Principles of physics implicit in emergency medical rescue education and operational practice–a case study of motor vehicle related rescue

By

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DECLARATION

I, Justice Selvyn Bosman, declare that the contents of this thesis represent my own unaided work. Where help was sought, it was acknowledged. I further declare that the thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.

14/01/2019

Signed Date

ABSTRACT

Title: Principles of physics implicit in emergency medical rescue education and operational practice – a case study of motor vehicle related rescue.

Key Words: Physics, medical rescue, motor vehicle rescue, legitimation code theory, Semantic dimension, Delphi, process tracing, emergency medical care

Introduction:

Road traffic injuries are the ninth leading cause of death globally. Projections indicate that without new and sustained commitment globally to preventing such injuries, the situation will only worsen. Motor vehicle rescue does not lend itself to the prevention of road traffic incidents but through ensuring that all incidents are managed using sound evidence could contribute in positive outcomes for victims. It is unknown what contribution rescue education makes to the body of medical rescue knowledge in South Africa.

Aims:

The aim of this research was to investigate the relevance and scope of the principles of physics within medical rescue specifically in the context of motor vehicle rescue. It appears that current traditional methods of presenting rescue training, which is mainly procedural and technical, may contribute to 'segmented' learning.

Research Methodology:

Using an interpretive research design, multiple qualitative methodologies were employed. This methodological triangulation was intended to improve construct validity and trustworthiness of findings. A modified Delphi process through which questionnaires was repeatedly distributed to rescue experts was employed. Process tracing was used to evaluate the developed typical motor vehicle rescue case scenario narrative for underpinnings of the principles of physics. The Bachelor Emergency Medical Care Physics and Extrication subject guides was evaluated for its educational alignment during the document analysis. Legitimation Code theory as a theoretical framework was utilised to appraise the knowledge gap.

Results & Discussion:

Motor vehicle rescue incident may not always present in a similar manner due to various factors and influences. Development of the typical motor vehicle case narrative from which its physics principles could be identified was imperative. Most motor vehicle rescue related training occur with the vehicle in the upright orientation on all four wheels. This manner

of frequent training may restrict rescue practitioners from moving beyond their ‘typical’ training knowledge when the situation presents “atypical”.

The thematic document analysis of the BEMC Physics and Extrication subject guides lacked the necessary coherence which is required for a professional degree. It was deemed void of certain threshold concepts and structure which would allow the student to move between the theoretical and contextual knowledge. Motor vehicle rescue subject guides and most textbooks on the topic leaned towards a procedural and very technically detailed pedagogy, to the extent that it could contribute to segmented learning.

Conclusion:

Developing curricula that is underpinned by a theoretically sound evidence base would promote credibility of a qualification. Curricula by design inform the teaching, learning and the competencies which would ultimately be assessed. Professional degrees are intended to develop practitioners who would graduate with the knowledge and competencies to adapt to situations. In addition, graduate attributes of lifelong learning, reflective practice and the ability to contribute to the development of new knowledge is secondary to the goal of qualification attainment.

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DISCLAIMER:

Opinions expressed in this thesis and the conclusions arrived at, are those of the author, and are not necessarily to be attributed to the Cape Peninsula University of Technology's (CPUT) Emergency Medical Sciences Department and/or that of CPUT Fundani.

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CLARIFICATION OF TERMS

DEFINITIONS:

Atypical case scenario: the Merriam-Webster dictionary (2019) defines atypical as being irregular and uncommon. For the purpose of this study atypical cases scenario's will be defined as that which differ from the typical cases as unusual or uncommon in terms of its frequency, probability, impact, consequences, etc.

Case studies: "…afford researchers opportunities to explore or describe a phenomenon in context using a variety of data sources. It allows the researcher to explore individuals or organizations, simple through complex interventions, relationships, communities, or programs and supports the deconstruction and the subsequent reconstruction of various phenomena…" (Baxter & Jack, 2008).

Curriculum: is defined by the South African Qualifications Authority (SAQA) (2014) as "…a statement of the training structure and expected methods of learning and teaching that underpin a qualification or part qualification to facilitate a more general understanding of its implementation in an education system…". Kern (1998) stated that a curriculum may give rise to a planned educational experience but is not the experience itself and Keating (2015) explains that it "provides the goals for an educational program with guidelines for how they will be delivered and ultimately, evaluated for effectiveness". Curriculum as defined by the South African Qualifications Authority (SAQA) will form the basis of this study. Where a differentiation in the definition of curriculum may exist within the thesis it would be further explained.

Emergency medical care: "…means the rescue, evaluation, treatment and care of an ill or injured person in an emergency care situation and the continuation of treatment and care during the transportation of such patients to or between medical facilities in order to prevent loss of life, aggravation of illness or injury…" (Health Professions Act 56 of 1974).

Emergency care: also refers to the emergency care profession, as regulated by the Health Professions Council of South Africa (HPCSA).

Extrication incident: involves the removal and treatment of victims who are trapped by some type of man-made machinery or equipment (Hall & Adams, 1999).

Heavy motor vehicles may be defined as any form of motorized transportation which is not termed a light motor vehicle. The South African National Road Agency Society Limited (SANRAL, no date) classify and define it as "…a motor vehicle with at least one heavy axle and/or any vehicle which is principally designed or adapted for the conveyance of persons exceeding sixteen (16) in number…".

Light motor vehicles: is a term that is becoming harder to define due to the rapid change in vehicle design. It refers to "light" passenger vehicles such as the family car (Morris, 2009). SANRAL (no date) classify and define it as "…a motor vehicle designed or adapted for the conveyance of persons and freight with no heavy axle…."

Legitimation Code Theory (LCT): is an explorative educational framework which consist of five dimensions with Semantic being one of the dimensions that explores forms of knowledge (Maton, 2014; Van Krieken, 2014).

Medical Rescue: for the purpose of the study the term medical rescue would be defined or described as the rendering of direct medical care at an incident which is termed as a rescue. A rescue could be defined as the utilization of technical skills (possibly at various levels ranging from basic to advanced) to aid in the extrication (removal) of a victim from their entrapped (irrespective if it is due to physical or structural/environment) environment. The term "medical" may be used interchangeably with "technical" within the context of a rescue related incident.

Motor vehicle accident: is defined as the unintended collision of one motor vehicle with another, a stationary object, or person, resulting in injuries, death and/or loss of property (McGraw-Hill Concise Dictionary of Modern Medicine, 2002).

Physics: is a discipline of learning about the physical world by finding ways to make sense of what we observe and measure (Cummings *et al*., 2004). For the purpose of the study, physics will be defined as the conceptual and its applied principle; rather than pure and theoretical physics within the physical world context of emergency medical care and rescue scenarios that could explicate the nature, design, implications and interventions of rescue.

Rescue incidents: involve the removal and treatment of victims from situations involving natural elements, structural collapse, elevation differences, or any other situation not considered to be an extrication incident (Hall & Adams, 1999).

Rescue technician: a person who is trained to perform or direct the technical rescue incident (National Fire Protection Association [NFPA], 2003).

Technical rescue: is defined as the application of special knowledge, skills, and equipment to safely resolve unique or complex rescue situations by the National Fire Protection Association (NFPA, 2003). The definition of the National Fire Protection Association (NFPA,

2003) will be utilised as the core definition of technical rescue and further explanation and description of such term would be provided where required within the Master's thesis document.

Typical case scenario: the Merriam-Webster dictionary (2019) defines typical as "combining or exhibiting the essential characteristics of a group" as well as "conforming to a group". For the purpose of this study a typical case scenario would be that which is rendered typical by its frequency, probability, impact, significance, etc. in nature or characteristic of that for groupings of motor vehicle related incidents.

Semantic Density (SD): refers to the "…degree of condensation of meaning where the stronger the SD (+), the more the meaning are condensed within a symbol or practice; and the weaker the SD (-), the less meanings are condensed" (Van Krieken, 2014:175).

Semantic Gravity (SG): refers to the "…degree of context-dependence of meaning where the stronger the SG (+), the more knowledge is dependent on its context to make sense; and the weaker the SG (-), the less dependent knowledge is on its contexts for its meaning" (Van Krieken, 2014:175).

COMMONLY USED ABBREVIATIONS

BEMC	Bachelor Emergency Medical Care
CPUT	Cape Peninsula University of Technology
Cf.	Confer/Conferatur
DEMS	Department of Emergency Medical Sciences
EMS	Emergency Medical Services/Systems
HEQF	Higher Education Qualification's Framework
HPCSA	Health Professions Council of South Africa
LCT	Legitimation Code Theory
MVA	Motor Vehicle Accident
MVR	Motor Vehicle Rescue
NFPA	National Fire Protection Agency (United States)

NQF	National Qualifications' Framework
SAQA	South African Qualifications Authority
SD	Semantic Density
SG	Semantic Gravity
SGB	Standards Generating Body

CHAPTER ONE

ORIENTATION TO THE STUDY

1.1 INTRODUCTION AND BACKGROUND TO THE RESEARCH PROBLEM

Emergency care is an emerging profession which aspires to prehospital clinical best practice and evidence-based medicine. Rescue is envisaged as a specialization[1] which forms part of the firefighting (Collins, 2004) and emergency care duties and responsibilities. The author's insider experience suggests that the educational emphasis has historically been on the 'how to' (implying technical and procedural knowledge) to manage and mitigate an incident; with little and sometimes no emphasis and explanation as to the 'why' (implying theoretical knowledge). As a disclaimer, I hold no *a priori* claim to technical or theoretical hegemony in relation to medical rescue. I use the personal pronoun, 'I' and third person references (such as 'the author') interchangeably, where appropriate.

The paragraphs below will provide a background, motivation, problem statement and other aspects related to the orientation of the study. This will serve as a rationale and purpose for research within the area of Motor Vehicle Rescue (MVR) and the need to contribute towards the fundamental physics knowledge implicit in medical rescue.

1.2 MOTIVATION FOR STUDY

1.2.1 Introduction

Emergency care as an emerging profession requires that the rescue education component also be revised and critically interrogated as has the emergency medicine component. It is unknown what contribution rescue education makes to the body of medical rescue knowledge in South Africa. MVR textbooks are very technical and procedural, with very little to no reference made to principles of physics that underpin the relevant rescue for example, the phases of a motor vehicle collision or equipment operations. Hence, the need to investigate the principles of physics; and the alignment or misalignment between educational

[1] The rescue specialisation is at a practice level. The profession is intent on its specialisation, but there has been no appraisal, to date, of the state of specialisation.

and operational practice within emergency medical rescue persistence[2]; which further constitutes the motive of this study.

The benefit for addressing and investigating the current alignment within emergency medical rescue education and practice is to elevate the discourse of rescue given the burden of South African rescue. Rescue practice is landscaped with differing rescue scenarios such as: high angle rescue, mountain search and rescue, trench rescue, MVR, aquatic rescue, disaster response, etc. This study chooses MVR as a 'case' of medical rescue due to its high frequency probability (World Health Organization [WHO], 2013; WHO, 2015) the health and economic burden it creates (Arrive Alive, 2017; Lehohla, 2017), and the caseload to both fire-rescue and emergency medical services (EMS). This deliberately narrow case study may have transversal[3] rescue implications to other rescue contexts. The limitation to MVR is intended to delineate the scope of this study.

1.2.2 Motor vehicle rescue as a 'legitimate' case study

Road traffic injuries are the ninth leading cause of death globally, resulting in more than approximately 1.2 million deaths each year, and are the leading cause of death among young people aged 15–29 years globally (WHO, 2010; WHO, 2013; WHO, 2015). Projections indicate that without new and sustained commitment globally to preventing such injuries, the situation will only worsen. The number of road traffic deaths since 2007 have remained fairly constant (WHO, 2013; WHO 2015) and it is expected that road traffic injuries will become the fifth leading cause of death globally by 2030 (WHO, 2010). MVR, therefore, is of relevance in the response and mitigation of road traffic injuries as its value proposition is mortality and morbidity reduction.

Irrespective of the probable causes and contributing factors, all motor vehicle accidents have a chronology. Where there is a collision, there is essentially a victim(s) involved that may or may not have sustained injuries, with a response from emergency medical services (if activated) and other allied agencies which would result in the mitigation of the incident. Mitigation in part or as a whole could involve various aspects such as the rendering of

[2] Where educational (what is found in curricula & textbooks) and operational practices (that which happen in reality) differ, there may exist a mal alignment especially if procedural practice lack the theoretical (explanatory) rigour and evidence.
[3] This implies cross-cutting implications or elements of commonality.

medical assistance and/or the extrication of a victim(s) who may then require transportation to an appropriate medical facility for further evaluation and medical intervention.

1.2.3 Principles of Physics and Motor Vehicle Rescue

Car manufacturers and developers have extensively researched and evaluated which principles of physics are implicit during the incident phase[4] of a motor vehicle collision, taking into account the type of collision (whether it be a frontal, side , rear or roll over collision) and the involuntarily response of the occupants. The focus of the developers and manufacturers is to use principles of physics in designing safer vehicles that could lead to a reduction in fatalities during motor vehicle accidents. Car manufacturers and developers do not principally take into account what the impact of creating safer vehicles would have on rescuers, their equipment and knowledge.

The principles pertaining to the working of hydraulics, pneumatics, metal under tension or torsion (Morris, 2009b) and the effects of gravity regarding unstable objects (Worsing, 1993) is well known. Due to the nature of motor vehicle rescue being very procedural and technical this may pose a threat to the safety of rescuers as rescuers may only possess the ‘how to’ knowledge and lack the theoretical knowledge which may be able to address the ’why’. There is poor documented physics evidence contained in motor vehicle rescue textbooks which in turn does not, at face value, extensively present within rescue curricula.

1.2.4 Horizontal and vertical alignment in an emergency care education system

Emergency care education is a higher education competency and as such, the rescue education that is embedded must enjoy pedagogic fit with the programme in which it resides. Within educational systems the aim is to ensure validity and accountability regarding content and assessment thereof. In the development of Higher Education (HE) programmes, curricula and subject guides there should be an alignment with respect to the level of qualification, National Qualifications Framework (NQF), relevance to the society, etc. This, however in some respect, only addresses the horizontal alignment of assessments and content; and does not necessarily address the vertical alignment in respect of the policies, textbooks, student progression and delivery of content. Qualifications and programs should

[4] This would be the collision phase of the incident irrespective of the type of collision kinetic and/or factors involved. In the Master’s thesis this may also be referred to as the “collision/ event” phase.

periodically go through a process of evaluation with inputs from stakeholders. An opportunity presents emergency care education to evaluate the horizontal and vertical discourse [breadth[5] and depth[6] respectively] (Bernstein, 1999) and level descriptor as aligned to the NQF at which the rescue is being currently offered within the Bachelor degree qualification.

1.2.5 Summary

The assumption of the study is that physics is the basis from which all rescue sciences emanate. Understanding the wounding forces of trauma as energy transference, for example, may require knowledge of the basic laws of physics. It appears that current traditional methods of presenting rescue training, which is mainly procedural and technical, contribute to 'segmented' learning[7]. Rescue interventions; however, are contextual as each rescue scenario is different. It is unknown if rescue practitioners can draw from the principles of physics underpinning the best possible method or process to mitigate and manage the rescue incident. Contributing to this discourse or curricula enhancement could possibly inform operational practice, particularly the atypical scenarios for which the training environment is not always able to prepare for (Dunbar, 2011a).

1.3 PROBLEM STATEMENT

Through the study of physics one is able to understand natural laws which show how everything in nature is connected and enhance the way in which we view and understand the physical world. Physics is arguably fundamental to all sciences through which the nature of basic phenomena and everyday observations such as motion, forces, energy, heat and sound can be explained and explored (Hewitt, 2014).

Motor vehicle accidents are an everyday occurrence which has a huge impact on the national burden of disease profile as a result of the trauma sustained during a collision. In

[5] Horizontal discourse refers to "every day or common knowledge" where the knowledge is segmentally differentiated and is context dependent and specific whilst vertical discourse takes the form of a coherent, explicit, systematically principled structure which is hierarchically organized as in the sciences (Bernstein, 1999).
[6] Vertical discourse takes the form of a coherent, explicit, systematically principled structure which is hierarchically organized as in the sciences (Bernstein, 1999).
[7] This segmented learning is based on the definition of horizontal and vertical discourse of Bernstein (1999).

total, 460 236 deaths were recorded in South Africa for 2015 (both those of natural and unnatural causes) of which 11,1% were due to non-natural causes of which road traffic accident deaths comprised 12,3% which was the 3rd most common cause of unnatural deaths (Lehohla, 2017). It is reported that in 2015 there were 12 944 reported road fatalities (motor- and pedestrian vehicle related) which was a 2% increase over 2014, seeing a total of 14 071 deaths which were reported in 2016 with an increase of 9% over 2015 (Arrive Alive, 2017).

During a traumatic incident or event an injury may occur when the body is exposed to energy levels beyond its tolerance levels. Different forms of energy may produce different kinds of trauma. During a motor vehicle collision, a human body within a motor vehicle is moving at the same rate of speed as the vehicle. When the body must dissipate and sustain energy absorption this often may result in broken bones or ruptured internal organs (Caroline, 2008). Physics may have implications for rescue educational theory and practice within emergency care, but one must first define what these are.

The field of emergency care has made huge progress in terms of professionalizing the discipline through the development of qualifications and a scope that is comparable with international standards and that of other related professions. However, the field and specialty of emergency medical rescue lacks the criteria and rigour for professionalization due to the field being a highly technical and procedural discipline, hitherto. Technical processes in rescue practice globally seems to lack the documented underpinnings of physics explanations. This may have the impact of limiting professional growth and discipline development. To professionalise rescue as a discipline, a sound theoretical basis is required.

The contribution to the burden of disease of road traffic related deaths which the emergency medical care as a profession makes is unknown. Very little research and evidence is available with regards to on-scene mortality prior to the arrival of EMS for example. Neither does research exist which highlight if patient outcomes are improved through the interventions of EMS. The investigation and evaluation of motor vehicle rescue education and its operational practice could shed light on its alignment. Education ultimately influences that which are enacted within practices.

1.4 RESEARCH QUESTIONS

The research question was formulated with ‘who’ and ‘what’ the rescue practitioners should be at the end of an educational endeavour. The aim and purpose of the professional degree in emergency medical care is to develop graduates who will be competent in the knowledge, attitude, insight and skills required for the emergency medical care and rescue profession

The Bachelor of Emergency Medical Care (BEMC) qualification is designed to develop cognitive, technological and scientific enquiry capability and promote the research, innovation and management skills necessary for management and development of the emergency medical and rescue professions (CPUT-DEMS, 2014a). Due to emergency care having strong links to and foundations in physical science, the researchers aim was to elevate the discourse within rescue with the aid of the physical sciences.

The main research question is: What principles of physics are implicit[8] in emergency medical rescue education and practice?

The sub-questions are:

- What are ‘typical cases’ and ‘atypical cases’ in ‘motor vehicle related rescue’ scenario typologies?
- What are the principles of physics that are implicit in typical motor vehicle related rescue scenarios?
- What is the alignment/misalignment of the principles of physics implicit in motor vehicle related rescue to medical rescue education?
- What is the alignment/misalignment of the principles of physics implicit in motor vehicle related rescue to medical rescue practice?

