate space and equipment	5	35.7%
Insufficient technology	2	14.3%

Respondents were asked what approach (if any) they take to alleviate the day-to-day challenges (Tables 4.18 and 4.19). Six indicated that they are planning and budgeting for additional simulation training for staff. This training includes technical training for using high-technology manikins correctly and effectively, as well as for general maintenance. One respondent indicated that they plan training in collaboration with other simulation facilities to share knowledge. Three respondents indicated that they need more physical space. One had been successful in motivating for it by using the facility's usage statistics, so the facility will be expanding in the near future.

Two indicated that they work closely with discipline-specific staff and lecturers (from other departments) to help create the scenarios well in advance in order to avoid rushing it later. These “outside” staff also helps to run the scenario in the simulation facility. Three of the facilities motivate for additional, dedicated staff on an annual basis to try and alleviate the shortage of staff. One mentioned that in these motivations, they also request additional time in the students’ schedule to utilise simulation.
Two respondents commented on the challenges of high-technology simulation. One re-iterated the expensive equipment. The other said that learning objectives must be clearly defined and that high-technology could be distracting (“nice to play with but not always the best teaching tool”), and that medium-fidelity will often achieve the same goals for the students’ teaching.

4.11 CONCLUSION

The objective of the questionnaire survey was to establish the operational approach and identify the challenges experienced regarding high-technology clinical simulation at public, accredited health professions training institutions in South Africa.

The results of the questionnaire showed that most participating simulation facilities have some form of high-technology simulation, and that the majority of these high-technology facilities are not stand-alone units but part of another department.

Institutional budget allocation and government education grants are the major sources of income for high-technology simulation at the institutions. With regard to staffing allocation, it was indicated that multiple roles are covered by the same staff members (“multi-tasking”). Some stand-alone facilities use staff on an *ad hoc* basis to assist with simulations.

In most facilities there will be a facilitator in the room to guide the students during simulations. In a few institutions however simulations take place without a facilitator in the room.

With regard to utilising separate debriefing areas from where the simulation activity had taken place, the split between the two options is even. While most facilities have audio-visual recording, the minority uses it to stream the simulation activity to a separate observation room.

Large student groups, a lack of time for simulation activities and a lack of trained simulation staff are some of the most frequent challenges being faced by the high-technology simulation facilities in South Africa.

The results of the questionnaire were used to inform the Delphi survey, and the results of the Delphi survey will be reported on in the next chapter, ***Chapter 5: Results of the Delphi survey***

CHAPTER 5
RESULTS OF THE DELPHI SURVEY

5.1 INTRODUCTION

In the previous chapter, the results of the questionnaire survey were presented. In this chapter, the results of the Delphi survey will be presented. The survey was conducted over three rounds between September 2019 and April 2020, using the process described in paragraph 3.3.3 (*cf.* Figure 3.3). Ten potential simulation experts were identified by the researcher and promotor, and approached to take part in the Delphi survey. Eight experts responded and took part with two not responding to the invitation. All eight participants are simulation education experts with varying background expertise, each covering multiple disciplines. Seven are based in South Africa and one outside South Africa. Three have backgrounds in medicine, three in nursing, and four in emergency care. Two have additional technical background. One expert (emergency care) did not participate in round three.

The results will be presented according to the six themes of the Delphi questionnaire:

- Management
- Funding
- Staffing and staff development
- Curriculum integration
- Physical simulation environment
- Research

Each theme was divided into two main areas. The first was general statements on the specific theme, and the second was the participants' opinions on possible solutions to challenges identified in the questionnaire survey.

Statements were added or in some cases amended (for reasons of clarity) between rounds, based on feedback from the participants. The results are reported on in the order that the questions were presented to the participants. During rounds one and two, the n value was eight, and in round three (where stability was reached), it was seven. In instances where everybody did not respond to a statement, the n value is given next to the percentage. In some cases where stability was reached, two or three response options received an equal number of votes. In these cases, all the relevant results are listed, as well as the percentage obtained. To improve the readability of the tables, each result (essential, optional, and not necessary) is highlighted in a different shade of aqua, and instances where stability was reached are in purple.

Participants were able to comment on any of the statements presented to them. These comments will be reported at each theme.

5.2 MANAGEMENT

During round one of the survey, the management theme consisted of 33 statements. Two additional statements were added in round two after feedback from the participants. Consensus was reached in 29 (82.9%) statements, with six reaching stability (17.1%).

5.2.1 General statements regarding management

Table 5.1 summarises the results of the general statements. Most of the listed documents were considered essential and, in most cases, consensus was reached in round one.

Table 5.1: Outcomes of the general statements regarding management

Statement	Result	Round[1]	Percentage[2]
How important is it to have a stand-alone, high-technology simulation unit vs being part of another department?			
Stand-alone unit	Optional	R3	85.7%
Indicate the importance of the documents (listed in alphabetical order) for the successful management of a high-technology simulation unit.			
Financial plan	Essential	R1	87.5%
Goals and strategies	Essential	R1	87.5%
Mission statement	Essential	R1	75%

Table 5.1: Outcomes of the general statements regarding management (continued)

Statement	Result	Round[1]	Percentage[2]
Indicate the importance of the documents (listed in alphabetical order) for the successful management of a high-technology simulation unit.			
Needs analysis	Essential	R1	75%
Organogram	Essential	R2	75%
Performance indicators for the unit	Essential	R1	100%
Policy document	Essential	R1	75%
Quality assurance	Essential	R1	75%
Staff development plan	Essential	R1	75%
Staff succession plan	Essential	S	57.1%
Standard operation procedures	Essential	R1	87.5%
Statistics of facility usage	Essential	R1	75%
Stock management plan	Essential	R1	87.5%
Student feedback forms	Essential	R1	87.5%
SWOT (strength, weaknesses, opportunities and threats) analysis	Essential	R2	75%
Vision statement	Essential	R1	87.%
"Suspension of disbelief" contract (to clarify the nature of simulation, expected behaviour of students and confidentiality agreement)[3]	Not necessary	S	57.1%
Simulation design template (standard template recording detail planning of a simulation session)[3]	Essential	R2	87.5%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: Added in round two

5.2.1.1 Comments on general statements regarding management.

5.2.1.1.1 Stand-alone units

The participants had a wide range of opinions on the value (or not) of a stand-alone facility. The advantages of having a simulation facility as part of an existing department (not stand-alone) included the fact that there is increased access to specialised staff and resources that are already established (n=3). It could also be more practical with regards to access to a specific department without having to go to an external, stand-alone facility (n=1). A disadvantage pointed out was the potential limitations of point-of-care and teamwork simulations (n=1). The main advantages of having a stand-alone facility as pointed out by the participants were the fact that resources (staff and equipment) can be shared and do not need to be duplicated amongst different departments (n=3). It was also pointed out that stand-alone facilities can be easier to access for different departments, and utilised by many (n=3). Being a stand-alone unit also has the benefit of aligning teaching, learning and assessment frameworks amongst the different departments (n=1). One participant pointed out that simulation usually starts out in one department, and then as the program grows and other departments are needed for more complex scenarios, these will evolve into stand-alone facilities.

5.2.1.1.2 Documentation

Regarding documents, the participants highlighted a number of aspects. One of the most important aspects is the needs analysis, as this is the basis of how decisions will be made (n=3) and must be reviewed annually to adapt to the changing needs of the students (n=1). Finances should not be the driver for high-technology simulation (n=1), and financial planning is essential due to the high cost of high-technology simulation (n=4). Goals and strategies are needed in order to align the facility with the larger curriculum and teaching and learning strategies (n=2). The mission and vision statements will ensure that staff members work towards a common outcome, and the aim of the facility will be clear to the clients (n=3). This will underpin the facility’s day-to-day activities and can be used as a marketing tool for further expansion (n=3). An organogram is an important tool for an overview of where a facility fits in the larger organisation. It also indicates designated members and reporting structures (n=4). Performance indicators are essential as these are needed to measure the success of a facility and ensure future growth (n=3). This ties into the importance of facility usage statistics as evidence to obtain higher budgets (n=1).

Staff development plans and staff succession plans are important for future growth and stability during staff turnover at a facility (n=2). One participant added that if simulation is not part of the curriculum, but rather a “nice-to-have”, then a staff succession plan is not that important. The development of standard operation procedure (SOPs) documents and SWOT analyses are ongoing processes during the lifetime of a facility (n=2). The SOPs are important for trainees to know what is expected of them (n=1), while a SWOT analysis is only important if the facility is not functioning optimally (n=1).

Student feedback forms are important to show the facility where its strengths and weaknesses lie, and where to expand (n=2). One participant noted that the “suspension of disbelief” is an essential contractual relationship that is foundational to establishing psychological safety for the learner, and it clarifies what the learners can expect from the simulation and what is expected of them as learners. However, other participants (n=3) noted that this does not have be formalised in a document and can be part of the students’ orientation to simulation. It was noted (n=2) that the simulation design template helps to keep everyone on the same page when planning a simulation experience, and it creates an important framework for communication. It should include sufficient elements to ensure validity, trustworthiness and authenticity of the case, while it ensures sufficient scaffolding that will meet the needs of the participants (n=1).

5.2.2 Proposed solutions to management challenges

Management challenges identified during the questionnaire survey were presented to the participants with possible solutions to them. The results of these are reported on in Table 5.2. Most of the proposed solutions were considered essential.

Table 5.2: Solutions to management challenges for high-technology simulation

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering addressing the challenges caused by a lack of **management documents** (financial plan, goals and strategies, mission statement, organogram, policy document, quality assurance, SWOT analysis, vision statement).			
Input from simulation staff when creating the document(s) (bottom-up approach)	Essential	R1	87.5%
Adapt existing institutional document	Optional	R1	75%
Only management staff should have input when creating this document(s) (top-down approach)	Not necessary	R1	75%
Training for simulation staff regarding the content of the document(s)	Essential	R1	75%
Distribution of document content to external stakeholders (vendors)	Optional	S	42.9%

Table 5.2: Solutions to management challenges for high-technology simulation (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering addressing the challenges caused by a lack of **management documents** (financial plan, goals and strategies, mission statement, organogram, policy document, quality assurance, SWOT analysis, vision statement).			
Distribution of document content to clients (students/learners)	Essential	S	71.4%
Distribution of document content to institutional stakeholders (external lecturers and heads of other departments)	Essential	R3	85.7%
Annual review of the document(s)	Essential	R1	75%
In your opinion, indicate how important the following are, when considering addressing the challenges caused by a lack **operational documents** (needs analysis, performance indicators, staff development plan, staff succession plan, standard operation procedures, statistics of facility usage, student feedback forms).			
Input from simulation staff when creating the document(s) (bottom-up approach)	Essential	R1	87.5%
Adapt existing institutional document	Optional	S	57.1%
Only management staff should have input when creating this document(s) (top-down approach)	Not necessary	R2	87.5%
Training for simulation staff regarding the content of the document(s)	Essential	R1	100%
Distribution of document content to external stakeholders (vendors)	Essential	S	42.9%
Distribution of document content to clients (students/learners)	Essential	R1	75%
Distribution of document content to institutional stakeholders (external lecturers and heads of other departments)	Essential	R3	87.5%
Annual review of the document(s)	Essential	R3	87.5%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.

5.2.2.1 Comments on challenges regarding management.

5.2.2.1.1 Lack of documents

The comments from the participants for both the lack of management documents and operational documents were closely aligned. Input from simulation staff is essential for input in both management documents as well as operational documents, as this will create a sense of ownership (n=3). A top-down approach with input only from management is not ideal (n=6), and consultation should always take place with the end users of any documents. It is important to refer to institutional documents when creating operational or management documents, as alignment between the simulation facility and the larger institution is vital (n=3). One participant also added that it might be difficult to adapt institutional documentation for a small facility.

Training of staff in the contents of documents can be done while the documents are in development, and then the training should be linked to a staff training initiative (n=1). This training is vital to ensure that all staff is on the same page, and that there is no ambiguity or misinterpretation of any part of a document (n=2). Distribution of documents should only be to the relevant sector (vendors, students, external lecturers, etc.) (n=8), but should be accessible for anybody if they wish to access it (n=1). An annual review of the documents is essential (n=4), especially in a changing environment with regard to available technology (n=1), change in usage patterns (n=1), financial matters (n=1), and goals and strategies (n=1).

5.3 FUNDING

The funding theme consisted of 46 statements. During the three rounds, consensus was reached on 26 (56.5%) statements while 20 (43.5%) reached stability. No additional statements were added during the survey.

5.3.1 General statements regarding funding

Table 5.3 summarises the results of the general statements. In most cases, the items were deemed essential.

Table 5.3: Outcomes for the general statements regarding funding

Statement	Result	Round[1]	Percentage[2]
Indicate the importance of the following when choosing a **funding model** for high-technology simulation for long term sustainability.			
Internal, institutional funding	Essential	R1	85.7%
Government grants	Essential	R2	75%
Third stream, external sources	Essential	S	42.9%
Consortium model	Optional	R2	75%
Research funding	Optional	S	42.9%
Combination of different models	Essential	R1	87.5%
Corporate sponsorships	Optional	S	57.1%
Indicate the importance of having an **own financial management** as opposed to being governed by other institutional processes.			
Own financial committee	Essential	R1	75%
Own procurement policy	Essential	S	71.4%
Own financial standard operating procedures (SOPs)	Essential	R3	85.7%
Indicate the importance of the following aspects when choosing vendors for a high-technology simulation equipment.			
Adherence to financial regulations of training institution	Essential	R1	87.5%
After sales care, training and support should be provided	Essential	R1	100%
Cost of initial equipment	Essential	S	71.4%
Cost of consumables, replacements and upgrades	Essential	R2	75%
Cost of software licence subscriptions	Essential	S	71.4%
Quality and durability	Essential	R1	87.5%
Product must address training needs	Essential	R1	100%
Availability of equipment locally (South Africa)	Essential	R2	75%
Availability of equipment internationally	Optional	R1	75%
Usage across multiple disciplines	Essential	R1	87.5%
Ease of use and compatibility	Essential	R1	100%
Initial training in using the equipment/high fidelity simulators	Essential	R1	87.5%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.

5.3.1.1 Comments on general statements regarding funding.

5.3.1.1.1 Sources of funding

One participant commented that internal, institutional funding is important for the basic, operational running cost, while another stated that it is important to get this funding before the development of a high-technology simulation facility. Although one participant added that clinical training grants (government grants) are important, two other stated concern about the lengthy process involved to secure these grants, and mentioned that it cannot be relied upon for operational running costs and *ad hoc* staff of a facility. Concerns were raised about third stream income viability as it takes a long time to establish (n=1) and is seen as a nice-to-have option (n=1). Policies and procedures should also be in place to make sure it is above board and accounted for (n=1). The fact that third stream activities may occur infrequently was also raised as a concern, as it will not allow for a steady, constant stream of income (n=1). It was commented that when a high-technology simulation facility is planned, research should be part of the development plans (n=1). The challenge is that research funding takes time to establish (n=3). The potential for research with high-technology simulators is high as the high-technology simulators lend themselves to accurate, high quality data capture (n=1). Two participants raised concerns regarding corporate sponsorships. The first concern was the potential ethical aspects of promoting one funder over another. Another concern was the fact that it is difficult to secure corporate sponsorship as an ongoing source of income. One participant added that it might be useful for once-off projects or events to secure capital items. A combination of funding models is optimal, and should cover different aspects of the financial sustainability of a facility (n=3).

It was re-iterated by two participants that high-technology simulation should not fund itself, as this will shift the focus from teaching and learning to a more business-like approach that will negatively impact the number of students being trained in the pursuit of external funds.

5.3.1.1.2 Financial management

Regarding the importance of independent financial management as opposed to being governed by other institutional processes, the comments from the participants on the three statements were very closely aligned. It is stated that although independence is preferred, it is not completely possible as the facility's financial committees, policies, and SOPs need to adhere and be aligned to the larger institution's financial management (n=6). However, frustration was indicated on being governed by the larger institutional financial management by four participants. The example given is the fact that high-technology simulation requires unique, specialised equipment, and cumbersome financial processes hinder and slow down the procurement and import of such items (n=3). Another example was that non-simulation decision makers find it difficult to understand the expenses involved in a high-technology simulation facility (n=1). A hybrid model, where some form of independence is given to the facility, while still being aligned to the larger financial policies, was proposed by four participants.

5.3.1.1.3 Vendors

Considering aspects when choosing vendors for high-technology simulation equipment, three participants commented that after-sales care, training and support are essential. Another important aspect is the cost of initial equipment (n=3), but that is dependent on the available budget (n=1). As most high-technology simulators are imported to South Africa, a fluctuating exchange rate becomes a real challenge with regard to cost and budgeting (n=1). One participant noted that in their experience it is most often better to buy the more expensive simulator as it usually lasts longer. The cost of consumables, replacements and upgrades must be clarified before purchasing the simulator, as this will impact future running costs (n=1). The decision on the software license subscriptions depends on the available budget (n=1) and what model is used, i.e. how many PCs it is allowed to run on, and whether it is a once-off cost or has to be renewed annually (n=1). Another participant added that software licence renewal is sometimes a challenge due to the fact that in the initial purchase was a capital expense, but the subsequent renewal is a totally different process in their financial management model.

5.3.1.1.4 Equipment

Three participants re-iterated that any purchased equipment must address the training needs of the facility. Higher quality simulators are preferred as they last longer even if they are more expensive. Two participants commented that due to the high cost of high-technology simulators, it is essential that these should be able to address the needs of multiple disciplines. Another participant commented that although usage across multiple disciplines is preferable, it is not always possible as there are high-technology simulators that apply only to one discipline.

Regarding ease of use and compatibility, one participant added that this is essential to their facility, while another one stated that compatibility should also be about building a simulation system where the same software is used across multiple simulators, as a single system ensures ease of use and reduced complexity. Initial training is essential, and two participants commented that training should be continued and repeated.

5.3.2 Proposed solutions to funding challenges

In Table 5.4 the results are presented of the proposed solutions to funding challenges identified during the questionnaire survey. In most cases the proposed solutions were considered essential by the experts.

Table 5.4: Solutions to funding challenges for high-technology simulation

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering addressing the challenges caused by a **lack of financial support**.			
Increase third stream income	Essential Optional Not necessary[3]	S	33.3% (n=6)
Procure cheaper equipment (cut back on capital expenditure)	Optional	S	66.7% (n=6)
Procure cheaper consumables (cut back on operational expenses)	Optional	R3	83.3% (n=6)
Partnerships with vendors for increased sponsorships	Essential	S	66.7% (n=6)
Cut back on staff expenditure	Not necessary	R1	75%
Student accounts billed additionally (simulation lab fee)	Not necessary	R2	75%
Charge department who use the facility per sessions presented	Not necessary	S	42.9%
Charge departments who use the facility per student using the facility for simulation training	Optional	S	57.1%
In your opinion, indicate how important the following are, when considering **increasing return on investment** (expensive equipment not being used optimally).			
Increase the number of students in each simulation experience	Not necessary	S	71.%
Due to large number of students, in some cases some students might only be observers of a simulation experience. With this in mind: Increase the number of simulation experiences by reducing the number of observing students and more "hands-on" participants for each experience	Essential	S	42.9%
Rent out equipment to external partners for third stream income	Not necessary	R1	75%
Staff to host additional third stream income generating simulations	Essential	S	57.1%
Utilise *ad hoc* staff to host third stream income generating simulations	Essential	S	57.1%
In your opinion, indicate how important the following are, when considering the high cost of **capitalisable equipment.**			
Remove maintenance contracts on technology equipment	Not necessary	S	57.1%
Buy models that are used by a number of disciplines but might not be as specialised as others (used by more students)	Essential	R3	85.7%
Focus only on specialised equipment (used by less students)	Not necessary	R2	75%

Table 5.4: Solutions to funding challenges for high-technology simulation (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering the high cost of **capitalisable equipment.**			
Partnerships with departments whose students utilise high-technology simulation to share costs	Essential	R3	85.7%
Adapt simulation experiences to use with medium- or low-technology simulators	Essential	R1	75%
Hire or obtain sponsored equipment from companies on an *ad hoc* basis e.g. for specific courses instead of buying the equipment.	Optional	S	71.4%
In your opinion, indicate how important the following are, when considering the high cost of consumables.			
Use cheaper alternatives that is not supported by the vendor	Optional	S	71.4%
Adapt simulation experiences to use with medium- or low-technology simulators with cheaper consumables	Essential	R1	75%
Increase number of students observing and less that actually take part in the experience (reducing wear and tear on simulator)	Not necessary	R1	75%
Negotiate for external sponsors of simulators	Essential	S	71.4%
Partnerships with departments whose students utilise high-technology simulation to share costs	Essential	S	71.4% (n=7)

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: An even split between two or three options

5.3.2.1 Comments on funding challenges

5.3.2.1.1 Funding sustainability

A participant commented that sustained funding after the initial establishment of a facility is important for sustained, high-quality training. Another comment was that simulation should be formally structured into a clinical programme, which would allow it to qualify for clinical and research grants.

Regarding third stream income, the feedback was mixed. One participant noted that it is important to become self-funded, while another remarked that a facility's focus should be on teaching and learning activities of its own students, rather that becoming a business where these activities are shifted to the background. On the topic of potentially buying cheaper equipment and consumables, it was noted by two participants that this might lead to lower quality equipment and consumables, making replacement more expensive in the long term. One participant noted that it might be prudent to rather start slowly when buying new capital equipment, and make sure that it aligns with the facility's mission and vision and needs. It was also commented that in some cases simulator-specific consumables are dictated by the brand and might not be an option that is negotiable. This should be kept in mind when buying the simulator (n=1).

To charge students for the use of the facility, either directly through a department per session, or per student, was generally discouraged in the comments (n=5). This might discourage the use of the high-technology simulation facility (n=3), and become a barrier to learning. It can also lead to additional overhead financial administration tasks (n=3). If the decision is made to do this, however, it should rather be part of general lab or tuition fees (n=2).

5.3.2.1.2 Vendor partnerships

Although the importance of partnerships with vendors was highlighted (n=2), it was also mentioned that most of the vendors in South Africa are owned by parent companies abroad, and the South African branches do not always have authority to negotiate partnerships (n=2).

5.3.2.1.3 Equipment cost

It was commented that the key element for maximum return on investment is to maximise the use of equipment through maximised learning through active participation (n=1). To increase the number of students for a simulation experience would dilute the learning platform (n=1). Three other comments were the fact that simulation is a small-group learning activity, and student numbers should not be increased for each simulation experience. Four participants commented that increasing the number of simulation experiences is a good option, but it might lead to raised staff costs due to increased contact time (n=1) and will not be feasible in all cases (n=1).

Renting out equipment was not considered as a feasible option. Four participants commented that this leads to damaged equipment and higher costs in the long run. One added that simulation facilities should not be required to earn funds from outside sources as this leads to a shift to incorrect priorities.

Sharing the cost amongst departments whose students utilise high-technology simulation is a good idea, but not always very practical (n=3). Each situation is unique, and guidelines need to be negotiated and agreed upon by all departments involved (n=1).

5.3.2.1.4 Equipment use

It was commented that equipment should be ready to work at any time, so the maintenance contracts are particularly important (n=2). This is also dependent on the contract with the vendor and the capital outlay (n=2). Regarding the decision on high-technology simulators that can be used by more than one discipline versus specialised simulators, it will be dependent on the needs analysis (n=4). Although specialised simulators might not be good value compared to the number of students that can utilise them, they are generally needed for post-graduate programmes and should therefore be considered (n=2).

To adapt a simulation experience to use medium or low technology will depend on the objectives that need to be achieved (n=1), but might lead to a less realistic experience. (n=1). Two participants also commented that utilising medium- and low-technology simulators can be more cost-effective with more or less the same educational results in some cases. Five comments were made on the possibility to rent or obtain sponsored equipment from companies on an *ad hoc* basis. The comments were mainly reservations about this, as it might be too expensive (n=1), the possibility exists that a simulator is not available when needed (n=1), and it is not cost-effective for companies in South Africa to do this (n=2). One stated that it is a good idea, especially if the training staff of the company can be utilised as well.

When considering the use of cheaper alternative consumables not supported by the vendor, one participant commented that this should only be done for low-technology consumables, while three others said that it should only be done if it does not compromise the learning. Three commented that to adapt a simulation to a low- or medium-technology simulation is fine if it is still appropriate for the learning outcomes. To increase the number of students observing and not actively participating in a simulation should be avoided, as not all students get the same experience from the simulation. The funding models should also support learner-centred education (n=3).

5.3.2.1.5 Staffing costs

Cutting back on staff expenditure was commented on by five participants, and was not advised. Three noted that understaffing in South Africa with regard to high-technology simulation is already an issue, and the pressure on staff will increase if the staff is cut further. One participant commented that staff hosting additional third stream income-generating simulations might be a good idea. However, three had reservations regarding this aspect, with one stating that it is not a good idea, and another that it will depend on staff capacity. One added that they used to do this, but the overhead in administration and follow-up became too cumbersome and time-consuming to make it worthwhile. To utilise *ad hoc* staff for the third stream income activities was also not considered a good idea (n=2). Two other participants added that it would depend on the competencies and training of the *ad hoc* staff, and where such training is lacking, this burden would fall back on the permanent staff (n=1).

5.4 STAFFING AND STAFF DEVELOPMENT

The staffing and staff development theme consisted of 55 statements. Consensus was reached in 31 (56.4%) statements while 24 (43.6%) reached stability. No additional statements on this aspect were added during the survey.

5.4.1 General statements regarding staffing and staff development

Table 5.5 summarises the results of the general statements on staffing and staff development. In the majority of cases, the items were considered to be essential.