[8] Implicit refers to the inherence and implications of physics rather than only an application of physics

1.5 AIM & OBJECTIVES OF STUDY

1.5.1 Aim of the study

The aim of the research study was to investigate the relevance and scope of the principles of physics within emergency medical rescue specifically in the context of MVR; and to contribute to the professional discourse of medical rescue.

1.5.2 Objectives of the study

There are four objectives to this research study. **Objective one** was to determine and evaluate what are "typical" cases and "atypical" cases within motor vehicle related rescue scenario typologies. **Objective two** was to evaluate the principles of physics that are implicit in typical motor vehicle related rescue scenarios. The **third objective** was to evaluate the alignment/misalignment of the principles of physics implicit in motor vehicle related rescue within medical rescue education [9]and the **fourth**, was to make recommendations to improve rescue education which may influence operational practice.

1.6 DELINEATION OF THE STUDY

This study will not define the typical motor vehicle related case with respect to the clinical presentation of the patients involved; neither would it cover all environmental factors or resource influences. During the process tracing of the typical motor vehicle related case the themes of physics (principles) would emerge to the limits of the trace. The curriculum design of the rescue and physics subject, in terms of the National Qualifications Framework (NQF) descriptor levels, will not be evaluated.

This study would have a narrow focus as described within Chapter 3 due to time constraints and the qualification level at which this study is being completed.

[9] CPUT BEMC Physics (EBS 100A) and Extrication (EMR203M) subject guides will be evaluated as part of the document analysis and gap appraisal methodology which will be discussed further within the relevant Chapter's of the thesis document.

1.7 RESEARCHER'S POSITION

The researcher is currently registered with the Health Professions Council of South Africa (HPCSA), Professional Board of Emergency Care (PBEC), under the Emergency Care Practitioner (ECP) register. The researcher is also a lecturer at the Cape Peninsula University of Technology in the Department of Emergency Medical Care in the undergraduate programs. The researcher holds a Higher Diploma in Higher Education and Training (HDHET), and during the early years of his career was as a fire-fighter and operational paramedic. A change in career to an academic and researcher was made in 2009. This prompted the researcher to undertake a study within the field of emergency medical care, specifically rescue education, in an attempt to elevate the discourse within the rescue discipline towards professionalising it.

1.8 SIGNIFICANCE OF THE RESEARCH AND STUDY

Changes within the educational fields are requiring that all qualifications periodically be re-evaluated, not just for content that is being provided within the qualifications, but also that the qualifications are aligned in terms of the vertical (depth) and horizontal (breadth) discourse. This requires that educators and those responsible for the development of curricula, the setting of standards by Standards Generating Bodies (SGB's), drafting of policies and guidelines are constantly engaged and at the forefront of researching and the development of what are current best local or international practice. The advent of newer qualifications brings more stringent entrance requirements. These new qualifications must be relevant for the needs of the industry and environment; and align to best practice and an evidence informed practice.

Technology and advancement within the areas and field of motor vehicles, building construction, machinery, etc., requires research continually to be conducted within the areas and field of medical and technical rescue. Most areas and fields which the emergency care and rescue practitioner will work within mainly focus on improvement of safety standards and preventative strategies as these pose challenges to both the practitioner and their equipment. The technology that could potentially be applied in these areas could hold certain principles of physics that can either contribute in aiding, minimizing or preventing injury which would equally hold value for the field of emergency care and rescue. Due to the nature and uniqueness of emergency care and rescue much research is required to ensure that practices and functions of this profession is based on evidence that is current, adaptable and relevant to the need.

1.9 RESEARCH DESIGN AND METHODS

1.9.1 Study design

Using an interpretive research design, multiple qualitative methodologies were employed. This methodological triangulation was used to improve construct validity and trustworthiness of findings.

1.9.2 Methods and flow of study

A modified Delphi technique (using questionnaires) in order to reach consensus was repeatedly distributed to rescue experts and EMS professionals within the South African emergency medical care and rescue context to determine expert consensus on typical case scenarios within the defined area of MVR.

Using process tracing (*c.f.* Chapter 3) the typical case scenario narrative of a MVR was screened for underpinnings of the principles of physics pertaining to the defined incident. The Delphi results and the deconstruction of the typical case presentation constituted a chronology of events that highlighted the intersections of physics.

The Bachelor Emergency Medical Care (BEMC) Physics and Extrication (MVR) subject guides was evaluated for alignment of education and praxis/practices pertaining to principles of physics during the document analysis. A translation device was developed using Legitimation code theory (LCT) as a theoretical framework. This was based upon the Semantic dimension[10] which would shed light on the educational alignment of the identified principles of physics from the process tracing and document analysis to the Semantic Gravity (SG) and Semantic Density (SD) in order to appraise the knowledge gap.

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[10] Legitimation code theory (LCT) is an explorative educational framework which consist of five dimensions with semantic being one of the dimensions that explores forms of knowledge (Maton 2014; Van Krieken, 2014)

1.10 IMPLEMENTATION OF FINDINGS

This study's contribution to the body of knowledge is to document the evidence for inclusion of principles of physics within medical rescue training curricula; and the development of medical rescue practitioners' operational practices. A theoretical evidence base for rescue research with reference to physics emerged. Finally, the methods employed may be affirmed as valid in the emergency care and rescue field.

The findings and results will be distributed and disseminated to the various Head of Departments of the Universities of Technologies who are offering Certificate-, Diploma- and Degree programs in Emergency Medical Care where rescue forms part of its curriculum. Further distribution and dissemination will be made to the HPCSA who is currently the SGB for medical rescue training for EMS and other agencies who hold accreditation to offer certain emergency medical care and medical rescue training programs. The research results and findings will be submitted to various relevant national and international journals for publication of findings. Application will be made to present results and findings of the research at conferences nationally and/or internationally where it may have relevance.

1.11 ARRANGEMENT OF REPORT

The following is a brief outline and organisation of the thesis with references to the various Chapters to be presented in this report.

In this chapter (Chapter 1), titled the Orientation to the study, the researcher provided a list of definitions and commonly used abbreviation's which are relevant and related to the field of study (which preceded the beginning of this chapter). The researcher proceeded with brief introductions and information which is related and relevant to the research. These are addressed within Chapter 1 under headings such as the background, motivation for the study, research problem statement, research question, delineation of the research, methodology for the research study and arrangement of the report.

Chapter 2 deals with the literature review, where a theoretical orientation of the study is provided. It further deals with aspects such as the motor vehicle accident and the impact it has on society; and vehicle extrication (access and removal of the patient) as a component of motor vehicle (road traffic) related incidents. Medical physics and human mechanics as it would relate to the field of emergency medical care and rescue, medical rescue education, educational theories and the conceptual framework related to the horizontal and vertical discourse of educational programs/curricula will form part of the discussions within Chapter 2. This chapter of the document critically appraises the current evidence regarding MVR and its links to physics (sciences), educational practices and theories.

Chapter 3 addresses the study design and methodology, with it being described and validated within the context of health sciences and educational research. The design and structure of the Delphi questionnaire, as well as process tracing as a tool within research to evaluate the principles of physics is addressed. The Delphi process is explained regarding the inclusion, exclusion criteria and the questionnaire development with each rounds processes is detailed as well as the rescue landscape within South Africa is discussed. The purpose of the document analysis which is supported as a methodology by the theoretical framework with the aid of LCT– Semantic dimension is discussed and matters pertaining to the ethical considerations surrounding the research.

Chapter 4 presents the various processes, aims, purpose of the various Delphi round questionnaire with the analysis, findings and results (discussion) of the Delphi process[11] after the completion of each round. The final typical case narrative is presented with the equipment used at the typical motor vehicle related rescue incident and the atypical case is defined at the end of the Delphi process.

Chapter 5 presents an overview of process tracing and its use within the research process to obtain the thematic analysis of the principles of physics for the typical motor vehicle rescue related incident as defined by the Chapter 4 Delphi process. The findings and results (discussion) of the thematic analysis to the principles of physics is presented.

[11] When referring to the Delphi process during the research thesis the investigator is making reference to the respective rounds in which a particular questionnaire was circulated for completion to the individual expert participants who participated within each self-administered round (of which there was three).

Chapter 6 presents the analysis, findings and results (discussion) of the thematic document analysis supported by the development of a translation device which is underpinned by the theoretical framework using LCT –Semantic dimension. This methodology and process was used as a basis to evaluate the theoretical and/or contextual placement of the principles of physics highlighted through the document analysis and the appraisal of the gap within the current BEMC Physics and Extrication (MVR) subject guide.

Chapter 7 provides a further discussion of the main points/ideas as highlighted in the previous research methods finding in a contextual manner and with purpose of connecting (providing a flow) the objectives of the research thesis. A self-critique of the findings is presented.

Chapter 8 is where the research thesis is summarized with recommendation made which highlight areas where development and/or future research could be conducted, dissemination of results, which is followed by the conclusion of the main areas and take home message of the study.

1.12 CONCLUSION

It can be argued that it is a moral imperative to be professionally relevant, beyond serendipity, on the basis that professions are integral to the well-being of society. Within poorly developed and researched fields and disciplines, one can be deemed an ‘expert’ based upon seniority, position or status. Experience is necessary for expertness but not sufficient (Dreyfuss & Dreyfuss, 2005). With exposure comes experience, and through sufficient exposure one can progress from a novice to a beginner, advanced beginner and eventually, an expert. ‘Experts’ have mastered skills based on exposure and a comprehensive overview of the professional field. This is aided through having conducted relevant research within the field (Dreyfuss & Dreyfuss, 2005).

Fields and specializations which are technical, procedural and lack evidence, especially where the context is not similar, may expose itself to scenarios which may potentially lead to poor outcomes. This is particularly so when a specialization is not equipped to adapt and draw from the theoretical principles underpinned by evidence.

Research within the field of emergency medical care and rescue is much needed especially if the discipline is hoping to attain a professional status; and want to earn the respect of their counterparts such as medicine. Huge gaps exist within the emergency medical and rescue field; and this requires a more focused need to see what research would contribute to its growth and development. To create new qualifications with the continuation of “old content” within a new qualification might not contribute to an improved profession (field and discipline) and practitioner.

CHAPTER TWO

LITERATURE REVIEW:

2.1 INTRODUCTION

The aim of the literature review would be to document relevant literature and evidence pertaining to the relevance, context and motivation of the study. Various search engines (Google® and Scholar) and the CPUT library databases (web-portal) were used to obtain literature related to themes of principles of physics in the context of MVR; educational theories within health sciences, emergency medical care and rescue practice.

Themes such as “motor vehicle rescue physics”, “road traffic collision physics”, road traffic accident physics”, medical rescue education physics” to name but a few was used. Most searches during the filtering process yielded very to no literature which had any direct relationship or worthiness for inclusion. Articles were either filtered based on the relevance it had to the topic under study or its application to the context or subject. This resulted in most of the evidence for the literature review being obtained from textbooks and trade journals related to the field of motor vehicle rescue or conceptual physics.

2.2 EXTRICATION (MOTOR VEHICLE RESCUE)

2.2.1 Introduction

Vehicle extrication is commonly associated with the use of the “jaws of life” (a colloquial term for hydraulic cutters and spreaders with their associated equipment) and may be described as the process of removing a person from a vehicle that has been involved in a motor vehicle accident when the conventional method of disembarking is not possible. The focus of extrication is centred and aimed primarily towards that of the victim(s) and their need(s) (Dunbar, 2011c). MVR scenes are dynamic with various factors contributing to its changing nature (Dunbar, 2011d; Van Rensburg & Fleischman, 2017). The sections below will briefly highlight some of the skills, abilities, considerations; in part certain components related to the processes which may be prevalent within the motor vehicle related incident and some of the relationships or implications it may have due to the physics within.

2.2.2 The process of motor vehicle related rescue.

MVR related incidents and more so extrication may involve various steps or process or systematic approaches as documented by various textbooks and literature. Some will speak or refer to it involving various components or phases. Others describe it as fourteen steps (Deiner, 2016) or a team (Dunbar, 2013.) or systematic (Morris, 2009b) -approach or incident (Moore, 2003) or extrication incident-management system (International Fire Service Training Association [IFSTA], 2009) or vehicle rescue life cycle (Moore, 2003). Irrespective of how different literature or authors or textbooks may refer to the processes or steps or systems which is being used in the mitigating and management of these incidents there are always some inherent principles which are applied to all MVR incidents.

The literature review will cogently highlight some of the processes, systems or approaches which may be prevalent within the MVR related incident and some of the relationships and implications it may have due to the principles of physics embedded within.

2.2.3 Knowledge, skills, and abilities for safe extrication operations:

The reduction of risk or harm whilst providing care to victims involved is the end goal with regards to management and mitigation of the MVR incident (IFSTA, 2009; Van Rensburg & Fleischman, 2017). Each MVR incident present itself as being unique (Wargclou, 2011; Dunbar, 2013) with several factors which could influence the outcome and duration of the incident. The knowledge that practitioners and rescuers should have need not only be around their narrow scope and area of specialization hence recommendations for a multi-disciplined practitioner (Dunbar, 2011a). Both the rescuer and emergency care practitioners should be equipped to recognize existing and potential dangers to themselves and others (IFSTA, 2009; Deiner, 2016).

The safe and successful management of the MVR incident requires a holistic approach (Deiner, 2016) with all role players at the incident being able to fulfil their individual roles and responsibilities (O'Shea, 2005). Some personnel would be assigned duties, roles and responsibilities specific to a component (Deiner, 2017) with communication being key to the overall success of the incident (Dunbar, 2011c). The approach, system or principles which contribute to the safe and successful management of a motor vehicle rescue related incident should comprise of the assessment of the situation (scene size-up), the making of informed decisions about how to stabilize the situation (stop it from getting worse) and; devise and implement a plan of action that protects the rescuers and victims from further injury (IFSTA, 2009).

The knowledge, skills and abilities which is required could be underpinned by the need to safely extricate the victim(s) and ultimately to transfer those to definitive care (Morris, 2009b). The medical rescue and emergency care practitioner should have an understanding of vehicle construction and crash dynamics, scene control and protection, mechanism of injury, vehicle stabilization and; assessment and management of the critically injured victims (IFSTA, 2009). Rescue organizations that have quality training programs which are well planned, delivered and reviewed will ensure that their teams possess the required knowledge, skills and competencies. (Dunbar, 2012b).

2.2.4 The Motor Vehicle

Knowledge of how vehicles are constructed and designed with respect to new car technology is critical to the safety of rescuers, trapped occupants, and bystanders (IFSTA, 2009). This should not be limited to only possessing knowledge, skills and an ability to identify and locate these vehicle features and systems, but should include an understanding of the operational function and how to provide mitigation measures that would contribute to the protection of on scene personnel (Moore, 2003; IFSTA, 2009). The associated features of 'new car technology' include safety (airbags), driving systems (fuel, battery, hybrid) [Moore, 2003] and the deformed structures (glass, metal which is under tension) and may influence the outcome of the MVR incident (Morris, 2009b:23; Dunbar, 2013).

Dunbar (2011a) purports that theoretical knowledge need to form part of the learning process due to the lack of newer vehicles to train on. Rescue training departments are not able to obtain the newer technology vehicles to develop the required knowledge, competencies, skills, and abilities prior to the practitioner having to undertake extrication in a real-life situation. Proactive training programs must endeavour to find out 'what they don't know' with operational debriefs used as a means to facilitate this knowledge transfer depending on the nature of the incident (Dunbar, 2011a).

Understanding vehicle and kinematics of trauma during the various phases of the collision is of importance as this could influence the manner in which the vehicle is stabilized and provides for a high index of suspicion of underlying injuries (IFSTA, 2009; Dunbar, 2013.) Newton's first law states that an object in motion will stay in motion with the same speed and in the same direction unless acted upon by an unbalanced force (Automotive Plastics, 2017; Hewitt, 2014). As a result, if a vehicle is travelling at a certain speed, the occupants will travel at the same speed as well. If the vehicle hits a solid object during the initial collision and comes to a stop immediately, the occupants will continue going in the same direction of travel and speed (Automotive Plastics, 2017; Calland, 2005; O'Shea, 2005 and Dunbar, 2013).

Although the vehicle may have come to a stop the occupants will continue to move forward at the same speed until they come in contact with a part of the automobile (object) or another human being, which may result in causing injury to the occupants (Automotive plastics, 2017; Calland, 2005; O'Shea, 2005; Dunbar, 2013). Even after a human body comes to a stop during the various phases of a collision, its internal organs continue to move, slamming against each other internally (for example the lungs against heart and the brain against the skull, etc.) because of the inertia (Automotive plastics, 2017; Calland, 2005; O'Shea, 2005; Dunbar, 2013).

Newton's 2nd law of motion - force = mass x acceleration - (Cutnell & Johnson, 2013; Hewitt, 2014), states that as the duration (time) taken for the vehicle to come to rest (stop) or change in direction is increased; the force experienced by the vehicle (and its occupants) is decreased. Conversely, if the time to stop is shorter, the force experienced is greater. Crumple zones, primarily found in the front of a vehicle, increases the time (to come to a stop) to the crash by absorbing energy (during the impact phase of the collision). The crumple zones contribute to reduce the force being applied on the occupants during the collision phase, which could potentially decrease the severity and extent of the injuries (Automotive Plastics, 2017).

MVR related incidents may involve either one type or a combination of vehicle collision kinetics such as a frontal impact, side impact, rear-end, roll-over or a combination of any of these types (Dunbar, 2013; Morris, 2009b). The final position of rest of the vehicle may not necessarily be indicative of the type of collision kinetics involved as many other contributing factors are at play. For example, the amount of vehicles involved and their respective, speed and/or direction of travel may affect collision kinetics. Vehicle occupants travelling forward do not have much lateral movement. Vehicle collisions such as rear-ending, roll-over or side impact collisions may exert additional forces on the occupants (Dunbar, 2013).

Newer vehicles may present with much more ‘damage’. The technology that goes into the design and construction of the vehicle protects the occupant compartment (Wargclou, 2011). It is designed to function by absorbing and/or deflecting forces during the collision phases. Understanding vehicle collision kinetics will likely allow practitioners to manage the various aspects of stabilization, emergency medical care, the process of extricating the entrapped patients by being mindful of the forces which had been exerted on the vehicle and its victims (O’Shea, 2005; Dunbar, 2013).

2.2.5 The Motor Vehicle Rescue Related Incident/Scene

The magnitude of the motor vehicle related rescue incident could range from a minor incident with one vehicle involved and no serious injuries sustained with or without hazards present to a major incident where multiple factors have influenced the incident (Dunbar, 2013). Irrespective of the magnitude of the incident, a well-coordinated management system should be present, comprising of personnel who understand their individual and collective duties, roles and responsibilities which is further supported by a good on-scene communication system (Deiner, 2016).

An Incident Command System (ICS) is an organizational tool which is used to command and control the motor vehicle rescue related incident. The benefits and purpose of the ICS is to minimize confusion and ensure efficient operations at the incident. The ICS may be adapted based on the need of the incident and may include aspects such as scene size-up, recognition and mitigation of hazards, identification of resources required, scene control and management at the motor vehicle rescue related incident (Moore, 2009).

Hazards at a MVR incident may take various forms, exist at various times and present as either being static or dynamic (Dunbar, 2013; Van Rensburg & Fleischman, 2017). Ensuring that the scene is protected and cordoned off is also of critical importance to the safety of rescuers, entrapped victims, and bystanders. All existing and potential safety hazards should be identified and appropriately mitigated if the MVR related operations are to be conducted and performed safely (Moore, 2003; IFSTA, 2009).

Stabilizing a vehicle to ensure that it remains in a position of rest after the collision phase is an important safety and patient care consideration (Dunbar, 2013). Stabilizing the vehicle could reduce further injury to the victims and on scene personnel, provide a basis from which emergency medical care and extrication could be conducted by means of gaining access to the victims (Dunbar, 2013). The decision-making pertaining to stabilization of the vehicle should consider on scene safety, initial level of response of the patient (Dunbar, 2011d & 2013) the type of vehicle collision kinetics (based on the vehicle's final position of rest and other factors such as terrain, centre of gravity/mass, etc.),(IFSTA, 2009) equipment and techniques available (Dunbar, 2011d & 2013). Performing the correct method and decision would enable the safe and efficient gaining of access and extrication of the victims (IFSTA, 2009 and Dunbar, 2013).

The equipment commonly found on rescue vehicles could be grouped based on its use within the context of the MVR related incident. The equipment may be further classified according to their manner in which they are powered (driven) for example hydraulic, pneumatic, electrical, hand tools, etc. (IFSTA, 2009; Moore, 2009; Van Rensburg & Fleischman, 2017). Some of the main uses by which equipment may be grouped is safety, hydraulic, pneumatic, stability, assist and medical (Dunbar, 2013).

The efficiency of the extrication team during the various phases of the motor vehicle related rescue could be further enhanced by the manner in which they use their equipment and the intelligent design incorporated by the manufacturers (Dunbar, 2012b). Equipment selection with the application of the requisite knowledge which enable a safe; and practical performance (Dunbar, 2012b) and use which is guided by the adherence to the manufacturer's recommendations and specifications could contribute to an improved outcome (IFSTA, 2009).

2.2.6 Emergency Medical Care and Extrication

Different countries apply different systems when dealing with the provision of emergency medical care to the casualties (Morris, 2009a; Dunbar, 2013). Each motor vehicle collision is unique due to various factors and variables. For example, the type and number of vehicle(s) involved, position of rest post the collision phase, number and condition of victim(s), hazard(s) and the location where the incident occurred, etc. all play to a reasonable extent a role in the actions and sequence in which the incident would be managed (Morris, 2009b). Within these different systems different personnel attending to the MVR incident would be responsible for the delivery of care at different levels depending on the scope of practice and qualification of the personnel (Dunbar, 2013).

Having a holistic (Deiner, 2016) and casualty centred approach (Morris, 2009a; Dunbar, 2011c) to the extrication process where all efforts are synchronized to the benefit of the victims is a well-established practice. Due consideration is needed from a technical perspective towards the victims needs and requirements (Dunbar, 2011c). Not one function at a motor vehicle related incident is deemed as being more important than another due to the synergistic nature of the endeavour. The extrication (gaining access and creating of space for the removal of the patient) and the delivery of emergency care (assessment and management of the casualty) are equally important with good communication required between all involved (Dunbar, 2012a). Proximal outcomes may include a safe extrication, but the endpoint of the intervention is improved clinical outcomes, risk reduction and prognosis.

When dealing with trauma as an emergency medical care- and medical rescue- practitioner one has to consider the ‘golden hour’ (Niks, 2010; Dunbar, 2013; Deiner, 2016) and ‘platinum ten minutes/rule’ (Calland, 2005). The ‘golden hour’ refers to the time of the incident (traumatic event and the collision) until the casualty reaches definitive care[12] which should be completed within an hour (Niks, 2010; Dunbar, 2013; Deiner, 2016). The ‘platinum ten minutes/rule’ refers to the time taken for the casualty to be safely moved to the ambulance (Calland, 2005).

[12] Definitive care could be provided at a high level hospital with theatre and surgical capabilities.

The theory of the ‘golden hour’ and ‘platinum ten minutes/rule’ relates to the chance of survival of the casualty which has suffered a traumatic incident. The casualty’s chances of survival (Morris, 2009a) and outcome may decrease with time due to the treatment having to commence on scene, especially if the patient is entrapped within the vehicle (Morris, 2010; Niks, 2010:32). Speed and time is very important as factors which could influence the ‘golden hour’ and ‘platinum ten minute/rule’ in addition to the time taken for responding agencies to arrive, complexity of the incident (Niks, 2010) and developing well-run ambulance services (Morris, 2009a).

Dunbar (2013) stated that statistically, most extrications are conducted on vehicles which are on its wheels and that have suffered frontal, side or rear impact collision kinetics. This tends to be the most common manner in which rescuers also train based on Dunbar’s (2013) experience. The South African experience of extrication typology is poorly documented. No motor vehicle rescue related incident presents in exactly the same manner with respect to orientation, vehicle collision kinetic, injuries sustained by casualties, environmental factors; skills, and capabilities of the attending emergency care and rescue practitioners (Morris, 2009b). Practitioners at motor vehicle rescue related incidents may draw from their theoretical and procedural knowledge obtained during training to achieve the end goal of ensuring the casualty is extricated from the vehicle in the safest, efficient and timely manner, as every incident is unique (Dunbar, 2011a).

Different vehicle collision kinetics and the extent of deformity of the motor vehicle may influence the manner of entrapment and injuries which would be sustained by the casualties. During the extrication and emergency medical care phase a team approach (where multiple tasks by various on scene personnel is conducted) is advocated where all members have trained together and is familiar with the process at hand (Dunbar, 2013; Calland, 2005). Mindful of the “golden hour”, a twenty-minute period is allocated for the stabilization, disentanglement and stabilization of the casualties. Challenges to this time period include new car technology, environmental factors and rescuer skill (Dunbar, 2013; Deiner, 2016).

Deiner (2016) states that extrication of the patient will generally always be the most challenging part of the rescue effort due to the huge forces, equipment and the confined environment in which the rescue is taking place. Various factors would have to be considered during the decision making, implementation and continuous evaluation of the extrication and emergency medical care process of the MVR related incident. The condition of the victims (from degrees of entrapment and injuries sustained), access, ability to assess and perform emergency medical care, exit route and manner of extrication from vehicle, and safety considerations related to any aspect of the extrication process (for example, cutting through metal resulting in exposed sharp metal which could present as a hazard and safety risk) are some of the major factors which need to be considered of the MVR incident (Dunbar, 2013; Calland, 2005).

Developing the extrication plan may depend on the level or degree or nature of entrapment and; when combined with the medical status or condition of the casualty based on the injuries sustained. Extrication during the MVR should not only be used in the event a casualty is physically entrapped but could contribute in preventing the further compromising of the casualty's existing injuries during the removal phase from the vehicle (Morris, 2009b). Many motor vehicle related rescue textbooks such as Moore (2011) 'Vehicle Rescue 1-2-3', Morris (2009b) 'Holmatro's Vehicle Extrication Techniques', Dunbar (2013) 'Vehicle Extrication Techniques' and IFSTA (2009) 'Principles of Vehicle Extrication' explain in detail the possible methods and procedures based on the level of entrapment and vehicle orientation which could be used to create space for accessing and removal of the patient from the vehicle during the extrication operation. This is not a 'one-size-fits-all' solution to the extrication process which requires rescuers to possess the knowledge, experience, competencies, skill and abilities to deal with the extrication operation in a safe, timely and efficient manner.

Developing a high index of suspicion by drawing from the theoretical knowledge related to the kinematics of trauma, vehicle collision kinetics, deformity of the vehicle, use and activation of occupant safety systems would guide the emergency care practitioner to develop an assessment plan. Assessment and the evaluation of the casualties is critical steps in the entire extrication operation (IFSTA, 2009 and Deiner, 2016). If an injury is overlooked during this assessment and evaluation of the casualty, it could potentially contribute in the clinical deterioration and development of adverse events during the extrication process (IFSTA, 2009). Emergency medical care and rescue practitioner's decision for an extrication path, to protect and package the casualties to prevent further harm or injuries should be in accordance with the findings of their medical assessment and within their scope of practice (IFSTA, 2009).

2.2.7 Summary

Emergency medical care and rescue practitioners should have a holistic understanding, with knowledge and training which should equip them to manage any MVR related incident. The extrication and management of the critically ill and injured victim(s) for transport and further care requires the practitioner to be current (in knowledge pertaining to the evidence and best practice within the field with relevant experience).

While MVR incidents are probably never the same, certain aspects will present at most incidents. Understanding the principles which underpin and informs or explain certain phenomena or processes could assist medical rescue practitioners in having to make those informed decisions which could bode well for the victims involved in the MVR incident. The introduction of newer technology to our motorized and construction industry contributes to every situation being unique and changing over time. Work safety relies on the hierarchy of controls for occupational risk i.e. removal of hazard, engineering, administration, and personal protective equipment (in the order of being effective to least effective) (Manuele, 2005). Formal policies and standard operating procedures can only go so far and this may necessitate that rescuers need the training to perceive risks as they evolve and the right skills and knowledge to manage them.

Due to the diverse nature and approaches to MVR it requires practitioners attending these types of incidents to be able to either specialize (accepting the role and responsibility) with respect to incident management, emergency medical care, technical rescue or any particular or specific aspect that requires certain competencies from a basic to an advanced level depending on the size and magnitude of the incident. Whilst environmental factors remain difficult to manage, the standardisation of the practitioner knowledge and fundamental understanding is possible.

Morris (2009a) stated that approximately 50% of road accident related deaths occur on scene hence the need for well-developed systems which endeavour to reduce the frequency, incidence, mortality and morbidity. Research within the field of extrication is also stated by Morris (2009a) as being extremely limited with him citing ethical and practical issues as being a contributory factor to it. The majority of the information used in the development of this section was obtained from trade journals and textbooks related to the field of MVR.

These resources lack the scientific rigour and peer review mechanisms which is characteristic of well-researched scholarly work.

2.3 PRINCIPLES OF PHYSICS

2.3.1 Introduction

Notwithstanding improvements in vehicle safety, motor vehicle crash related trauma remains a compelling public health problem and a challenge for pre-hospital medical care providers, emergency medicine physicians and trauma surgeons. This section of the literature review will discuss some of the literature regarding the principles of physics which is well documented, pertaining to MVR, medicine and human mechanics.

2.3.2 The laws of physics and motor vehicle related rescue incident

Using an example of a motor vehicle travelling at a certain speed with an unrestrained driver, certain principles of physics may be demonstrated and explained. From Newton's first law of motion, the motor vehicle will remain in motion until it is acted upon by an outside, unbalanced force (Cutnell & Johnson, 2013; Hewitt, 2014; Sanders *et al.*, 2012). If the driver gradually applies the brakes, the friction of the braking mechanism converts the mechanical energy of the car to thermal energy[13]. In the event the motor vehicle strikes a tree and is stopped instantly, the tree absorbs the mechanical energy of the car and driver system[14] (Sanders *et al.*, 2012).

The laws of physics is stated as being applicable in every rescue situation due to rescuers often having to either, perform actions of lifting, moving, stabilizing of an object, or vehicle, using various techniques and equipment. This requires the rescuers to understand and account for the effects of inertia, momentum, reaction forces, gravity, etc. (Worsing, 1993). Crash characteristics influence injury patterns and severity. It provides valuable information for the diagnosis and rapid treatment of the trauma patient (Conroy *et al*., 2008). Collisions are complex events and many crash parameters[15] may influence injury risk to occupants.

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[13] Conservation of energy law explained which states that energy cannot be created or destroyed in that it can only change form (Cutnell & Johnson, 2013; Hewitt, 2014; Sanders *et al.*, 2012).
[14] The vehicle and everything contained within the vehicle maybe thought of as being the 'system'.
[15] These crash parameters may include delta *V* (vehicle change in velocity at the time of impact), delta *T* (crash duration), and the crash pulse (vehicle deceleration over time) (Conroy, *et a*l. 2008).

The vehicle's stiffness, mass, and structure may also influence the impact (Conroy *et al.*, 2008).

When considering the motor vehicle and the rescue related incident, a profusion of energy forms is revealed. For example, unstable vehicles possess mechanical[16] potential energy in the form of gravitational potential energy by virtue of its positional[17] state. When the mechanical potential energy is not reduced to a minimum, the vehicle will remain unstable. There could easily be a conversion of potential to kinetic energy when an external force is applied to the vehicle, resulting in motion. It is therefore important to stabilise vehicles post-collision to avoid this from occurring during rescue operations. During the management of an unstable load which requires shoring, one working principle is the establishment of a triangle of stability with respect to the use of mechanical struts. In ensuring a triangle of stability, horizontal and lateral forces are controlled (Morris, 2008).

Instabilities could manifest within the structures of the vehicle which may have deformed during the collision. For example, metal may be under tension and plastic components bent. During rescue operations components under stress (tensioned, flexed, etc.) may suddenly spring free due to a shift of forces as a result of rescue procedures, such as cutting or spreading (Calland, 2006; Morris, 2009b). Components under stress have elastic potential energy which can be transformed into kinetic energy during rescue procedures. Such energy conversions, if not suitably mitigated, may lead to harm for entrapped victims and on scene emergency care personnel.

Morris (2009), in a Holmatro[18] guideline, stated that metal that is bent (flexed), stretched (tensioned), or twisted (torsioned) (see Figure 1 below), requires caution. Rescuers need to understand the mechanical and potential reactions in the body of a vehicle that occur due to collision phase deformations.

[16] 'Mechanical' refers to the motion of systems.
[17] Gravitational potential energy of the vehicle is the energy it possesses by virtue of the mass and the distance of the centre-of-gravity from the ground.
[18] Holmatro hydraulic equipment and system solutions is a privately owned global supplier and manufacturer of equipment and services which are predominantly used in rescue, special tactics and industrial applications (obtained from Holmatro home page at https://www.holmatro.com/en/paginas/163-about-holmatro.html).

Figure 1. Illustrating the effects of components under stress post-collision. Adapted from "Medical Care in Extrication Rescue" (Morris, 2009b).

During the MVR related incident, the rescue practitioner would be required to perform different tasks using a variety of equipment to either, cut, break, spread, or push on different structures of the vehicle. Most of the equipment (hydraulic and pneumatic) and tools (hand tools used for cutting, breaking, etc.) would require the application of pressure. Pressure is the perpendicular component of a force applied to an area (Cutnell & Johnson, 2013; Hewitt, 2014). Force in common terms implies a push or a pull (Cutnell & Johnson, 2013).

The equipment which is used during MVR incidents could be powered either manually, pneumatically, hydraulically or electrically (Moore, 2003; IFSTA, 2009; Van Rensburg & Fleischman, 2017). Various physics textbooks, for example Hewitt (2014), 'Conceptual Physics', and Cutnell & Johnson (2013), 'Introduction to Physics', explain the principles pertaining to the above phenomena. Rescue textbooks, such as those of Moore (2011) 'Vehicle Rescue 1-2-3', Morris (2009b) 'Holmatro's Vehicle Extrication Techniques', Dunbar (2013) 'Vehicle Extrication Techniques', and IFSTA (2009) 'Principles of Vehicle Extrication', which are related to the field of motor vehicle rescue, lacks sufficient discussion on the principles of physics. The above rescue related reference books appear sufficient in relation to procedural knowledge. The inclusion of physics threshold concepts in rescue textbooks could contribute to a more insightful discourse around equipment usage and 'trouble-shooting'. In this way rescuer attributes such as problem solving and critical thinking could be enhanced.

Most vehicles use a form of fuel to support the particular engine during the combustion process. The fuels possess chemical potential energy. This, as well as other chemical agents (battery acid/fluid, brake fluid, etc.) pose particular threats to the motor vehicle rescue incident, such as fire-, corrosive- and slip-hazards (Calland, 2006). The chemical potential energy from the on-scene fuels could result in fire in the presence of an ignition source (Calland, 2006).

Power supplies of vehicles providing the electrical energy (Calland, 2006) may remain active post-collision, posing particular dangers. For example, airbags which have not deployed, may deploy during the rescue action phase. 'Start-stop' technology may appear inactive, but may still be operational. Hence the need to deactivate electrical systems of vehicles to mitigate this as a potential hazard on scene (Wargclou, 2011).

2.3.3 Physics and its applied[19] forms within the Health Sciences

2.3.3.1 Medical Physics

Hollins (1990) defines medical physics as the "physics that is applied to medicine". Within the medical practice there are three stages in the provision of care to patients, namely; examination, diagnosis and treatment. Diagnosis in medicine is based on patient 'history', 'physical examination', and the use of medical technology (for example, thermometers, stethoscopes, x-rays, electrocardiograms, etc.), enabling medical practitioners to obtain relevant information. Radiation therapy, external or internal pacing of the heart etc., are used in the treatment of various conditions (Hollins, 1990). These technologies draw from physics' principles in its design and application.

[19] This is physics as it would relate to the human mechanics and the medical sciences.

The human body has a wide range of physical functions, including mechanical, optical, acoustic, electrical and metabolic, which can be measured. At the cellular level, processes such as depolarization occur. These, as well as the mechanics of the human body, such as skeletal motion and the movement of joints through muscle contraction etc., (Splinter, 2010), involve principles of physics.

2.3.3.2 Human body mechanics

Maintaining a safe scene, minimizing the risk of harm or injury to oneself, one's crew, and the patient, is of the highest priority at the MVR incident (Dunbar, 2013). Annually, many people die, or are injured, in the attempt to save the lives of others (Calland, 2006). Many rescue personnel can recall a near miss[20] event. Rescue personnel, by virtue of their training, do not embark on assisting at an event either with; the intent of causing injury to themselves, or knowingly sacrificing themselves (Calland, 2006). During rescue operations involving equipment and victims, the practitioner may suffer injury when lifting and carrying tasks are performed incorrectly, mainly lower back injuries (Lavender *et al*, 2000; Schottke, 2016). A greater awareness of the principles of body mechanics and its application to the musculoskeletal system may reduce the possibility of injury (Schottke, 2016).

For example, in the prevention of injuries to weaker muscles, the practitioner could use the larger leg muscles to aid in the lifting of objects, instead of the over-reliance on their back muscles. Principles of good posture during lifting, such as; keeping the object close, having a good footing, and avoiding twisting, as well as not exceeding one's own weight lifting capacity (Lavender *et al*, 2000), could contribute to the reduction of injury (Schottke, 2016).

A study conducted by Lavender *et al*. (2000), analysed the posture and forces which applied to firefighters and paramedics during frequently occurring strenuous work tasks. Conclusions which emanated from the study indicated that; during the transfer of a patient between beds and stretchers, the optimal stable posture was found to be standing as opposed to kneeling; the use of an interface board to reduce frictional forces minimized the

[20] The National Safety Council (2013), in a case report, stated that "a near miss is an unplanned event that did not result in injury, illness, or damage – but had the potential to do so". Howard (2012) states that the OSHA defines "a near miss as an incident in which no property was damaged and no personal injury was sustained, but where, given a slight shift in time or position, damage or injury easily could have occurred".

flexing of torsos and/or shoulders during the lift (Lavender *et al*, 2000). Schottke (2016) states that practitioners should follow their local protocols pertaining to lifting and movement of patients or equipment in combination with good body mechanics practices. Protocols which are informed by studies such as Lavender *et al*. (2000) could inform and guide responsive practice.