Table 5.5: Outcomes of the general statements regarding staffing and staff development

Statement	Result	Round[1]	Percentage[2]
Indicate the importance of the following staff designations **for providing effective high-technology simulation** in a facility.			
Simulation facility head(s)/manager	Essential	R1	75%
Lecturers as simulation facility staff	Essential	R2	75%
Lecturers *ad hoc* from other departments	Optional	S	71.4%
Scenario facilitators	Essential	R1	87.5%
Debriefing facilitators	Essential	R1	87.5%
Administrative	Essential	R2	87.5%
Technical	Essential	R1	100%
Dedicated permanent IT staff member(s) in facility	Essential	R2	75%
Operational set-up staff	Essential	R3	100% (n=6)
Simulated patient (SP) co-ordinator	Optional	S	71.4%
Indicate the feasibility of having an in-house vs external **training programme** for the following **staff designations** for high-technology simulation.			
In-house:			
Simulation facility head(s)/manager	Essential	R2	75%
Lecturers (simulation facility staff)	Essential	R2	75%
Lecturers *ad hoc* from user departments	Essential	R1	75%
Scenario facilitators	Essential	R1	75%
Operational set-up staff	Essential	R1	87.5%
Technical staff	Essential	R1	75%
Administrative staff	Essential	R1	75%
Debriefing facilitator(s)	Essential	R1	75%
Co-ordinator for standardised patients (recruitment, payment and training)	Essential Optional[3]	S	50% (n=4)
Single simulation course covering multiple aspects of staff designations	Optional	S	60% (n=5)
External			
Simulation facility head(s)/manager	Essential Not necessary	S	40% (n=5)
Lecturers (simulation facility staff)	Optional	S	50% (n=4)
Lecturers *ad hoc* from user departments	Essential Optional	S	50% (n=4)
Scenario facilitators	Essential Optional	S	50% (n=4)
Operational set-up staff	Essential	S	50% (n=4)
Technical staff	Essential	S	60% (n=5)
Administrative staff	Optional	S	50% (n=4)

Table 5.5: Outcomes of the general statements regarding staffing and staff development (continued)

Statement	Result	Round[1]	Percentage[2]
External			
Debriefing facilitator(s)	Essential	S	60% (n=5)
Co-ordinator for standardised patients (recruitment, payment and training)	Essential Optional Not necessary	S	33.3% (n=6)
Single simulation course covering multiple aspects of staff designations	Optional	S	60% (n=5)
Indicate the importance of including the following topics in a training programme for staff of high-technology simulation.			
Scenario planning	Essential	R1	100%
Scenario programming (on PC)	Essential	R2	87.%%
Simulation facilitation	Essential	R1	100%
Physical planning	Essential	R1	75%
Technical support	Essential	R2	75%
IT support	Essential	R2	75%
Debriefing	Essential	R1	100%
Moulage	Essential	S	71.4%
Ethics	Essential	R1	87.5%
Financial planning	Essential	S	42.9%
Management aspects	Essential	S	57.1%%
Co-ordinator for standardised patients (recruitment, payment and training)	Essential	S	71.4%
Annual refresher courses	Essential	R1	75%
Application of specific training by vendor	Essential	R1	85.7% (n=7)

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: An even split between two or three options

5.4.1.1 *Comments on general statements regarding staffing*

5.4.1.1.1 Staff designation

Comments made regarding the staff designation mainly focused on the experience and training of the staff involved. It was mentioned that, ideally, clinicians should be the subject matter experts (using medicine as an example) (n=1), and that simulation staff must be well versed in educational theory (n=3). Two participants commented that simulation lecturers must have the needed skills to transfer knowledge as facilitators, rather than "one-way" speakers. Regarding *ad hoc* staff, one participant commented that they prefer not to make use of such staff (no reason given), while two others said that *ad hoc* staff must be highly skilled in their perspective disciplines and work closely with simulation staff when developing a simulation experience. It was commented that scenario and debriefing facilitators can interchange (or cross over) to meet the training needs, and can be done by the same person (n=2). One participant also said that debriefing facilitation is a scarce skill and an essential part of the simulation learning experience.

A general comment made on the staff designation was that there need not be a staff member for each specific designation, but that staff can fulfil more than one designation. The different roles are essential, however (n=1). Another added that sending staff to other simulation facilities is a good idea as this will lead to a diversification of ideas.

Two comments re-iterated that administrative staff is important due to the high number of logistical issues that need to be considered in a high-technology simulation facility. It was also stated that administrative staff should have a clinical background (n=1), while another added that administrative staff could be utilised to teach (with enough experience). They also act as a link to convey simulation teaching tips amongst instructors, as these instructors very seldom work together at the same time in the simulation facility. It was commented that the technical designation could be covered by the dedicated, permanent IT member (n=1), and is important for smooth running for the simulation (n=1). The need for a dedicated set-up staff component will depend on the size of the facility (n=1). One participant commented that the set-up could also be done by other simulation staff members together with the instructor of the particular session. The need for an SP co-ordinator will depend on the size of the facility (n=1) and the number of high-technology simulations that require standardised patient(s) (n=1).

5.4.1.1.2 Staff training

When considering training for the different designations, five participants commented that in-house training is preferred over external training, as it is more context-specific and easier to attend. It was, however, stated that due to the specialised nature of high-technology simulators, external training by vendors is essential (n=4). The decision on internal versus external training for any of the designations should be dependent on the quality of the training, available experience and skills that need to be transferred (n=3).

With regards to the topics covered by a training programme for high-technology simulation staff, a participant commented that although all topics are important, it should depend on the size and scope of the facility. Scenario planning and debriefing are, however, essential and should be included. Two comments on technical and IT support were that it should cover the configuration and setting up of simulators, as well as basic end-user troubleshooting and network connectivity skills.

On the inclusion of moulage skills as part of a staff training programme, one participant commented that moulage is overrated, especially in high-technology simulations where the intellectual aspect is important. Another participant stated that it is underrated in their setting and should be explored further, but should not overwhelm the students and distract them from the learning outcomes.

Annual refresher courses should only be done as needed for permanent staff (n=1). For application-specific training by a vendor, one participant added that this is important to maximise the use of a simulator or product. Another participant commented that vendor training should be included in the price of a new simulator, and the facility should not be charged additionally for this.

One participant commented that for ethical aspects it is important to focus on the ethics of simulation (consent, confidentiality, and care of manikins), and that financial planning should cover budgeting for maintenance, repairs and consumables.

5.4.2 Proposed solutions to staffing and staff development challenges

Proposed solutions to staffing and staff development challenges for high-technology simulation as identified during the questionnaire survey are presented in Table 5.6. In most cases the proposed solutions were considered to be essential by the experts.

Table 5.6: Solutions to staffing and staff development challenges for high-technology simulation

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are when considering addressing the challenges caused by staffing issues of high-technology simulation staff. These include **fear of technology** and **limited technical knowledge** on using simulators.			
Staff should not multi-task	Optional	S	57.1%
Dedicated permanent technical staff	Essential	R1	87.5%
Technical training for non-technical staff (who will then multi-task)	Essential	S	57.1%
Ad hoc (temporary or hourly) technical staff for simulation experience programming	Essential Optional Not necessary[3]	S	33.3% (n=6)
In your opinion, indicate how important the following are when considering addressing the challenges caused by **additional workload** on and **multi-tasking** of simulation staff in high-technology simulation units.			
More permanent staff should be appointed	Essential	R1	75%
Increased/improved high-technology simulation training programmes for staff (increased productivity)	Essential	R1	87.5%
Ad hoc (temporary or hourly) staff to address specific areas	Optional	S	57.1%
In your opinion, indicate how important the following are when considering addressing the challenges caused by **poor communication** between simulation and teaching and learning or clinical staff.			
More robust cross-departmental processes implemented (formalise and enforce communication between health professions departments (clients) and the simulation unit)	Essential	R2	87.5%
Dedicated simulation committee with teaching and learning members from other departments	Essential	R1	87.5%
High-technology training programme for non-simulation staff	Essential Optional	S	42.9%
High-technology simulation representative (or co-ordinator) in each department where students utilise high-technology simulation	Optional	S	57.1%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: An even split between two or three options

5.4.2.1 Comments on staff and staff development challenges

5.4.2.1.1 Staff structure

When proposing possible solutions to staff and staff development challenges, three participants commented that staff should be able to multi-task if they have the capacity. It was also commented that non-technical staff should have some level of technical training in case it is needed, but this should be limited to staff who are more interested in the technical aspects of simulations (n=2). With regards to *ad hoc* technical staff, one participant commented that this would be a cheaper way to run simulations while another stated that it is an option they should explore as they cannot motivate for full-time, technical staff. Three others commented that this a not a good idea. They stated that staff should be permanent and be part of the team that develops the simulation experience. One added that systems are too complex, the learning curve too steep and in some cases the usage too infrequent to justify *ad hoc* technical staff.

One participant commented that temporary staff and students are useful as standardised patients, and that senior students and recently retired clinicians can volunteer as teachers. Regarding *ad hoc* staff to address specific areas, three participants commented that this would not be ideal. *Ad hoc* staff would require additional training and potentially supervision too, and this will lead to additional workload (n=1). Areas where the *ad hoc* staff is utilised should not be specialised areas (n=2).

5.4.2.1.2 Technical orientation

Regarding a high-technology training programme for non-simulation staff, a comment was made that this could be in the form of orientation to the simulators and stressing the use of the right simulator for the right outcomes. This orientation should also include training in simulation design. Two participants commented that a high-technology simulation representative in each department is a good idea, but that it might not be feasible in every situation.

5.5 CURRICULUM INTEGRATION

The number of statements regarding the curriculum integration theme was 214. The reason for the high number of statements in this section is the fact that differentiation was made for each year group in a specific discipline as well as training, formative assessment and high-stakes summative assessment (as set out in Table 5.7). One additional statement was added during round two and another was removed. Consensus was reached in 117 (54.7%) statements while stability was reached in 97 (45.3%).

5.5.1 General statements regarding curriculum integration

Table 5.7 summarises the results of the general statements. In most cases, high-technology simulation was seen as essential to the training component, however, it depended on the year group of the students.

Table 5.7: Outcomes of the general statements regarding curriculum integration

Statement	Result	Round[1]	Percentage[2]
In your opinion, in which year of study does **Medicine** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential Not necessary[3]	S	50% (n=6)
Formative assessment	Not necessary	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	S	66.7% (n=6)
Year 2			
Training	Essential	S	50% (n=6)
Formative assessment	Not necessary	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	66.7% (n=6)
Year 3			
Training	Essential	R1	85.7% (n=7)
Formative assessment	Essential	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	S	66.7% (n=6)
Year 4			
Training	Essential	R1	100% (n=7)
Formative assessment	Essential	R2	75%
High-stakes summative assessment	Essential	S	42.9%
Year 5			
Training	Essential	R1	100% (n=7)

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, in which year of study does **Medicine** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Formative assessment	Essential	R3	100% (n=6)
High-stakes summative assessment	Essential	S	71.4%
Year 6			
Training	Essential	R1	100% (n=6)
Formative assessment	Essential	R3	100% (n=6)
High-stakes summative assessment	Essential	R3	85.7%
Post-graduate			
Training	Essential	R1	83.3% (n=6)
Formative assessment	Essential	R2	83.3% (n=6)
High-stakes summative assessment	Essential	R3	100% (n=6)
In your opinion, in which year of study does **Nursing** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Not necessary	S	50% (n=6)
Formative assessment	Not necessary	R1	80% (n=5)
High-stakes summative assessment	Not necessary	S	71.4%
Year 2			
Training	Optional	S	66.7% (n=6)
Formative assessment	Essential	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	S	57.1%
Year 3			
Training	Essential	R2	80% (n=5)
Formative assessment	Essential	R3	83.3% (n=6)
High-stakes summative assessment	Essential	S	71.4%
Year 4			
Training	Essential	R1	85.7% (n=7)
Formative assessment	Essential	R3	100% (n=6)
High-stakes summative assessment	Essential	S	71.4%
Post-graduate			
Training	Essential	R1	75% (n=4)
Formative assessment	Essential	R3	80% (n=5)
High-stakes summative assessment	Essential	R3	83.3% (n=6)
In your opinion, in which year of study does **Emergency care** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential	S	66.7% (n=6)
Formative assessment	Essential	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	42.9%
Year 2			
Training	Essential	R1	85.7% (n=7)

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	**Result**	**Round[1]**	**Percentage[2]**
In your opinion, in which year of study does **Emergency care** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Formative assessment	Essential	R3	83.3% (n=6)
High-stakes summative assessment	Essential Not necessary	S	42.9%
Year 3			
Training	Essential	R1	85.7% (n=7)
Formative assessment	Essential	R1	85.7% (n=7)
High-stakes summative assessment	Essential	S	71.4%
Year 4			
Training	Essential	R1	100% (n=7)
Formative assessment	Essential	R1	85.7% (n=7)
High-stakes summative assessment	Essential	S	71.4%
Post-graduate			
Training	Essential	R1	100% (n=7)
Formative assessment	Essential	R3	100% (n=6)
High-stakes summative assessment	Essential	R3	83.3% (n=6)
In your opinion, in which year of study does **Physiotherapy** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Not necessary	S	50% (n=6)
Formative assessment	Not necessary	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	S	66.7% (n=6)
Year 2			
Training	Essential Optional Not necessary	S	33.3% (n=6)
Formative assessment	Optional	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	50% (n=6)
Year 3			
Training	Essential	R1	83.3% (n=6)
Formative assessment	Essential	S	66.7% (n=6)
High-stakes summative assessment	Optional	S	42.9%
Year 4			
Training	Essential	R1	83.3% (n=6)
Formative assessment	Essential	R1	83.3% (n=6)
High-stakes summative assessment	Optional	S	42.9%
Post-graduate			
Training	Essential	R2	100% (n=1)
Formative assessment	Optional	R2	100% (n=2)
High-stakes summative assessment	Essential	S	66.7% (n=6)

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, in which year of study does **Dietetics and Nutrition** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential Not necessary	S	50% (n=6)
Summative assessment	Not necessary	R1	75% (n=4)
High-stakes summative assessment	Not necessary	R2	83.3% (n=6)
Year 2			
Training	Essential Not necessary	S	50% (n=6)
Formative assessment	Not necessary	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	R2	83.3% (n=6)
Year 3			
Training	Optional	S	60% (n=6)
Formative assessment	Not necessary	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	66.7% (n=6)
Year 4			
Training	Essential	R1	83.3% (n=6)
Formative assessment	Essential	S	66.7% (n=6)
High-stakes summative assessment	Optional	S	50% (n=6)
Post-graduate			
Training	Essential	R2	100% (n=1)
Formative assessment	Essential	S	60% (n=6)
High-stakes summative assessment	Essential Not necessary	S	40% (n=5)
In your opinion, in which year of study does **Occupational therapy** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Not necessary	S	50% (n=6)
Formative assessment	Not necessary	R1	75% (n=4)
High-stakes summative assessment	Not necessary	R2	83.3% (n=6)
Year 2			
Training	Essential Not necessary	S	50% (n=6)
Formative assessment	Not necessary	S	50% (n=6)
High-stakes summative assessment	Not necessary	R2	83.3% (n=6)
Year 3			
Training	Essential	R1	80% (n=5)
Formative assessment	Not necessary	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	66.7% (n=6)
Year 4			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	S	50% (n=6)
High-stakes summative assessment	Optional	S	50% (n=6)

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, in which year of study does **Occupational therapy** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Post-graduate			
Training	Essential	R2	100% (n=1)
Formative assessment	Essential Not necessary	S	40% (n=5)
High-stakes summative assessment	Essential Not necessary	S	40% (n=5)
In your opinion, in which year of study does **Pharmacy** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential Not necessary	S	50% (n=6)
Formative assessment	Not necessary	R1	75% (n=4)
High-stakes summative assessment	Not necessary	R2	83.3% (n=6)
Year 2			
Training	Essential	S	50% (n=6)
Formative assessment	Not necessary	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	R3	83.3% (n=6)
Year 3			
Training	Optional	R2	75% (n=1)
Formative assessment	Essential	S	50% (n=6)
High-stakes summative assessment	Essential Optional Not necessary	S	33.3% (n=6)
Year 4			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R3	83.3% (n=6)
High-stakes summative assessment	Essential	R1	83.3% (n=6)
Post-graduate			
Training	Essential	R1	75% (n=4)
Formative assessment	Optional	R2	100% (n=2)
High-stakes summative assessment	Essential	S	60% (n=5)
In your opinion, in which year of study does **Radiography** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential	S	66.7% (n=6)
Formative assessment	Not necessary	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	50% (n=6)
Year 2			
Training	Essential Not necessary	S	50% (n=6)
Formative assessment	Essential Not necessary	S	50% (n=6)

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, in which year of study does **Radiography** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 2			
High-stakes summative assessment	Not necessary	S	50% (n=6)
Year 3			
Training	Essential	R1	100% (n=5)
Formative assessment	Essential	R2	85.7% (n=7)
High-stakes summative assessment	Essential	S	50% (n=6)
Year 4			
Training	Essential	R1	100% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Essential	R1	80% (n=5)
Post-graduate			
Training	Essential	R2	100% (n=1)
Formative assessment	Optional	R2	100% (n=3)
High-stakes summative assessment	Essential	R3	80% (n=5)
In your opinion, in which year of study does **Biokinetics** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential	S	50% (n=6)
Formative assessment	Not necessary	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	66.7% (n=6)
Year 2			
Training	Optional	S	66.7% (n=6)
Formative assessment	Optional	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	S	50% (n=6)
Year 3			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Optional	S	50% (n=6)
Year 4			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Essential	R1	80% (n=5)
Post-graduate			
Training	Essential	R2	100% (n=2)
Formative assessment	Optional	R2	100% (n=2)
High-stakes summative assessment	Essential Optional	S	40% (n=5)

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, in which year of study does **Dentistry and Dental therapy** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential	S	50% (n=6)
Formative assessment	Not Necessary	R1	75% (n=4)
High-stakes summative assessment	Not Necessary	R1	75% (n=4)
Year 2			
Training	Optional	S	50% (n=6)
Formative assessment	Essential	S	50% (n=6)
High-stakes summative assessment	Not necessary	R1	75% (n=4)
Year 3			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Essential	S	50% (n=6)
Year 4			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Essential	R1	80% (n=5)
Post-graduate			
Training	Essential	R2	100% (n=2)
Formative assessment	Essential	R3	80% (n=5)
High-stakes summative assessment	Essential	S	60% (n=5)
In your opinion, in which year of study does **Optometry** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential Optional	S	50% (n=6)
Formative assessment	Not necessary	S	66.7% (n=6)
High-stakes summative assessment	Not necessary	R3	83.3% (n=6)
Year 2			
Training	Optional	R2	80% (n=5)
Formative assessment	Optional	R1	75% (n=4)
High-stakes summative assessment	Not necessary	S	50% (n=6)
Year 3			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Essential	S	50% (n=6)
Year 4			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Essential	R1	80% (n=5)

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, in which year of study does **Optometry** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Post-graduate			
Training	Optional	R2	100% (n=5)
Formative assessment	Optional	R2	100% (n=2)
High-stakes summative assessment	Essential	S	60% (n=5)
In your opinion, in which year of study does **Speech and Language therapy** lend itself to high-technology simulation for training, high-stakes formative assessment and summative assessment respectively.			
Year 1			
Training	Essential Not necessary	S	50% (n=6)
Formative assessment	Not Necessary	R1	75% (n=4)
High-stakes summative assessment	Not Necessary	R1	75% (n=4)
Year 2			
Training	Essential Not necessary	S	50% (n=6)
Formative assessment	Essential Optional Not necessary	S	33.3% (n=6)
High-stakes summative assessment	Not Necessary	R1	75% (n=4)
Year 3			
Training	Essential	S	50% (n=6)
Formative assessment	Essential	S	50% (n=6)
High-stakes summative assessment	Not necessary	S	50% (n=6)
Year 4			
Training	Essential	R1	80% (n=5)
Formative assessment	Essential	R1	80% (n=5)
High-stakes summative assessment	Essential	R1	80% (n=5)
Post-graduate			
Training	Essential	R2	100% (n=1)
Formative assessment	Essential	R3	80% (n=5)
High-stakes summative assessment	Essential Not necessary	S	40% (n=5)
Indicate the importance of including the following steps when **planning** a high-technology simulation experience.			
Theory overview	Essential	R1	100%
Analysis of lesson objectives	Essential	R1	100%
Technical meeting	Essential	R1	87.5%
Participants training	Essential	R1	87.5%
Dry-run of simulation experience	Essential	R1	87.5%

Table 5.7: Outcomes of the general statements regarding curriculum integration (continued)

Statement	Result	Round[1]	Percentage[2]
Indicate the importance of including the following steps when **executing** a high-technology simulation experience.			
Presentation on theory congruent with the simulation experience[4]	Essential	R2	85.7% (n=7)
Pre-briefing of students	Essential	R1	87.5%
Simulation experience	Essential	R1	100% (n=7)
Debriefing of students directly after the simulation experience	Essential	R1	75%
Delayed debriefing of students after the simulation experience	Optional Not necessary	S	42.9%
Repeating the simulation experience	Optional	R1	75%
Student evaluation of scenario	Essential	S	57.1%
Lecturer/facilitator evaluation of scenario	Essential	R1	100%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: An even split between two or three options
4: An additional question was removed from this section after round one because it had an opposite meaning to this statement.

5.5.1.1 Comments on general statements regarding curriculum integration

5.5.1.1.1 Alignment of curriculum

One participant commented that simulation is useful for all levels of healthcare training if done correctly, and in line with the academic level of the students. Another said that scaffolding of the curriculum is important, where students first master a particular skill before moving on to medium-technology simulations, and only then move on to high-technology simulation. Four participants indicated that they are not familiar with the curriculum details of some of the listed disciplines, and did not comment further. One participant highlighted the usefulness of flat-screen simulation (which is often overlooked) in teaching complex concepts and mathematical models.

Constructive alignment between theory and the simulation experience is essential, but the teaching of theory should precede any simulation experience and should not form part of the "same-day" activities (n=4). Delayed debriefing is not ideal and should be avoided as efficacy is lost (n=3). Four participants commented that repeating a simulation experience, where possible and if time allows, can be beneficial.

Student feedback (both formal and informal) is important to ensure improvement in the programme and simulation experiences (n=2). It was also mentioned that the technical (IT) staff must be involved in the feedback (n=1).

5.5.1.1.2 Assessment

With regards to assessment, three participants mentioned that high-technology simulation should not be used for assessment (formative or summative) if the students did not have exposure to it during the teaching and learning phase. Another was not convinced that high-technology simulation is a rigorous tool for assessment.

5.5.2 Proposed solutions to curriculum integration challenges

Table 5.8 presents the results of the possible solutions to curriculum integration challenges as identified during the questionnaire survey. All proposed solutions for learning objectives not being achieved were deemed essential, but for proposed solutions for the other challenges the split was more even between the different options.

Table 5.8: Solutions to curriculum integration challenges for high-technology simulation

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering addressing the challenges caused by **time limitations** in using high-technology simulation with a group of students.			
Increase number of students per group to reduce number of simulation experiences	Not necessary	R3	85.7%
Minimise lecture (theory) time before an experience	Essential	S	42.9
Reduce time spent on debriefing	Not necessary	R1	75%
Have more students only observing during the experience	Optional	S	71.4%

Table 5.8: Solutions to curriculum integration challenges for high-technology simulation (continued)

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering addressing the challenge of **learning objectives not being achieved** by a high-technology simulation experience.			
Learning objectives should be analysed long enough before an experience to be able to adapt it in time	Essential	R1	100%
Academic review after each simulation experience by staff	Essential	R2	75%
Use of student feedback forms	Essential	R2	87.5%
Dry-run(s) of experience focusing on learning objectives	Essential	R1	75%
In your opinion, indicate how important the following are when considering addressing the challenges caused by the **change in case mix, when considering a curriculum,** with regard to high-technology simulation.			
Negotiate with vendors to design simulators specific to the case mix of a curriculum	Optional	S	57.1%
Develop own high-technology simulators to address specific needs to the case mix	Optional	S	57.1%
Use medium- or low-technology simulators instead	Essential	R2	75%
Employ other types of simulations such as SPs or hybrid (high-tech and SPs combined) simulations[3]	Essential	R2	100% (n=7)
In your opinion, indicate how important the following are, when considering addressing the challenges caused by large student groups and **reducing/limiting the teaching platform** with regard to high-technology simulation.			
Increase number of simulation experiences to reduce number of students per group	Essential	R1	87.5%
Have more students observe only during an experience	Not necessary	R1	75%
Increase self-directed learning opportunities for the students using high-technology simulators (allow students to use high-technology simulators without supervision after some basic training in its use)	Essential Optional[4]	S	42.9%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: Added in round two
4: An even split between two or three options

5.5.2.1 Comments on curriculum integration challenges

5.5.2.1.1 Group size

When considering an increased number of students for each simulation experience, three participants commented that this is not good practice. Simulation is a small-group learning activity, and students must have maximum, hands-on experiences (n=3). One added that the increase of students for a simulation experience might be possible for scenarios where there is a focus on cognitive outcomes of early learners. Four participants commented that it is not a good idea utilising simulation time for theory lectures as these should be done in advance. One suggested a "flipped classroom" approach where students can study the theory on their own beforehand. Three participants commented that debriefing time should never be reduced, with one adding it is the "heart" of learning through simulation. Students only observing might save time but is not ideal, and should be followed by a hands-on experience (n=4). Two general comments were that more time needs to be built into the curriculum for simulation, and that simulation should be scheduled for smaller groups with repeated experiences. Reducing some aspects of the simulation experience reduces the efficacy of the simulation (n=1).

Three participants commented that increasing the number of students that only observe is not a good idea and should be avoided, with one adding that the observers must be part of the debriefing. With high-technology simulators giving objective, score-based feedback to learners, the option for increased self-directed learning is very appealing (n=3). In such an instance the students will however not have the benefit of a facilitated debriefing session (n=2). The students should also be well trained in the equipment and prove proficiency to protect the equipment against accidental breakage (n=3).

5.5.2.1.2 Learning objectives

Scenarios must be written to achieve learning objectives, but must also allow for some flexibility as students will sometimes go off-script – which can also be a learning opportunity (n=1). An academic review of a simulation experience is essential (n=3), should involve the technical staff (n=1), and be measured against the desired learning outcomes (n=1).