During movement, components of the musculoskeletal system act as levers with axes of rotation. The tensed muscle attached by tendons to bone, produce resistive and motion forces (Hollins, 1990; Splinter, 2010). An analysis of the forces acting, the work done on the musculoskeletal system and the external object to be moved, can be made (Hollins, 1990). Such an analysis will allow quantitative evaluation of workplace practices and optimization of safer methodologies. For example, an analysis of the forces involved in the lifting of a load would suggest that bending of the knees; and keeping an object closer to the body during carrying, would contribute to safer practice (Hollins, 1990).

Injuries, especially to the lower back, are common (Lavender *et al*, 2000) more so during bending and lifting of loads as stated by Hollins (1990). A review by Davis & Marras (2000) of 53 studies pertaining to trunk motion as an important risk factor to consider when attempting controlling lower back disorders in the workplace indicated that a better understanding of muscle coactivity may ultimately lead to reducing the risk associated with dynamic exertions. Trunk strength and spinal structural loading is stated by Davis & Marras (2000) as being the two major categories which contribute to the relationship between dynamic motion and lower back disorders. Lower back disorders are exacerbated by the tolerance limits of muscle supporting spinal structures, due to external forces, being exceeded (Davis & Marras, 2000). Many other human body mechanic factors may also contribute to back injuries.

2.4 EDUCATIONAL THEORIES AND ITS RELEVANCE TO MEDICAL RESCUE EDUCATION

2.4.1 Introduction

Theoretical knowledge in emergency medical rescue has been documented by procedural and technical knowledge. Motor vehicle rescue related textbooks are void of the principles (explanatory power) that underpin the procedural and technical knowledge. This does not bode well for the construction of knowledge for the student and practitioner post qualification as this tends to develop segmented learning. This section of the literature review will be discussing theories as it would relate to: knowledge, teaching and learning, curriculum development; and its relevance to motor vehicle rescue education in a professional health sciences degree.

2.4.2 Theories of Knowledge

Social realism is said to have emerged as a new approach in the 21st century in understanding knowledge and its role in education. Van Krieken (2014) cites Basil Bernstein and Bourdieu's culturist theories as the premise on which social realism is build. Van Krieken (2014) further purports that it emerged from discussions among a range of sociologists. Education is said to be a distinctive field due to the production, curricularisation and; teaching and learning of knowledge. It is believed that we are entering a new age where knowledge is crucial which require citizens to actively engage in lifelong learning (Van Krieken, 2014). Van Krieken (2014) states that this is largely attributed to the "information age" which is associated with "knowledge societies" based on "knowledge economies".

Due to the vast field of medical rescue in which knowledge and the theories related to it could be discussed (epistemology, education, etc.) this next section will be focusing on theories related to knowledge building and the relationships within knowledge.

2.4.2.1 Horizontal and Vertical Discourse

Knowledge may be social but is also real within social realism, with different forms of knowledge having effects for intellectual and educational practices. Using the horizontal and vertical discourse from the work of Basil Bernstein (1999) helps in understanding and analysing how knowledge helps in shaping education and society. Horizontal and vertical discourse as per Bernstein (1999) is a proposed model that generates a language which relates the internal structure of specialised knowledge, the positional nature of their fields or arenas of practice, identity constructions and their change, and the forms of acquisition for successful performance.

Horizontal discourse refers to knowledge which is usually typified as ‘everyday’ or ‘common sense’. It is likely to be oral, local, context dependent and specific, tacit, multi-layered, and contradictory across but not within contexts that are being segmentally organised (Bernstein, 1999). Vertical discourse refers to knowledge which takes the form of a coherent, explicit, and systematically principled structure which is hierarchically organised as in the sciences (Bernstein, 1999). Bernstein (1999) further states that it may also take the form of a series of specialised languages with specialised modes of interrogation and specialised criteria for the production and circulation of texts, as in the social sciences and humanities. A further distinction within the vertical discourse is made by Bernstein into the hierarchical knowledge structure[21] and horizontal knowledge structure[22] as cited by Van Krieken (2014). Maton (2014) states that a key to understanding segmentalism[23] is through the concepts of Bernstein through which the development of knowledge is explained.

Horizontal knowledge structures, cited by Van Krieken (2014), (based on work by Maton and Moore) serves to limit cumulative progress due to the same basic ideas which are reinvented with each new segmented approach. Van Krieken (2014) further states that hierarchical knowledge structures, in contrast, build on previous knowledge, enabling ever-more powerful explanations to be constructed that reach across an expanding range of phenomena. An example of this is highlighted by the research conducted in 2010 by Wheelahan based on Australian students which is cited by Van Krieken (2014). Van Krieken (2014) stated that learning specific skills for specific task were less transferable to other contexts, rather than being taught principles of knowledge. This was said to allow learned ideas to be used across a wide range of contexts (Van Krieken, 2014).

[21] Hierarchical knowledge structure is stated as that which was developed through integrating past knowledge within more overarching ideas that attempt to explain a greater number of phenomena than what was previously understood (Van Krieken, 2014).
[22] Horizontal knowledge structures is stated by Van Krieken (2014) as having developed through the addition of a new approach or theory alongside a existing approaches and from which it is strongly bound.
[23] Segmentalism is stated by Maton (2014) to occur “when knowledge or knowing is so strongly tied to its context that it is only meaningful within that context”. Maton (2014) further states that “within intellectual fields segmentalism arises with the accumulation of new ideas or approaches that fail to integrate existing knowledge”.

Textbooks used within the field of MVR (extrication) include Moore (2011): 'Vehicle Rescue 1-2-3', Morris (2009b): 'Holmatro's Vehicle Extrication Techniques', Dunbar (2013): 'Vehicle Extrication Techniques' and IFSTA (2009): 'Principles of Vehicle Extrication'. The assertion that these materials are very procedural and skills based orientated suggests that it could contribute to segmented learning by the student. This is plausible as what exists within textbooks as a resource of information is what is included in curricula; and enacted during the teaching and learning. The promise of the sciences (such as physics) for rescue education is that it could create opportunities to contribute to the vertical discourse of the MVR (extrication) discipline as it is able to provide deeper meaning to everyday phenomena and occurrences.

2.4.2.2 Bernstein's Pedagogic Device

Maton (2014) states that Bernstein's pedagogic device reaches from social structure to individual consciousness. It is said to "comprise of a complex web of relations among finely differentiated series of agents, contexts and practices". Bernstein's pedagogic device is stated to have inspired studies which ranged from macro-processes of national curriculum formation to micro-processes of classroom interaction (Singh, 2002; Maton, 2014). Bernstein argued that the pedagogic device created an arena of struggle which comprises of three fields of practice namely, production[24], reproduction[25] and recontextualisation[26]. These field are hierarchically related which allows for the shaping of the pedagogic discourse through the analytical distinguishing of practices and context (Maton, 2014).

Singh (2002) states that Bernstein described the pedagogic device "as an ensemble of rules or procedures via which knowledge is converted into classroom talk, curricula and online communication". The pedagogic device fields do not refer to different levels of education systems but should be viewed as locations; with universities (field of production), schools (field of reproduction) and education departments of tertiary institutions (field of recontextualisation) being some of the more typical sites. Knowledge could be curricularised from the field of production to recontextualisation, pedagogised from recontextualisation to

[24] "A field of production where new knowledge is constructed, modified and positioned" (Maton, 2014).
[25] "A field of reproduction where knowledge from the field of production are selected, rearranged and transformed to become pedagogic discourse" (Maton, 2014)
[26] "A field of recontextualisation (sites of teaching and learning) where discourses from the field of production are selected, appropriated and transformed to become pedagogic discourse available to be taught and learned within the field of reproduction" (Maton, 2014)

the reproduction field and intellectualised from recontextualised field into the production field (Maton, 2014).

The responsibility of university academics typically involves knowledge production, teaching and curriculum design and based on Bernstein's pedagogic device each field should have its own structure and logic. School physics may not merely be understood by studying the research practices of physicists (Maton, 2014). This is due to the specialist expert knowledge which are in the form of highly complex symbols and information located within the field of production. The specialist expert knowledge would require decoding or translation to be accessible and understandable to those outside of the field for example into the field of reproduction or recontextualisation. This decoding and translation is not always possible by the specialist expert which requires agencies within the other fields having to undertake these conversions and translation of knowledge. Research related to the structuring of knowledge using a pedagogic model is important due to an increased focus on life-long learning and learning through innovation (Singh, 2002).

2.4.2.3 Legitimation Code Theory (LCT)

Legitimation Code Theory (LCT) is developed by Karl Maton with it being built on "Bourdieu's field theory and Bernstein's code theory" (McNamara & Fealy, 2011). "LCT incorporates insights from Popper, Foucault and systemic functional linguistics" as stated by McNamara & Fealy (2011). LCT according to Maton (2014) can be described as an "explanatory framework for enactment in and (re)shaping by substantive research". LCT is said to be less of a set of claims about the nature or purpose of education but rather offers a conceptual toolkit for research (Van Krieken, 2014). LCT as a framework is used to explore a diverse range of issues within education with the framework allowing research to get beneath the surface features of empirical situations to explore their organising principles or 'codes' (Van Krieken, 2014).

Maton (2014) reflects that various researchers highlight the current debates around knowledge and education. Maton (2014) further states that the aims and purpose of each or combined is in contributing and providing meaning to the lifelong learning. This is to meet the demands of working in a knowledge society where workers are able to continually build their knowledge, learn new skills and give new meaning to existing abilities. The role of educational knowledge is highlighted by Maton (2014) as being often missing from these debates as research on the transfer of knowledge focuses on forms of knowing (‘knowing that’, or ‘knowing how’, etc.) rather than on forms of knowledge. Basil Bernstein’s code theory and the extended concept from the framework of LCT dimensions are stated as being able to address the question of how educational knowledge enables and constrains cumulative learning (Maton, 2014).

McNamara & Fealy (2011) cited that Maton and Moore in their 2010 research stated that “LCT is a theoretical lens that brings knowledge into focus as the central object of enquiry”. McNamara & Fealy’s (2011) editorial pertaining to the academic practices of nursing in Ireland stated that LCT also provides a means of conceptualising the implications for knowledge forms, its capacity to build powerful and cumulative knowledge, its relevance to its clinical nursing base, models of curriculum pedagogy, and the identity of the nursing academic as both nurse and academic.

2.4.2.3.1 Legitimation Code Theory (LCT) and Semantic dimension

LCT comprises of five different types of dimensions, with each individual dimension able to provide concepts for analysing a set of organising principles underlying practices as legitimation codes (Maton, 2014:17-18). Semantic is a dimension of LCT which explores forms of knowledge pertaining to the concept of its ‘-gravity[27]’ and ‘-density[28]’ (Van Krieken, 2014). Figure 2 is a representation of the Bachelor degree and the field of EMC with respect to the Semantic dimension gravity (degree of context / practice dependence) and density (degree of condensation/theory). Theory and context co-exist within the field and bachelor degree qualification of EMC with each having a particular strength through which knowledge could be analysed.

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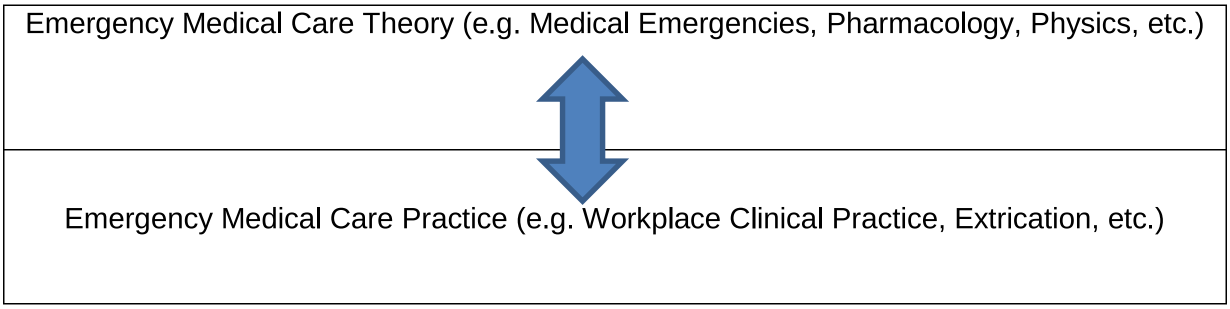
[27] “Semantic Gravity (SG) or the degree of context-dependence of meaning- the stronger the SG (+), the more knowledge is dependent on its context to make sense; the weaker the SG (-), the less dependent knowledge is on its contexts for its meaning” (Van Krieken, 2014).

[28] “Semantic Density (SD) or the degree of condensation of meaning- the stronger the SD (+), the more the meaning are condensed within a symbol or practice; the weaker the SD (-), the less meanings are condensed” (Van Krieken, 2014).

2.4.2.3.2 Semantic dimension and Emergency Medical Care (EMC)

Shay (2012) stated that both the theoretical and practical knowledge is principled, with there being an important difference as the principled practical knowledge emerge from the principles from the practices themselves, and it is a codification of practice. In 'proceduralized' theoretical knowledge, the principles emerge from theory (Shay, 2012). The assumption of the study is that theory guides practices and protocols are informed by theory (as indicated by the arrows within Figure2).

Figure 2 Representation of the Bachelor of Emergency Medical Care qualification to context (gravity) and condensation (density)



The relative strengths of Semantic Gravity (SG- context) and Semantic Density (SD- theory) may be varied independently to generate a range of Semantic codes. This may be analysed along a continuum where SG [where context] and SD [where theory] could be either weak or strong as illustrated by Figure 3. The concept of Semantics is thereby able to move beyond dichotomizing and homogenising categories as it is able to offer a basis not only for typologizing practices but also for topologically exploring differences within types and; dynamic processes of strengthening and weakening (Maton, 2014).

Figure 3 Strength of Semantic dimension with regards to EMC Theory and Practice

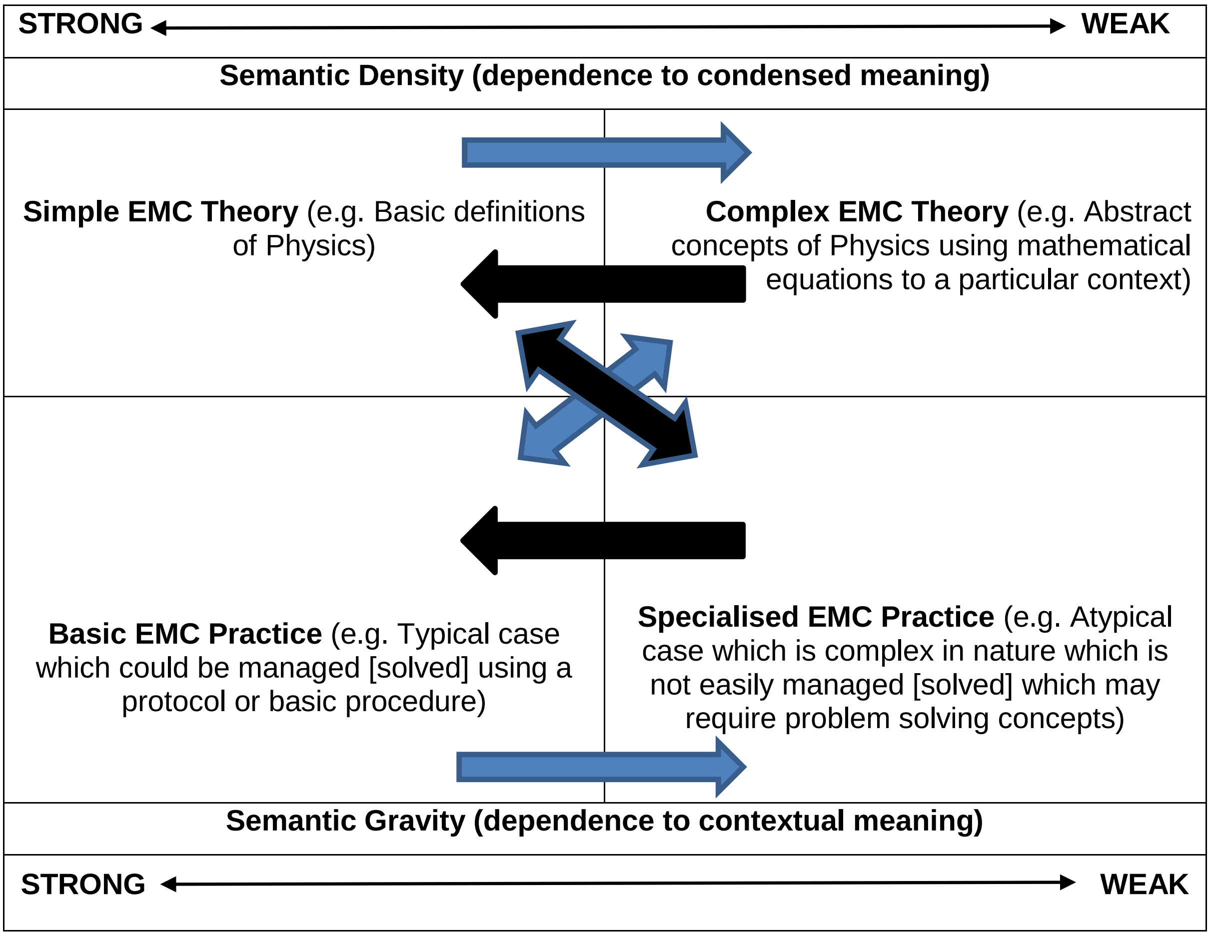
STRONG ⟵⟶ WEAK	
Semantic Density (dependence to condensed meaning)	
Simple EMC Theory (e.g. Basic definitions of Physics)	**Complex EMC Theory** (e.g. Abstract concepts of Physics using mathematical equations to a particular context)
Basic EMC Practice (e.g. Typical case which could be managed [solved] using a protocol or basic procedure)	**Specialised EMC Practice** (e.g. Atypical case which is complex in nature which is not easily managed [solved] which may require problem solving concepts)
Semantic Gravity (dependence to contextual meaning)	
STRONG ⟵⟶ WEAK	

Figure 3 above illustrate the strengthening of theory as it would relate to the semantic density (condensed meaning) from the simple EMC theory where an example of a basic definition of physics namely Newton's 3rd Law is required to be understood by the student. A basic definition of Newton's 3rd Law is therefore stated as being strong due to multiple meanings being able to be derived from the symbolic (defined) meaning to various contexts. The theory becomes weak when its meaning is less condensed for example in physics where students are required to demonstrate understanding by applying Newton's 3rd Law to solve a complex problem using an equation (formula) to a specific context. The degree of complexity and understanding is therefore increased and hence the strength of condensed meaning pertaining to its semantic density (theory) is weakened.

EMC practice can be seen as the context (semantic gravity) in which knowledge is to be applied. Using an example of Extrication, the contextual meaning could be seen as being strong when a rescue practitioner has to stabilise a vehicle post the collision phase of a motor vehicle related incident following a basic standardised and protocol driven approach. The EMC practice would decrease in strength when the knowledge related to the context requires a more specialised and complex approach such as where a motor vehicle is submerged partially in water with the rescue practitioner not able to apply a specific protocol or guideline to mitigate or manage the incident safely. The practitioner may have to draw from various principles which is underpinned by the theoretical constructs or concepts through which they would be able to apply their problem solving, reflective (in action and post-) and judgement skills.

Shay (2012) stated that where meaning is context dependent (SG is strong) with a likelihood of it being less condensed in meaning (SD is weak) is similar to that of horizontal discourse as described by Bernstein or what Friedson deems practical knowledge as illustrated through Figure 4 with the blue arrow. This holds true for Bachelor degree EMC subjects where subjects such as Emergency Medical Care has a particular (strong) context which require the understanding of abstract (weak) theoretical concept and principles that are condensed in meaning. Conversely there appears to be strong alignment between meanings that are context independent (SG is weak) and strong condensation (SD is strong) with this being similar to that of Bernstein's vertical discourse as described by him (Shay, 2012) which is illustrated through Figure 4 with the black arrow.

Figure 4 Relational power of the Semantic dimension with regards to EMC Theory and Practice



2.4.2.3.3 LCT Semantic profile

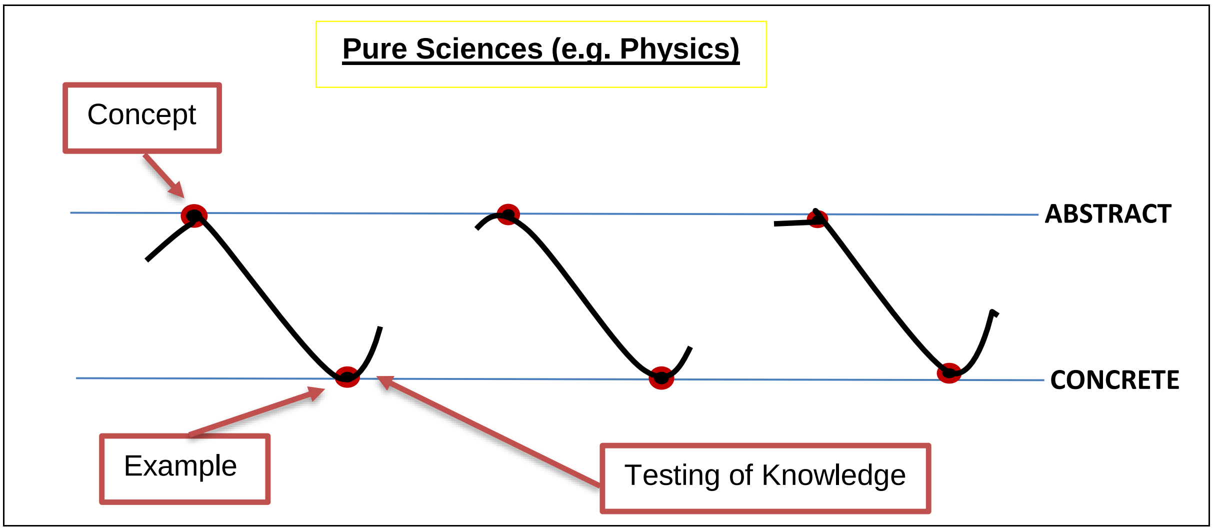
An objective of this study relates to the appraising of the educational knowledge gap of the BEMC Physics (EBS100S)[29] and Extrication (EMR203S)[30] subject guide content utilising the LCT Semantic dimension. The relational power of dependence to the Semantic dimension in terms of context and theory could be heuristically illustrated by means of a wave or flat line through which change is represented over time (Maton, 2014). The change could be analysed using for example the delivery of subject content in terms of the theoretical and contextual dependence over time in relation to the order in which it is covered (Maton, 2014).

Figure 5 below is an illustrative representation of a manner through which the LCT Semantic profile of waving and weaving could be demonstrated for a pure science physics subject pedagogy within tertiary education (Winberg, 2018). Pure sciences under-graduate qualifications such as a Bachelor of Sciences (BSc), within higher education are highly theoretical with context-independence. A concept of physics which is abstract in nature is introduced to the learner group during a teaching event. As the pure sciences qualification is void of a particular context an everyday example may be used to further develop the students' knowledge pertaining to the relevance or application of the introduced physics concept. Following this the students' knowledge could be tested (in a formal or informal manner) (Winberg, 2018). This cycle of pedagogy of moving from the abstract into the concrete could be repeated.

[29] The study is delineated to the CPUT BEMC Physics (EBS 100S) subject guide for the 2014 academic year of study.

[30] The study is delineated to the CPUT BEMC Extrication (EMR 203M) subject guide for the 2014 academic year of study.

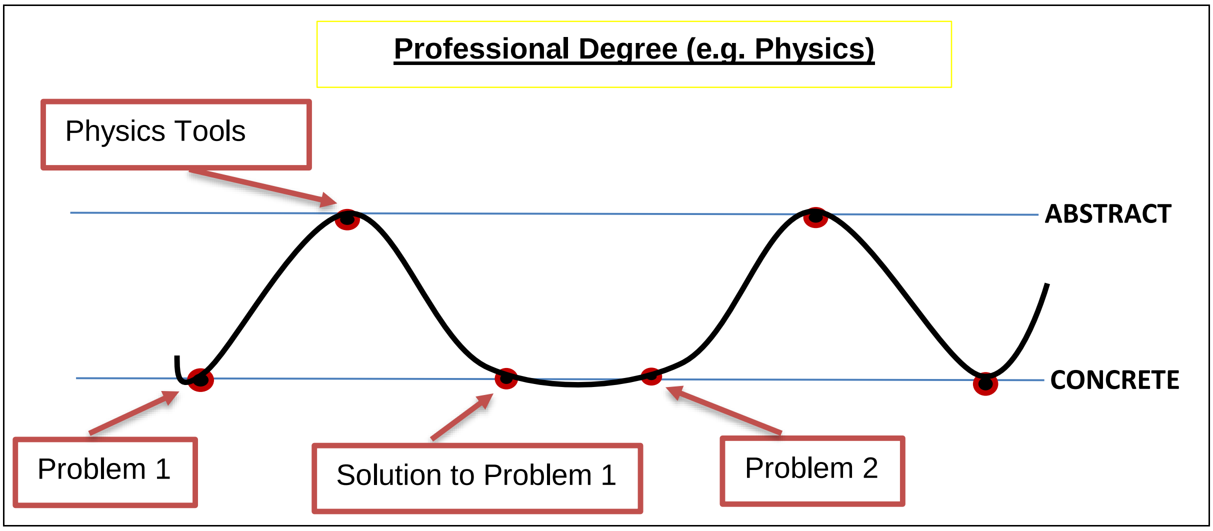
Figure 5 LCT Semantic profile related to the pedagogy of a Pure Sciences tertiary qualification subject such as Physics



Hence a different approach is required during the pedagogy as to those under-graduate qualifications within professional fields such as a Bachelor of Emergency Medical Care (BEMC) as illustrated through Figure 6 (Winberg, 2018). Professional under-graduate qualifications have greater context dependence due to the practical nature of the field of study. The qualifications practice relies on theory which is based on research that is evidence based. Therefore, the notion of theory influences practice and *vice versa* (Shay, 2012).

The subject of Physics within professional degrees such as those form the Health Sciences field are seen as being foundational. This is due to the knowledge which is gained from these subjects having to build and scaffold onto the core subjects within the professional degree. Figure 6 is an illustrative representation of the LCT Semantic profile related to the pedagogy using the example of the subject of Physics within a professional degree such as the BEMC (Winberg, 2018). During the teaching event a problem is introduced to the student group which is related to the field and context of the profession. The physic concepts needed to solve the problem is introduced after which the solution in solving the problem using the physics concepts in facilitated. Students are moved from the concrete to the abstract which would generate a waving and weaving pattern over time during the pedagogy as this cycle is repeated (Winberg, 2018). These pedagogical approaches are seen with flipped classroom approaches as those used by for example Eric Mazur (Winberg, 2018).

Figure 6 LCT Semantic profile related to the pedagogy of a Professional Degree tertiary qualification subject such as Physics



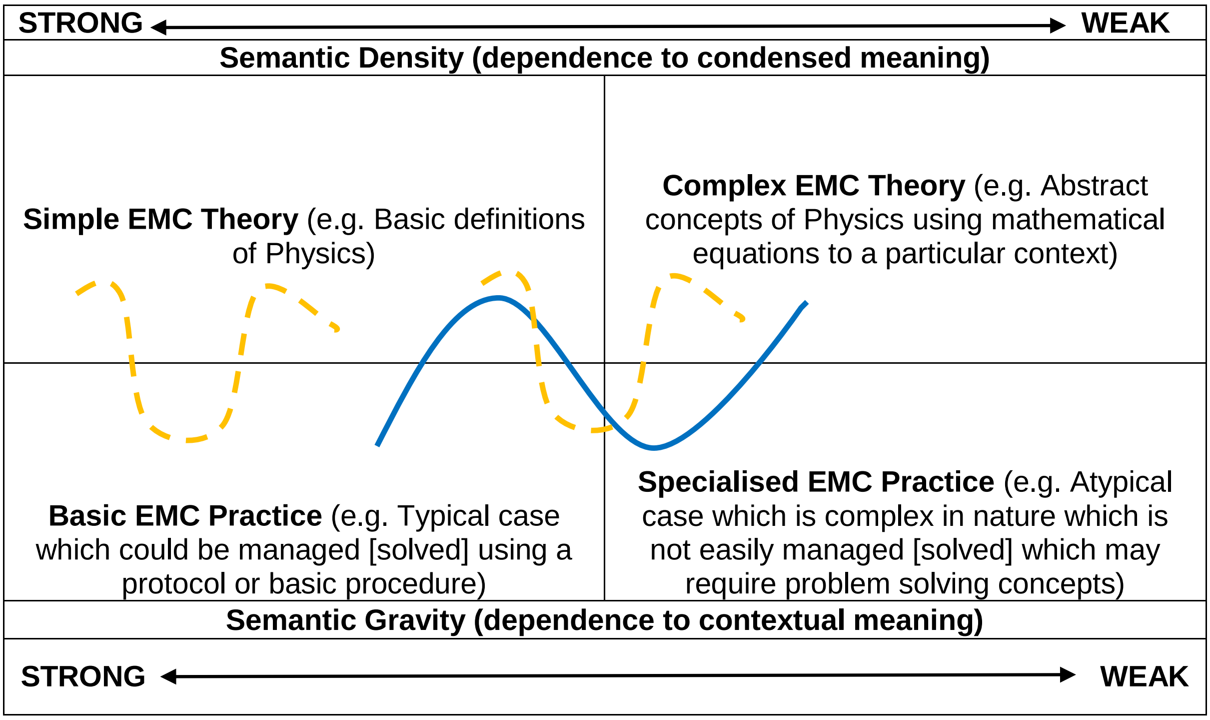
A flatline and weaker semantic gravity would emerge as suggested by Maton (2014) when teaching and learning of abstract, decontextualized and generalised knowledge is encountered. Where pedagogy of specialised knowledge is predominantly stronger in terms of the semantic gravity which is locked into its context a flatline would similarly emerge (Maton, 2014).

2.4.2.3.4 Semantic profile and Emergency Medical Care (EMC)

The wave pattern (in orange and blue colour) as illustrated through Figure 7 is demonstrable of a possible "journey" where the delivery of a subject where its practice (context) is underpinned by theory could move from the abstract to the concrete and *vice versa* in terms of the Semantic code concepts. A subject's profile (in terms of being linear [high or low], waving or weaving) could be analysed through the means of a developed translation[31] devices drawing form the LCT Semantic code concepts. An educational argument and rationale for the translation device is made in Chapter 3 of the Research Methodology. Inferences can be drawn from the LCT Semantic profile regarding knowledge theories as used within other research such as student essays from secondary school English (Maton, 2014).

[31] The translation device is explained and a case for its use within the study is made in Chapter 3.

Figure 7 Semantic profile of a professional degree related to the field of Emergency Medical Care



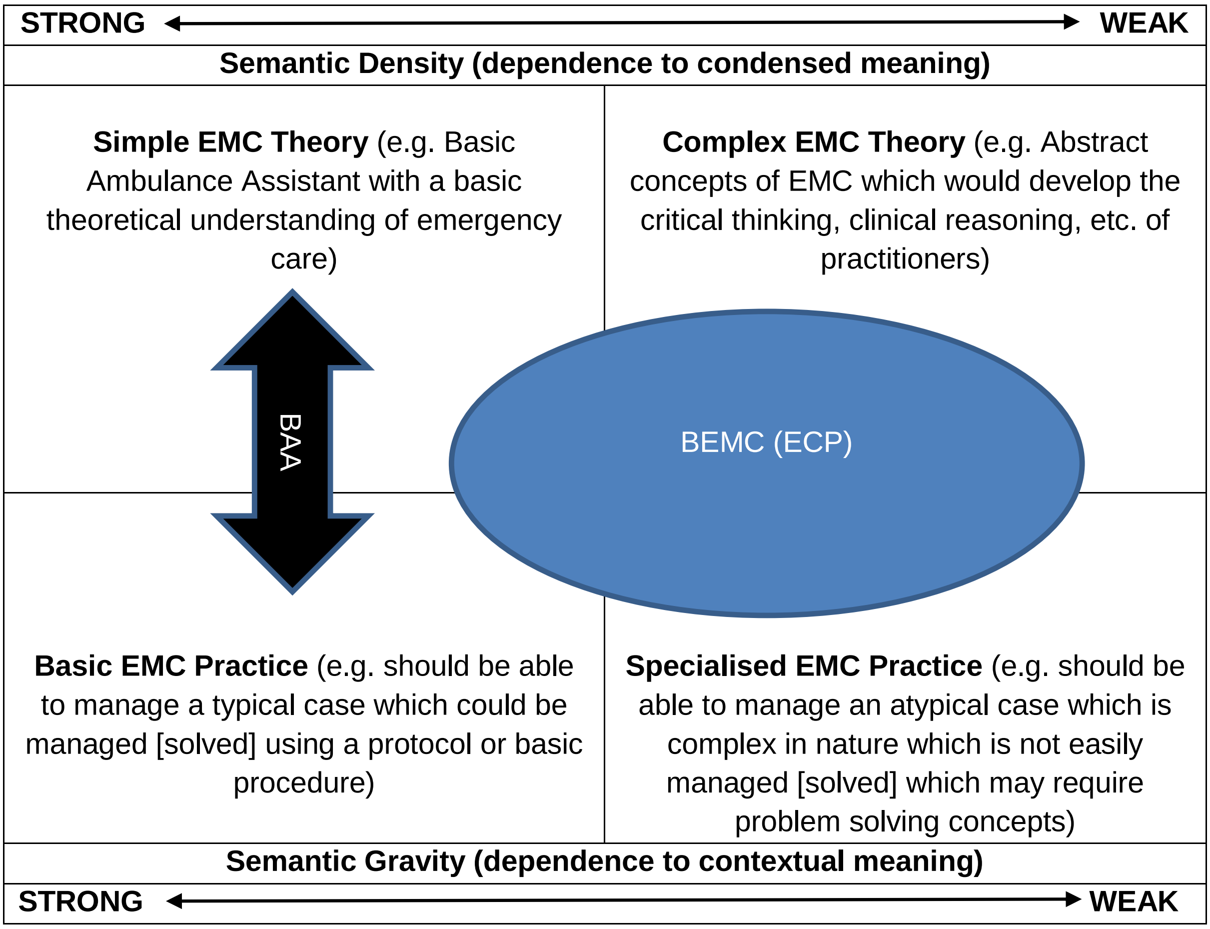
2.4.2.3.5 Semantic dimension and Emergency Care (EC) qualifications

The EC profession in South Africa has various qualifications that is aligned to a scope of practice which is regulated by the HPCSA PBEC. These qualifications follow various educational models through which the minimum outcomes may be achieved to allow for registration and practice. Figure 8 is a representation of the semantic gravity (practice or context) and theory (condensed meaning) dependence to qualification within the emergency care profession within South Africa. For example, the Basic Ambulance Assistant (BAA) qualification requires registered practitioners to work within a defined scope following basic protocols which is underpinned by basic theoretical content.

This qualification is classroom based with some theory content which is aligned to a practical skills-based competency which is covered over a 5-week period. Emergency care practitioners would therefore develop and construct knowledge from theoretical concepts which are drawn from basic theory where understanding is drawn from simple explanations, definitions, etc. which is enough for selective recalling. The practical knowledge would be very much contextually bound due to the following and application of protocols with it therefore have strong semantic gravity. This is illustrated through Figure 8 with the black arrows which demonstrate the application of the Semantic dimension to the BAA related qualifications.

The professional degree Emergency Care Practitioner (ECP) qualification is designed to develop their critical reasoning, clinical judgment, etc. which would require the program to be able to foster cumulative knowledge building rather than a segmented approach. In the early years of the qualification students would be required to understand the basic theoretical and practical concepts and principles. Scaffolding of the students' knowledge in terms of their foundational sciences subjects such as the anatomy, physiology, etc. is integral in the laying of the foundation on which the abstract and complex subjects in later years are to build from such as pharmacology, pathology, etc. and atypical cases covered during the exit level years in emergency medical care. The circle[32] as represented in Figure 8 is illustrative of the Semantic dimensions to the scaffolding of knowledge within a professional EMC degree as the theory and practice is not defined to a particular area of focus.

Figure 8 Relational power of the Semantic dimension with regards to EMC Theory and Practice with reference to the various forms of qualifications within the emergency care profession



32 This is not drawn to scale.

The use of concepts such as the Semantic dimension to explore educational practices is said to reveal ways in which the forms of knowledge practices may help to enable or constrain cumulative knowledge learning (Maton, 2014).

2.4.3 Curriculum Development

Luckett (2010) states that students are searching for new identities in a post-colonial and globalising context with them needing to achieve agency and authenticity by learning new ways of thinking, acting and being. Learning is further stated as not only about acquiring content and developing skills but is also about becoming and transforming the self. A curriculum should take students beyond their limitations and they should learn about powerful, decontextualized, abstract and specialised forms of knowledge (Luckett, 2010).

African universities need to offer high standard curricula, based on disciplines legitimated by knowledge codes, whilst responding to the call for Africanization tends to focus attention on those knowledge forms legitimated by a knower code (Luckett, 2010). Curriculum development requires a conceptual rather than a mechanistic view of the curriculum development process (Prideaux, 2007). Prideaux (2007) states that it requires thought to be given to the relationships between the various elements of a curriculum, a global view, and how its varying emphases and organisational arrangements determine its ultimate manifestation.

Coetzee (2007) states that the South African Qualifications Authority (SAQA) proposes a design down, deliver up approach to learning programmes. In this approach it is said that designers move towards a more learner-centred approach. It requires an analysis of the objectives, or overall purpose; to the purpose of the qualification; to the unit standard and a close examination of the learning outcomes, its assessment criteria, course content, learning- and assessment activities; and other relevant information (Coetzee, 2007).