5.5.2.1.3 Simulator selection

Negotiating with vendors to design a specific simulator is difficult in South Africa as it represents a very small section of the world-wide client base (n=2). It is also difficult due to the small number of users in a niche group (n=1). It is also likely that a simulator to address a certain aspect might already exist, and is available for import (n=1). It is not viable for facilities to develop their own high-technology simulators, as this requires large research and development resources, and is expensive (n=3). Medium or low technology can be used to prepare students for high-technology simulations (n=1,) and depending on the objectives, can be used instead of a more expensive, high-technology simulator (n=1).

A one-size-fits-all approach should not be followed when selecting the simulator(s) (low, medium, high technology, hybrid approach or simulated patients) used for an experience (n=1), but should be derived from the learning objectives (n=1).

5.6 PHYSICAL ENVIRONMENT

There were 32 statements for the physical environment theme, and another two were added after round one. Consensus was reached in 15 (44.1%) statements, and 19 (55.9%) reached stability.

5.6.1 General statements regarding physical environment

The results of the general statements are summarised in Table 5.9. The results of the statements are divided between essential and optional.

Table 5.9: Outcomes of the general statements regarding the physical environment

Statement	Result	Round[1]	Percentage[2]
Indicate the importance of having the following areas available for high-technology simulation.			
Dedicated simulation room(s)	Essential	R2	87.5%
Clinical skills training area	Essential	R1	87.5%
Interchangeable rooms	Essential	R1	75%
Lecture halls	Optional	S	57.1%
Access to *in situ* areas	Essential	R2	75%
Dedicated debriefing rooms	Essential	S	57.1%
Debriefing in same room as simulation experience	Optional	R3	100%
Flat screen simulation (computer lab)	Essential	S	57.1%
Separate observation room(s)	Optional	S	57.1%
Control rooms with direct observation of simulation area through one-way glass windows	Optional	S	71.4%
Control rooms with video facilities to observe the simulations	Optional	S	57.1%
Secure storage areas	Essential	R1	75%
Technical maintenance area	Essential	S	57.1%
Holding or waiting area for students[3]	Essential	R2	75%
Creating a flow through the unit (especially during assessments)[3]	Essential	R2	100%
Indicate the significance of having the following available for successful high-technology simulation.			
Audio-visual for real-time streaming to another room	Optional	S	71.4%
Audio-visual recording for later viewing	Optional	S	57.1%
Debriefing area separate from simulation room	Optional	S	57.1%
Debriefing in same room as simulation	Optional	R3	85.7%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: Added in round two

5.6.1.1 Comments on general statements regarding physical areas

5.6.1.1.1 Flexibility of rooms

Commenting on the general statements of the physical environment for high-technology simulation, two participants said that flexibility is key and having interchangeable rooms for simulations is essential. However, two stated that dedicated simulation rooms are better for high-technology simulation, as the complex and expensive equipment can be dedicated to an area and does not move on a regular basis. Two commented that having a skills training area is important, and the ideal is to host it in dedicated rooms where students can access it after hours for self-directed practice.

5.6.1.1.2 Debriefing and video playback

One comment on debriefing in the same room as the simulation experience was that it could be particularly useful to run through the scenario in slow motion as part of the feedback, instead of watching a "disembodied" video playback. Two other participants commented that this approach is not ideal, and that debriefing should take place in a separate space. Regarding observation of the simulation, a participant commented that observers can be in the same room as the simulation, with the option to draw them into the scenario in some way. It was also commented that direct observation of a scenario is essential, and much better than using a camera system with its limitations (n=3). Control rooms with video facilities were seen as a nice-to-have (for live streaming and recording), but not essential (n=4). Their use depends on the versatility and capabilities of the camera system (n=2). One participant added that the money could be spent better.

5.6.1.1.3 Flat-screen simulation

Three participants commented that flat-screen simulation is especially useful and, in many cases, underutilised (n=1). Flat-screen simulation could also teach and assess many of the six cognitive levels, which is essential to achieve before clinical exposure (n=1).

5.6.2 Proposed solutions to physical environment challenges

Proposed solutions to address physical environment challenges for high-technology simulation as identified during the questionnaire survey are presented in Table 5.10. In most cases, the proposed solutions to physical environment challenges were considered to be optional.

Table 5.10: Solutions to physical environment challenges for high-technology simulation

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering addressing the challenges caused by **technical issues** with and maintenance of high-technology equipment.			
Have duplicates (whole simulator) available of certain critical high-technology simulator(s)	Optional	S	71.4%
Have duplicate spare parts available for swap on short notice	Essential	S	71.4%
Technical staff available for each simulation experience	Essential	R2	75%
Negotiate with vendors to have spares available in South Africa on short notice	Essential	R1	75%
"Blackout" periods when equipment cannot be booked and must be available for (software/hardware) upgrades	Essential	R2	75%
Regular review to assess wear and tear on equipment	Essential	R1	75%
In your opinion, indicate how important the following are, when considering addressing the challenges caused by **inadequate simulation space**.			
Adjust high-technology simulation time to also run after office hours and on weekends	Optional	S	57.1%
Rent space at external buildings	Optional	S	71.4%%
Combine some learning objectives into the same simulation experience in order to run fewer simulations	Optional	S	42.4%
Increase student groups per simulation experience (repeating the experience more often for more (smaller) groups of students)	Optional	S	71.4%
Convert debriefing areas into high-technology simulation areas and debrief in the same room as the experience	Optional	R1	75%
Split larger areas into smaller simulation rooms	Optional	R2	75%
Increase the use of *in situ* simulations	Essential	S	57.1%
In your opinion, indicate how important the following are, when considering addressing the challenges caused by **inadequate storage space**.			
Lease off-site storage area for consumables and equipment not regularly used	Optional	S	71.4%
Decrease floor space of current simulation areas to increase cupboards etc.	Optional	S	71.4%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.

5.6.2.1 Comments on physical area challenges

5.6.2.1.1 Technical assistance

Three participants commented that having technical staff available for each simulation experience is ideal, but not always achievable. Another participant commented that technical troubleshooting should happen between simulations to ensure time-on-task and seamless activity during the experience. This troubleshooting will act as a review to assess wear and tear (n=1), but also negates formal blackout periods (n=2). Five participants commented that having duplicate simulators is not worthwhile as the costs would be prohibitive. One participant added that it might be justified if it is used in an assessment situation.

5.6.2.1.2 Simulation hours

Running high-technology simulations after hours should only be done as a last resort as this adds strain on the available resources (n=3). This should be done to assist in the training of registrars, and not “to make money” (n=1). Leasing additional space is not ideal as this will lead to duplication of resources (n=3).

5.6.2.1.3 Repeated simulations

Combining some learning objectives into one simulation experience is risky as limited objectives per scenario are ideal (n=1), while more complex scenarios are not always ideal (n=1). Repeating the simulation experience for more groups is important as this will lead to more hands-on opportunities for the students (n=3). Increased *in situ* simulations is regarded as a good idea (n=4), but will depend on the availability of the space (n=1) and trained staff (n=1).

5.6.2.1.4 Storage space

Regarding storage space, it was suggested that it is much better to use space-saving solutions (n=1) rather than taking away floor space from the current simulation area. This should be planned properly from the start, rather than try to change it later (n=3). Leasing off-site storage space is not practical, as in some cases it is not allowed by the institution, and it is expensive (n=2). The transport and availability of equipment then also become an issue (n=2). One participant commented that it would be better to expand the building, if possible, rather than making use of off-site storage or reduced floor space for simulation. Another participant commented that curtain screens could be used in some of the simulation rooms. With smaller groups the equipment can be hidden behind the curtains. When needed for a larger group, the equipment can be temporarily removed out of the room, the curtains pulled back, and the extra space is available.

5.7 RESEARCH

Statements on the research theme were 16 during round one, and one additional statement was added in round two. Consensus was reached in 12 (70.6%) statements and stability was reached by 5 (29.4%).

5.7.1 General statements regarding research

Table 5.11 summarises the results of the general statements for research elements. All elements of research within high-technology simulation were deemed essential by the experts.

Table 5.11: Outcomes for the general statements regarding research

Statement	Result	Round[1]	Percentage[2]
Indicate the importance of research in a high-technology simulation unit.			
Research in a health profession discipline utilising high-technology simulation	Essential	R1	87.5%
Research on the transfer of skills acquired from simulation training and measured by clinical performance outcomes	Essential	R1	100%
Research studies assessing patient safety	Essential	R1	87.5%
Research on the cost-savings benefits of simulation training	Essential	R1	75%
Simulation research on the implementation of protocols or standard operating procedures	Essential	S	57.1%
Research about educational aspects of simulation or high-technology simulation	Essential	R1	100%
Research on the technology/simulators	Essential	R1	75%
Research on the development and testing of new simulators or equipment	Essential	S	42.9%
Research as an additional income stream	Essential	S	57.1%
Research on effectivity and return on investment	Essential	R1	75%
Research on aspects of the healthcare system/facility[3]	Essential	R2	87.5%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: Added in round two

5.7.1.1 Comments on general statements with regards to research

5.7.1.1.1 Research income

Although all research in high-technology simulation is important, money should not be the driving force because a simulation facility should not be required to fund itself (n=3).

5.7.1.1.2 Types of research

One participant commented that research on the transfer of skills acquired from simulation training and measured by clinical performance outcomes is incredibly complicated, as it is difficult to agree on the scoring rubrics to be used. Another participant added that high-technology simulators provide amazing data collection options with minimum effort. Simulation research on the implementation of protocols or standard operating procedures is critical to give input and feedback on healthcare systems and their impact on patient safety and service delivery (n=1). Three participants commented on research on the development and testing of new simulators, with one commenting that this is something vendors do and not the facilities. Two others added that this could be done in partnership with the vendors and is important in identifying gaps and flaws in the high-technology simulators.

5.7.2 Proposed solutions to research challenges

Table 5.12 summarises the results of the proposed solutions to the research challenges for high-technology simulation that were identified during the questionnaire survey. The proposed solutions were more or less divided equally between being considered essential and optional.

Table 5.12: Solutions to research challenges for high-technology simulation

Statement	Result	Round[1]	Percentage[2]
In your opinion, indicate how important the following are, when considering addressing the challenges caused by **unsatisfactory research output** (lack of time and research staff).			
Additional staff allocated for research output only	Optional	S	57.1%
Combine existing teaching and learning activities with a research project	Essential	R1	87.5%
Additional simulation equipment dedicated for research purposes	Essential Optional[3]	S	42.9%
Running research projects outside of normal simulation programme hours	Optional	R2	87.5%
Additional research training for simulation staff	Essential	R1	75%
Rent out simulation space, equipment and staff to external researchers	Optional	R2	75%

1: Indicates in which round consensus was reached. R1=round one, R2=round two and R3=round three. S indicates that stability was reached.
2: N=8 for rounds one and two. For round three and stability, n=7. Instances where everybody did not answer a statement the n value would be given next to the percentage.
3: An even split between two or three options

5.7.2.1 Comments on challenges with regards to research

5.7.2.1.1 Research and staff

Two participants were of the opinion that additional staff for research might be too costly and difficult to manage in a busy facility.

5.7.2.1.1 Research and equipment

One participant commented that high-technology simulators can collect and analyse data during any simulation event, and can easily collect this data during existing teaching and learning activities. Another participant added that equipment should be used for student learning and not research. Running research projects out of normal working hours is not ideal (n=1), but is sometimes the only option as clinicians are usually busy with clinical or teaching and learning activities during normal work hours (n=3). Renting out simulation equipment for research purposes should only be done under supervision (n=1). Two other participants said that renting out equipment is a bad idea as it sets incorrect priorities for a simulation facility.

5.8 ADDITIONAL GENERAL COMMENTS

The following comments were general comments added by the participants and grouped into themes by the researcher.

5.8.1 Specialised simulation training to staff

An additional general comment by a participant on the use of high-technology simulation was that the training of staff is essential for faculty to understand the principles of simulation, and that it is not about the technology but about the technique. The participant also added that training workshops that is more accessible would be very useful as it is not often possible for a person to be out of their post for a week at a time. More *in situ* training should be offered. The participant also added that a contextually relevant South African simulation textbook would be useful. The final general comment made was that collaboration should happen within regions to optimise equipment use and skills.

5.8.2 Level of fidelity

High-technology simulation is nice to have, but students learn just as effectively if the scenario is well planned and piloted with the content specialist and a simulation specialist on a low-fidelity simulation. One high-technology manikin in a facility can be sufficient for the advanced, complex cases that are seldom seen. There should rather be three basic simulators for your undergraduate students and community service healthcare professionals, as their learning will be as effective on those as on a high-technology simulator. Simulation educators need to be creative and think out of the high-technology simulation box.

5.8.3 Sustained human resources

Another participant commented that when an institution/organisation decides to establish a high-technology simulation facility, it requires continuous human resources and financial support to sustain the unit. If this does not happen, the facility's efficiency will degrade exponentially. This is an essential part when conducting the feasibility study prior to the establishment of a facility.

5.8.4 Cost of implementation

Another participant commented that the main problem facing high-technology simulation is the cost of its implementation. Support from various local and international sources with regards to funding and maintenance plays a crucial role in maintaining a simulation facility. To create a more accessible platform, other technologies such as flat-screen simulation can be incorporated to give students the opportunity to learn. This can allow high-technology simulator(s) to be more available for use in specialisation areas that cannot use other means such as task trainers or flat-screen simulation.

5.8.5 Types of simulation

Another comment was that trainees should have all the cognitive knowledge, skills and correct attitudes before being exposed to real-time simulation scenarios. A common, incorrect starting point for new simulation facilities is often the focus on crisis event simulations, videotaping and debriefing. This error occurs because the instructors do not differentiate between crisis management (CM) such as ACLS (drugs and dosages), and crew resource management (CRM), which involves team aspects, communication, using all your resources, avoiding fixations, etc. A participant added that if the trainee does not know how to interact with the simulator, or how to use equipment such as an infusion pump, then the simulation is wasted. With regards to multi-disciplinary simulation, they added that the nurses should learn all the nursing skills in a nurse only group, similarly, the medical students learn in their group, etc. When everyone knows their tasks, then a multi-disciplinary, high-technology simulation can be designed and hosted. The focus can then be on team and communication skills.

5.9 CONCLUSION

The objective of the Delphi survey was to obtain consensus amongst simulation experts on best practices for a sustainable integrated systems approach to high-technology clinical simulation in South Africa.

The total number of statements across the six themes were 401. Consensus was reached in 230 (57.4%) and stability in 171 (42.6%). Valuable comments on all the relevant topics were given by the experts. The total number of instances where statements were deemed “essential” were 271 (67.6%), “optional” were 82 (20.4%) and “not necessary” were 83 (20.7%). In some cases where stability occurred, two or in some cases all three answers were tied for the highest percentage. In these cases, both or all three answers were accepted as answer for the statement.

Consensus was highest for the management theme at 82.9% (“essential” = 80.0%, “optional” = 11.4% and “not necessary” = 8.6%), followed by research at 70.6%

(“essential” = 82.4%, “optional” = 23.5% and “not necessary” = 0%). Consensus for funding was at 56.5% (“essential” = 63.0%, “optional” = 21.7% and “not necessary” = 19.6%), staff and staff development at 56.4% (“essential” = 83.6%, “optional” = 27.3% and “not necessary” = 5.5%) and curriculum integration at 54.7% (“essential” = 64.5%, “optional” = 14.5% and “not necessary” = 31.8%). Consensus for physical environment was the lowest at 44.1% (“essential” = 47.1%, “optional” = 52.9% and “not necessary” = 0%).

In ***Chapter 6: High-technology clinical simulation in South Africa: The role of a sustainable integrated systems approach and achieving it,*** the results of the questionnaire survey and Delphi survey will be discussed against the background of the literature review.

CHAPTER 6
HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA: THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH AND ACHIEVING IT

6.1 INTRODUCTION

In the previous two chapters, the results of the questionnaire survey and Delphi survey were presented. In this chapter, these results, in conjunction with the literature review, will be used in the discussion on the role of a sustainable integrated systems approach to support and enhance high technology clinical simulation in South Africa, and how to achieve it.

The departure points for the creation of recommendations and guidelines will be presented, followed by a discussion of the participation and response rate, and an overview of the characteristics and limitations during the questionnaire and Delphi surveys. The discussion of the six operational subsystems identified in Chapter 1 (*cf.* 1.2) will then follow.

Under the discussion of each subsystem, the challenges experienced by the participating South African facilities (*cf.* Chapter 4) in that subsystem will be highlighted. Using the literature (*cf.* Chapter 2) and input from the Delphi survey (*cf.* Chapter 5), recommendations will be made to address the challenges. After the six operational subsystems have been discussed, and recommendations given, the recommendations will be summarised, and the integration of the different subsystems and their overlap with each other will be discussed.

The chapter concludes with guidelines to achieve each recommendation as well as which subsystems would be directly impacted by each guideline, as well as the role-players involved.

6.2 DEPARTURE POINTS

The following departure points were used in creating guidelines and recommendations for a sustainable, integrated systems approach in high-technology simulation in South Africa:

The guidelines and recommendations should be useful not only when establishing a new facility but also for existing facilities with a specific focus on the high-technology components of clinical simulation. The guidelines should be practical. The guidelines and recommendations should also be easy to understand and disseminate. Facilities should be able to use (some or all) the recommendations and guidelines and apply these to their specific challenges.

6.3 PARTICIPATION AND RESPONSE RATE

The questionnaire survey was conducted at South African public, accredited health professions training institutions. The total number of potential institutions that could have participated was 42, and 23 (54.8%) (*cf.* 4.2) institutions participated, either by completing the questionnaire or indicating that no simulation activities are taking place.

In 2019, Swart *et al.* published the South African Simulation Survey (SASS) with the aim of providing greater understanding of the simulation-based education landscape in South Africa. The responses from the SASS study came from 60 individuals across 25 institutions. The SASS study was conducted not only in public institutions, but also in private institutions. Individual respondents were reported on rather than institutions, making it difficult to compare the response rates of the two studies. In that study, 1859 e-mails were sent out and 60 (3.2%) responses were received.

A possible reason for the higher response rate in this study compared to the SASS study is the fact that institutions and facilities were the intended target instead of individual users of simulation. This study also focused on the operational approaches and challenges faced by simulation facilities, and not the attitudes and perceptions of individuals towards simulation-based education.

There was a difference in response rate between the three different categories of institutions included in the study. All of the approached universities responded (100%), but four did not complete the survey, leaving 19 (82.6%) participating. Only two out of 12 (16.7%) nursing colleges responded, and two out of seven (28.6%) emergency care colleges responded (*cf.* 4.2).

A possible reason for the low response rate from nursing colleges might be that fact that simulation activities are possibly not prevalent at these institutions. Both the respondents indicated that they do not utilise simulation at their facility (*cf.* 4.2). In 2020 an evaluation document on the 2017 and 2018 memorandum of agreement and situational analysis from the South African Nursing Council (Hugo 2020:7) indicated that simulation is a requirement prior to clinical placement (as submitted in the MoU of 2017 and 2018), but in some cases simulation facilities are not available. An assumption can be made that simulation activities should have been in place from 2017/2018, but in some cases that still needs to be implemented at the nursing colleges.

It can be assumed that simulation activities take place at the emergency care colleges as it is prescribed as an assessment tool in the Emergency Care Assistant curriculum (HPCSA 2016:7). This is also reflected in the fact that both of the emergency care facilities that responded indicated that they utilise high-technology simulation (*cf.* 4.2).

If the assumption is made that South African nursing colleges do not yet make full use of simulation, their lack of participation therefore does not skew the results. However, the low response rate from emergency care colleges (28.6%) and the high participation rate of universities (82.6%) skew the data in favour of the universities. However, when it is considered that only nine institutions (four universities and five emergency care colleges) did not participate, the study can be considered as representative of the high-technology simulation landscape at South African public, accredited health professions training institutions.

Initially, 10 experts were approached for the Delphi survey, but two did not respond to the invitation, so eight participated. The response rate of the Delphi survey was eight out of 10 (80%) for rounds one and two, and seven out of 10 (70%) for the final round. One expert could not participate during the final round. The high response rate and the varied background of the experts (*cf.* 5.1) ensure that the data is a valid representation of the views and opinions of the experts in the field.

6.4 CHARACTERISTICS OVERVIEW

Both the questionnaire and Delphi surveys focused on the operational subsystems of high-technology simulation. The questionnaire survey was used to establish the current approach to these operational subsystems and challenges faced in South African facilities. These answers were used to formulate the Delphi survey and achieve consensus amongst the experts on how to overcome these operational challenges within each subsystem. This approach ensured that the topics and statements given to the experts (to reach consensus) were real-world data and not only theoretical “what-ifs”.

The roles of the respondents in the questionnaire survey were “Head of Unit” (47.1%), “Lecturer” (47.1%) and “Simulation Co-ordinator” (5.8%) (*cf.* 4.3), which would indicate that the information received is an accurate reflection of the approach used by the facilities. Four (28.6%) of the respondents had been involved in the initial setup of their facilities, and provided valuable insights regarding the challenges faced during this process (*cf.* 4.10).

While most (71.4%) participating facilities are part of another department (integrated in an existing department) (*cf.* Figure 4.2), the majority (64.7%) of facilities also serves more than one profession (*cf.* 4.3). This would indicate that departments are receptive to accommodating other professions in their simulation facility. All participating facilities also utilise low-technology simulation (mostly with part-task trainers) (*cf.* Table 4.2), so none of the 14 is a “high-technology-only” facility. The discussion and recommendations will apply to simulation facilities but will focus on the high-technology component.

6.5 LIMITATIONS OF THE STUDY

With two nursing colleges indicating that they do not utilise any simulation and the other 10 not responding, nursing colleges will be excluded from the discussion. The low response rate from emergency care colleges is also a limitation of the study.

6.6 MANAGEMENT OF HIGH-TECHNOLOGY CLINICAL SIMULATION

6.6.1 Documentation

Considering the documentation in place at participating South African facilities (cf. Table 4.4), only 35.7% has done a formal needs analysis. A needs analysis is crucial to set goals and strategies (Kim *et al*. 2015:84). The feedback from the experts (*cf.* Table 5.1) agrees with this and it is clear that a needs analysis is essential to the successful implementation of high-technology simulation at a facility. A needs analysis should also be the starting point for any management decisions (*cf.* 5.2.1.1.2) and should be reviewed from time to time to adapt to changing needs and the environment. Another important tool in the initial setup, as well as during a review processes, is the use of a SWOT analysis. This should be an ongoing process (Johnson & Augustson 2015:370) over the lifetime of a facility (*cf.* 5.2.1.1.2). However, only 21.4% of facilities had conducted a SWOT analysis (*cf.* Table 4.4).

To gauge the successful running of a facility, performance indicators should form part of a strategic plan, and will be derived from one's goals and strategies. These performance indicators will allow a facility to compare its actual results against its predetermined parameters (Olsen 2011). From the participant responses, only 28.6% of the participating South African facilities has performance indicators, while 42.9% has documented goals and strategies (*cf.* Table 4.4). Most facilities (71.4%) utilises student feedback forms (*cf.* Table 4.4) and when asked how to make decisions on selecting a vendor for high-technology simulators, the most prevalent response was that the “product must address training needs” (*cf.* Table 4.5).

This, however, raises two interesting questions. Firstly, if there is no needs analysis, how do you determine your training needs to inform your decision on which product(s) and vendor(s) to use? Secondly, if there are no predetermined performance indicators, against what will the student feedback (or any other feedback) be measured for future improvements? Even though the facilities collect the correct data in the form of student feedback and have a good approach to vendor selection (addressing training needs), it must still be compared to predetermined criteria in the form of a needs analysis and key performance indicators to have any substantial usefulness in the decision-making process. These gaps should easily be discoverable as an internal weakness during a SWOT analysis, but since a SWOT analysis is only done by 21.4% of the facilities, these shortcomings might never be fully discovered and addressed. This could lead to a facility not running at its best possible potential and capacity. The need for additional documentation by facilities to execute its strategic goals successfully and effectively was also acknowledged in the comments during the questionnaire survey (*cf.* 4.4). Another comment made by a participant of the survey on missing documentation was the problem of not having operational documents for new staff members (*cf.* 4.4).

During the Delphi survey, the experts agreed that all simulation staff should be involved when creating these documents, and that a top-down approach (where their content is only informed by management) is not ideal (*cf.* Table 5.2). Involving all staff will ensure a sense of ownership, and all staff should be trained in their content. These documents should be reviewed annually and should be aligned with the larger organisation’s mission and vision and strategic goals (*cf.* 5.2.2.1.1).

6.6.1.1 Documentation recommendations

Considering that a needs analysis, performance indicators and SWOT analysis are such vital parts of the optimal management of a simulation facility, it is crucial that these aspects are not ignored (Kim *et al*. 2015:84; Johnson & Augustson 2015:370; Olsen 2011). To overcome this shortcoming, a training program for simulation staff and management should include these basic management principles. The program should focus on both low-technology and high-technology simulation, as all these facilities incorporate both modalities. As part of such a training programme, a set of management templates specifically with simulation in mind should be developed that can easily be adjusted by each facility to address their specific environment (Zigmont *et al*. 2015:547; *cf.* 5.4.1.1.2; *cf*. Table 5.6). The completion of the documentation should involve all simulation staff (*cf.* Table 5.2). Each document should have a predetermined review date by which time it should be reviewed and adapted to ensure it stays current in a changing environment. These documents should also be stored where they are easily accessible to all staff members (the researcher's suggestion). When staff members are part of the document creation process a sense of ownership will exist, and they will have knowledge of the contents (*cf.* 5.2.2.1.1). It is important that new staff members are trained on the contents of the documents as part of their induction (*cf.* Table 5.2).

It is important to align the objectives with the key performance indicators (KPIs) to measure success easily and accurately (Olsen 2011; Johnson & Augustson 2015:368; *cf.* Table 5.1). To help with this, it might be beneficial to create a table with relevant categories that are important and relevant to a specific facility, and to list the objectives and the relevant key performance indicators for each category. KPIs should be SMART (specific, measurable, attainable, relevant and adhere to a specific time-frame). An example of how to write KPIs as compiled by the researcher is presented in Table 6.1 below.

Table 6.1: Objectives and key performance indicators alignment example (compiled by the researcher R van Wyk)

Category	Objectives	KPI
Financial	Increase third stream income	Ensure X amount from third stream income in year 20xx
	Improve productivity of simulator usage	Monitor number of hours that simulator X achieved during a 12-month period
Staff	Train competent simulation staff in the facility	Ensure X% of staff is competent in simulation principles by 20xx
	Improve staff satisfaction levels	Ensure staff satisfaction levels are above X% by 20xx
Teaching and learning	Create a positive teaching atmosphere for the students	Analyse student feedback for period X
	Increase opportunities for departments to utilise simulation	Analyse facility usage for period X
Physical environment	Increase room utilisation	Monitor number of hours room X was utilised during period X

6.6.2 Positioning of simulation facility within a larger organisation

A simulation facility within a larger organisation can be a stand-alone unit of which other departments make use, or simulation capabilities can be part of an existing department, and both approaches have their benefits and drawbacks (Lewandowski 2008:477; Bajaj *et al.* 2018:113; Peets & Ayas 2013:530). In South Africa, amongst the facilities surveyed, 71.4% indicated that they are part of another department and not a stand-alone facility (*cf.* Figure 4.2). During the Delphi survey the experts concluded that the importance of a stand-alone facility is optional (*cf.* Table 5.1), and expanded on the benefits and drawbacks of each option in their comments (*cf.* 5.2.1.1.1). One of the advantages noted was the fact that in a department there might already be expertise and access to a simulator, close to the other departmental activities. An advantage of having a stand-alone unit as pointed out by the experts is that resources could be shared, and less duplication will take place amongst the different departments. This was echoed in the survey with South African facilities, when asked how to make decisions on selecting a vendor for high-technology simulators, “usage across multiple disciplines” ranked 3rd (*cf.* Table 4.5).

6.6.2.1 Facility positioning recommendations

Since both approaches have advantages and disadvantages, and the experts agreed that the importance is optional, the decision of where in an organisation a simulation facility is situated in the organisation depends on the needs analysis, goals and strategies of the organisation. This is yet another example of the importance of a needs analysis, since this is an important decision that will impact every other aspect of the simulation facility. Another element to consider is the current make-up of the organisation, and which approach will be the best fit.

Schematically the two approaches can be represented in Figures 6.1 and 6.2. For a stand-alone facility, an adapted model from Labuschagne (2012) can be used.

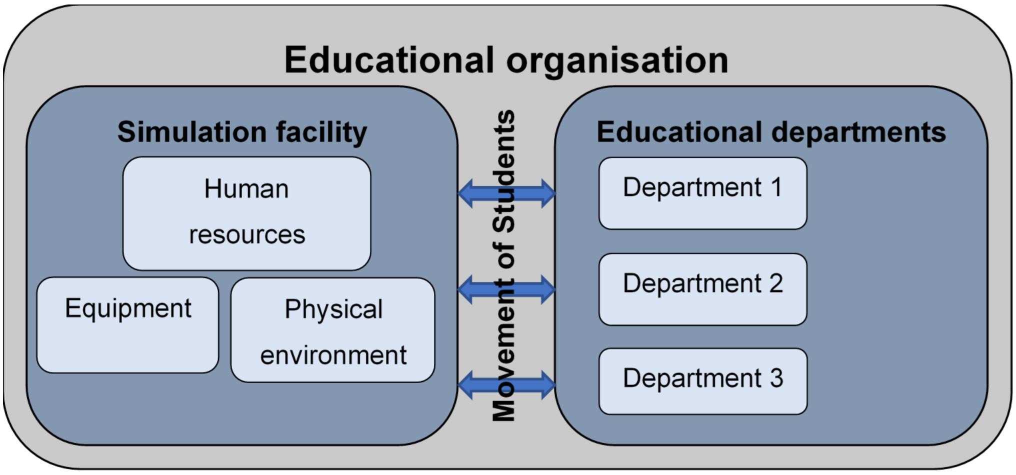

Figure 6.1: Proposed stand-alone simulation facility (adapted from Labuschagne 2012)

Figure 6.2 illustrates the approach when simulation is not a stand-alone facility but run by each department.

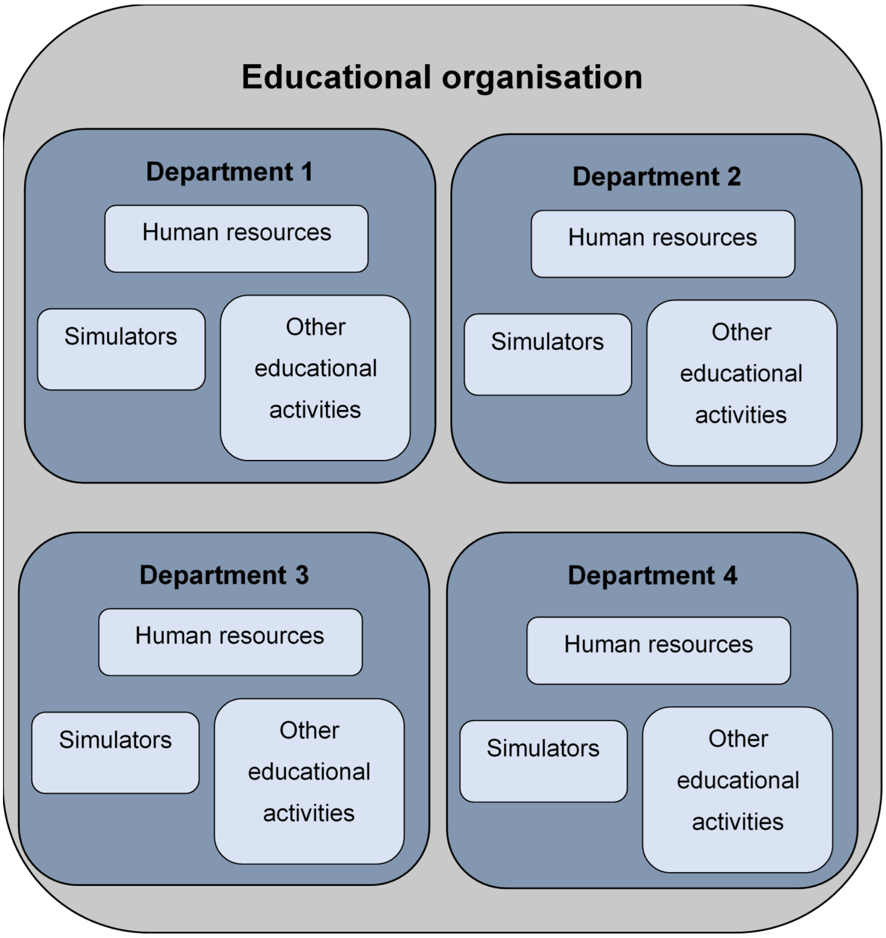

Figure 6.2: Proposed simulation facility as part of a department (compiled by the researcher R van Wyk 2020)

When considering the use of simulators that can be used across multiple disciplines, it is more advisable to have a stand-alone facility in order to maximise the resources within an educational institution, and to not duplicate the same technology and expenses across multiple departments (*cf.* 5.2.1.1.1). In some cases, however, a simulator may be specialised and only useful for one discipline. An example is a laparoscopic simulator with only certain surgical procedures (CAE Healthcare 2017:online). In such cases, it is usually only applicable for post-graduate students (or specialist) (*cf.* 5.3.1.1.4), and the number of students utilising it will be much lower than in undergraduate programmes. If this is the case it might be better to have the simulator in the relevant department as only those students will use it.

In cases where an institution already has a simulation facility, a hybrid model is also possible, where the specialised simulator will be paid for by the department that will utilise it, but the existing simulation facility's floor space, staff, security, and access control will be leveraged to host the simulator (the researcher's suggestion).

Regardless of which model is used, a recommendation would be for the educational institution to establish a simulation committee to oversee and co-ordinate simulation-related decisions. A technical expert in simulation should form part of this committee to guide the different departments when decisions need to be made regarding the purchasing and integration of high-technology simulators (*cf.* 5.3.1.1.2).

6.7 FUNDING OF HIGH-TECHNOLOGY CLINICAL SIMULATION

6.7.1 Income and expenses

Funding is essential for simulation activities and even more so for high-technology simulation due to the high cost of the simulators (Calzada 2015:268, Bar-on *et al.* 2013:e532). This is not only true for the initial establishment of a simulation facility, but also for the sustained, day-to-day operational elements such as replacements, upkeep and software updates, as well as the future expansion of the facility. Confirmed, long-term funding is essential for long-term sustainability (Calzada 2015:268; CAE Healthcare 2013:online). Three facilities (all three at universities) indicated that they do not utilise any form of high-technology simulation. In only one case the reason was that there is no need for it in the curriculum, while the other two indicated that they do not have the financial resources for it (*cf.* 4.2).

Looking at solutions for fiscal challenges, there are two sides to it. One is to increase funding (or income), and the other is to decrease spending (or a combination of both).

During the initial setup of four of the facilities, four respondents were involved, and three (75%) indicated that budget constraints were a challenge during the initial setup of the facility (*cf.* Table 4.16). For the day-to-day operations, nine out of 14 (64.3%) indicated that a lack of financial support is a challenge (*cf.* Table 4.19).

The importance of funding was echoed by the experts during the Delphi survey. It was mentioned that high-technology facilities require continuous financial support to sustain them (*cf.* 5.8.4). It was also mentioned that the high cost of implementation and maintenance of high-technology simulators require sustainable funding to be maintained (*cf.* 5.8.5).

In the participating South African facilities, the simulation facilities mainly acquire their funding through institutional budget allocations (78.6%) and government education grants (78.6%). Fifty percent of the facilities also receive funds through government health grants (*cf.* Table 4.6). These are internal funding streams generated by the day-to-day teaching and learning activities of the institution's students.

Other sources of income are through external sources (non-government funding, also referred to as third stream income) and are mainly generated through training of certification courses (35.7%) and other training to external clients (57.1%) (*cf.* Table 4.6). Other options for external funding are once-of corporate sponsorships and research funding.

In the Delphi survey (*cf.* Table 5.3), the experts agreed that internal and government funding is essential for the long-term sustainability of high-technology simulation in South Africa. To increase funding opportunities, it is important to integrate the simulation activities formally and fully in the curriculum (educational programme) as this will enable the facility to qualify for research and clinical grants (*cf.* 5.3.2.1.1).

To charge the students and departments for day-to-day use of the simulation facility is strongly discouraged as this could lead to an additional financial burden on the students and might become a barrier to learning (*cf.* 5.3.2.1.1). It is recommended that simulation equipment should not be rented out for additional income (*cf.* Table 5.4) as this may lead to damaged equipment, a lack of availability and higher long-term cost and additional administrative strain.

Concerns raised by the experts with regards to third stream funding (*cf.* 5.3.1.1.1) included that it could take a long time to establish and could be unsustainable, with an unreliable and inconsistent source of income. Sustainable income is vital for the long-term success of a simulation facility (Barrott, *et.al* 2013:174; CAE Healthcare 2013:online). The experts could not reach consensus on third stream income as a means of income. (*cf.* Table 5.4). With regards to corporate sponsorships, concerns were raised regarding the ethical aspects of promoting one funder over another, and what this could mean for the day-to-day training of the institution's regular students. Another issue was that these sponsorships are typically not an ongoing, sustained stream of income. The pursuit of external funding should not be a driving factor for high-technology simulation, and should not be at the cost of the institution's own students.

Regarding minimising expenses, it was noted by the experts that various factors make this difficult to achieve (*cf.* 5.3.2.1.3). Increasing the number of students in a simulation experience (thus minimising how many times the same simulation should be run) to minimise the wear and tear on a simulator and consumables is not advised as the whole point of simulation is to have hands-on experience for the students. This approach will dilute the learning experience. The current (2020) situation with regards to COVID-19 social distancing rules also makes larger groups impossible (Arandjelovic *et al.* 2020:1; Khan 2020:2). The use of alternative, cheaper consumables are not advised, as in most cases the specific consumables are prescribed by the vendors and might impact warrantees of the simulator resulting in higher costs in the long term (*cf.* 5.3.2.1.4). It was added by the experts that some high-technology simulation activities might rather be done with cheaper low- or medium-technology models, if the same educational outcomes can be achieved (*cf.* 5.3.2.1.4).

6.7.1.1 Income and expenses recommendations

While it is difficult to minimise expenses when utilising high-technology simulation, a shift in perspective might be needed. With this in mind, it can be useful to rather focus on maximising the value added by the high-technology simulation to the institution. When expenses cannot be lowered, one should aim to increase productivity by maximising the usage of the resources (simulators, staff and time). To achieve this, the number of students and departments using a specific simulator should be maximised as far as possible (*cf. 5.3.2.1.3).* Once again, a thorough needs analysis must be done to make sure money is spent in the most productive way.

When asking the institution for funding of simulation activities, it is important to be able to show the effectiveness and optimal usage of the high-technology simulation components within a simulation facility (CAE Healthcare 2013:online). To achieve this, it is important to formally integrate simulation activities into the educational programme (curriculum) and justify the usage of the facility by using the correct documentation (*cf.* 5.3.2.1.1). Here again, it links back into the management operational subsystem of a facility as well as curriculum integration. In the participating South African facilities, only 42.9% has statistics of facility usage (*cf.* Table 4.4). The lack of this information might make it more difficult to justify asking for funds, so it is important to make sure to document facility statistics. This can also be linked to performance indicators, ensuring that regular evaluations are done.

Even if a facility does not plan to leverage any form of third stream income and will only supply a service to the institution's students, a fee structure (Jamal *et al.* 2015:293) should be put in place. This will enable the facility to better understand its expenses, and will be much more accurate when justifying the need for funding.

It is strongly discouraged to charge the students or external departments additional fees to use the simulation facility, as this can lead to a barrier to learning and additional administrative overhead costs for the facility (*cf.* 5.3.2.1.1). Simulation activities can be re-assessed periodically, and simulation activities utilising high-technology simulators can potentially be achieved using cheaper simulators instead (*cf.* 5.3.2.1.4). This can potentially save costs on wear and tear of an expensive, high-technology model, or free up that model to be used in another simulation activity, thereby increasing its productivity and return on investment, or negating the need for an additional expensive, high-technology model.

6.7.2 Financial governance

Because financial control is such an important factor in achieving sustainable success, a financial steering committee should be in place for a simulation facility, especially with the relatively higher costs involved in high-technology simulation modalities (Calzada 2015:268; Bar-on *et al*. 2013:e532; Barrott *et al.* 2013:174; CAE Healthcare 2013:online; Sekandarpoor *et al*. 2019:135). During the survey, 78.6% of the participating South African facilities stated that they use a financial steering committee, and the same number has a procurement policy in place (*cf.* 4.5). An element highlighted by the experts in the Delphi survey was the fact that a facility's financial policies and procedures should be aligned and adhere to the larger institution's financial policies and procedures (this will usually include insurance of the equipment), and that total independence from the institution will not be possible (*cf.* 5.3.1.1.1). This could, however, lead to frustration as the procurement of imported specialised equipment often takes a long time to move through the financial process. This is especially problematic in times of currency volatility, as the quoted expense might be significantly higher by the time the approval process is completed, due to currency fluctuations (*cf*. 5.3.1.1.2 and 5.3.1.1.3).

6.7.2.1 Financial governance recommendations

A representative that understands the complexities of specialised, high-tech simulation equipment, consumables and their impact on operations should be part of any financial steering committee within the larger institution where decisions are made that can influence the simulation facility. This can either be a committee within the facility itself or one situated in the larger institution. This expert should be the link between the financial steering committee and the finance department/officers of the institution when complex purchasing decisions must be made and to streamline time-sensitive purchases (*cf*. 5.3.1.1.2). An example could be the importing of equipment, and how to leverage the South African agents or suppliers to ease the process, as well as technical assistance when deciding on software licensing payments.

6.8 STAFFING AND STAFF DEVELOPMENT OF HIGH-TECHNOLOGY CLINICAL SIMULATION FACILITIES

6.8.1 Staff allocation

People are the greatest resource of a simulation facility, but could also be a barrier to success when not utilised correctly (Canales & Huang 2015:584). The various designations such as head of the facility, lecturers, administrative, simulation and debriefing facilitators, IT and technical staff, and simulated patient co-ordinators and set-up staff are important, but each designation does not have to be filled by a full-time employee, and some employees can cover multiple roles (depending on the size of the facility) (*cf.* 5.4.1.1.1).

A lack of trained staff and a lack of human resources were a challenge for facilities during their initial setup (*cf.* Table 4.17), as well as during day-today operations (*cf.* Table 4.18 and Table 4.19). These concerns were echoed by the experts during the Delphi survey. It was mentioned that high-technology facilities require continuous human resources to sustain them (*cf.* 5.8.4). The importance of specialised simulation-focused training for staff was re-iterated by the experts. They also emphasised that it is essential to understand that simulation is not about the technology but about the technique (*cf.* 5.8.1).

With the focus on high-technology simulation, the discussion will mainly focus on the technical role designation. In the participating South African facilities, five facilities have dedicated simulation technical staff while the other nine have none (without specifying how this gap is bridged) (*cf.* Table 4.7 and Table 4.8).

The lack of dedicated technical simulation staff will place more pressure on the educational staff to set up and run potentially complex simulations. This will side-track the educators from their main role of observing and facilitating the sessions (*cf.* 5.4.2.1.1)

It was also stated that “IT support” and “technical support” designations can be combined into one role and covered by the same person or team. Due to the logistical complexities of high-technology simulation, the importance of administrative staff should not be underestimated (*cf.* 5.4.1.1.1).

Although some experts commented that *ad hoc* staff might be the only solution where the workload does not warrant a full-time staff member, concerns were raised on using *ad hoc* staff to fulfil certain specialised simulation tasks with complex systems (*cf.* 5.4.2.1.1). This requires repeated training and supervision of the *ad hoc* staff members, as the same person might not be used for future simulations, thus increasing the workload on the full-time staff. The matter of using *ad hoc* staff should be analysed for each designation, and its impact on the team's workload should be balanced between short-term gains and long-term (potential) frustrations and overworked team members. A good fit for using *ad hoc* team members can be in the less technical roles such as standardised patients in a hybrid scenario, where less training and supervision are required.

6.8.1.1 Staff allocation recommendation

Without dedicated technical simulation staff, an option to consider is the use of the institution's IT support staff. A challenge with this approach, however, is that the institution's IT staff might not be familiar with the technical aspects of a specific simulator or system. Staff turnover for technical staff can be an issue as well. Another aspect to consider is that the technical simulation expert is not only there for troubleshooting issues, but also for the day-to-day programming and running of a simulation activity. This will typically fall outside the scope of the institution's IT support staff that mainly focuses on troubleshooting and fixing issues rather than day-to-day operations.

When looking at a structure for stand-alone facilities, Labuschagne's adapted model (2012:243; *cf.* Figure 6.1) will be recommended, where the technical staff is part of the operational staff allocation of a stand-alone facility.

For simulation facilities within each department, it might become more complex as the amount of technical work, although important, might not warrant a full-time technical staff member within a department. A solution to this could be to establish a technical simulation oversight committee, comprising of one or more technical support staff. This committee would function closely with each department for technical assistance and support of their respective high-technology simulations. As the use of high-technology simulations grows in the various departments, the staff allocated to this committee can also grow. The committee does not have to be limited to day-to-day support only, but could also assist with technical specifications when buying new simulators for the various departments and liaising with financial steering committees and vendors (*cf.* 6.4.2.1).

Figure 6.3 illustrates the proposed solution to technical support staff being utilised by different departments for high-technology simulation activities.

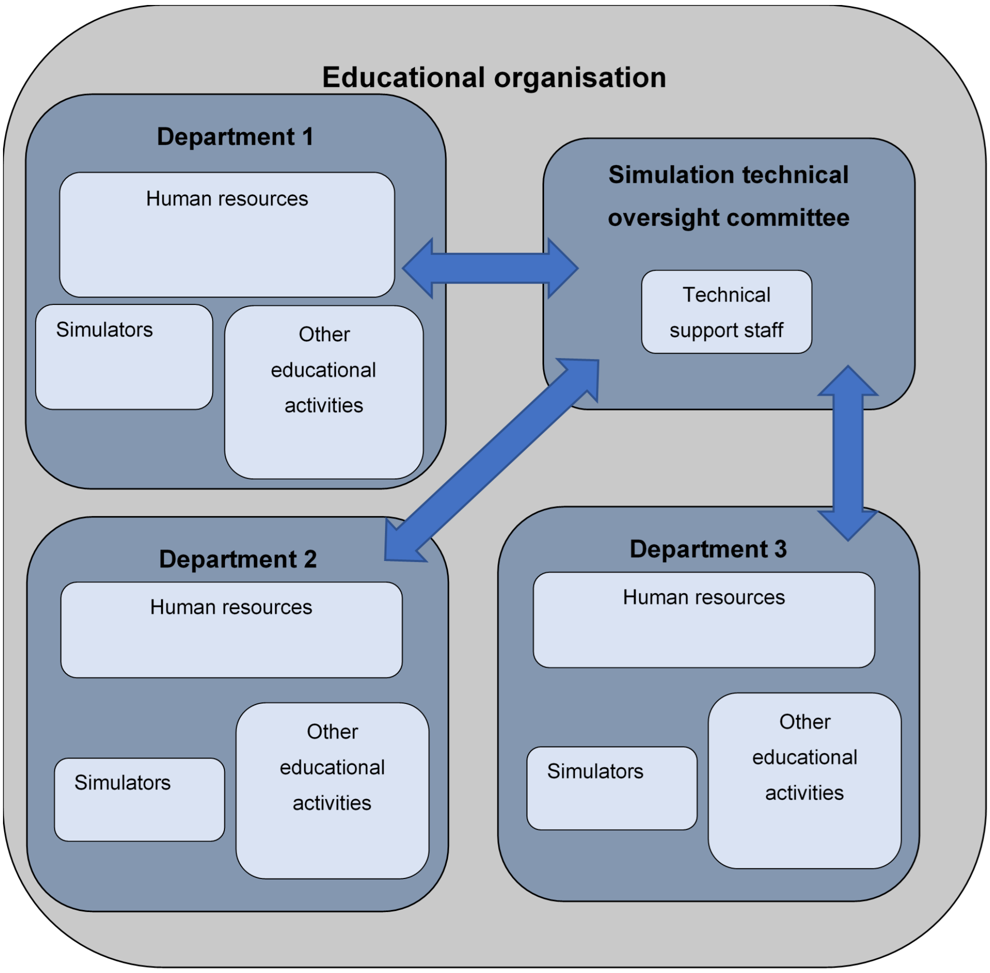

Figure 6.3: Proposed structure for departmental simulation technical support (compiled by the researcher R van Wyk 2020)

6.8.2 Staff development

Not only is it important to have the correct roles defined, but each staff member should receive relevant and suitable training in those roles to enable them for success (Andreatta 2019:47; Labuschagne 2012:243; Canales & Huang 2015:584). Considering the training plans currently in place in the participating South African facilities, the topics that are covered well are the educational areas of simulation. This is evident from the data in Table 4.10 with "scenario planning and programming" (85.7%), "simulation facilitation" (85.7%) and "debriefing" (71.4%) being the top three topics covered by training plans. However, other topics related to the success of high-technology simulation are not covered well at all, and are only prevalent in 50% or less of the facilities. These include "technical support" (50%), "financial planning" (42.9%) and "management aspects" (42.9%) (*cf.* Table 4.10). The shortcomings of training for technical staff were also echoed by the HETI (2014) survey.

Although all topics were deemed essential by the experts (*cf.* Table 5.5), not all are covered by the facilities, and this creates knowledge gaps within a facility and limits the effective use of high-technology simulation. This could not only potentially lower the educational effectiveness for the students, but also decrease the productivity of the simulators and facilities as they might not be optimally utilised. Due to its higher financial costs and complexities (Calzada 2015:268), high-technology simulation could be more sensitive to mistakes made in financial planning and management elements. The lack of financial planning and management elements in training topics covered could lead to detrimental decisions such as spending money on the wrong simulator due to the absence of or an inadequate needs analysis, a fee structure that is not realistic, or performance indicators that are absent or not relevant to the objectives. All of these may negatively impact the effectiveness of high-technology simulation.

Of the South African facilities surveyed, 46.2% indicated that there is no back-up plan in place if a staff member is absent on the day of a simulation. The other 53.9% tries to ensure that all staff members are involved in the planning phase so that another staff member can cover certain aspect when someone is absent (*cf.* 4.6).

To ensure effective multitasking in some areas by individuals, it is important to equip them with the correct resources in terms of training and development. This is especially relevant in light of the COVID-19 protocols (CSUM 2020:4; Arandjelovic *et al.* 2020:1) if some staff members are not able to be on-site. According to the experts, in-house training is preferred over external training (*cf.* Table 5.5).

6.8.2.1 Staff development recommendations

When training topics are considered for high-technology simulation, it is important to not only focus on the teaching and learning philosophies of high-technology simulation, but also on the more "behind-the-scenes" and practical aspects of making sure that high-technology simulation is utilised optimally (*cf.* Table 5.5). For the sake of multitasking between staff designations, it is important to make sure all staff members have a basic overview and understanding of all topics of simulation, and especially of high-technology simulation and its complexities. This could be covered in a basic course on simulation (*cf.* 5.4.1.1.2). Each topic could also have an advanced track for the specific designated staff members. Content should be tailored for the specific institution (on-site training) and facility to contextualise it more closely in the specific facility (*cf*. Table 5.5). In Table 6.2 the recommended layout for advanced training topics for a simulation facility, as compiled by the researcher, is presented.