Coetzee (2007) reported that a learning programme is a plan for implementing a curriculum and that entails the specifics of the ‘what’, ‘when’ and ‘how’ of learning and assessment activities, which leads learner’s in the achievement of the programmes learning outcomes. Learning programmes often consist of learning units, or modules and these modules are structured and ordered to assist learners to progressively achieve the learning outcomes. As the modules build up from the first to second and so forth, the learners learn how to achieve the learning outcomes of the programme as a whole (Coetzee, 2007). A learning programme is about what happens in the classroom and a learning programme curriculum deals with the plan of action for achieving the learning programme objectives which contribute in the enabling of learners to master the learning outcomes (Coetzee, 2007).

2.4.4 Constructive alignment (CA)

Constructive alignment (CA) is stated by John Biggs (2002) as being a system where it is an approach to curriculum design that optimises the conditions for quality learning. The 'constructive' aspect refers to what the learner does, which is to construct meaning through relevant learning activities. The 'alignment' aspect refers to what the teacher does, which is to set up a learning environment that supports the learning activities appropriate to achieving the desired learning outcomes. The key is that the components in the teaching system, especially the teaching methods used and the assessment tasks are aligned to the learning activities assumed in the intended outcomes (Biggs; 2002; Houghton, 2004).

Houghton (2004) states that the basic premise of the whole system is that the curriculum is designed so that the learning activities and assessment tasks are aligned with the learning outcomes that are intended in the course; this means that the system is consistent. Advantages of constructive alignment is said to encourage clarity in the design of the curriculum, and transparency in the links between learning and assessment and that within a truly constructively aligned curriculum deep learning is facilitated as the learning activities are designed for that purpose (Houghton, 2004).

2.4.5 Taxonomies

"Taxonomy" simply means "classification" (Goodman & Clemow, 2010) which is systematically (Sibson & Mursell, 2010), and the 1956 taxonomies of teaching and learning which was presented by Benjamin Bloom was revised 50 years later based on newer research. This resulted in a Taxonomy for learning, teaching, and assessing which was a revision of Bloom's taxonomy of educational objectives as stated by Anderson *et al.* in 2001 as cited through the work of Lindstrøm (2010). The major idea of the taxonomy is that what educators want students to know (encompassed in statements of educational objectives) can be arranged in a hierarchy from less to more complex. The levels are understood to be successive, so that one level must be mastered before the next level can be reached. Huitt (2011) reports that the original taxonomies levels presented by Bloom *et al*., in his research which was published in 1956 were ordered as follows: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

The most frequent uses of the original taxonomies have been the classification of curricular objectives and test items in order to show the breath, or lack of breath of the objectives. The most important goals of education are to have a curriculum which is situated towards assessments and objectives that are classified into the more complex categories of the taxonomies and not merely within the Knowledge domain (Krathwohl, 2002). Knowledge can be categorized in a number of ways as stated by Sibson & Mursell (2010), which is either tacit or explicit. In order to understand how learning occur for students and those involved in students learning experiences, an understanding is required of the various types of knowledge (Sibson & Mursell, 2010).

2.4.6 Teaching and learning

The purpose of teaching which includes the supervision of students as well as the development of curricula, assessments, etc. is to facilitate learning. In order to ensure effective teaching, a firm foundation is required in the understanding of how students learn and their needs to it (Fry, *et al*., 2009). Teaching and learning take place in a whole system which encompasses the classroom, department and institutional levels. A system which is poor, in that the components of the curriculum, teaching and assessment tasks are not necessarily integrated and tuned to support learning; could contribute to only ‘academic’ students spontaneously using higher-order learning processes. In an integrated system, all aspects of teaching and assessment are tuned to support high level learning (Biggs; 2002).

The important question in selection of teaching and learning methods is that they facilitate the match between content and outcomes. For example, use of manikins, patient actors and standardised patients for teaching and learning introductory clinical skills need to be sequenced with simulations and real patient contact in clinical settings to drive the progressive attainment of outcomes in this area of the curriculum (Prideaux, 2007).

Fry, *et al.,* (2009) suggest that some academics teach students without having much formal knowledge of how students learn. Lecturers are said to draw from their own learning experiences from when they were students to formulate a basis from which they would understand the manner by which their students are able to learn without necessarily considering how their students would learn. This could have a negative impact on the students learning as the lecturers own manner of teaching would be predicated on his own perspective (past experiences as student) as they would not have the required concepts to understand, explain or articulate the processes as they sense it is happening in their students. The relationship between teaching and learning with respect to both parties' attitudes and actions ultimately would affect the outcome. Student throughput and competencies which graduates require for the place of work post qualification are some of the factors which could be affected by this (Fry, *et al*., 2009).

2.4.7 Theories of competence

The basic idea of a theory of competence is that it addresses the question, "what does it take to really be able to do X?" (Schoenfeld, 1999). With this being relevant to the technical nature of rescue practice where there is a high reliance on the ability to show competency in performing certain skills, practical operations and procedures. Competency based education (CBE) is a framework for designing and implementing education that focuses on the desired performance characteristics of health care professionals (Schoenfeld, 1999).

Learning objectives often focus on what the learner should 'know' whereas competencies focus on what the learner should be able 'to do'. Education systems can improve the efficiency and effectiveness of their mission through competency-based education and a focus on the performance requirements for all health professionals. CBE begins with a careful consideration of the competencies desired in the health professional workforce; it provides a vehicle for integrating the health needs of the country with the priorities of the profession (Gruppen *et al.*, 2012).

2.4.8 Summary

The field of education is well researched and there are many theories which exist to explain knowledge building, curriculum development, teaching, learning, assessments, and many other aspects related to its practices. The current debates are centred on educational knowledge and curricula with the aim of ensuring relevance so that students participate as equals in knowledge building. This is more significant for vocational fields like emergency medical care where graduate attribute such as lifelong learning in post graduate qualification is of paramount importance. For professional higher education and the qualifications within it to develop research should be prioritized. This could open up for new ways of seeing, knowing and being in lifelong learning.

Medical rescue education, however, has historically been based on very little scientific evidence to support many of its practices with some mostly reliant on guidelines and requirements obtained through its SGB or accreditation institutions. The manner and methodology in which or through which qualifications are designed, developed, presented and evaluated should be based on sound educational theories and principles. This could ultimately lead to graduates that would be able to contribute and be productive within the field and society for which it had been intended.

2.5 MEDICAL RESCUE EDUCATION AND OPERATIONAL PRACTICE IN SOUTH AFRICA

2.5.1 Introduction

Emergency medical care and rescue personnel are always mindful of the “platinum ten minutes/rule” (Calland, 2005) that entails that patients who are entrapped should be freed within ten minutes from their entrapped environment. The application of the “golden hour” (Niks, 2010; Dunbar, 2013; Deiner, 2016) within the context of the MVR incident which relates to the out of hospital critically ill and injured patient reaching definitive care within one hour from the time of injury should also be considered. Poor access to definitive healthcare is sustained when emergency personnel are on scene but cannot access an entrapped patient. This sub-section of the literature review will briefly discuss the landscape of emergency medical care and rescue with regards to education and operational practice.

2.5.2 Medical Rescue Practice within South Africa

Emergency medical services (EMS) in South Africa have developed rapidly over the last 20 years. However, it is characterized by an inequitable distribution of services with many rural areas being poorly resourced. Response times vary from 15 minutes in sophisticated urban systems to 40 minutes or longer in some rural services (MacFarlane *et al*., 2005). This is seen as performance indicators for EMS as contained within the annual report of the Western Cape Department of Health (2017)

Many emergency organizations provide some form of rescue service within the geographical borders of South Africa. This is either supported by their mandate through the respective acts such as the Ambulance Services Act of 2003 and No 3 of 2010 or the South African Fire Service Act, No. 99 of 1987 which govern their role and responsibilities. The function of providing a rescue service is to some extent currently being done by some local and district Fire Services, the Provincial Department of Health's, Emergency Medical Services, in certain areas and in some instances volunteer organizations such as National Sea Rescue Institute (NSRI). The Western Cape Department of Health (2017) for EMS in their annual report states that the rendering of rescue operations forms part of their sub-programme, however rescue does not find expression in the statement of purpose. Rescue functions by various services and organizations may be performed only in part as an area of specialization (for example wilderness search and rescue, lifesaving, etc.) or to a particular level of expertise and/or capacity due to constraints such as training, manpower and resources[33]

The field of rescue is poorly documented (unpublished and void of any scientific rigour) and under-researched (as current qualifications do not produce much research output attributable to the field of rescue) within South Africa. Very little to no literature is available to describe the history, background, challenges and developments. Available information regarding any discipline of rescue is mainly located within trade journals which is non-peer reviewed with a strong fire-related focus such as '*Fire and Rescue International*', a South African publication. Other rescue organizations may publish information which forms part of either their "in-house" newsletter and/or annual reports.

2.5.3 Rescue Training & Development

Rescue training in South Africa is being presented in many different formats. The Universities of Technologies (UOT's) and Universities are offering rescue as part of their subjects or modules towards obtaining emergency medical care qualifications. Graduates post qualification from accredited Higher Education Institutions (HEI's) where rescue form part of the curriculum is registered with the Health Professional's Council of South Africa (HPCSA), Professional Board of Emergency Care (PBEC), as independent emergency care practitioners within a defined scope of practice for the primary qualification obtained as defined by the Health Professions Act 56 of 1974. There is no requirement to be registered

[33] Resources include the NSRI, MCSA, ADD++Red Cross Society Air Mercy Services, etc.

as rescue-practitioners or technicians or as a specialization with any regulatory body post-qualification.

The Fire- and Emergency Medical -Services (EMS) provide the rescue modules as part of their technical training. Some Fire Services follow the National Fire Protection Association (NFPA) 1006 (2003) Rescue Technician standards where the individual disciplines of rescue are completed first at an awareness level followed by operations with the highest and last level being that of technician. The EMS in some provinces across South Africa provide rescue training to selected personnel due to it not being a basic job requirement in fulfilment of their emergency care duties. This could in part be due to very few dedicated positions existing on their organograms for technical and medical rescue dedication[34]. The technical and medical rescue qualification offered by EMS is provided to a reasonable extent based on the 12 rescue modules as outlined by the 2003 draft document of the HPCSA Professional Board of Emergency Care (PEBC) (HPCSA, 2003). The draft document was developed by the National Rescue Training Standards Committee, Fire and Rescue Standards Generating Body, and Department of Emergency Medical Care at the then Technicon Witwatersrand (HPCSA, 2003).

The field of emergency medical care has made huge progress in terms of professionalizing the discipline through the development of qualifications and a scope that is on par with international standards and other professions. However, the field and specialty of emergency medical rescue lacks the criteria and rigor for professionalization due to the field being a highly technical and procedural. In terms of making a contribution towards professionalization a sound theoretical basis is required. Physics, it would seem, intersects with both the educational and practice realm of emergency medical care and rescue.

2.5.4 Standards Generating Bodies (SGB) for Medical Rescue and Training

The Fire and Rescue Services currently have a SGB that oversee the accreditation and generating of standards pertaining to rescue training. The South African Emergency Services Institute (SAESI) has an education committee that provides assistance and advice

[34] The author uses the term ‘specialisation’ and ‘dedication’ with reference to medical and technical rescue interchangeably. This is due to ‘specialisation’ could imply an exclusivity and expertness whereas ‘dedication’ refers to the purposefulness of it.

to fire service pertaining to training needs and requirements. The Health Professional Council of South Africa (HPCSA), Professional Board of Emergency Care (PBEC), is currently responsible for the generating of standards pertaining to rescue for Higher Education Institutions (HEI) and EMS services offering rescue. There is currently no register on which practitioner may elect to register with the HPCSA on completion of any or all of the current rescue modules.

Rescue training as accredited within qualifications by the HPCSA, PBEC, is currently provided at four[35] HEI's within South Africa, namely: the Cape Peninsula University of Technology (CPUT), Nelson Mandela University (NMU), Durban University of Technology (DUT) and University of Johannesburg (UJ). Each HEI will offer rescue differently from each other within their respective qualifications.

CPUT was the only HEI that offered the National Certificate in Emergency Care (NCEC) which is a mid-level worker qualification with 240 credits at a National Qualifications Framework (NQF) 5 level with rescue being an elective from which learners may choose in their second year of the qualification (CPUT DEMS, 2015b). Rescue within the qualification was completed in a modular format with the covering of Light Motor Vehicle Rescue (LMVR), High Angle (HA) and Fire, Search and Rescue (FS&R) (CPUT DEMS, 2015). Each module is being offered and/or presented over a five (5) to ten (10) day period. This qualification is in the process of being phased out with the last student intake in 2015. It has been replaced with the new NQF 6 Diploma in Emergency Care (DEC) where the LMVR, HA and FS&R is embedded within the offering of the qualification as a core subject and not as an elective (CPUT DEMS, 2017).

Previously most of the HEI's with the exception of Nelson Mandela University (NMU) offered the National Diploma in Emergency Care (N Dip EMC), with the rescue being offered within the qualification covering either all or in part some of the 12 rescue modules with each module presented over a five (5) to a ten (10) day period. The N Dip EMC qualification has been phased out (South Africa, 2017) and replaced with the new professional Bachelor of

[35] An uncertainty existed at the time of finalizing the research report regarding the accreditation status of the Central University of Technology (CUT) with the HPCSA, PBEC, in the offering of the National Diploma in Emergency Medical Care. This qualification is in a teaching phase out process with most institutions having discontinued the offering of it.

Emergency Medical Care (BEMC) or Bachelor of Health Sciences in Emergency Medical Care/Sciences (BHS EMC/S) qualification at most of the HEI's that offers emergency medical care with the exception of the Central University of Technology (CUT).

CPUT is currently offering the Baccalareus of Technologiae (BTech) EMC for candidates who hold a N Dip EMC qualification and who has registered as an advanced life support practitioner with the HPCSA, PBEC. Rescue IV which is currently forming part of the B-Tech EMC qualification is a subject where learners complete a research project and therefore this subject is lending no current new knowledge (unless a research project is undertaken where rescue or a component of it is the focus area) or skills to practitioners post qualification specifically to the field of rescue (CPUT DEMS, 2015a).

The Bachelor of Emergency Medical Care qualification at the Cape Peninsula University of Technology is at a NQF level 8 with 480 credits. Currently medical rescue has a significant 84 credits with emergency medical theory (108 credits), emergency medical care practical's (48 credits) and clinical practice (48 credits) as contained within the CPUT DEMS BEMC (2014a) Curriculum document.

Rescue education in South Africa has not previously been offered in a professional Bachelor's Degree prior to 2010 by most HEI's. This opportunity that presents emergency care education is to evaluate the horizontal and vertical discourse (breadth and depth respectively) and level description (NQF 5 in the first year, NQF 6 in second year and NQF 7 in third and fourth year of study) at which the rescue is currently offered at CPUT. Foundational sciences subjects such as Physics could contribute towards addressing the educational discourse and alignment of the medical rescue subject within a professional degree.

2.6 CONCLUSION

Historically, the purpose of emergency care education and training institutions, with respect to medical rescue training, was to facilitate skill and procedural knowledge development of graduates which in turn would reflect in the operational practice. Although many strides and much had been achieved in the improvement in the quality and standard of medical rescue training, the scientific and educational underpinnings are poorly documented. According to the Higher Education Qualification Sub-Framework (HEQSF), a shift is required from the historical ‘modularised training’ to an ‘educational framework’ aligned structure and process (Council on Higher Education, 2013), which requires consideration for the medical rescue qualifications if it is to gain any professional recognition within the higher education arena.

Much research within the South African context is required with respect to medical rescue education and training if the ideals of ‘who’ and ‘what’ the medical rescue practitioner should ‘be’ is to be realized. Textbooks with very little scientific principles rigour could not be the sole source from which curricula are developed and informed. In order to progress as a profession, the field of emergency medical care and rescue should explore the principles of physics implicit in rescue. This could lead towards the identification of the threshold concepts that explain the threshold practices in rescue. The literature fails to make explicit what the physics principles are, therein lays the gap in the knowledge that is the object of this study.

CHAPTER THREE

RESEARCH DESIGN & METHODOLOGY

3.1 INTRODUCTION

The aim of this chapter is to provide a theoretical basis for the research purpose, design and choice of research methodology. In this chapter the researcher will address areas pertaining to the research question, objectives, aim of the study and provide supporting arguments for the choice of methods. The rationale for the respective approaches used to develop the case and investigate the principles of physics within the context of the case is presented. The rationale related to the methodology of the document analysis and theoretical framework of the gap appraisal of the related rescue curricula is also presented. In this chapter a broad overview of the experts who participated during the Delphi questionnaire process as well as the South African context will be provided.

3.2 STUDY PURPOSE

3.2.1 Research Question

The chief question is: What principles of physics are implicit in emergency medical rescue education and practice? By 'principles of physics' I refer to 'threshold concepts'[36] (Meyer & Land, 2003; Land *et al*, 2016) from the physical sciences without which medical rescue cannot be meaningfully explained. These concepts underpin the collective understanding; and due to the dynamic nature of medical rescue and the subsequent emergency response which are *implicit* (suggested) and therefore not always *explicit* (directly expressed). Documenting such concepts assists medical rescue education and practice by deconstructing the phenomenon of medical rescue. It is therefore of theoretical and practical utility in the emergency care profession.

[36] Meyer and Land (2003) suggested that: *'Threshold Concepts' may be considered to be "akin to passing through a portal" or "conceptual gateway" that opens up "previously inaccessible way[s] of thinking about something"*: In: Meyer, J.H.F. and Land, R. (2003) Threshold concepts and troublesome knowledge: linkages to ways of thinking and practising, In: Rust, C. (ed.), Improving Student Learning - Theory and Practice Ten Years On. Oxford: Oxford Centre for Staff and Learning Development (OCSLD), p 412-424.
In addition, more recent work on threshold concepts supports the unpacking of physics principles: Land, R; Meyer, JHF and Flanagan, MT. (2016). Threshold Concepts in Practice (2016). Educational Futures: Rethinking Theory and Practice, Michael A Peters (Series Editor), volume 68. Sense Publishers, Rotterdam/Boston/Taipei

Other questions that serve to operationalize this research are:

- What are '*typical* cases'[37] and '*atypical* cases'[38] in 'motor vehicle related rescue' scenario typologies?
- What are the principles of physics that are implicit in typical motor vehicle related rescue scenarios?
- What is the alignment/misalignment of the principles of physics implicit in motor vehicle related rescue to medical rescue education?
- What is the alignment/misalignment of the principles of physics implicit in motor vehicle related rescue to medical rescue practice?

3.2.2 Research Objectives:

The research objectives that emerged from the above questions are:

- Determine and evaluate what are 'typical' cases and 'atypical' cases within motor vehicle related rescue scenario typologies.
- To evaluate the principles of physics that are implicit in typical motor vehicle related rescue scenarios.
- To evaluate the alignment/misalignment of the principles of physics implicit in motor vehicle related rescue within medical rescue education.
- To make recommendations to improve rescue education or practice

3.2.3 Research Methodology:

Using an interpretive research design, multiple qualitative methodologies were employed. The research relied on a constructivist paradigm (Bergman *et al.,* 2012) where multiple truths are constructed by and between people. In terms of the research posture (pertaining to its ontology) it was of a relativist nature where reality is socially and experientially based and where multiple realities exist, conflict, and/or become more crystalized. The epistemology is

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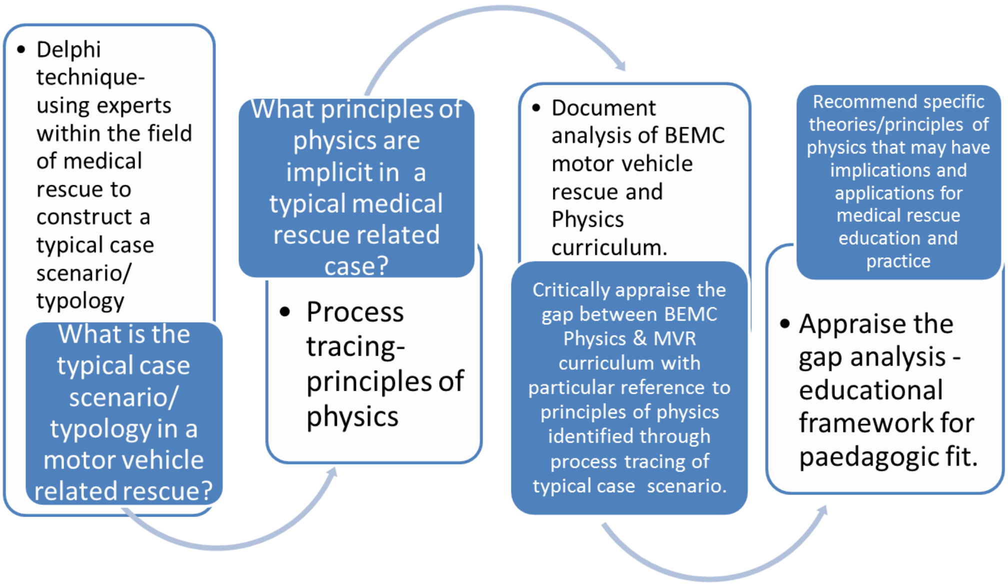
[37] Typical cases are in need of identification as undergraduate curricula should detail what is commonly experienced as a majority theme. This is a first step in deconstructing phenomena.

[38] Atypical cases should not dominate the medical rescue discourse as these may be 'esoteric' in nature. They are rare occurrences and are likely to be understood by a small group of people with specialist experience or knowledge.

radical subjectivism due to knowledge which consists of constructions that arise from interaction between the researcher and participants.

The following methodological triangulation was used to improve construct validity due to the different methodologies employed within the research. Figure 9 illustrates the relationship between the different research methodologies employed in the research process and how it was used to investigate the research question or sub-questions. Only brief descriptions are presented here. The technical methodological details are continued in the following 3 chapters[39].

Figure 9 Flow diagram of the research method linked to the research question and sub-questions



3.2.3.1 Objective 1 (Case scenario/typology)

A modified Delphi technique (using questionnaires) in order to reach consensus was repeatedly distributed to rescue experts and EMS professionals within the South African emergency medical care and rescue context to determine expert consensus on typical case scenarios within the pre-defined area of motor vehicle related rescue.

[39] Chapters 4, 5 and 6 provide methods, related results and initial analysis, so structured to enable readability. The methods and results are sufficiently complex to deserve individual chapter mention. Chapter 7 provides the overarching discussion.

Atypical case scenarios were defined on the basis of those case scenarios which fell outside of the confines and boundaries as defined by the findings from typical case scenarios of motor vehicle related rescues.

3.2.3.2 Objective 2 (Principles of Physics)

Using process tracing the typical case scenario narrative of a MVR which was developed through the modified Delphi methodological process was screened for underpinnings of the principles of physics pertaining to the incident. The Delphi results and the deconstruction of the typical case presentation constitute a chronology of events that highlight the intersections of physics and medical rescue.

3.2.3.3 Objective 3 & 4 (Rescue Education & Rescue Practice)

The CPUT BEMC Physics (EBS100A) and Extrication (EMR 203M) subject guides were evaluated for alignment of education and praxis/practices pertaining to principles of physics using a thematic document analysis methodology. Legitimation Code Theory (LCT) with the aid of a validated translation device was used to evaluate the semantic-density (condensed meaning) and semantic-gravity (contextual meaning) of the identified units of study from the thematic analysis of the subject curricula of Extrication and Physics on the BEMC qualification.

3.3 ARGUMENT FOR METHODOLOGICAL CHOICE

3.3.1 Delphi Technique

The Delphi technique is reported to be well suited as a means and method for consensus building by using a series of questionnaires to collect data from a panel of selected experts. Delphi, in contrast to other data gathering and analysis techniques, is a group facilitation technique (Hasson, *et a*l. 2000) which employ multiple iterations designed to develop a consensus of opinion concerning a specific topic (Hsu & Sandford, 2007).

The iterations and/or feedback process allows and encourages the selected Delphi participants to reassess their initial judgments about the information provided in previous iterations. Thus, in a Delphi study, the results of previous iterations regarding specific statements and items can change or be modified by individual panel members in later iterations based on their ability to review and assess the comments and feedback provided by the other Delphi expert panelists (Hsu & Sandford, 2007).

Other notable characteristics inherent with using the Delphi technique are the ability to provide anonymity to respondents, a controlled feedback process, the suitability of a variety of statistical analysis techniques to interpret the data, some assessment of the group judgment or view; and an opportunity for individuals to revise views (Okoli & Pawlowski, 2004; Hsu & Sandford, 2007). These characteristics are designed to offset the shortcomings of conventional means of pooling opinions obtained from a group interaction (i.e. influences of dominant individuals, noise, and group pressure for conformity) (Hsu & Sandford, 2007). Additionally, the issue of confidentiality is facilitated by geographic dispersion of the subjects as well as the use of electronic communication such as e-mail to solicit and exchange information (Hsu & Sandford, 2007).

The Delphi method is a flexible approach which is reported by Hasson, *et al*. (2000) as being a common method of research methodology within the health and social sciences. It is stated that it could contribute significantly in broadening knowledge within the sciences if used systematically and rigorously (Hasson, *et al*. 2000).

3.4 South African Rescue Expertise and Delphi Participants

3.4.1 South African Rescue Landscape

Emergency medical and technical rescue is currently provided in South Africa either by the Provincial ambulance service (as mandated/contained within the Western Cape (South Africa) Ambulance Services Act of 2003 and No 3 of 2010 or the local fire service (as mandated within the South African Fire Service Act, No 99 of 1987 or a volunteer organization such as the National Sea Rescue Institute (NSRI). At times, assistance is provided by the local, provincial or national disaster management organizations; or South African National Defence Force (SANDF). During for example a disaster incident where the magnitude of the incident exceed that of the responsible agency a combination of these organizations and services mentioned would provide support in mitigating the incident as mandated and prescribed within their own various individual Acts or policies where applicable.

South Africa consist of nine provinces with each provinces needs from an emergency medical rescue perspective being completely different. Each province is unique in their landscape, climate, culture, population, infrastructure, etc. with each of these variables contributing in some way to the diversity of the emergency medical care and rescue needs and coverage which is offered and provided (Brysiewicz, 2001). Certain provinces have mountainous terrain which is visited annually by tourist and locals due to its popularity which result in mountain rescues being conducted frequently, similarly other provinces have a vast coastline which sees a high number of water related rescues incidents; and those areas which have much more developed infrastructure and roadways, may experience that road traffic related incidents contribute to a huge number of the annual road fatalities.

With medical and technical rescue not being regulated there is no specific or dedicated service or organization responsible for the overseeing and management of rescue both at a local, provincial or national level. This therefore contributes to different standards in training, quality assurance and the delivery of rescue which exist throughout South Africa pertaining to the field of medical and technical rescue. To this end rescue is not seen as a professional qualification but merely as a field or discipline where skills are used to aid in the relief of suffering of victims during their hour of need.

Certain provinces such as the Western Cape have developed systems in place where rescue is offered in a co-ordinated and controlled manner due to good working agreements and memorandums of understanding which exist between different organizations and services. For example, the provision of sea rescue and wilderness related rescue incidents with the NSRI and South African Red Cross Society Air Mercy Services. The metropole and urban areas of the Western Cape enjoy largely from these well-developed systems from a resource and response time perspective. However, the outlying rural areas of the Western Cape region does not experience similar benefits with rescue units having to cover larger areas which are often not easily accessible by road and response times in the event of an emergency being at times hours in relation to the location of the base of response. This is evident in the Western Cape Department of Health (2017) annual report for the EMS where differences exist for response time's requirements between urban (15 minutes) and rural (40 minutes).

Disparity may further exist with regards to equipment (availability of replacement equipment due to service centres being mostly in urban and metropole areas) and manning levels (one-man rescue units versus 2 person rescue vehicle crews within the urban and metropole setting by most municipal fire departments) for your rural regions even though similar standards and outcomes are expected as for those within the metropole and urban areas. The metropole and urban areas enjoys shorter response distance from their base of operation and is at times dispatch with a duplication of services resulting in two rescue vehicles arriving at a MVR incident which is equipped with the minimum standard of equipment to manage and mitigate such incidents. This is largely attributed to similar services being rendered by the Provincial Department of Health, EMS, and the local municipal F&RS. Deiner (2017) states that a crew of two or three is a ‘fact of life’ for emergency responders in South Africa when having to deal with the challenges related to that of the MVR incident.

3.4.2 South African Rescue Expertise

With each rescue service or organization or department having different standards and requirements pertaining to training and qualifications it is difficult to establish who is deemed an expert within the context of medical and technical rescue. The field of rescue is very wide in that rescue practitioner in some instances may be seen as a ‘jack of all trades and a master of none’ due to approximately 12 (twelve) sub – disciplines existing within and under the umbrella of medical- and technical rescue as offered by certain training institutions and rescue organizations.

The term rescue expert is not necessarily ascribed to professionals who have attained the status of being heralded as an expert “based on the making of immediate, unreflective situational responses with intuitive judgment” as expressed by Dreyfus and Dreyfus (2005). Lindstrøm (2010) in her unpublished thesis cited the following differences between novices and experts pertaining to resolving problems as “novices generally focus on surface features whereas experts have a comprehensive overview of the field that enables them to see the underlying principles of a problem” which was based on research from Sutherland in 2002. The term expert within the Delphi participants will refer mainly to their qualifications, position and professional registration as delineated within the inclusion and exclusion criteria which is discussed further in Chapter 4 due to the difficulty which exist in adequately defining the rescue expert within the context of emergency medical rescue as per the above definitions and descriptions.

3.5 Delphi participants

3.5.1 Delphi participant's recruitment

Research participation information and leaflets was distributed to the heads of local, provincial, national and private training institutions and rescue services or organizations or departments (group 1) and amongst operational personnel (group 2) via email. This invited participant to contact the researcher via email indicating their interest to participate. The researcher obtained the email addresses of the different services or organization contact details as listed on websites, from the researcher's personal data base of contacts and through networking with rescue practitioners throughout South Africa using various platforms (such as conferences, training programs, rescue exercises).

Prospective participants were e-mailed individually with the researcher being blind copied. Bulk and group emailing was deliberately avoided to avoid spam-software detection and out of respect for privacy. Further correspondence during the study process was managed in a similar manner with regards to the dissemination and requesting of information via email during the recruitment, consent/accent and modified Delphi phases of the study.

3.5.2 Delphi participants sample size

The sample size considerations included validity, reliability and statistical significance. In order to ensure that consensus findings amongst participants would be obtained within the time and scope limitations of this study, a minimum of 10 (ten) emergency medical care practitioners (of an estimated 30) was deemed to be required to participate as a Delphi panelist in order to ensure that when consensus regarding the development of a typical case typology/scenario is obtained; that a majority finding has prevailed amongst participants with at least 80% (eighty percent) of the participant group size agreeing on a statement.

3.5.3 Delphi participant's inclusion criteria

Participants were required to be registered health care practitioners with the HPCSA, PBEC, as independent practitioners. Group 1 inclusion within the study was aimed at current heads of rescue units/services and those who are heads of training services offering motor vehicle rescue. Group 2 of the study was practitioners within the field of medical and technical rescue that either currently employed by a Local, Provincial or Private Emergency Medical

Rescue Service in the capacity of an operational rescue technician. Below are the additional criteria for inclusion of which both groups had to meet in order to be able to participate within the Delphi process:

- Rescue heads/practitioners should have at least more than 5 years of operational experience relevant to the field of motor vehicle rescue.
- Participants should be registered with the Health Professions Council of South Africa (HPCSA) as a healthcare practitioner at an Intermediate life Support level (ILS) and higher[40];
- Possess a suitable rescue technician and/or a medical rescue qualification (preferably advanced).
- Participants should have relevant knowledge regarding operational and educational practices within the field and/or discipline of motor vehicle rescue (light and heavy).

3.5.4 Delphi participant's exclusion criteria

All rescue practitioners who would have been contacted by the principal investigator via either email, telephone, through training heads contacts, at rescue meetings/events (local and nationally hosted) and in person whom does not meet all of the inclusion criteria would be excluded from participation within the study as defined within this Chapter.

Rescue practitioners could at any point during the study indicate their voluntary withdrawal from the study and indicate whether all or in part their contribution was to be included or excluded from the study.

[40] The offering of the 12 Medical Rescue modules draft standards document which was developed by the National Rescue Training Standards Committee, Fire and Rescue Standards Generating Body and the Department of Emergency Medical Care (TWR) on behalf of the HPCSA required those wishing to undertake any of the rescue training to possess a current HPCSA rescue practitioner certification as part of the entrance requirement. This is similarly for most rescue training organisations in South Africa which offer Motor vehicle Rescue as a discipline. The Intermediate Life Support (ILS) registered qualification was utilised as a minimum criteria for inclusion due to higher medical rescue disciplines which has this as a minimum entrance requirement for most training services offering Medical Rescue training.

3.5.5 Delphi participant's criteria for consensus finding

The aim and purpose of the Delphi method (as motivated for within this Chapter) was to ensure that the participant group within the study was required to obtain a majority consensus finding (with more than 80% of participants indicating as being in either agreement, disagreement or neutral) within the individual sections and criteria within the questionnaire.

The questionnaire was sent to participants through a series of three rounds. Participants were able to view the findings and consensus from all participants and were provided an opportunity to review their previous response where no majority finding had been obtained.

At no point throughout the Delphi rounds were participants able to identify who was participating in the study. Further information was requested during Rounds 2 and 3 of the Delphi questionnaire process only pertaining to those areas where no majority consensus (less than 80% agreement or neutral/undecided or disagreement) was reached. This was to the effect where participants could either exercise their right to remain with their previous selection to the affected area or elect to change their view Participants were at all times reminded that they were under no obligation to change their views pertaining to a particular area in order to 'manufacture' a majority finding. There was no undue duress to support another opinion pertaining to the elements of a typical case scenario for the motor vehicle related rescue within the modified Delphi study.

The data from the majority finding which was obtained through the modified Delphi methodology was analysed and enabled the researcher to construct a typical case scenario narrative through which the underpinnings for principles of physics could then be investigated.

3.5.6 The Delphi study expert's participation

A total of 15 rescue practitioners (50% return rate) indicated their intention to participate within the Delphi process of the study by completing the consent form and sending it either via email or handing the hard copy provided to the principal researcher.

All 15 who provided consent to participate was sent the 1st round questionnaire of the Delphi process (*confer/conferatur* [cf.] Appendix C) with 12 participants completing and returning the questionnaire within the timeframe (approximately 2 [two] months)[41]. During the 2nd round of the Delphi process only 12 participants completed the questionnaire (cf. Appendix G) and in the 3rd and final round of the questionnaire (cf. Appendix I) 13 participants completed the questionnaire during which a majority consensus was obtained to develop the typical case for a motor vehicle related rescue.

One participant submitted their 1st round questionnaire after the first two rounds of the questionnaire had been completed and whilst the 3rd round questionnaire was being distributed. It was decided to include the information into the 1st round responses and allow this particular participant to complete only the 3rd round questionnaire. Two rescue practitioners whom initially provided consent for participation failed to provide and/or return any of the 1st, 2nd or 3rd round questionnaires resulting in 13 participants completing the Delphi process of this study.

The table below provides further information pertaining to the 15 rescue practitioners who provided consent for participation within the study and how they met the inclusion criteria for participation within the Delphi process of the study.

[41] Two months was afforded to reply. One participant submitted their 1st round Delphi questionnaire response after the due date.

Table 1Delphi questionnaire participants (experts)

Number	Highest HPCSA PBEC EMC Registration	Rescue training completed within N Dip EMC[42], Fire Service (NFPA 1600) or 12 individual Modules[43]	Position in service (e.g. training, operational, etc.)	Years of service experience (at time of Delphi study)
1.	Paramedic (ALS)	N.Dip (in part[44]) & NFPA 1600 (in part)	Operational	>15 years
2.	Paramedic (ALS)	N.Dip (in part) & NFPA 1600 (in part)	Operational	>15 years
3.	Paramedic (ECP)	N.Dip (in part) & NFPA 1600 (in part)	Operational	>15 years
4.	Paramedic (ALS)	N.Dip (in part) & NFPA 1600 (in part)	Operational	>15 years
5.	Paramedic (ECP)	N.Dip (in part) & HPCSA modules (in part)	Training	>15 years
6.	Intermediate Life Support (ILS)	HPCSA (in part) & NFPA 1600 (in part)	Training	>15 years
7.	Paramedic (ECP)	12 x HPCSA modules	Operational	>10 years
8.	Intermediate Life Support (ILS)	12 x HPCSA modules	Operational	>20 years
9.	Intermediate Life Support (ILS)	12 x HPCSA modules	Training	>10 years
10.	Paramedic (ALS)	N.Dip (in part) & HPCSA modules (in part)	Training	>10 years
11.	Paramedic (ECP)	N.Dip	Training	>5 years
12.	Paramedic (ALS)	N.Dip	Operational	>5 years
13.	Paramedic (ALS)	N.Dip	Training	>5 years
14.	Emergency Care Technician (ECT)	12 x HPCSA modules	Training	>10 years
15.	Paramedic (ALS)	N. DIP (in part) & HPCSA modules (in part)	Operational	>10 years

[42] The National Diploma in Emergency Medical Care qualification which was offered by the former Technicon' s; and current Universities of Technology and Universities had the 12 different rescue modules embedded within it as part of its programme.
[43] The 12 modules refer to the individual rescue modules which formed part of the old Medical Rescue (MR) Levels (starting from Basic- [BMR] to Intermediate- [IMR] up to Advanced- [AMR] or -Technician qualification as per draft document of the HPCSA Professional Board of Emergency Care (PEBC), Medical Rescue Education on the various 12 rescue modules which was developed in 2003 by the National Rescue Training Standards Committee, Fire and Rescue Standards Generating Body, and Department of Emergency Medical Care at the then Technicon Witwatersrand.
[44] Certain practitioners would have completed their rescue modules with different services and/or organizations and would have received Recognition of Prior Learning (RPL) within the National Diploma Emergency Medical Care for the previously completed modules with some modules being completed as part of the qualification.

3.6 AIM AND OBJECTIVES OF THE QUESTIONNAIRE DURING THE DELPHI PROCESS

3.6.1 Introduction

The questionnaire was developed by the principal investigator and validated for relevance. In the development of the questionnaire it was not the intention to focus on whether the typical case involved a particular number of casualties and what their conditions would be post the motor vehicle collision or upon arrival by the emergency medical services.