Table 6.2: Recommended layout of advanced training topics for high-technology simulation facilities (compiled by the researcher R van Wyk 2020)

Category	Topic	Target designations for advance courses
Management and administration	Management elements	Management
	Financial planning	Management
	Coordination for standardised patients (recruitment, payment, and training)	Administration
	Physical planning	Administration, operational and technical
General	Ethics	All
Educational principles and theories of simulation education (teaching, learning and assessment)	Scenario planning	Facilitators and technical
	Simulation facilitation	Facilitators
	Debriefing	Facilitators
	Simulation and assessment	Facilitators
Research	Research utilising simulation	Management, facilitators and technical
Technical	Technical support	Technical and operational
	IT support (hardware and software integration and network troubleshooting)	Technical
	Application-specific training by the vendor	Technical
	Scenario programming (on PC)	Technical
	Audio-visual	Technical and operational
	Moulage	Technical and operational

6.9 CURRICULUM INTEGRATION OF HIGH-TECHNOLOGY CLINICAL SIMULATION

6.9.1 Positioning of high-technology simulation within the curriculum

It is important to determine which parts of the curriculum are suitable for augmentation with simulation (Motola *et al.* 2013:e1512). During the survey, it was established that high-technology simulation is used for students from their 1st year through to their final year and during post-graduate studies as well (*cf.* Table 4.11). The most prevalent usage of high-technology simulation is during the later (3rd through 6th) years (clinical phases) of the respective programmes (*cf.* Table 4.12). While almost all (92.9%) of the facilities utilise high-technology simulation for teaching and learning activities, only 50% use it for summative assessment, and 57.1% use it for formative assessment (*cf.* 4.7). However, 11 out of 14 (78.6%) facilities mentioned a lack of time as a challenge when performing simulation activities (*cf.* Table 4.19).

Considering the input of the experts during the Delphi survey, the trend for most disciplines (with the exception of Medicine, Emergency care and Pharmacy) was that high-technology simulation should not be essential for 1st and 2nd year students, but that it is an effective modality for years three and onward (*cf.* Table 5.7). This is consistent with data from the South African facilities surveyed and in line with the literature, which states that learning should be a movement between theory, simulation, and clinical training (Labuschagne 2012:20). In other words, students must first be comfortable with the theoretical background of a topic and then move onto skills training and simulation, followed by clinical training (scaffolding of the curriculum). It was also stated by the experts that in some cases, high-technology simulators might be a nice-to-have and that one such simulator might be sufficient. Some educational outcomes could be achieved on lower-technology and cheaper simulators (*cf.* 5.8.2).

It is important to ensure that whenever a high-technology simulator is used for assessment (summative or formative), the students had adequate teaching and learning experiences on the particular model (Van Wyk 2016:88; *cf.* 5.5.1.1.2).

From the data gathered, it seems that the participating South African facilities integrate high-technology simulation correctly into the curriculum from a curriculum scaffolding and assessment point of view.

Although the COVID-19 lockdown happened after the data collection phase of this research project, it is important to address this issue as well (Arandjelovic *et.al* 2020:1; Khan 2020:2). The COVID-19 outbreak and resultant lockdown of 2020 brought its unique challenges to health education and simulation. In South Africa, the lockdown started in March 2020, and this led to students not being able to complete their normal clinical rotations in wards, clinics and theatres. To overcome this situation, simulation and high-technology simulation could play a greater role in the training of students. An example of this is already happening at the University of the Free State, where the Department of Anaesthesiology, together with the Clinical Simulation and Skills Unit, developed a simulation program for the senior medical students, where they are trained in skills and procedures on low- and high-technology simulators (Odendaal 2020:E-mail). These procedures and skills would usually be completed during clinical rotations, but with the effect of the COVID-19 pandemic on the training platform where theatre time and limited cases directly influence the training, high-technology simulation was a good replacement for clinical training hours.

6.9.1.1 Recommendations on the positioning of high-technology simulation within the curriculum

As with other aspects of high-technology simulation, a needs analysis approach is key to decide if, where and how to utilise high-technology simulators in the curriculum (*cf.* 5.3.1.1.3; 5.3.2.1.4). A few basic questions could be useful to guide the approach to these decisions. First, ensure that high-technology simulation is indeed the correct modality to achieve the desired outcomes. In some cases, other modalities than simulation or cheaper simulation modalities might be just as or even more effective to achieve the desired educational outcomes (*cf.* 5.5.2.1.3).

One has to ensure that the students' theoretical knowledge is at a point where it will be beneficial to move forward with skills and/or simulation. The learning outcomes should be analysed and a decision should be made whether skills training will be required. The students need to be at an adequate skill level before subjecting them to a high-technology simulation scenario (Van Wyk 2016:90). Once a decision is made to move forward, the logistical challenges should be considered. These are typically decisions on the size of the groups and schedule of the students, facilitators, and simulation resources. Examples of these include: Will the simulation be for one student at a time or will it be group work (dependent on outcomes)? What should the size of the group be to make the simulation as realistic as possible? How many times will the simulation have to be repeated to accommodate the whole class? Will it be possible to run different groups simultaneously (dependent on physical space, number of facilitators, simulators, and simulation staff)?

These questions and their answers will give a good framework on how to approach a topic and achieve the set learning outcomes. Simulation experiences should be subject to academic review to ensure that they address the learning outcomes (Motola *et al.* 2013:e1512; Van Wyk 2016:90; *cf.* 5.3.1.1.4; 5.3.2.1.4)

Participants in this study (*cf*. 5.5.1.1.2) and the researcher in previous research (Van Wyk 2016:88) indicated that high-technology simulators may be used for assessment, but only if the students are familiar with the simulator and have used it during teaching and learning.

6.9.2 Logistical elements of a high-technology simulation session

The simulation experience consists of two main parts, namely the experience itself and the debriefing of students after the experience (Jeffries 2005:100). There can also be a pre-briefing of the students to explain to them what is expected, and with high-technology simulation it can also be used to explain how the manikins (technology) work, how it will be different from a real patient and what the limitations of the technology is. Behind the scenes, there is also the preparation of the simulation experience that is crucial for success (*cf*. Table 5.7).

In South Africa, the facilities surveyed mainly follow these steps (*cf.* Table 4.13), and scenarios are developed by the subject matter experts (lecturers) to ensure that the scenarios are aligned with the learning outcomes. Some facilities will also do a test run of the scenario to make sure that everything runs as planned (*cf.* 4.7). The experts agreed that these steps are essential and also added that theory overview (using lectures, online resources or videos) by the students should be part of the process (*cf.* Table 5.7). This should, however, rather be done in advance before the actual simulation day, so as not to impede on simulation time (cf. 5.5.2.1.1). This approach is also aligned with the blended learning principle of online instruction (Khan 2020:online) and face-to-face learning (Hrastinski 2019:564).

Simulation is a small-group learning activity, and group sizes should not be increased to accommodate large classes, but simulation experiences should rather be repeated more often (*cf.* Table 5.8 & 5.5.2.1.1).

6.9.2.1 Recommendations on the logistical elements of a high-technology simulation session

It is important to remember that the principles of and approach taken in simulation apply to both low-technology simulation and high-technology simulation. These are principles such as Peyton's four-step approach to skills, Jeffries' model for simulation and Labuschagne's spiral approach (Walker & Peyton 1998:175; Jeffries 2005:97; Labuschagne 2012:20).

On the logistical side, there are however slight deviations of the two modalities that should be considered. Consider a typical undergraduate scenario using a human patient simulator. During the planning phase, additional time should be set aside for the educational expert(s) (lecturers) and technical team to schedule a meeting and translate the clinical aspects of the "patient" into the simulator's software language. This can potentially be challenging due to scheduling conflicts as well as a potential knowledge gap between the two parties (Koh & Dong 2018:190). To ease this translation, a template could be created where the clinical vignette of the patient can be broken down into the different parameters used by the specific software. It should also include clear paths for interventions (or lack thereof) by the students, and how that would affect the state of the patient (set of parameters). This will create an easy to follow flowchart of the scenario and will ease the programming of the software. This flowchart can also be printed out and assist with navigation during the simulation (*cf.* Table 5.1; 5.2.1.1.2). As stated previously (*cf.* 6.8.2.1), training of simulation staff is essential for the "behind-the-scenes" aspects, and a basic overview of how programming a scenario on a PC works for the lecturers, will greatly ease this translation activity.

Another deviation in logistics to consider when using high-technology simulation is the fact that in most cases it is advisable that a technical expert (technician) should be available to run the hardware and software components of the scenario. This is not only for the running of the scenario, but also to troubleshoot technical issues if any appear during the simulation experience (HETI 2014:6). This could be problematic if multiple sessions are run at the same time, and only one technician is available. To overcome this, another staff member(s) (administrative or operational or external *ad hoc* staff members) should be part of the meeting when the scenario is discussed and translated into the software, and should also be present when the scenario is programmed. In this way, the multitasking staff is familiar with the scenario and the pathways it may take. They could easily then operate the computer during the scenario. Typically the facilitator (subject matter expert) will be with the computer operator, but it is not advisable for the facilitator to multitask the role of computer operator as his/her focus should be to observe the students and outcomes of the scenario. By doing this multiple scenarios can be run at the same time with the technical expert free to troubleshoot issues if any appear (*cf.* Table 5.6; 5.4.2.1.1).

6.10 PHYSICAL ENVIRONMENT REQUIREMENTS FOR EFFECTIVE HIGH-TECHNOLOGY CLINICAL SIMULATION

6.10.1 Room requirements

It is important for students to immerse themselves during a simulation session, and the room and room setup play an important part in the creation of fidelity (Milkins *et* *al.* 2014:22). When thinking of functional areas for a typical simulation scenario, one should include the area where the actual simulation experience will take place, the area from where this scenario will be observed and controlled (control of high-technology simulators), and the area where the debriefing will take place (Horley 2016:17).

The South African facilities that participated in the survey indicated that infrastructure and finding appropriate spaces (layout) were challenges (*cf.* Table 4.16). The majority of them utilises dedicated observation\control rooms, and footage of the simulation can be streamed or recorded to an observation area (*cf.* 4.8). The experts indicated that the type of observation area (separate room with streaming footage, direct observation through a one-way mirror or in the same room as the simulation) should be optional depending on the physical layout of the facility and what is available (*cf.* Table 5.9 and 5.6.1.1.2). They also indicated that audio-visual equipment should be optional, and that direct observation is in some instances better than watching a monitor. Control rooms with video capabilities should be seen as a “nice-to-have”, and money can be spent better (*cf.* 5.6.1.1.2).

Regarding debriefing areas, only half (50%) of the South African facilities surveyed have spaces that they can use for debriefing (three have dedicated debriefing rooms, and the other four use other unspecified open spaces). In some cases (57.1%) these open spaces are not utilised for debriefing (*cf*. Table 4.15 and 4.8). The location of the debriefing (in a separate room or same room as the simulation experience) is optional according to the experts (*cf.* Table 5.9), and both options have advantages and disadvantages. It was commented by the experts that in some cases it might be useful to re-run parts of the simulation as part of the feedback, while others added that debriefing should take place in a separate space. The experts also indicated as optional that solutions to inadequate simulation space should not hamper the learning experience (*cf.* Table 5.10). Some of these could be to increase the number of student groups for simulation sessions, combining learning objectives to run fewer simulations, and running simulations out of office hours and over weekends. This could also be a solution for social distancing protocols during the COVID-19 pandemic (M Simulation 2020:4; CSUM 2020:4; Khan 2020:2).

Other spaces that were deemed essential by the experts are clinical skills training areas, access to *in situ* areas and flat-screen simulation areas (*cf.* Table 5.9).

6.10.1.1 Recommendations for room requirements for high technology simulation

When considering the usage of rooms in a high-technology simulation facility, it is important to keep in mind that there is no one-size-fits-all approach to it. Flexibility is key, and the utilisation of spaces will depend on the needs analysis for the simulation activities, the available options, and available funds to adapt existing structures (Sekandarpoor *et al*. 2019:117). The details of an activity (such as from where to observer/control and where to debrief) are not inflexible and can easily be adapted to conform to the physical constraints of existing rooms (*cf*. 5.6.1.1.1).

To ensure fidelity, it is important to furnish the room with the needed clinical equipment, and to ensure that the room is larger than the actual room it represents. This is to ensure that there is enough space for students and observers (Sekandarpoor *et al*. 2019:117). In some cases, manikins might be connected to their controlling PCs with physical cables (and not wireless technology), and it might be that the controller will have to be in the same room and need enough space for the control PC and stay out of the way of the students' activities during the simulation.

There are also high-technology simulators that can be used by students in a self-directed way in their own time, without any props, without additional fidelity elements, and with no facilitation or debriefing. These are typically flat-screen simulators (such as laparoscopic training simulators or running software for didactic training) where the feedback to the student is given by the program directly after each practice session (Penn State Hershey 2017:online). In these cases, a room setup can be straight forward with tables or benches for a few desktop PCs or laptops where students can utilise the computers at any time. Larger flat-screen simulators such as laparoscopic simulators can also be used in this room against the wall, with minimum disruption to the rest of the room (*cf.* Table 5.9; 5.6.1.1.3).

6.10.2 Other physical and technical considerations

The use of high-technology simulators adds some additional complexities that should be considered when planning the physical environment. These include aspects such as cabling and wireless network setup (Seropian *et al.* 2015:436). In the surveyed South African facilities, one participant commented on the poor sound quality in some rooms, while another mentioned that their manikins need to be moved around to other rooms as the need arises (*cf.* 4.8). The experts agreed that it is essential to have critical spare parts available to swap out on short notice, and for the vendors to have certain parts available in South Africa. Specific times should also be set aside for regular maintenance (*cf.* Table 5.10).

6.10.2.1 Other physical and technical recommendations

When planning a room that will be used for high-technology simulation, it is important to keep the increased technical complexities in mind (Seropian *et al.* 2015:436). Although the experts did not explicitly expand on these requirements, from extensive practical experience the researcher has certain suggestions. It is important to be mindful of the electrical systems in place, for instance, where high-technology simulation equipment are to be installed. It is also advised that an uninterrupted power supply (UPS) system (or equivalent) be in place to ensure that the equipment can be safely switched off without any data or system corruption when there is a power failure, or when a few minutes are needed to switch over to an alternative power source such as a generator. One should also be mindful where electrical distribution boards are located. Try to have these in a hallway away from the actual equipment, as the electrical currents can disrupt wireless communication between manikins and the control PCs or tablets.

One should ensure there are air-conditioning units or a climate control system in the rooms. Higher humidity in a room could lead to mould inside a manikin if there is no regular maintenance, while low humidity could increase the risk of static build-up from users and potentially cause shorts on sensitive equipment (Seropian *et.al* 2015:436).

If possible, try to make sure the internal walls of a facility are made of dry-walling. This will ensure the minimum interference of Wi-Fi signals between rooms and make future cable installations easier. Instead of investing money in an installed audio-visual system with installed camera and microphones in each room, it might be more economical and beneficial to rather invest in a laptop with a few high-quality webcams with built-in microphones. These are much cheaper, mobile and the cameras can be mounted and changed easily around a room. A mobile microphone can be moved around the room to minimise poor sound quality due to environmental factors such as air-conditioning units. In some cases, the manikin suppliers even have software to seamlessly integrate the footage from a mobile system into the debriefing system and manikin feedback (Laerdal 2020:online).

One should ensure that there is also physical network cabling available in case a simulator does not have Wi-Fi or if there is interference on the Wi-Fi signals. All networking installations should be done in accordance and collaboration with the institution's IT services. In some cases, simulators need to connect to the internet for services and updates from the vendors, and public and educational institutions have various firewalls and internet proxies in place. Working with the institution's IT service will ensure that the internet can be reached safely by these simulators.

6.11 RESEARCH RELATED TO HIGH-TECHNOLOGY CLINICAL SIMULATION

6.11.1 Research characteristics

Utilising simulation for research can be broadly divided into two categories, namely research about simulation itself and utilising simulation and simulators to research health concepts and interventions (Gaba in White & Peterson 2015:607). Research can also be utilised to secure additional income for a facility through research grants (Kahol 2013:634).

In the South African facilities surveyed, six of the 14 (42.9%) produce research outputs. The research activities can be split between publications in journals (66.7%), where simulation staff are post-graduate examiners or study leaders (promotors) (83.3%), or post-graduate students using the high-technology simulators for their research (50%). In the six facilities where research is conducted, research about simulation itself is done at five (83.3%), and utilising simulation and simulators to research health concepts and interventions is also done at five facilities (83.3%) (*cf.* 4.9).

The experts agreed that all forms of research should be explored and considered essential (*cf.* Table 5.11). However, it was re-iterated that money should not be the driving factor for research, and that a facility should not be expected to fund itself (*cf.* 5.7.1.1.1). The experts also agreed that research training for staff is essential, but additional staff for research should be optional (*cf.* Table 5.12).

6.11.1.1 Recommendations regarding research output in high-technology simulation

Research output is an important component of any tertiary educational institution, but scheduling time and staff resources to achieve this in a busy simulation facility can be challenging (*cf.* 5.7.2.1.1). Some strategies to consider is to combine existing teaching and learning activities into a research project (*cf.* 5.7.2.1.1; Table 5.12). Many high-technology simulators record data while they are used, and this data could easily be obtained for quantitative research data on various topics and interventions. It is important to make sure staff is trained in research methodology, specifically while utilising simulation (*cf.* 5.3.1.1.1; 5.7.1.1.2; Table 5.12).

A recommendation from the researcher to increase simulation-based research is to ensure that a simulation representative is a member of the relevant research committee(s) of the institution to promote simulation facilities and its resources and research potential.

6.12 SUMMARISED CHALLENGES AND RECOMMENDATIONS FOR THE OPERATIONAL SUBSYSTEMS

A summary of the challenges identified by the surveyed South African facilities, and recommendations, are presented in Table 6.3. The table provides a quick overview of all the identified challenges and recommendations discussed above, and are categorised by the operational subsystems. This can be used by the reader to quickly find and address a specific problem area in a facility.

Table 6.3: Summary of identified challenges and recommendations (compiled by the researcher R van Wyk 2020)

Subsystem	Challenges	Recommendations
Management	Missing documents	Add document creation to a management training module for simulation staff (*cf.* 6.6.1.1)
	Missing documents	Create templates of documents to ease the process of completing them (*cf.* 6.6.1.1)
	Staff not familiar with document contents	Staff should be part of document creation, and new staff should be trained in the contents during their induction (*cf.* 6.6.1.1)
	Staff not familiar with document contents	Documentation should be accessible (*cf.* 6.6.1.1)
	Facility positioning	Two models. Inside a department and stand-alone facilities (*cf.* 6.6.2.1)
Funding	Income and expenses	Focus on increasing productivity from simulators (*cf.* 6.7.1.1)
	Income and expenses	Do not charge additional fees to students and departments (*cf.* 6.7.1.1)
	Income and expenses	Re-assess if cheaper modality will suffice for simulation activity (*cf.* 6.7.1.1)
	Justification for funding	Formalise simulation activities into the curriculum (*cf.* 6.7.1.1)
	Justification for funding	Gather usage statistics (*cf.* 6.7.1.1)
	Calculate internal costs	Create a fee structure (*cf.* 6.7.1.1)
	Financial governance and complex procurement	Enable a simulation representative to be part of the institutional financial committee (*cf.* 6.7.2.1)
Staff and staff development	Technical staff allocation	Simulation technical oversight committee available to departments (*cf.* 6.8.1.1)
	Technical staff allocation	Technical staff member part of the facility (*cf.* 6.8.1.1)
	Staff training	Basic training for all designations (*cf.* 6.8.2.1)
	Staff training	Focused, advanced training for the relevant designations (*cf.* 6.8.2.1)

Table 6.3: Summary of identified challenges and recommendations (compiled by the researcher R van Wyk 2020) (continued)

Subsystem	Challenges	Recommendations
Curriculum integration	Positioning of high-technology simulation within the curriculum	Needs analysis, student level, and applicability to high-technology simulation (*cf.* 6.9.1.1)
	Assessment	Students must not be exposed to high-technology simulator assessments if they have not used these during teaching and learning (*cf.* 6.9.1.1)
	Logistical elements	Availability of technical staff during a simulation (*cf.* 6.9.2.1)
	Programming of PCs	Teamwork between technical and educational staff (*cf.* 6.9.2.1)
Physical environment	Room requirements	Flexibility is key and use clinical equipment for fidelity (*cf.* 6.10.1.1)
	Room requirements	Rooms must be larger than real-life counterparts (*cf.* 6.10.1.1).
	Room requirements	Self-directed area for flat screen simulations (*cf.* 6.10.1.1)
	Technical considerations	Ensure that electrical, networking and other hardware have been installed properly (*cf.* 6.10.2.1)
	Technical considerations	Ensure environmental control (air-conditioning units) (*cf.* 6.10.2.1)
	Technical considerations	Use mobile audio-visual solutions (*cf.* 6.10.2.1)
	Technical collaboration	Networking and other larger IT installations should be done in collaboration with the institutional IT department (*cf.* 6.10.2.1)
Research	Increase output	Combine existing teaching and learning activities with research projects (*cf.* 6.11.1.1)
	Increase output	Utilise the institution's research committees and support structures (*cf.* 6.11.1.1)
	Improve data gathering	Utilise the data gathering capabilities of high-technology simulators to capture quantitative data. (*cf.* 6.11.1.1)

6.13 INTEGRATION OF THE SUBSYSTEMS IN HIGH-TECHNOLOGY CLINICAL SIMULATION

Although a simulation staff member (depending on designation) might only work with one or a few aspects of simulation, it is important to realise that there are various building blocks to make up the whole, and all of these are needed for sustainable success. As all the surveyed facilities in South Africa utilise low- and high-technology simulation modalities, it is important not to neglect the complexities of the high-technology component. The basic operational principles of simulation will equally apply for low-technology simulation as well as high-technology simulation. There are, however, areas where these two modalities deviate, and awareness of these differences and how to successfully navigate them could potentially enhance the successful integration of a high-technology simulation component within a facility.

From the literature, questionnaire survey and Delphi survey, the areas where the main deviations occur are where management and funding are involved (expensive simulators, maintenance and consumables), staff designation and training (technical staff needed and specialised training for complex systems), and certain physical and technical considerations (building requirements to run the high-technology equipment). With regards to curriculum integration and research, the same principles (with minor deviations) will apply to all forms of simulation.

The six operational subsystems used throughout the research project should be seen as subsystems of the whole, and these subsystems are all integrated with one another to achieve successful and sustainable high-technology simulation. If one of these building blocks are neglected or ignored, the whole system will suffer. On the other hand, if all are managed correctly, the success will flow through all the subsystems and sustainability will be achievable.

Management is needed to ensure that **funding** is used optionally. Management and funding can be seen as the foundation for high-technology simulation, and it will be challenging to successfully integrate and implement high-technology simulation in a simulation facility without them.

Management elements such as a vision, mission, clear objectives and a needs analysis are crucial to ensure that the correct resources are utilised. With well-defined key performance indicators (KPIs), a SWOT analysis and statistical data, progress and gaps can be measured over time, evaluated, and reacted on (Calzada 2015:269). Where the facility should be positioned within the larger institution is equally important, and the decision about this should be based on the goals and the needs analysis (Bajaj *et al.* 2018:113; Peets & Ayas 2013:530).

Funding is essential to all activities in any institution, and this is even more so in the case of high-technology simulation (Calzada 2015:268; Bar-on *et. al* 2013:e532). Curriculum and research activities need funding and, in some cases, can generate an income for the facility (Calzada & Leland 2019:63). Funding should be approached in two phases, firstly for the initial funding to establish the facility, and secondly continued funding to ensure day-to-day operations. The initial funding for the establishment of the facility will include elements such as building costs, and acquisition of simulators and equipment computer hardware and software. Sustainable funding should be ensured for day-to-day operations, such as regular maintenance of simulators, equipment, buildings, consumables, expansion of the staff complement and staff salaries (CAE Healthcare 2013:online). From time to time, expensive capitalisable equipment will need to be replaced.

The **staff and their training** and the **physical environment** are the additional supporting resources needed for successful and sustainable high-technology simulation. These can be seen as additional building blocks on the foundations of management and funding.

All **staff** and their **development** are crucial to high-technology simulation as a resource to support the activities (Canales & Huang 2015:584). Additional costs might occur for high-technology over low-technology simulation due to the need for technical staff members with speciality training (Andreatta 2019:47). The composition of the staff will depend on the goals and needs analysis. In order to ensure sustainable success, regular evaluation of staff performance against the KPIs will have to be done and responded upon.

The **physical environment**, the rooms (with their technical specifications), storage, and equipment are also crucial resources for sustainable success when using high-technology simulation. Just like staff, the environment does not stand in isolation, but needs funding to be built (or adapted) and equipped, as well as management to ensure that this is derived from setting goals and needs analyses and regular evaluation based on KPIs (Seropian 2008:179).

Curriculum integration and **research** can be seen as the products created by high-technology simulation. These two aspects are also firmly connected to the foundations of funding and management.

Curriculum integration, as with the other subsystems, should be firmly linked to funding as the activities can cost money and will need funding to be sustainable. However, curriculum integration could also be a source of funding through increased institutional budget allocations and government education grants. Again this subsystem should be firmly integrated with management, with decisions based on goals, and a needs analysis, and should be reviewed against KPIs (Motola *et. al* 2013:e1512).

Research should be firmly linked to funding, as the research activities could lead to a source of funding through research grants. Research activities should also be integrated with the management subsystem, with decisions based on goals, needs analysis, and reviewed against KPIs (Kahol 2013:634).

Figure 6.4 is a visual representation of the six subsystems that do not stand in isolation from each other but are integrated in their support of high-technology simulation in South Africa in a sustainable way. The arrows indicate the flow of resources and information between the subsystems.

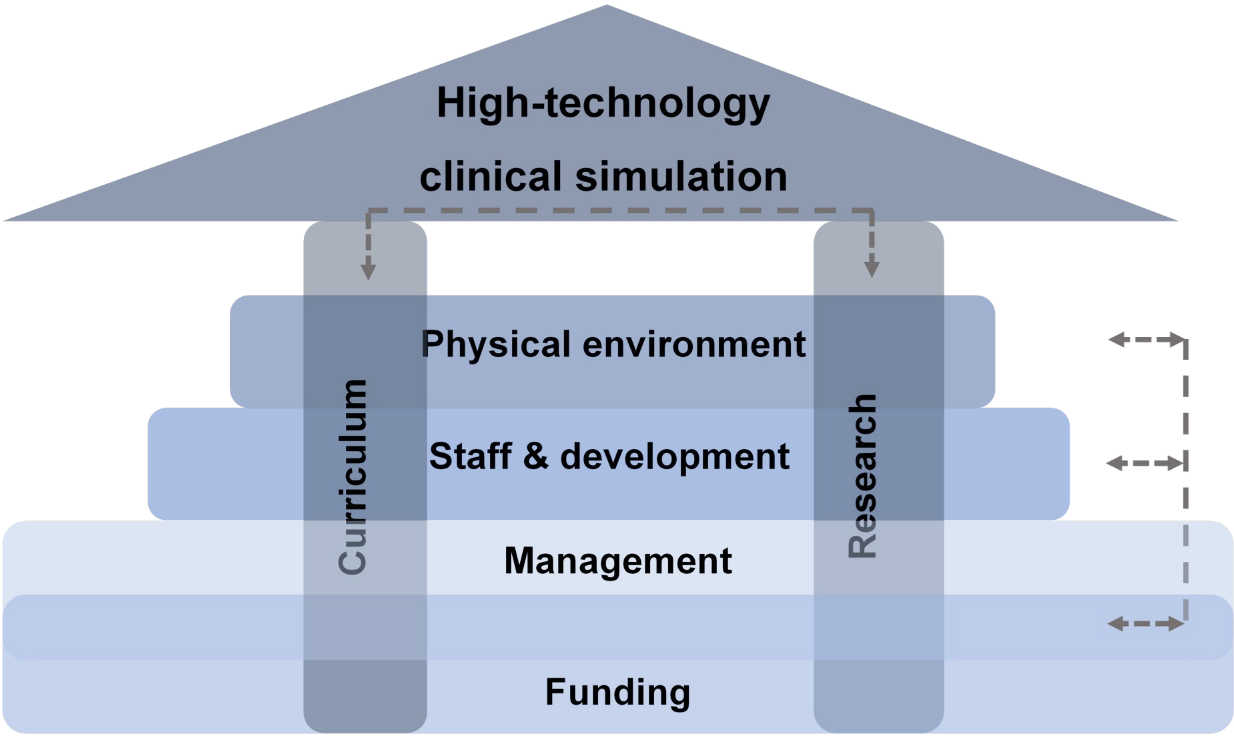

Figure 6.4: A sustainable, integrated systems approach in high-technology simulation (compiled by the researcher R van Wyk. 2020)

6.14 GUIDELINES TO ACHIEVE A SUSTAINABLE, INTEGRATED SYSTEMS APPROACH IN HIGH-TECHNOLOGY SIMULATION

Using the literature, the information from the survey in South African facilities and the Delphi survey with experts, certain challenges were identified with high-technology simulation in South Africa, and recommendations to address these were given (*cf.* 6.6, 6.7, 6.8, 6.9, 6.10, 6.11 and Table 6.3). To address these recommendations and achieve a sustainable, integrated systems approach, guidelines are given in Table 6.4. These guidelines show how the different subsystems integrate with each other, as well as which role-players are involved. Brief comments are added in each guideline to provide context or more details.

To utilise the recommendations and guidelines and achieve a sustainable, integrated systems approach to high-technology simulation, the various role-players need to be identified. There are simulation staff and their various designations namely management, educators, and technical and administrative staff. In addition, there are the institution's management, committees, and departments. These role-players are external to the simulation facility but represent the broader institution's interests. There are also the students and researchers that will utilise the facility. Students and researchers can be internal (from the same institution as the facility) or external. Lastly, there are vendors. Vendors are important role-players, especially keeping in mind the complexity of high-technology simulators. Their knowledge and support can be leveraged to benefit the facility.

Table 6.4: Guidelines to achieve a sustainable, integrated systems approach to high-technology simulation in South Africa (compiled by the researcher R van Wyk 2020)

Recommendations:	• Add document creation to a management training module for simulation staff (*cf.* 6.6.1.1). • Basic training for all designations (*cf.* 6.8.2.1). • Focused, advanced training for the relevant designations (*cf.* 6.8.2.1).
Guideline:	**Create a basic training course of simulation and all its elements for all simulation staff, and an advanced course specialising in each designation. Vendor-specific training should be arranged for specialised simulators.**
Affected subsystems:	Management Staff & staff development Funding Curriculum integration Physical environment Research
Role-players:	All simulation staff Vendors
Comment:	The training courses will not only enable all simulation staff to have an overview of all the elements of simulation, but will also enable the various designations to have advanced knowledge in their particular fields. These training courses will integrate all subsystems, as the course content will touch on each of the operational subsystems.

Recommendations:	• Create templates of documents to ease the process of completing them (*cf.* 6.6.1.1).
Guideline:	**Utilising the management part of an advanced training course, a set of management document templates can be created for the management team to easily complete. This will include crucial documents such as a needs analysis, KPIs, swot analysis, fee structure and day-to-day SOPs.**
Affected subsystems:	Management Staff & staff development Funding
Role-players:	Simulation staff: Management
Comment:	It is important to make this potentially complex and difficult task as easy as possible without compromising quality. The quality and content of these documents will have an impact on the utilisation and funding of the facility. Using a pre-set template will ease the completion of these documents

Recommendations:	• Staff should be part of document creation, and new staff should be trained in the contents of documents during their induction (*cf.* 6.6.1.1). • Documentation should be physically accessible (*cf.* 6.6.1.1).
Guideline:	**When creating management documents, all staff should be involved to help establish a sense of ownership. The documents should be stored at a location (virtual or physical) that is accessible to the staff. New staff members should receive training in the contents of the documents as part of their induction overview.**
Affected subsystems:	Management Staff & staff development
Role-players:	All simulation staff
Comment:	A sense of ownership from the simulation staff on the contents of management documents will ensure that the staff has a better understanding of the mission, vision and values and achieving objectives within the simulation facility.

Recommendations:	• Two models. Inside a department or stand-alone facilities (*cf.* 6.6.2.1). • Simulation technical oversight committee is available to departments (*cf.* 6.8.1.1). • Technical staff member is part of the facility (*cf.* 6.8.1.1).
Guideline:	**The decision regarding where in the institution a simulation facility is situated should be made according to the needs of the institution and its departments.** **Once a department indicates a need for high-technology simulation, it is important to second a simulation representative in the institution that will liaise with the other departments to ascertain whether there might be some shared needs that can be addressed to increase productivity.**
Affected subsystems:	Management Funding Staff & staff development
Role-players:	Institution's management, committees, and departments. Simulation staff: Management and Technical
Comment:	This is usually one of the first steps when establishing a new facility, and simulation staff or management will most likely not exist yet. Once a decision is made, a technical expert should advise on the technology involved.

Recommendations:	• Formalise simulation activities into the curriculum (*cf.* 6.7.1.1).
Guideline:	**Ensure that the simulation activities are formally integrated (documented) into the curriculum to ensure qualification for grants.**
Affected subsystems:	Management Funding Curriculum integration
Role-players:	Institution's management, committees and departments. Simulation staff: Management. Students
Comment:	A simulator or simulation facility could potentially be used as a "nice-to-have" by a department or module without any formal documentation of its use in the curriculum. Formalising the simulation activities into the curriculum ensures that there is a document trail when applications are made for grants.

Recommendations:	• Focus on increasing productivity from simulators (*cf.* 6.7.1.1).
Guidelines:	**Increase the productivity of a simulator by increasing the number of hours it is in use.** **Assess the curriculum regularly and convert content to simulations where applicable.**
Affected subsystems:	Management Funding Curriculum integration Staff & staff development
Role-players:	Institution's departments, students and all simulation staff. Students.
Comment:	Although this approach will initially lead to more pressure on all simulation staff, the increased use of simulations can eventually be used to justify an increase in staff numbers

Recommendations:	• Do not charge additional fees to students and departments (*cf.* 6.7.1.1).
Guideline:	**Do not charge the internal students or departments for simulation sessions as this will create a barrier to learning, and a department might decide to use other teaching modalities. Rather use the number of students as justification for more institutional funding.**
Affected subsystems:	Management Funding Curriculum integration
Role-players:	Institution's departments, students and simulation staff: Management. Students
Comment:	Charging students and departments for simulation sessions are also an additional administrative task that takes the focus away from day-to-day simulation activities.

Recommendations:	• Re-assess if a cheaper modality will suffice for a simulation activity (*cf.* 6.7.1.1). • Needs analysis, student level, and applicability to high-technology simulation (*cf.* 6.9.1.1). • Students must not be exposed to assessment on high-technology simulators if they have not used them during teaching and learning (*cf.* 6.9.1.1).
Guidelines:	**Assess the curriculum content to make sure which elements should utilise simulation and high-technology simulation. No assessment activities should be linked to simulation modalities if the teaching and learning component is not also linked to it.** **If a decision needs to be made on what type of simulator to purchase, make sure by way of a thorough needs analysis whether a cheaper modality is perhaps possible.** **If a simulator is not utilised effectively, it might be replaced by a cheaper modality, which will reduce the maintenance costs.** **Vendors and agents should be leveraged to assist with the latest and most suitable models.**
Affected subsystems:	Management Funding Curriculum integration
Role-players:	Institution's departments and simulation staff: Management & educators. Students. Vendors
Comment:	A decision on the usage of a particular simulator should always be linked to the educational goals that it helps to achieve.

Recommendations:	• Gather usage statistics (*cf.* 6.7.1.1).
Guideline:	**Utilise the administrative staff to develop a process to keep track of all students using the facility. It is also important to capture which year of study the students are, which department is organising the activity and what type of activity (teaching and learning vs assessment) is taking place.**
Affected subsystems:	Management Curriculum integration Funding
Role-players:	Simulation staff: Management and administrative. Students
Comment:	Facility usage statistics is a vital tool to justify continued funding

Recommendations:	• Create a fee structure (*cf.* 6.7.1.1).
Guideline:	**Decide on an income fee philosophy and develop a fee structure aligned with it.**
Affected subsystems:	Management Funding
Role-players:	Simulation staff: Management
Comment:	Even when the facility will not charge the internal student a fee, it is important to have a fee structure. In this way, a facility will know its cost for the activities per hour, and can use it as justification for funding and budgeting processes.

Recommendations:	• Enable a simulation representative to be part of an institutional financial committee (*cf.* 6.7.2.1).
Guideline:	**Make sure a technical simulation expert represents the simulation facility on the relevant institutional finance committee.**
Affected subsystems:	Management Funding
Role-players:	Institution's management and committees and simulation staff: Technical
Comment:	To ease the procurement of specialised high-technology equipment, it is important for the technical expert to liaise with the relevant financial teams.

Recommendations:	• Teamwork between technical and educational staff (*cf.* 6.9.2.1). • Availability of technical staff during a simulation (*cf.* 6.9.2.1).
Guidelines:	**Formal adequate timeslot should be set aside for each new simulation activity for the technical and education team to meet, programme and test-run a high-technology activity.** **Management should create a policy to ensure that all high-technology simulations are overseen by a technical expert to facilitate troubleshooting. For the running of a simulation, administrative staff can act as a stand-in with the needed technical training.**
Affected subsystems:	Management Staff and staff development Curriculum integration
Role-players:	Simulation staff: Management, technical, administrative and educators
Comment:	The formal meeting between the technical team and educators is vital for a high-quality simulation experience. If such a meeting and programming is done haphazardly, it will negatively impact the simulation experience. Technical staff should be on-hand for troubleshooting during an activity, but if there are multiple activities at the same time, other staff can be utilised to run the simulations.

Recommendations:	• Flexibility is key, and clinical equipment should be used for fidelity (*cf.* 6.10.1.1). • Rooms must be larger than real-life counterparts (*cf.* 6.10.1.1). • Self-directed area for flat screen simulations (*cf.* 6.10.1.1). • Use a mobile audio-visual solution (*cf.* 6.10.2.1).
Guidelines:	**Make sure to budget and allow for clinical equipment to enhance the realism of an area.** **Make sure all equipment is easily portable to allow conversion of the rooms for other types of simulations.** **Where possible, increase the size of the room compared to its real-life counterpart.** **An area for self-directed learning using flat-screen simulation does not need the higher fidelity and additional equipment, and can be set up with benches and chairs only.** **Do not spend money on expensive, static audio-visual systems. Rather use a less expensive mobile solution than can integrate with simulation software.**
Affected subsystems:	Management Funding Curriculum integration Physical environment
Role-players:	Simulation staff: Management, technical and educators. Students
Comment:	The type of additional equipment (e.g. ventilators or E.C.G machines) will depend on the discipline(s) that will be taught, and should follow a needs analysis. Having larger rooms will ensure space for the students and additional simulation equipment. The furniture and additional equipment for a self-directed learning area are relatively cheap, and a good solution for flat-screen simulation. Static installed audio-visual systems tend to be expensive with no flexibility, and are in some cases, unable to integrate with other software.

Recommendations:	• Make sure electrical, networking and other hardware are installed properly (*cf.* 6.10.2.1). • Ensure environmental control (air-conditioning units) (*cf.* 6.10.2.1). • Networking and other larger IT installations should be done in collaboration with the institutional IT department. (*cf.* 6.10.2.1).
Guideline:	**Make sure to involve and leverage the institution's ICT and other building contractor resources from the inception of a high-technology simulation facility.**
Affected subsystems:	Management Funding Physical environment
Role-players:	Institution's management, simulation staff: Management & technical
Comment:	Some of the larger, behind the scenes infrastructure such as air-conditioning units and IT infrastructure will have to be done in collaboration with the institution's policies.

Recommendations:	• Combine existing teaching and learning activities with research projects (*cf.* 6.11.1.1).
Guideline:	**Collaborate with the different departments and dissect the curriculum for opportunities to conduct research.**
Affected subsystems:	Funding Curriculum integration Research
Role-players:	Institution's departments, simulation staff: Management & educators. Students. Researchers
Comment:	Close collaboration between the simulation facility and the institution's various departments is not only important for day-to-day operations, but also to identify potential research opportunities.

Recommendations:	• Utilise the institution's research committees and support structures (*cf.* 6.11.1.1).
Guideline:	**Have a simulation staff member serving on the institution's relevant research committee to ensure that research opportunities which might not be otherwise identified, are utilised.**
Affected subsystems:	Funding Management Research
Role-players:	Institution's committees, simulation staff: Management & educators. Researchers
Comment:	Having knowledge of planned research projects, the use of simulation could be advanced in the relevant projects.

Recommendations:	• Utilise the data gathering capabilities of high-technology simulators to capture quantitative data (*cf.* 6.11.1.1).
Guideline:	**Work with the technical staff and vendors to leverage the data gathering capabilities of some high-technology simulators.**
Affected subsystems:	Research Staff and Staff development
Role-players:	Simulation staff: Technical. Researchers. Vendors
Comment:	The data gathering of some research projects can be automated with the correct setup and knowledge of a system.

6.15 CONCLUSION

Due to the relatively high response rate of the questionnaire survey, it can be established that the feedback received is representative of the high-technology simulation landscape in South African, public, accredited health professions training institutions with the exception of emergency care colleges, and that the statements derived from it for the experts are representative of real-life situations. It was also established that all participating high-technology simulation facilities also utilise low-technology modalities for simulation.

The feedback from the panel of experts from the Delphi survey is valid, due to the high response rate and broad representative expertise of participants.

For each operational subsystem the challenges and/or gaps in the participating South African facilities were identified. The discussion on the **management** subsystem focused on the issue of correct documentation that should be in place, as well as where a facility should be situated in the larger institution. In the **funding** subsystem the discussion focused on income and expenses and financial governance.

During the discussion of the **staff and staff development** operational subsystem, the focus was on staff allocation and staff development for successful high-technology clinical simulation. The challenges identified for the **curriculum integration** discussion were the positioning of high-technology simulation in the curriculum and the logistical elements of a high-technology simulation session.

The **physical environment** discussion focused on the issues of room requirements and other physical and technical considerations. Lastly the **research** operational subsystem's discussion focused on research outputs.

Recommendations for these challenges were given and summarised in Table 6.3. Recommendations were given across the focus areas and six subsystems.

These operational subsystems do not stand in isolation from each other, but are integrated. A gap in the performance of one subsystem (such as curriculum goals not being achieved), might be traced back to a task not done in a completely different element (for example something not addressed in the needs analysis, or the needs analysis not performed). Likewise implementing a recommendation for one subsystem will influence other subsystem(s) as well.

Guidelines were given to address each of the recommendations, and in some cases one guideline may address multiple recommendations. The affected operational subsystems and role-players are also listed for each guideline.

In the next chapter, ***Chapter 7:*** **Overview, conclusions and contributions of the study,** an overview of the study will be provided.

CHAPTER 7
OVERVIEW, CONCLUSIONS AND CONTRIBUTIONS OF THE STUDY

7.1 INTRODUCTION

In the previous chapter, the results of the questionnaire survey and Delphi survey were discussed. The departure points and limitations for the study were also stated. Recommendations were given to achieve a sustainable, integrated systems approach in supporting and enhancing high-technology simulation in South Africa. Guidelines to achieve the recommendations were also set out.

In this chapter, an overview of the study will be presented. Conclusions will be drawn, the contributions of the study, recommendations for further research will be given, and concluding remarks made.

Simulation-Based Health Education (SBHE) can be achieved by using different modalities of simulators. These modalities are broadly divided into low technology and high-technology. However, the high-technology simulators are not the only elements needed for successful high-technology simulation. Other subsystems needed are management, funding, staff and their development, curriculum integration, physical elements, and research (Palaganas *et al.* 2015; Labuschagne 2012; Kyle Jr & Murray 2008).

These subsystems are the building blocks of high-technology simulation and are well established in the literature. However, challenges are experienced by facilities when using high-technology simulation (Al-Ghareeb & Cooper 2016:284). The question arises regarding the challenges faced by the South African facilities with respect to these subsystems, and how to address them through a sustained, integrated systems approach.

The goal of the study was to investigate and understand how a sustainable, integrated systems approach to support and enhance high-technology clinical simulation in South Africa can be achieved.

7.2 OVERVIEW OF THE STUDY

The study was conducted between September 2017 and July 2020, with the empirical research phase between February 2018 and March 2020 (*cf.* 1.5). The design of the study was a descriptive, quantitative study (*cf.* 1.1). The focus of the study was the operational subsystems of high-technology clinical simulation in South African public accredited health professions education institutions (*cf.* 1.3).

To achieve the goal of the study, one research question was formulated (*cf.* 1.3): ***How can a sustainable integrated systems approach to high-technology clinical simulation in South Africa be achieved?***

To address the research question, four objectives were identified, and a combination of a literature study, a questionnaire survey and Delphi survey was used to achieve the objectives.

Objective one: ***To conceptualise the various operational subsystems of high-technology clinical simulation and determine the best practices and challenges to high-technology clinical simulation***. By pursuing objective one, it was established from the literature that the various subsystems for a successful approach to high-technology clinical simulation consist of six operational subsystems. These six subsystems are management, funding, staff and their development, curriculum integration, the physical environment and research (*cf*. 2.2, 2.3, 2.4, 2.5, 2.6 and 2.7). It was also established that although the subsystems and principles of simulation are applicable to both low- and high-technology simulation, the latter has its own unique challenges due to its increased complexity (*cf.* 2.8). Objective one was successfully achieved.

Objective two: ***To establish the current approach to and challenges experienced regarding high-technology clinical simulation in South African simulation facilities.*** Objective two was pursued using a questionnaire survey (informed by the results of objective one) and sent out to the simulation facilities of South African public accredited health professions education institutions. The results of the survey revealed the approaches used by the facilities in each of the six identified subsystems. It also revealed the challenges faced by the facilities in each of the subsystems (*cf.* Chapter 4). Objective two was successfully achieved.

Objective three: ***To reach consensus amongst simulation experts on elements needed for a sustainable integrated systems approach to high-technology clinical simulation in South Africa***. Objective three was pursued using the results from objectives one and two to inform the Delphi survey with a panel of eight simulation experts. Using the Delphi survey technique over three rounds, the experts gave feedback on their approach to elements within the six operational subsystems and the specific challenges identified by the questionnaire survey. They also provided valuable comments on their approaches to the various subsystems and challenges within each subsystem presented to them (*cf.* Chapter 5). Objective three was successfully achieved.

Objective four: ***To explain and illustrate the integration of the operational subsystems with each other and to set out recommendations and guidelines needed to achieve a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa.*** In order to pursue objective four, the results from objectives one, two and three were used. The identified challenges regarding high-technology simulation in South African facilities were discussed in relation to the literature study for each subsystem. Information from the Delphi survey was used to create recommendations for the experienced challenges (*cf.* Chapter 6). The recommendations were used to establish a sustainable integrated systems approach to high-technology clinical simulation in South Africa (*cf.* 6.13). The approach also included guidelines to follow, highlighting the integration of each subsystem, as well as the relevant role-players needed for each guideline (*cf.* Table 6.4). Objective four was successfully achieved.

By achieving success in all four objectives, the research question was answered.

7.3 CONCLUSION

Clinical simulation forms an important part of health education in South Africa as an intermediary step between theory and practice, and it enhances the curriculum. Public accredited health professions education institutions in South Africa that utilise high-technology simulation also utilise low-technology simulation modalities. To achieve success in clinical simulation, it is important to understand the different operational subsystems of simulation and where the elements of these subsystems overlap and integrate with each other. Success in simulation is not only the initial creation of a facility, but also the sustained and long-term success of day-to-day operations.

These elements or subsystems of simulation are applicable whether low-technology or high-technology modalities are used. However, due to its increased complexity, high-technology simulation has some additional challenges and considerations. These considerations are the fact that the simulators are more expensive and technical in nature to operate and maintain. This leads to an impact on the amount of **funding** needed and is indirectly linked to **management,** as a thorough needs analysis needs to be performed to make sure money is spent on the correct technology.

Another subsystem where high-technology simulation differs from low-technology simulation is in **staffing and staff development**. High-technology simulators need expert technical input to operate and maintain. This creates the need for the development of specialised technical staff skills. This is not only for day-to-day operations but also for troubleshooting problems when something goes wrong, as well as advising and working with vendors when decisions need to be made on which simulators to purchase.

When considering the **physical environment** and the impact that high-technology simulation has on it, special consideration needs to be made for installation aspects such as connectivity (network cabling and Wi-Fi) and power requirements (electrical). Potential connectivity interference from other equipment such as air-conditioning units or electrical distribution boards needs to be considered.

In some cases, high-technology simulators can gather and store quantitative data captured in real-time during a simulation activity. This data-gathering capability could be a useful tool for **research** projects and activities within a simulation facility.

The recommendations and guidelines set out in this research project can be applied by simulation facilities to support and enhance their day-to-day operational activities, especially where high-technology simulation is concerned, and achieve long-term sustainability. It also highlights which elements are integrated in the different subsystems.

Thorough understanding of the integration of the six subsystems may enable long-term sustainability of high-technology simulation within a facility or institution.

7.4 CONTRIBUTION OF THE RESEARCH

The overall goal of the study was to support and enhance high-technology clinical simulation in South Africa. The contribution of the study is that it represents integration between the subsystems in high-technology clinical simulation clearly and concisely and will assist when facilities need to plan and implement high-technology simulation in a sustainable systems integrated manner.

The results of the study are a set of recommendations and guidelines that can be used by any public South African or other developing country simulation facility to support and enhance a sustained integrated systems approach to high-technology simulation. Internationally it can also be useful for simulation facilities that experience challenges with high-technology simulation.

7.4.1 Value and significance of the study

The value of the study is the understanding of the approach and challenges of high-technology clinical simulation in South Africa.

The significance will be the possible improvement of integration and long-term success of high-technology clinical simulation at South African facilities.

Understanding and describing the different subsystems of a sustainable integrated systems approach to high-technology clinical simulation in a South African context would add value to the field of Clinical Simulation in South Africa.

7.4.2 Implementation of the findings

The report will be submitted to the Heads of the three Simulation Units of the FoHS as well as the faculty management at the UFS to contribute to the knowledge on, and awareness of, a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation that could be utilised at the FoHS (UFS). The report will also be used to inform staff development and integration in the Simulation for Healthcare short learning program at the UFS. A digital copy of the report will be uploaded to KovsieScholar, the UFS digital repository, which will make it accessible to any organisation or individual worldwide. Elements of the report will be adapted for academic articles and congress presentations.

7.5 RECOMMENDATIONS FOR FURTHER RESEARCH

For the study to produce substantial and practical results, the following recommendations are made:

- A similar study focusing on the private sector simulation training landscape in South Africa. It will be useful to compare the differences (if any) in approach between the private and public sectors.

- Further research to adapt the recommendations and guidelines for a custom-made approach at individual facilities. This study was a quantitative study focusing on the broader public South African clinical simulation landscape. A smaller, targeted qualitative study at an individual facility may be performed to address specific challenges at that facility.
- A similar study in resource-constrained countries in the rest of Africa.

7.6 CONCLUDING REMARK

Achieving sustained, long-term success using high-technology simulation might seem like a difficult task, but through planning and diligent management, all challenges can be addressed and overcome.

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APPENDIX A:

SURVEY QUESTIONNAIRE

Mark as shown: ☐ ☒ ☐ ☐ ☐ Please use a ball-point pen or a thin felt tip. This form will be processed automatically.
Correction: ☐ ■ ☐ ☒ ☐ Please follow the examples shown on the left hand side to help optimize the reading results.

INVITATION TO PARTICIPATE IN A QUESTIONNAIRE SURVEY

Dear Colleague,
I am currently occupying the position of Chief Technical Expert at the Clinical Simulation and Skills Unit, School of Biomedical Sciences (CSUM), at the University of the Free State. I am in the process of writing a thesis to obtain the Ph.D degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State (Student number: 1996510200). As part of my Thesis, I will conduct a questionnaire survey with representatives of clinical simulation facilities at South African, health professions educational institutions.

The survey will be online and take approximately 20 minutes to complete. ***Please note: the online survey cannot be saved, so please set aside 20 minutes without interruptions to complete it.***

The purpose of the questionnaire survey will be to gather data about the current approach and challenges regarding high-technology clinical simulation at South African facilities. The survey will be online and approximately 20 minutes. Participation is voluntary and will cost you nothing; neither will you receive any remuneration for your participation. All information will be treated in strict confidential manner.

Ethics reference number: HSREC 115/2017 (UFS-HSD2017/1147) Health Sciences Research Ethics Committee (UFS).

My promoter is: Dr Mathys Labuschagne
Head: Clinical Simulation and Skills Unit School of Biomedical Sciences Faculty of Health Sciences
University of the Free State Tel: 051 401 3869

My co-promoter is: Prof Gina Joubert
Head: Department of Biostatistics Faculty of Health Sciences University of the Free State
Tel: 051 401 3117

Contact details of the Health Sciences Research Ethics Committee at the University of the Free State:
Maré Marais
+27 51 401 7795
EthicsFHS@ufs.ac.za

Thank you very much for your consideration of this initiative and I am looking forward to hearing from you.

Yours sincerely
Mr Riaan van Wyk
Telephone number: 051 401 2504
Cellular phone: 082 291 5500
Email address: vanwykr3@ufs.ac.za
Postal address:Room 200, Block A, Francois Retief Building, University of the Free State, Bloemfontein, 9301

1. Demographics

1.1 How many years has the simulation facility been operational?

1. Demographics [Continue]

1.2 Which description would best describe your own role?
- ☐ Head
- ☐ Lecturer
- ☐ Scenario facilitator
- ☐ Debriefing facilitator
- ☐ Administrative
- ☐ Technical
- ☐ Operational set-up staff
- ☐ SP coordinator
- ☐ Other

1.3 1.5 - Please specify "other":

1.4 Which professions use the simulation platform at your facility? (Check all that apply)
- ☐ Biokinetics
- ☐ Dental Therapy and Oral Hygiene
- ☐ Dietetics and Nutrition
- ☐ Emergency care
- ☐ Medicine
- ☐ Nursing
- ☐ Occupational Therapy
- ☐ Optometry
- ☐ Pharmacy
- ☐ Physiotherapy
- ☐ Radiography
- ☐ Speech Language and Hearing Professions

1.5 Which low-technology simulation modalities are used at the facility? (Check all that apply)
- ☐ None
- ☐ Role-play - amongst students
- ☐ Role-play – using standardised patients
- ☐ Skills training using part task trainers
- ☐ Skills training using animal tissue (wet lab)
- ☐ Other

1.6 1.8 - Please specify “other”:

1.7 Which high-technology simulation modalities are used at the facility? (Check all that apply)
- ☐ None
- ☐ High-fidelity scenarios using Human patient simulators
- ☐ Virtual and/or augmented reality
- ☐ Flat-screen simulation
- ☐ Other

1.8 1.10 - Please specify “other”:

1.9 If no high-technology simulation is used what are the reasons for it? (Check all that apply)
- ☐ No need for it in curriculum
- ☐ Lack of time
- ☐ Lack of trained staff
- ☐ Lack of finances
- ☐ Insufficient support from manufacturers
- ☐ Maintenance of technology
- ☐ Additional workload
- ☐ Other

1.10 1.12 - Please specify “other”:

1.11 On average how many hours per week of high-technology simulation are conducted at the facility?

1. Demographics [Continue]

Thank you for your participation. The rest of the questionnaire is for facilities that utilise High-Technology Simulators. Please navigate to section 9 and press "Submit".

2. Management aspects

2.1 In your institution, is the simulation facility a stand-alone department/unit/centre or does it form part of another training or support department?

- ☐ Stand-alone
- ☐ Part of another department
- ☐ Other

2.2 2.2 - Please specify "other":

2.3 Does the facility have the following information documented? (Check all that apply)

- ☐ Needs analysis
- ☐ SWOT analysis
- ☐ Policy document
- ☐ Mission statement
- ☐ Vision statement
- ☐ Goals and strategies
- ☐ Performance indicators
- ☐ Statistics of facility usage
- ☐ Student feedback
- ☐ Staff development plan
- ☐ Organogram
- ☐ Financial plan

2.4 Additional documentation:

When deciding which vendors to use for high-technology simulation equipment, please rank the most important considerations at the facility. (1 being the most important and 5 being the least important of the 5)

2.5 1 -

2.6 2 -

2.7 3 -

2.8 4 -

2.9 5 -

2. Management aspects [Continue]

2.10 Any further comments on the management aspects of the simulation facility?

3. Funding aspects

3.1 Please check all applicable funding sources for the facility.

- ☐ Government - education grant(s)
- ☐ Government – health grant(s)
- ☐ Institutional budget allocation
- ☐ Income from external training
- ☐ Corporate grant(s)
- ☐ Corporate donations (sponsors)
- ☐ CPD / certification courses
- ☐ Research grant(s)
- ☐ Other

3.2 3.2 - Please specify "other":

3.3 Does the facility have its own financial committee to steer financial decisions? ☐ No ☐ Yes ☐ Part of an institutional / other department committee

3.4 Does the facility have its own procurement policy and procedures? ☐ No ☐ Yes ☐ Part of an institutional / other department committee

3.5 Any further comments on the funding aspects of the simulation facility?

4. Staffing and staff development aspects

4.1 Is the simulation facility is a stand-alone department/unit/centre?
If it is a stand alone unit, please indicate how many staff members are part of the simulation facility? ☐ Stand-alone facility ☐ Not a stand-alone facility

4.2 Full time emplyees

4.3 Part time emplyees

4.4 How many of each type of staff member is working at the simulation facility?
Head of facility:

4.5 Lecturers:

4.6 Scenario facilitators:

4. Staffing and staff development aspects [Continue]

4.7 Debriefing facilitators:

4.8 Administrative:

4.9 Technical:

4.10 Operational set up staff:

4.11 Standardised Patients co-ordinator:

4.12 Other:

4.13 4. 13 - Please specify "Other":

4.14 If the simulation facility is part of another department how many staff members are directly involved in high-technology simulation?
- ☐ Part of another department
- ☐ Stand-alone facility

4.15 Full time employees

4.16 Part time employees

4.17 How many of each type of staff member is directly involved with high-technology simulation?
Head of facility:

4.18 Lecturers:

4.19 Scenario facilitators:

4.20 Debriefing facilitators:

4.21 Administrative:

4.22 Technical:

4.23 Operational set-up staff:

4. Staffing and staff development aspects [Continue]

4.24 Standardised Patients co-ordinators:

4.25 Other:

4.26 4.26 - Please specify “other”

4.27 Does the facility or institution have a training plan for the following type of staff involved in high-technology simulation? (Check all that apply)

- ☐ Head
- ☐ Lecturer
- ☐ Scenario facilitators
- ☐ Debriefing facilitators
- ☐ Administrative
- ☐ Technical
- ☐ Operational set-up staff
- ☐ SP coordinator
- ☐ Other

4.28 4.28 - Please sepecify "other"

4.29 Which aspects are covered by these training plan(s)? (Check all that apply)

- ☐ Management aspects
- ☐ Financial planning
- ☐ Physical planning
- ☐ Scenario planning and programming
- ☐ Technical support
- ☐ Moulage
- ☐ Debriefing
- ☐ Ethics
- ☐ Simulation facilitation
- ☐ SP co-ordination
- ☐ Other

4.30 4.30 - Please specify "other"

4.31 Briefly describe the approach followed to ensure a successful simulation experience when a specific team member is not available.

4.32 Any further comments on staff and staff development aspects?

5. Curriculum integration aspects

5. **Curriculum integration aspects** [Continue]

5.1 1st year students: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ No 1st years
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.2 1st year students: Indicate the number of students utilising high-technology simulation at the facility

5.3 2nd year students: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ No 2nd years
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.4 2nd year students: Indicate the number of students utilising high-technology simulation at the facility

5.5 3rd year students: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ No 3rd years
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.6 3rd year students: Indicate the number of students utilising high-technology simulation at the facility

5.7 4th year students: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ No 4th years
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.8 4th year students: Indicate the number of students utilising high-technology simulation at the facility

5.9 5th year students: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ No 5th years
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.10 5th year students: Indicate the number of students utilising high-technology simulation at the facility

5.11 6th year students: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ Not applicable
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.12 6th year students: Indicate the number of students utilising high-technology simulation at the facility

5.13 Post grad / diploma: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ Not applicable
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.14 Post grad / diploma: Indicate the number of students utilising high-technology simulation at the facility

5.15 Continued professional development / accreditation courses: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.

- ☐ Not applicable
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.16 Continued professional development / accreditation courses : Indicate the number of students utilising high-technology simulation at the facility

5. **Curriculum integration aspects** [Continue]

5.17 Any other students: Indicate whether the use of high-technology simulation in the modules/ blocks is mandatory or a voluntary “add-on” training.
- ☐ Not applicable
- ☐ Mandatory
- ☐ Voluntary
- ☐ Mandatory in some cases and add-on in others

5.18 Any other students: Indicate the number of students utilising high-technology simulation at the facility

5.19 5.19 - Please specify other:

5.20 Indicate the use of high-technology simulation in the curriculum at the facility. (Check all that apply)
- ☐ Teaching and learning
- ☐ Summative assessment
- ☐ Formative assessment
- ☐ Other

5.21 5.21 - Please specify "other"

5.22 Indicate the typical steps during high-technology simulation session used in the facility. (Check all that apply)
- ☐ Lesson / presentation
- ☐ Pre-briefing
- ☐ Simulation experience
- ☐ Debriefing
- ☐ Repeat the simulation experience
- ☐ Other

5.23 5.23 - Please specify "other"

5.24 Indicate the types of high-technology simulation session used in the facility. (Check all that apply)
- ☐ Skills training
- ☐ Simulation experiences (with facilitator guiding)
- ☐ Simulation experience (without facilitator)
- ☐ Self-directed learning and feedback
- ☐ Other

5.25 5.25 - Please specify "other"

5.26 Briefly describe the steps taken when planning a typical simulation experience for the students

5. **Curriculum integration aspects** [Continue]

5.27 Any further comments on curriculum integration aspects?

6. **Physical environmental aspects**

6.1 Indicate which physical spaces are available for high-technology simulations. (Check all that apply)

- ☐ Dedicated simulation room(s)
- ☐ Interchangeable room(s)
- ☐ Makeshift room(s) in another department
- ☐ *In situ* (or on site) simulations
- ☐ Skills training area
- ☐ Flat screen simulation computer lab
- ☐ Virtual / augmented reality area
- ☐ Dedicated debriefing area(s)
- ☐ Lecture hall(s)
- ☐ Other

6.2 How many dedicated simulation rooms are available for high-technology simulations.

6.3 How many interchangeable rooms are available for high-technology simulations.

6.4 How many makeshift rooms in another department are available for high-technology simulations.

6.5 How many *in situ* (or on site) rooms are available for high-technology simulations.

6.6 How many skills training rooms are available for high-technology simulations.

6.7 How many flat screen simulation computer labs / rooms are available for high-technology simulations.

6.8 How many virtual / augmented reality rooms are available for high-technology simulations.

6.9 How many dedicated debriefing rooms are available for high-technology simulations.

6.10 How many lecture halls are available for high-technology simulations.

6.11 How many other type of simulation rooms are available for high-technology simulations.

6.12 6.12 - Please specify "other"

6.13 Does the facility have control room(s) / observation room(s)? ☐ Yes ☐ No

6.14 Is the room(s) a separate room or do observations happen in the same room as the simulation experience? (Check all that apply)

- ☐ Separate observation area
- ☐ Separate observation in some cases
- ☐ Observation from within same room

6. Physical environmental aspects [Continue]

6.15 Does the facility have audio-visual equipment to stream or record high-technology simulation experiences? ☐ Yes ☐ No

6.16 Does the audio-visual equipment stream or record high-technology simulation experiences? (Check all that apply)
☐ No streaming nor recording of experiences ☐ Streaming to separate observation area ☐ Recording for later viewing

6.17 Does the facility have debriefing area(s) ☐ Yes ☐ No

6.18 Does the facility have separate debriefing area(s) or does debriefing happen in the same area as the experience? (Check all that apply)
☐ Separate debriefing area ☐ Separate debriefing in some cases ☐ Debriefing in the same room as experience

6.19 Was the facility custom built as a simulation facility? ☐ Yes ☐ No

6.20 Any further comments on physical environment aspects?

7. Research outputs and high-technology simulation

7.1 Is the facility utilised for research? ☐ Yes ☐ No

7.2 What kind of research has been conducted at the unit? (Check all that apply)
☐ Research in a health profession discipline utilising high-technology simulation ☐ Research about simulation or high-technology simulation ☐ Other

7.3 7.3 - Please specify "others"

7.4 Indicate in which way simulation staff are involved in research. (Check all that apply)
☐ Published in journals ☐ Post-graduate student using simulation ☐ Post-graduate study leader
☐ Post-graduate examiner ☐ Other

7.5 7.5 - Please specify "other"

7.6 Any further comments on research outputs aspects?

8. Challenges of high-technology simulation

8.1 When considering the initial setup of high-technology simulation facility, indicate whether you were involved in initial setup ☐ Yes ☐ No

8. Challenges of high-technology simulation [Continue]

When considering the initial setup of high-technology simulation facility, indicate the 5 challenges that were most prominent ranked from 1 to 5 (1 being the biggest challenge and 5 being the least challenging of the 5)

8.2 1 -

8.3 2 -

8.4 3 -

8.5 4 -

8.6 5 -

8.7 Which of the following challenges did the facility experience during the initial setup? (check all that apply)

- ☐ Lack of time
- ☐ Fear of technology
- ☐ Lack of human resources
- ☐ Inadequate space and equipment
- ☐ Lack in trained staff
- ☐ Lack of financial support
- ☐ Insufficient technology
- ☐ Maintenance of technology
- ☐ Additional workload
- ☐ Applicability to curriculum

When considering the day-to-day operational running of a high-technology simulation facility, indicate 5 challenges that are most prominent ranked from 1 to 5 (1 being the biggest challenge and 5 being the least challenging of the 5)

8.8 1 -

8.9 2 -

8.10 3 -

8.11 4 -

8. Challenges of high-technology simulation [Continue]

8.12 5 -

8.13 Which of the following challenges does the facility experience during day-to-day operational running? (check all that apply)

- ☐ Lack of time
- ☐ Fear of technology
- ☐ Lack of human resources
- ☐ Inadequate space and equipment
- ☐ Lack in trained staff
- ☐ Lack of financial support
- ☐ Insufficient technology
- ☐ Maintenance of technology
- ☐ Additional workload
- ☐ Applicability to curriculum

8.14 Briefly describe the approach(s) followed to alleviate these challenges.

8.15 Any further comments on challenges of high-technology simulation?

Thank you for your participation. Please navigate to section 9 and press "Submit".

APPENDIX B:

HSREC APRROVAL

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

30 August 2017

RIAAN VAN WYK
SCHOOL OF MEDICINE
FACULTY OF HEALTH SCIENCES
UFS

Dear Van Wyk, Riaan

HSREC 115/2017 (UFS-HSD2017/1174)
PRINCIPAL INVESTIGATOR: RIAAN VAN WYK
PROJECT TITLE: THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

CONDITIONAL APPROVAL

1. You are hereby kindly informed that, at the meeting held on 29 August 2017, the Health Sciences Research Ethics Committee (HSREC) reviewed the above research project. Research may not be conducted before the following condition(s) has/have been met and the HSREC grants final approval for the project:

   1.1. Awaiting local institutional approval. Please submit once obtained.

   PLEASE NOTE: Upon receipt of the updated documentation/other request(s) from the HSREC in RIMS, the project will be re-considered.

2. Kindly use the **HSREC NR** as reference in correspondence to HSREC Administration.

3. The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite); Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines; Constitution of the HSREC of the Faculty of Health Sciences.

Yours faithfully

....

DR SM LE GRANGE
CHAIR: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

IRB nr 00006240
REC Reference nr 230408-011
IORG0005187
FWA00012784

15 September 2017

RIAAN VAN WYK
SCHOOL OF MEDICINE
FACULTY OF HEALTH SCIENCES
UFS

Dear Van Wyk, Riaan

HSREC 115/2017 (UFS-HSD2017/1174)
PRINCIPAL INVESTIGATOR: RIAAN VAN WYK
PROJECT TITLE: THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

APPROVED

1. You are hereby kindly informed that the Health Sciences Research Ethics Committee (HSREC) approved this project after all conditions were met. This decision will be ratified at the next meeting to be held on 26 September 2017.

2. The Committee must be informed of any serious adverse event and/or termination of the study.

3. Any amendment, extension or other modifications to the protocol must be submitted to the HSREC for approval.

4. A progress report should be submitted within one year of approval and annually for long term studies.

5. A final report should be submitted at the completion of the study.

6. Kindly use the **HSREC NR** as reference in correspondence to the HSREC Secretariat.

7. The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

Yours faithfully

....

MS MGE MARAIS
HEAD: HEALTH SCIENCES RESEARCH ETHICS COMMITTEE ADMINISTRATION

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Health Sciences Research Ethics Committee

02-Aug-2019

Dear **Mr Riaan Van Wyk**

Ethics Number: UFS-HSD2017/1174

Ethics Clearance: **THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA**

Principal Investigator: **Mr Riaan Van Wyk**

Department: **School of Medicine Department (Bloemfontein Campus)**

SUBSEQUENT SUBMISSION APPROVED

With reference to your recent submission for ethical clearance from the Health Sciences Research Ethics Committee. I am pleased to inform you on behalf of the HSREC that you have been granted ethical clearance for your request as stipulated below:

Delphi questionnaire

The HSREC functions in compliance with, but not limited to, the following documents and guidelines: The SA National Health Act. No. 61 of 2003; Ethics in Health Research: Principles, Structures and Processes (2015); SA GCP(2006); Declaration of Helsinki; The Belmont Report; The US Office of Human Research Protections 45 CFR 461 (for non-exempt research with human participants conducted or supported by the US Department of Health and Human Services- (HHS), 21 CFR 50, 21 CFR 56; CIOMS; ICH-GCP-E6 Sections 1-4; The International Conference on Harmonization and Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH Tripartite), Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines, Constitution of the HSREC of the Faculty of Health Sciences.

For any questions or concerns, please feel free to contact HSREC Administration: 051-4017794/5 or email EthicsFHS@ufs.ac.za.

Thank you for submitting this request for ethical clearance and we wish you continued success with your research.

Yours Sincerely

Dr. SM Le Grange
Chair : Health Sciences Research Ethics Committee

Health Sciences Research Ethics Committee
Office of the Dean: Health Sciences
T: +27 (0)51 401 7795/7794 | E: ethicsfhs@ufs.ac.za
IRB 00006240; REC 230408-011; IORG0005187; FWA00012784
Block D, Dean's Division, Room D104 | P.O. Box/Posbus 339 (Internal Post Box G40) | Bloemfontein 9300 | South Africa
www.ufs.ac.za

APPENDIX C:

LETTER TO ASCERTAIN WHETHER SIMULATION IS PART OF TRAINING

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

ASCERTAIN WHETHER SIMULATION IS PART OF THE TRAINING PLATFORM

Dear Colleague

I am currently occupying the position of Chief Technical Expert at the Clinical Simulation and Skills Unit, School of Medicine (CSUM), at the University of the Free State.

I am in the process of writing a thesis to obtain the Ph.D degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State (Student number: 1996510200). The title of my research is: The role of a sustainable integrated systems approach to high-technology clinical simulation in South Africa.

Ethics reference number: HSREC 115/2017 (UFS-HSD2017/1147) Health Sciences Research Ethics Committee (UFS).

My promoter is:
Dr Mathys Labuschagne
Head: Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State

My co-promoter is:
Prof Gina Joubert
Head: Department of Biostatistics
Faculty of Health Sciences
University of the Free State

The **aim** of the study is to determine the role of a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa. The **research question** is:

How can a sustainable integrated systems approach to high-technology clinical simulation in South Africa be achieved?

To achieve the aim and address the research question of the study a sequential approach will be followed to pursue the objectives:

1. To determine best practice approach and challenges to high-technology clinical simulation (Literature review).
2. To establish the current approach and challenges regarding high-technology clinical simulation of South African simulation facilities. (Questionnaire survey with health simulation facilities representatives).
3. To obtain consensus amongst simulation experts on best practises for a sustainable integrated systems approach to high-technology clinical simulation in South Africa (Delphi survey with simulation experts).
4. To identify the factors and their inter-relationship to each other needed to achieve a sustainable integrated systems approach to high-technology clinical simulation in South Africa (by analysing the results from 1, 2 and 3 above).

Kindly note that the information received during the project will only be used for research purposes and will not be released for any academic and/or employment-related performance evaluation, promotion and/or disciplinary purposes. The findings of this study will be made public to other educationalists in HPE through paper presentations at conferences and seminars and by the publishing of articles in applicable journals. The researcher undertakes to report the results in a way that will adequately protect the participants' identities.

I therefore kindly request the following information:

- **Does your institution utilise clinical simulation as part of the training and/or assessment platform for** *(specific profession)***?** This will include the usage of skills trainers, High-fidelity manikins, any computerised simulators (such as flat-screen simulators, and virtual/augmented reality simulators) and simulated patients.
- **Who would be the relevant simulation representative with whom the questionnaire should be conducted?**
- **What process or whom should be contacted at the institution to obtain permission to conduct a questionnaire survey at the relevant simulation facility?**

Please reply via e-mail to vanwykr3@ufs.ac.za

Should you have any specific questions, my contact details are as follows:

Telephone number:	051 401 2504
Cellular phone:	082 291 5500
Email address:	vanwykr3@ufs.ac.za
Postal address:	Room 200, Block A, Francois Retief Building, University of the Free State, Bloemfontein, 9301.

Thank you for taking the time to read this communication and I sincerely hope that you will be willing to contribute to this project.

Yours sincerely

Mr Riaan van Wyk
Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State
Bloemfontein

Contact details of the Health Sciences Research Ethics Committee at the University of the Free State:
Maré Marais
+27 51 401 7795
EthicsFHS@ufs.ac.za

APPENDIX D:

LETTER TO THE INSTITUTIONS

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Request permission to include the institution in a questionnaire survey

Request for permission to conduct a Philosophiae Doctor study in the programme Health Professions Education (HPE) at the UFS with the title: The role of a sustainable integrated systems approach to high-technology clinical simulation in South Africa

I am currently occupying the position of Chief Technical Expert at the Clinical Simulation and Skills Unit, School of Medicine (CSUM), at the University of the Free State.

I am in the process of writing a thesis to obtain the Ph.D degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State (Student number: 1996510200). The title of my research is: The role of a sustainable integrated systems approach to high-technology clinical simulation in South Africa.

Ethics reference number: HSREC 115/2017 (UFS-HSD2017/1147) Health Sciences Research Ethics Committee (UFS).

My promoter is:
Dr Mathys Labuschagne
Head: Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State

My co-promoter is:
Prof Gina Joubert
Head: Department of Biostatistics
Faculty of Health Sciences
University of the Free State

The **aim** of the study is to determine the role of a sustainable integrated systems approach in supporting and enhancing high-technology clinical simulation in South Africa. The **research question** is:

How can a sustainable integrated systems approach to high-technology clinical simulation in South Africa be achieved?

To achieve the aim and address the research question of the study a sequential approach will be followed to pursue the objectives:

1. To determine best practice approach and challenges to high-technology clinical simulation (Literature review).
2. To establish the current approach and challenges regarding high-technology clinical simulation of South African simulation facilities. (Questionnaire survey with health simulation facilities representatives).
3. To obtain consensus amongst simulation experts on best practises for a sustainable integrated systems approach to high-technology clinical simulation in South Africa (Delphi survey with simulation experts).
4. To identify the factors and their inter-relationship to each other needed to achieve a sustainable integrated systems approach to high-technology clinical simulation in South Africa (by analysing the results from 1, 2 and 3 above).

The **overall goal** of this study is to investigate and understand how a sustainable integrated systems approach to high-technology clinical simulation can be achieved. This will lead to a more robust integration of aspects, such as management functions, funding models, staff training, curriculum integration, physical space utilisation and research output that are essential to the success of high-technology simulation.

The **methods** that will be utilised in this study are, **a literature review**, a **questionnaire survey** and a **Delphi survey**. The literature review will be done to determine the best practice approach and challenges of high-technology clinical simulation education and training. A survey will be conducted using a questionnaire to gather data about the current approach and challenges to high-technology clinical simulation at South African facilities. The survey will be quantitative in nature, some open ended questions will allow for some qualitative answers, however these questions will be coded into themes and analysed quantitatively. A Delphi survey will be conducted amongst simulation experts to determine the best practises approach to high-technology, clinical simulation in South Africa.

The **value of the study** is the understanding of the approach and challenges of high-technology clinical simulation in South Africa. The **significance** will be the improved integration and long term success of high-technology clinical simulation at South African facilities.

Kindly note that the information received during the project will only be used for research purposes and will not be released for any academic and/or employment-related performance evaluation, promotion and/or disciplinary purposes. The findings of this study will be made public to other educationalists in HPE through paper presentations at conferences and seminars and by the publishing of articles in applicable journals. The researcher undertakes to report the results in a way that will adequately protect the participants' identities.

I therefore kindly request your permission to conduct a questionnaire survey at the relevant simulation facility.

Should you have any specific questions, my contact details are as follows:

Telephone number:	051 401 2504
Cellular phone:	082 291 5500
Email address:	vanwykr3@ufs.ac.za
Postal address:	Room 200, Block A, Francois Retief Building, University of the Free State, Bloemfontein, 9301.

Thank you for taking the time to read this communication and I sincerely hope that you will be willing to contribute to this project. ***Please complete the form below and send it back to my e-mail address as permission to conduct the questionnaire at your institution.***

Yours sincerely

Mr Riaan van Wyk
Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State
Bloemfontein

Contact details of the Health Sciences Research Ethics Committee at the University of the Free State:
Maré Marais
Tel: +27 51 401 7795
EthicsFHS@ufs.ac.za

Permission for simulation facility(ies) to participate in the study:

The role of a sustainable integrated systems approach to high-technology clinical simulation in South Africa.

I understand what the simulation facility(ies) representative involvement in the study means and I give permission for the research questionnaire to be distributed electronically to consenting staff member(s) involved in the simulation facility(ies).

Name: ___________________________

Signature: ________________________

Name of institution: ____

Date: ____________________

Official stamp of institution (if applicable)

APPENDIX E:

INVITATION LETTER - QUESTIONNAIRE SURVEY

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

INVITATION TO PARTICIPATE IN A QUESTIONNAIRE SURVEY

Dear Colleague

I am currently occupying the position of Chief Technical Expert at the Clinical Simulation and Skills Unit, School of Medicine (CSUM), at the University of the Free State.

I am in the process of writing a thesis to obtain the Ph.D degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State (Student number: 1996510200). As part of my Thesis, I will conduct a questionnaire survey with representatives of clinical simulation facilities at South African, health professions educational institutions.

The purpose of the questionnaire survey will be to gather data about the current approach and challenges regarding high-technology clinical simulation at South African facilities.

The survey will be online and approximately 30 minutes.

Participation is voluntary and will cost you nothing; neither will you receive any remuneration for your participation. All information will be treated in strict confidential manner.

My promoter is:
Dr Mathys Labuschagne
Head: Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State
Tel: 051 401 3869

My co-promoter is:
Prof Gina Joubert
Head: Department of Biostatistics
Faculty of Health Sciences
University of the Free State
Tel: 051 401 3117

Contact details of the Health Sciences Research Ethics Committee at the University of the Free State:
Mrs Jemima du Plessis
Tel: 051 405 3004
DuPlessisJ@ufs.ac.za

Thank you very much for your consideration of this initiative and I am looking forward to hearing from you.

Yours sincerely

Mr Riaan van Wyk

Telephone number:	051 401 2504
Cellular phone:	082 291 5500
Email address:	vanwykr3@ufs.ac.za
Postal address:	Room 200, Block A, Francois Retief Building, University of the Free State, Bloemfontein, 9301

APPENDIX F:

CONSENT TO QUESTIONNAIRE

CONSENT TO PARTICIPATE IN RESEARCH

Project title: **THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA**

Before signing consent for participating in the questionnaire survey, you should take cognisance of the following:

- Participation in this project is voluntary. You have the right to decline to participate in the study or to withdraw from the study at any stage. Should you be willing to participate in the research study, you will be requested to sign this consent form.
- Participation will cost you nothing; neither will you receive any remuneration for your participation.
- Should you decide to participate in the study, you can rest assured that the information you supply in the questionnaire will be treated in a strictly confidential manner and that your personal information will not be made public under any circumstances. Questionnaires will be coded using a number system to ensure the confidentiality of the response. No names or personal identifiers will appear on any data sheet that is sent for statistical analysis.
- The questionnaire will take approximately 30 minutes to complete.
- The results of this Ph.D study will be published without reference to any names of participants.
- Kindly note that the information received during the project will only be used for research purposes and will not be released for any academic and/or employment-related performance evaluation, promotion and/or disciplinary purposes.
- Should you be willing to participate, you will not be held responsible for any decisions or conclusions made from the study.

Hereby I, the undersigned, consent to participate in the questionnaire survey for clinical simulation representative.

....
Name

If you are willing to consent for execution of this study, kindly sign your consent below.

....
Signature **Date**

Please e-mail the signed and scanned consent form to vanwykr3@ufs.ac.za

Thank you for your kind cooperation.

Yours sincerely

Mr Riaan van Wyk

Telephone number:	051 401 2504
Cellular phone:	082 291 5500
Email address:	vanwykr3@ufs.ac.za
Postal address:	Room 200, Block A, Francois Retief Building, University of the Free State, Bloemfontein, 9301.

Ethics reference number: HSREC 115/2017 (UFS-HSD2017/1147) Health Sciences Research Ethics Committee (UFS).

Promoter:
Dr Mathys Labuschagne
Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State
Tel: 051 401 3869

Co-promoter:
Prof Gina Joubert
Associate Professor
Department of Biostatistics
Faculty of Health Sciences
University of the Free State
Tel: 051 401 3117

Contact details of the Health Sciences Research Ethics Committee at the University of the Free State:
Maré Marais
Tel: +27 51 401 7795
EthicsFHS@ufs.ac.za

APPENDIX G:

INVITATION LETTER - DELPHI SURVEY

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

INVITATION TO PARTICIPATE IN A DELPHI SURVEY

Dear Colleague

I am currently occupying the position of Chief Technical Expert at the Clinical Simulation and Skills Unit, School of Medicine (CSUM), at the University of the Free State.

I am in the process of writing a thesis to obtain the Ph.D degree in Health Professions Education in the Faculty of Health Sciences at the University of the Free State (Student number: 1996510200). As part of my Thesis, I will conduct a Delphi survey with simulation experts.

The purpose of the Delphi survey will be to determine the best practice approach to high-technology, clinical simulation in South Africa. The results of a questionnaire survey conducted with South African simulation facilities was used to inform the content of the Delphi survey. The results of the Delphi survey will be used to identify the factors and their inter-relationship to each other needed to achieve a sustainable integrated systems approach to high-technology clinical simulation in South Africa.

The survey will be word document and each round approximately 60 minutes.

Respondents will be followed up by the researcher via e-mail to complete the current round. The Delphi survey will conclude after consensus and/or stability is reach (typically after three or four rounds). Respondents will be anonymous to one another throughout the Delphi survey.

Participation is voluntary and will cost you nothing; neither will you receive any remuneration for your participation. All information will be treated in strict confidential manner.

My promoter is:
Dr Mathys Labuschagne
Head: Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State
Tel: 051 401 3869

My co-promoter is:
Prof Gina Joubert
Head: Department of Biostatistics
Faculty of Health Sciences
University of the Free State
Tel: 051 401 3117

Contact details of the Health Sciences Research Ethics Committee at the University of the Free State:
Mrs Jemima du Plessis
Tel: 051 405 3004
DuPlessisJ@ufs.ac.za

Thank you very much for your consideration of this initiative and I am looking forward to hearing from you.

Yours sincerely
Mr Riaan van Wyk

Telephone number:	051 401 2504
Cellular phone:	082 291 5500
Email address:	vanwykr3@ufs.ac.za
Postal address:	Room 200, Block A, Francois Retief Building, University of the Free State, Bloemfontein, 9301

APPENDIX H:

CONSENT TO DELPHI SURVEY

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

CONSENT TO PARTICIPATE IN RESEARCH

Project title: **THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA**

Before signing consent for participating in the Delphi survey, you should take cognisance of the following:

- Participation in this project is voluntary. You have the right to decline to participate in the study or to withdraw from the study at any stage. Should you be willing to participate in the research study, you will be requested to sign this consent form.
- Participation will cost you nothing; neither will you receive any remuneration for your participation.
- Should you decide to participate in the study, you can rest assured that the information you supply in the Delphi survey will be treated in a strictly confidential manner and that your personal information will not be made public under any circumstances. The Delphi survey will be coded using a number system to ensure the confidentiality of the response. No names or personal identifiers will appear on any data sheet that is sent for statistical analysis.
- The Delphi survey will take approximately 30 minutes to complete for each round.
- The results of this Ph.D. study will be published without reference to any names of participants.
- Kindly note that the information received during the project will only be used for research purposes and will not be released for any academic and/or employment-related performance evaluation, promotion and/or disciplinary purposes.
- Should you be willing to participate, you will not be held responsible for any decisions or conclusions made from the study.

Hereby I, the undersigned, consent to participate in the questionnaire survey for clinical simulation representative.

....
Name

If you are willing to consent for execution of this study, kindly sign your consent below.

....	....
Signature	**Date**

Please e-mail the signed and scanned consent form to vanwykr3@ufs.ac.za

Thank you for your kind cooperation.

Yours sincerely

Mr Riaan van Wyk

Telephone number:	051 401 2504
Cellular phone:	082 291 5500
Email address:	vanwykr3@ufs.ac.za
Postal address:	Room 200, Block A, Francois Retief Building, University of the Free State, Bloemfontein, 9301.

Promoter:

Dr Mathys Labuschagne
Clinical Simulation and Skills Unit
School of Medicine
Faculty of Health Sciences
University of the Free State
Tel: 051 401 3869

Co-promoter:
Prof Gina Joubert
Associate Professor
Department of Biostatistics
Faculty of Health Sciences
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Tel: 051 401 3117

Contact details of the Health Sciences Research Ethics Committee at the University of the Free State:
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Tel: 051 405 3004
DuPlessisJ@ufs.ac.za

APPENDIX I:

DELPHI QUESTIONNAIRE

THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

Delphi questionnaire by Riaan van Wyk (1996510200) as part of Ph.D. degree in HPE.

1. MANAGEMENT ASPECTS

1.1 How important is it to have a stand-alone, high-technology simulation unit vs being part of another department.

1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Stand-alone unit	-	

1.2 Indicate the importance of the documents (listed in alphabetical order) for the successful management of a high-technology simulation unit.

1-essential, 2-useful, 3-not necessary

	1, 2 or 3	Comments
Financial plan	-	
Goals and strategies	-	
Mission statement	-	
Needs analysis	-	
Organogram	-	
Performance indicators for the unit	-	
Policy document	-	
Quality assurance	-	
Staff development plan	-	
Staff succession plan	-	

	1, 2 or 3	Comments
Standard operation procedures	-	
Statistics of facility usage	-	
Stock Management plan	-	
Student feedback forms	-	
SWOT (strength, weaknesses, opportunities and threats) analysis	-	
Vision statement	-	
"Suspension of disbelief" contract (to clarify the nature of simulation, expected behaviour of students and confidentiality agreement)	-	
Simulation design template (standard template recording detail planning of a simulation session)	-	

Other:

1.3 ADDRESSING MANAGEMENT CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

1.3.1 In your opinion, indicate how important the following are, when considering addressing the challenges caused by a lack of **management documents** (financial plan, goals and strategies, mission statement, organogram, policy document, quality assurance, SWOT analysis, vision statement)
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Input from simulation staff when creating the document(s) (bottom-up approach)	-	
Adapt existing institutional document	-	

	1, 2 or 3	Comments
Only management staff should have input when creating this document(s) (top-down approach)	-	
Training for simulation staff regarding the document(s) content	-	
Distribution of document content to external stakeholders (Vendors)	-	
Distribution of document content to clients (students/learners)	-	
Distribution of document content to institutional stakeholders (external lecturers and heads of other departments)	-	
Yearly review of the document(s)	-	

Other:

1.3.2 In your opinion, indicate how important the following are, when considering addressing the challenges caused by a lack **operational documents** (needs analysis, performance indicators, staff development plan, staff succession plan, standard operation procedures, statistics of facility usage, student feedback forms)

1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Input from simulation staff when creating the document(s) (bottom-up approach)	-	
Adapt existing institutional document	-	
Only management staff should have input when creating this document(s) (top-down approach)	-	
Training for simulation staff regarding the document(s) content	-	

	1, 2 or 3	Comments
Distribution of document content to external stakeholders (Vendors)	-	
Distribution of document content to clients (students/learners)	-	
Distribution of document content to institutional stakeholders (external lecturers and heads of other departments)	-	
Yearly review of the document(s)	-	

Other:

2. FUNDING ASPECTS

2.1 Indicate the importance of the following when choosing a **funding model** for high-technology simulation for long term sustainability.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Internal, institutional funding	-	
Government Grants	-	
3rd stream, external sources	-	
Consortium model	-	
Research funding	-	
Combination of different models	-	
Corporate sponsorships	-	

Other:

2.2 Indicate the importance of having an **own financial management** as opposed to being governed by other institutional processes.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Own financial committee	-	
Own procurement policy	-	
Own Financial standard operating procedures (SOPs)	-	

Other:

2.3 Indicate the importance of the following aspects when choosing vendors for a high-technology simulation equipment.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Adherence to financial regulations of training institution	-	
After sales care, training and support should be provided	-	
Cost of initial equipment	-	
Costs of consumables, replacements and upgrades	-	
Cost of software licences subscription	-	
Quality and durability	-	
Product must address training needs	-	
Availability of equipment locally (South Africa)	-	
Availability of equipment internationally	-	
Usage across multiple disciplines	-	
Ease of use and compatibility	-	
Initial training in using the equipment / high fidelity simulators	-	

Other:

2.4 ADDRESSING FUNDING CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

2.4.1 In your opinion, indicate how important the following are, when considering addressing the challenges caused by a **lack of financial support**.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Increase 3rd stream income	-	
Procure cheaper equipment (cut back on capital expenditure)	-	
Procure cheaper consumables (cut back on operational expenses)	-	
Partnerships with vendors for increased sponsorships	-	
Cut back on staff expenditure	-	
Student accounts billed additionally (Simulation lab fee)	-	
Charge department who use facility per sessions presented	-	
Charge departments who use facility per student using facility for simulation training	-	

Other:

2.4.2 In your opinion, indicate how important the following are, when considering **increasing return on investment** (expensive equipment not being used optimally).
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Increase the number of students in each simulation experience	-	
Due to large number of students, in some cases, some students might only be observers of a simulation experience. With this in mind: Increase number of simulation experiences by reducing the number of observing students and more "hands-on" participants for each experience	-	
Rent out of equipment to external partners for 3rd stream income	-	
Staff host additional 3rd stream income generating simulations	-	
Utilise ad hoc staff to host 3rd stream income generating simulations	-	

Other:

2.4.3 In your opinion, indicate how important the following are, when considering the high cost of **capitalisable equipment.**
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Remove maintenance contracts on technology equipment	-	
Buy models that are used by more disciplines but might not be as specialised as others. (used by more students)	-	
Focus only on specialised equipment (used by less students)	-	

	1, 2 or 3	Comments
Partnerships with departments whose students utilises high-technology simulation to share costs	-	
Adapt simulation experiences to use with medium or low technology simulators	-	
Rent or sponsor equipment from companies on an ad hoc basis e.g. for specific courses instead of buying the equipment.	-	

Other:

2.4.4 In your opinion, indicate how important the following are, when considering the high cost of consumables.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Use cheaper alternatives that is not supported by the vendor	-	
Adapt simulation experiences to use with medium or low technology simulators with cheaper consumables	-	
Increase number of students observing and less that actually take part in the experience (reducing wear and tear on simulator)	-	
Negotiate for external sponsor of simulators	-	
Partnerships with departments whose students utilise high-technology simulation to share costs	-	

Other:

3. STAFFING AND STAFF DEVELOPMENT ASPECTS

3.1 Indicate the importance of the following staff designations **for providing effective high-technology simulation** in a facility.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Simulation facility head(s) / manager	-	
Lecturers as simulation facility staff	-	
Lecturers *ad hoc* from other departments	-	
Scenario facilitators	-	
Debriefing facilitators	-	
Administrative	-	
Technical	-	
Dedicated permanent IT staff member(s) in facility	-	
Operational set-up staff	-	
Simulated patient (SP) co-ordinator	-	

Other:

3.2 Indicate the feasibility of having an in-house vs external **training programme** for the following **staff designations** for high-technology simulation (**mark both**).
1-essential, 2-optional, 3-not necessary

	In-house	External	Comments
Simulation facility head(s) / Manager	-	-	
Lecturers (simulation facility staff)	-	-	
Lecturers *ad hoc* from user departments	-	-	
Scenario facilitators	-	-	
Operational set-up staff	-	-	
Technical staff	-	-	
Administrative staff	-	-	
Debriefing facilitator(s)	-	-	
SP co-ordinator	-	-	
Single, simulation course covering multiple aspects of staff designations	-	-	

Other:

3.3 Indicate the importance of including the following topics in a training programme for staff of high-technology simulation.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Scenario planning	-	
Scenario programming (on PC)	-	
Simulation facilitation	-	
Physical planning	-	
Technical support	-	
IT support	-	
Debriefing	-	
Moulage	-	
Ethics	-	
Financial planning	-	
Management aspects	-	
SP co-ordination	-	
Annual refresher courses	-	
Application specific training by vendor	-	

Other:

3.4 ADDRESSING STAFF AND STAFF DEVELOPMENT CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

3.4.1 In your opinion, indicate how important the following are, when considering addressing the challenges caused by staffing issues of high-technology simulation staff. These include **fear of technology** and **limited technical knowledge** on using simulators.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Staff should not multi-task	-	
Dedicated permanent technical staff	-	
Technical training for non-technical staff (they will then multi-task)	-	
Ad hoc (temporary or hourly) technical staff for simulation experience programming	-	

Other:

3.4.2 In your opinion, indicate how important the following are, when considering addressing the challenges caused by **additional workload** on and **multi-tasking** of simulation staff in high-technology simulation units.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
More permanent staff should be appointed	-	
Increased/improved high-technology simulation training programmes for staff (increased productivity)	-	
Ad hoc (temporary or hourly) staff to address specific areas	-	

Other:

3.4.3 In your opinion, indicate how important the following are, when considering addressing the challenges caused by **poor communication** between simulation and teaching and learning or clinical staff.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
More robust cross-departmental processes implemented	**-**	
Dedicated simulation committee with teaching and learning members from other departments	**-**	
High-technology training programme for non-simulation staff	**-**	
High-technology simulation representative (or co-ordinator) in each department where students utilise high-technology simulation	**-**	

Other:

4 ASPECTS REGARDING CURRICULUM INTEGRATION

4.1 In your opinion, in which year of study do the following disciplines lend themselves to high-technology simulation **training** (excluding assessment) (mark all applicable options).
1-Yes definitely, 2-Possibly 3-No, not at all

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Post Grad	Comments
Medicine	-	-	-	-	-	-	-	
Nursing	-	-	-	-			-	
Emergency care	-	-	-	-			-	
Physiotherapy	-	-	-	-			-	
Dietetics & nutrition	-	-	-	-			-	
Occupational therapy	-	-	-	-			-	
Pharmacy	-	-	-	-			-	
Radiography	-	-	-	-			-	
Biokinetics	-	-	-	-			-	
Dentistry & Dental Therapy	-	-	-	-			-	
Optometry	-	-	-	-			-	
Speech and Language Therapy	-	-	-	-			-	

Other:

4.2 In your opinion, in which year of study do the following disciplines lend themselves to high-technology simulation **formative assessment?** (mark all applicable options)
1-Yes definitely, 2-Possibly 3-No, not at all

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Post Grad	Comments
Medicine	-	-	-	-	-	-	-	
Nursing	-	-	-	-			-	
Emergency care	-	-	-	-			-	
Physiotherapy	-	-	-	-			-	
Dietetics & nutrition	-	-	-	-			-	
Occupational therapy	-	-	-	-			-	
Pharmacy	-	-	-	-			-	
Radiography	-	-	-	-			-	
Biokinetics	-	-	-	-			-	
Dentistry & Dental Therapy	-	-	-	-			-	
Optometry	-	-	-	-			-	
Speech and Language Therapy	-	-	-	-			-	

Other:

4.3 In your opinion, in which year of study do the following disciplines lend themselves to **high-stakes summative assessment** using high technology simulation? (mark all).
1-Yes definitely, 2-Possibly 3-No, not at all

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Post Grad	Comments
Medicine	-	-	-	-	-	-	-	
Nursing	-	-	-	-			-	
Emergency care	-	-	-	-			-	
Physiotherapy	-	-	-	-			-	
Dietetics & nutrition	-	-	-	-			-	
Occupational therapy	-	-	-	-			-	
Pharmacy	-	-	-	-			-	
Radiography	-	-	-	-			-	
Biokinetics	-	-	-	-			-	
Dentistry & Dental Therapy	-	-	-	-			-	
Optometry	-	-	-	-			-	
Speech and Language Therapy	-	-	-	-			-	

Other:

4.4 Indicate the importance of including the following steps when planning a high-technology simulation experience.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Theory overview	-	
Analysis of lesson objectives	-	
Technical meeting	-	
Participants training	-	
Dry-run of simulation experience	-	

Other:

4.5 Indicate the importance of including the following steps when **executing** a high-technology simulation experience.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Presentation on theory congruent with the simulation experience.	-	
Pre-briefing of students	-	
Simulation experience	-	
Debriefing of students directly after the simulation experience	-	
Delayed debriefing of students after the simulation experience	-	

	1, 2 or 3	Comments
Repeating the simulation experience	-	
Student evaluation of scenario	-	
Lecturer/ facilitator evaluation of scenario	-	

Other:

4.6 ADDRESSING CURICULLUM INTEGRATION CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

4.6.1 In your opinion, indicate how important the following are, when considering addressing the challenges caused by **time limitations** in using high-technology simulation with a group of students.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Increase number of students per group as to reduce number of simulation experiences	-	
Minimise lecture (theory) time used before an experience	-	
Reduce time spent on debriefing	-	
Have more students observe only during the experience	-	

Other:

4.6.2 In your opinion, indicate how important the following are, when considering addressing the challenge of **learning objectives not being achieved** by a high-technology simulation experience.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Learning objectives should be analysed long enough before an experience to adapt it in time	-	
Academic review after each simulation experience by staff	-	
Use of student feedback forms	-	
Dry-run(s) of experience focussing on learning objectives	-	

Other:

4.6.3 In your opinion, indicate how important the following are, when considering addressing the challenges caused by the **change in case mix, when considering a curriculum,** with regard to high-technology simulation.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Negotiate with vendors to design simulators specific to the case mix of a curriculum	-	
Develop own high-technology simulators to address specific needs to the case mix	-	
Use medium or low-technology simulators instead	-	
Employ other types of simulations such as SPs or hybrid (high-tech and SPs combined) simulations	-	

Other:

4.6.4 In your opinion, indicate how important the following are, when considering addressing the challenges caused by large student groups and **reducing/limited teaching platform** with regard to high-technology simulation.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Increase number of simulation experiences to reduce number of students per group	-	
Have more students observe only during an experience	-	
Increase self-directed learning opportunities for the students using high-technology simulators (allow students to use high-technology simulators without supervision after some basic training in using it)	-	

Other:

5. PHYSICAL SIMULATION ENVIRONMENT ASPECTS

5.1 Indicate the importance of having the following areas available for high-technology simulation.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Dedicated simulation room(s)	-	
Clinical skills training area	-	
Interchangeable rooms	-	
Lecture halls	-	
Access to *In situ areas*	-	
Dedicated debriefing rooms	-	
Debriefing in same room as simulation experience	-	
Flat screen simulation (computer lab)	-	
Separate observation room(s)	-	
Control rooms with direct observation of simulation area through one-way glass windows	-	
Control rooms with video facilities to observe the simulations	-	
Secure storage areas	-	
Technical maintenance area	-	
Creating a flow through the unit (especially during assessment)	-	

Other:

5.2 Indicate the significance of having the following available for successful high-technology simulation.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Audio-visual for real-time streaming to another room	-	
Audio-visual recording for later viewing	-	
Debriefing area separate from simulation room	-	
Debriefing in same room as simulation	-	

Other:

5.3 ADDRESSING PHYSICAL ENVIRONMENT CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

5.3.1 In your opinion, indicate how important the following are, when considering addressing the challenges caused by **technical issues** with and maintenance of high-technology equipment.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Have duplicates (whole simulator) available of certain critical high-technology simulator(s)	-	
Duplicate spare parts available for swap on short notice	-	
Technical staff available for each simulation experience	-	
Negotiate with vendors to have spares available in South Africa on short notice	-	

	1, 2 or 3	Comments
“Black-out” periods when equipment cannot be booked and must be available for (software/hardware) upgrades	-	
Regular review to assess wear and tear on equipment	-	

Other:

5.3.2 In your opinion, indicate how important the following are, when considering addressing the challenges caused by **inadequate simulation space**.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Adjusting high-technology simulation time to also run after office hours and weekends	-	
Renting space at external buildings	-	
Combine some learning objectives into the same simulation experience as to run less simulations	-	
	1, 2 or 3	Comments
Increase student groups per simulation experience (repeating the experience more often for more (smaller) groups of students)	-	
Convert debriefing areas into high-technology simulation areas and debrief in same room as experience	-	
Split larger areas into smaller simulation rooms	-	
Increase the use of *In situ* simulations	-	

Other:

5.3.3 In your opinion, indicate how important the following are, when considering addressing the challenges caused by **inadequate storage space**.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Rent offsite storage area for consumables and equipment not regularly used	-	
Decrease floor space of current simulation areas to increase cupboards etc	-	

Other:

6. RESEARCH ASPECTS

6.1 Indicate the importance of research in a high-technology simulation unit.
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Research in a health profession discipline utilising high-technology simulation	-	
Research on the transfer of skills acquired from simulation training and measured by clinical performance outcomes	-	
Research studies assess patient safety	-	
Research on the cost savings benefits of simulation training	-	
Simulation research on implementation of protocols or standard operating procedures	-	
Research about educational aspects of simulation or high-technology simulation	-	
Research on the technology / simulators	-	
Research on development and testing of new simulators or equipment	-	
Research as an additional income stream	-	
Research on effectivity and return on investment	-	
Research on aspects of the healthcare system/facility	-	

Other:

6.2 ADDRESSING RESEARCH CHALLENGES OF HIGH-TECHNOLOGY SIMULATION

6.2.1 In your opinion, indicate how important the following are, when considering addressing the challenges caused by **unsatisfactory research output** (lack of time and research staff).
1-essential, 2-optional, 3-not necessary

	1, 2 or 3	Comments
Additional staff allocated for research output only	-	
Combine existing teaching and learning activities with a research project	-	
Additional simulation equipment dedicated for research purposes	-	
Running research projects out of hours from normal simulation programme	-	
Additional research training for simulation staff	-	
Rent out simulation space, equipment and staff to external researchers	-	

Other:

7 ADDITIONAL

Please indicate whether there are other aspects you think should be considered to ensure that high-technology simulation is sustainable in South Africa.

APPENDIX J:

LANGUAGE EDITING DECLARATION

To whom it may concern

This is to state that the Ph.D. thesis titled THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA by Riaan van Wyk has been language edited by me, according to the tenets of academic discourse.

Annamarie du Preez

19 Reyger Street

Westdene

Bloemfontein

083 764 1864

B.Bibl.; B.A. Hons. (English)
27-10-2020

APPENDIX K:

TURNITIN REPORT

THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

by Riaan Van Wyk

21/11/2020

THE ROLE OF A SUSTAINABLE INTEGRATED SYSTEMS APPROACH TO HIGH-TECHNOLOGY CLINICAL SIMULATION IN SOUTH AFRICA

ORIGINALITY REPORT

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