The aim of the questionnaire was to guide the Delphi panel of experts to navigate through a series of statements and indicate whether they agree, disagree or are undecided/neutral pertaining to whether the statement is relevant to a typical motor vehicle collision based on their South African experience. The lay-out and structure of the questionnaire was done in a manner to ensure that the Delphi panel experts would be able to follow the process by first understanding what the intended aim of the study was, what their rights were in participating throughout the various rounds within the study (even though consent had been given at the beginning of the study), what was being sought from them as the experts during the completion of the questionnaire and what the processes after the completion of the questionnaire would entail (*confer/conferatur* (cf). Appendix C)

3.6.2 Ethical considerations related to participants and the questionnaire

The questionnaire was submitted as part of the documentation for ethics clearance to the Health and Wellness Sciences Faculty Research Ethics Committee (H&WS REC) as part of the requirements for conducting research at a Master's degree level and to ensure that the questionnaire prescribed to the code of ethics and regulations as guided by the institutional rules, policies and regulations for conducting research.

The questionnaire contained no identifiers other than a participant number which was used by the principal investigator to collate the individual responses and to communicate during the various rounds with the Delphi experts regarding either tracking the individual expert's status pertaining to the completion and or expected date of submission, etc. of the questionnaire and no other biographical and other identifiers was affixed to the questionnaire (cf. Appendix C).

The contact details of the researcher as well as supervisors were present on the questionnaire with the ethics approval number in the event of reporting an adverse event or ethical breach. The Delphi expert participants had to indicate how they met the inclusion criteria for participation within the study and had to provide the researcher with information regarding their geographical area and of expertise.

3.6.3 Explanation of the individual sections within the questionnaire (applicable to Rounds 1 and 2)

3.6.3.1 Introduction

Each section within the questionnaire had a specific focus with sub-sections. Randomly allocated colour was used to ensure that participants were able to differentiate between the different statements and how it related to the information being sought. The colour had no particular influence or meaning to the statement. The Delphi participant experts were required to indicate that they either agreed or disagreed or were undecided pertaining to a particular statement within the different section of the questionnaire. The comment section after the options to the statements was placed within the questionnaire to allow collation of responses. This was explained to the Delphi expert participants.

3.6.3.2 Section A- Equipment

Section A within the questionnaire focused on the various tools and equipment used within the context of emergency medical rescue and more so within the field of motor vehicle rescue. This excluded those pieces of equipment which would be used in the rendering of emergency medical care treatment, for example, medical oxygen, defibrillators, bandages, intravenous fluids, etc. It was not the intended purpose of the study to evaluate the principles of physics as it would pertain for example to gas laws, energy, fluids, etc. with respect to the equipment used within the rendering of medical care. See Appendix C for a detailed list of the equipment which was included and the structure of the questionnaire under Section A.

The aim of Section A was to determine which tools and equipment is typically used during the typical case narrative of a motor vehicle related rescue incident. Irrespective of the manner of the entrapment, Delphi participants had to indicate that they either agreed or disagreed or are undecided as to the prevalent use of a piece of equipment as contained within the list of Section A. Section A was subdivided into a sub section which focused on stabilization equipment, hand tools, powered rescue equipment (irrespective if the mode of power being pneumatic, hydraulic or electric or a combination of where the hydraulics is driven or aided by a petrol driven motor for example). The list was fairly comprehensive but as organizations differ, panelists could make additions. This process allowed the principal investigator the opportunity to present the information to the other Delphi expert participants and apply the methodology of reaching consensus pertaining to the information which warrant inclusion which has been brought to light by a Delphi expert participant based on the initial 1st round Section A.

The list of included equipment was developed by the principal investigator using various resources such as the textbook of Ron Moore (2003), “Vehicle extrication techniques”, and IFSTA (2009), “Principles of Vehicle Extrication Techniques”; and product information from certain manufacturers and distributors of motor vehicle rescue equipment for example, Holmatro®, Lukas® and Amkus®. Equipment nomenclature was avoided to a particular brand name as far as possible due to a variation in equipment procurement by various services, but where possible it was used to ensure its use was sufficient for identification. The rationale was that it would form part of the cache of equipment which forms part of the motor vehicle rescue subject and may have relevance to the typical case as indicated by the responses provided by the Delphi expert participants.

The emergency medical rescue practitioner would in some form or manner rely on a particular piece of equipment whether in isolation or combined with other pieces of equipment to facilitate a particular task. This necessitated the inclusion of Section A with regards to the most common tools/equipment which is used irrespective of its intended use, design, purpose whether in isolation or used in combination. The inclusion of the equipment in the study is further supported by the principle by which the equipment is designed to perform its task and its objective for example; cutting, breaking or stabilizing.

3.6.3.3. Section B- Type of vehicle, design and hazards

The aim of Section B was to determine the type of vehicle, design and hazards that are prevalent[45] at a typical motor vehicle accident which requires extrication of a victim(s) irrespective of the manner of the entrapment. See cf. Appendix C regarding the statements which formed part of Section–B which focused on the type of vehicle, the design and hazards. Statements to this particular section and sub-sections focused on establishing the motor vehicle by type and design such as new car technology with supplemental restraint systems, full frame versus unibody construction, passenger vehicle, etc.; and the presence of hazards such as glass, sharp metal, transportation or presence of hazardous material, etc.

The nature of the motor vehicle rescue related case is very dynamic with only certain elements of hazards presenting at motor vehicle collisions *post facto*. It does not necessarily mean that every motor vehicle rescue related case would involve a particular hazard or combination thereof as there is a multitude of hazards from environmental hazards for example weather, day/night conditions or terrain, physical hazards for example bystanders, animals, trees, etc. and chemical hazards for example radiator fluid or fuel. This section excluded *post facto* hazards due to the complex nature of the various risks and their confounding influence which certain perceived hazards would have at various incidents such as intersections and blind rises.

A narrow approach was therefore taken with regards to establishing the type of hazards for the motor vehicle rescue related case typology. All other factors and influences of hazards which was not included within the Delphi questionnaire also has some principles of physics which could have some or other relevance to the typical case. The delineation and narrowing of the hazards within the study was done to avoid over-extension of the scope and the length of the study. In establishing an inclusion and exclusion criteria for the hazards, the researcher used a mind map to aid in the developing of this section and to focus on certain hazards which would influence the emergency medical rescue practitioners ability to mitigate against that particular hazard for example fuel spills, fire, etc. versus those which he would not be able to change but would be able to mitigate against for example weather conditions such as rain, time of the day, single lane or multi-lane roads, etc. (cf. Appendix F).

[45] “Prevalent” in the context of the case design would mean “that which is commonly seen, encountered, experienced or found” in the opinion of the expert participant.

3.6.3.4 Section C- Type of vehicle, design and hazards

The aim of Section C was to classify road traffic accidents by collision kinetics and the amount of vehicles involved with respect to a motor vehicle accident which requires extrication of victim(s) irrespective of the manner of entrapment (cf. Appendix C). Statements to the sub-sections contained within this section focused on whether the typical motor vehicle related collision consisted of a single motor vehicle and/or multiple vehicles of similar type and whether it fits a particular collision kinetic in terms of being a frontal or side impact, etc. collision.

The various sub-sections were highlighted in different colours for the express purpose to indicate to Delphi expert participants that the section before and after are not necessarily related by seeking the same information but it may have relevance to the whole case in terms of having to construct a typical case narrative using a particular sequence of information.

It is important to understand the impact that the amount of vehicles involved in the collision and the type of collision kinetics would have on the motor vehicle related rescue incident. These factors and influences have an impact on the decision making of the rescue practitioner pertaining to having a high index of suspicion which would influence the evaluation, assessment and provision of emergency medical care to the casualties but also to understand the forces involved during the collision phase. Furthermore, understanding how these potential forces of the collision kinetics would impact their decision making on having to select a particular piece of equipment and tool with the possibility of gaining access or during the extrication process of a patient post collision would require the practitioner to draw from their knowledge pertaining to the design, presence of new car technology passenger safety systems (active or inactive), etc. as well as whether there would be additional considerations that they would need to be cognizant of.

It is important to delineate and narrow the case pertaining to its collision kinetic and amount of vehicles involved due to the nature and differences which each motor vehicle related incident may present. It is improbable to assume that most motor vehicle rescue related cases would present as frontal impacts and involve a secondary vehicle of equal design, build and type due to the complex nature of the South African landscape and environment.

3.6.3.5 Section D- Rescue response

The aim of this section is to determine what are the responses involved with respect to a typical motor vehicle rescue related incident which requires extrication of victims irrespective of the manner of the entrapment (cf. Appendix C). This sub-section focused on areas such as the rescue practitioners' actions through the use of body system functions such as lifting or lowering of a piece of equipment using musculoskeletal systems and the performance of a particular procedure such as using the spreader or cutter to cut or spread metal, breaking glass, stabilizing a vehicle, etc. All statements were within the context of a typical motor vehicle rescue related case.

The various sub-sections were highlighted using various colours for the express purpose to indicate to Delphi expert participants that the section before and after are not necessarily related by seeking the same information but it may have relevance to the whole case in terms of having to construct a typical case narrative using a particular sequence of information.

3.6.4 Sections within the questionnaire which was applicable only to Rounds 3

3.6.4.1 Introduction

The purpose and aim of the third round of the questionnaire was to triangulate the findings from the previous rounds in a manner where those areas where majority consensus was obtained through the previous two rounds were separated from the statements where no majority consensus was obtained. This allowed the Delphi panel experts a further opportunity to indicate whether they either agreed or disagreed with the particular statement. Set criteria was provided as comments to ascertain the rationale for the Delphi panel expert's selection in either agreeing or disagreeing with the individual statement.

The information which was sought through this process was to contextualize the factors and influences; and seek clarity pertaining to the rationale as to what contributed to either a majority consensus finding or non-majority finding. Cf. Appendix I for the explanation and guidance provided to Delphi panel expert participants to aid in the further participation and completion of the third round of the Delphi questionnaire.

3.6.4.2 Section A- Triangulation and validation of the majority consensus finding

In Section A of the 3rd round of the questionnaire the Delphi panel participant was required to indicate whether they agreed or disagreed with the statement as being prevalent within the typical motor vehicle related rescue case (cf. Appendix I) Delphi panel experts was requested to read the narrative for the typical motor vehicle related rescue case typology which was developed through the consensus finding from the previous two rounds of the Delphi process. This process was used to validate the consensus which has been obtained during the previous two rounds of the Delphi process of the questionnaire and to allow for the Delphi panel experts participants to comment on the inclusion of the consensus statements toward the case narrative for a typical motor vehicle related rescue incident.

Section A of the third round questionnaire of the Delphi panel expert process included all statements from the various sections from the previous rounds where a majority consensus was obtained such as the Section A- which focused on the equipment, Section B- which focused on vehicle type, design and hazards, etc. Delphi panel experts had to either agree or disagree in order to triangulate within the Delphi method and validate the previous rounds majority consensus findings of the statements as per the different sections (cf. Appendix I).

3.6.4.3 Section B- Triangulation and validation of the non-majority consensus finding

In Section B of the 3rd round of the questionnaire the Delphi panel participant was required to indicate whether they agreed or disagreed with the statement as being prevalent within the typical motor vehicle related rescue case. Participants of the 3rd round of the Delphi questionnaire was provided a further opportunity in Section B to indicate which factors influenced the prevalence of this pertaining to the typical motor vehicle rescue related case (cf. Appendix I).

When participants indicated that they agreed with a particular statement being prevalent at a typical MVR related case they could further indicate whether it was due to it being either “commonly seen/encountered in a typical motor vehicle related rescue case with some and/or minimal influences and/or factors on the rescue incident” or “commonly seen/encountered in a typical motor vehicle related rescue case with NO influences and/or factors on the rescue incident”. When participants indicated that they disagreed with a particular statement being prevalent at a typical MVR related case they could further indicate whether it was due to it being either “uncommon and/or rarely seen/encountered in a typical motor vehicle related rescue case with influences and/or factors on the rescue incident” or “uncommon and/or rarely seen/encountered in a typical motor vehicle related rescue case with some and/or minimal influences and/or factors on the rescue incident” or “uncommon and/or rarely seen/encountered in a typical motor vehicle related rescue case with NO influences and/or factors on the rescue incident”.

This process was used to validate the consensus which has been obtained during the previous two rounds of the Delphi process of the questionnaire and to allow for the Delphi panel participants to either change their previous views pertaining to a statement or indicate that they agreed with the inclusion of the statement as being now either prevalent or dissonant within the case narrative for a typical motor vehicle related rescue or it forms part of the atypical case narrative.

Section B of the 3rd round questionnaire of the Delphi panel participants process included all statements from the various sections from the previous rounds where a majority consensus was obtained (be it neutral/undecided or disagreeing to the statement). Where no majority consensus was obtained for a statement after both the first two rounds it was deemed not for inclusion within the typical motor vehicle rescue related case (cf. Appendix I). From the previous two rounds of the Delphi panel where no majority consensus was obtained statements were then included in Section B of the 3rd round Delphi questionnaire (cf. Appendix I).

The method of triangulation and validation was to be confirmed by means of where the participants either provided responses which was very much similar to their previous first two rounds of the Delphi panel questionnaire process and in their non-conflicting responses where no colour coding of the various different areas of statements was present. It was decided beforehand that in the event that the Delphi participants decided to change their particular response pertaining to a criterion in Section B of the 3rd round process as being prevalent that it would be further evaluated pertaining to the corresponding selection criteria where they indicated as to why they agreed to that particular statement in the selection of the influence based on the options provided on the rescue incident. This would possibly provide further information in respect of whether all expert participants held a similar opinion which could further validate the inclusion of the Section B statement/criteria where a majority consensus was obtained in the defining of the final case narrative for the typical MVR related case.

3.6.4.4 Section C- Comment and Feedback

The aim of Section C was to allow further comment and feedback from the Delphi participants to contribute further in the development of the typical case scenario for a typical motor vehicle related rescue case (cf. Appendix I). This presented another opportunity to all of the participants to raise missed concerns.

3.7 CASE STUDIES/SCENARIOS

A case study is the study of a "single instance of a decision, policy, institution, event, process, etc.," and may also be defined as a "phenomenon, or as an event conceptualized and analysed empirically as a manifestation of a broader class of phenomena or events" (Porta & Keating, 2008; Hancké, 2009). In short it can be stated as a single case in which the case is differentiated from other cases by having a single value (high or low, absent or present) in terms of either the outcome that the researcher is interested in or the explanation that is being explored. The main reason that this single instance or event is important is that it sheds light on a broader theory or argument. A case can therefore be a "person, country, region, city, company, sector, policy, an event, or just about anything, as long as it is, as an object of research, limited in time and space, and allows the researcher to say something meaningful beyond the case in question" (Hancké, 2009).

A case study is "a research strategy based on the in-depth empirical investigation of one, or a small number of phenomena in order to explore the configuration of each case, and to elucidate features of a larger class of (similar) phenomena, by developing and evaluating theoretical explanations" (Porta & Keating, 2008). Methodologically speaking, cases therefore can be defined on the basis of three important characteristics: they are "bound in time and space, the case has to relate to the rest of the world, and the case and theory have to be related" (Hancké, 2009). Case studies are stated as being diverse in their objectives, characteristics and results. The challenges confronted with a case is to acknowledge and uncover its specific meaning, while extracting generalizable knowledge actually or potentially related to other cases (Porta & Keating, 2008). Motor vehicle rescue, as a medical rescue application satisfies the above case definition. Its preference as a case over other rescue presentations such as drowning[46] or high-angle rescue is based on the premise of its high frequency[47] of occurrence and consequent socio-economic burden.

3.8 PROCESS TRACING

Process tracing "receives its methodological basis in the simple observation that most arguments and theories in (social) sciences are highly condensed versions of a causal or functional link, along the lines of 'A causes B' (in the sense that If A is present, then B will be present as well and will chronologically follow A)" (Hancké, 2009). Process tracing provides an opportunity to combine positivist and interpretivist approaches in the making of a case study allowing the researcher to explore both the causal 'what' and the causal 'how' (Porta & Keating, 2008).

Process tracing case studies is said to adopt a similar logic, but pay more attention to the causal detail: it starts with the most parsimonious[48], almost minimalist, version of a causal argument, and then try to understand the deeper mechanisms that a theory purports to explain or understand by analyzing the causality for each of these steps (Hancké, 2009). Theories are often implicit about what the exact mechanisms are; process tracing allows one to state those explicitly and qualify them where necessary. Such case studies will go down the causal chain, reconstructing the steps in the chain, and then demonstrating for example, how, at particular critical junctures, the decisions or choices that were made confirmed or disconfirmed basic mechanisms that the argument is exploring (Hancké, 2009).

Process tracing therefore involves not just detailed examination of the material, but also weighing the evidence in light of different theories. That means not just looking at the material but also making explicit what type of material is suggested by different theories and searching for that evidence. Once one has concluded which one the theories works best by

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[46] A systematic review of published literature was conducted by Saunders, et al. (2018:61) to review the available epidemiological data describing fatal drowning in SA. They reported that the fatal drowning burden in SA is stable at approximately 3.0 per 100 000 population, but is increasing as a proportion of all non-natural deaths. (Saunders, C. J., Sedwuth, D. and Naidoo, N. 2018. Keeping our heads above water: a systematic review of fatal drowning in South Africa. *South African Medical Journal*. 108(01):61-68. January.)

[47] Data from the 2017 Road Safety Annual Report (2017:476) regarding road crash fatalities in South Africa indicated that in 2015, there were 12 944 reported road fatalities, a 2% increase over 2014. In 2016, a total of 14 071 deaths were reported, which was an increase of 9% over 2015 with the fatality rate in 2016 at 25.2 per 100 000 inhabitants. (Arrive Alive South Africa. 2017. Road Safety Annual Report 2017, Chapter 35. Available: https://www.arrivealive.co.za/documents/SA%20Road%20Safety%20Report%202017.pdf)

[48] Scientific parsimony, as a generalization, states that, if there are a number of explanations for observed phenomena, the simplest explanation is preferred.

confronting the available data with the different arguments, one can then use that insight as a way to generalize to other cases. When that works, the single case has produced an explanation that ought to be helpful in understanding many other, similarly structured situations (Hancké, 2009). This is of interest as the MVR case may generate meanings applicable to other aspects of rescue education and practice.

3.9 DOCUMENT ANALYSIS

Document analysis is a systematic procedure for reviewing or evaluating documents, which require data to be examined and interpreted. This analytical method allows for the elicitation of meaning, gaining of understanding, and the development of empirical knowledge (Bowen, 2009). Documents are defined by Atkinson and Coffey in their 1997 work as being ‘social facts’, which are produced, shared, and used in socially organised ways as cited by Bowen (2009).

The analytic procedure entails finding, selecting, appraising (making sense of), and synthesising data which are then organised into major themes, categories, and case examples specifically through content analysis. The rationale for document analysis should lie in its role within the methodology of the research which is applicable to qualitative research. Document analysis as a research methodology holds certain advantages as it is an efficient method (not time consuming), cost effective (most documents are freely available and if in the public domain readily accessible), lack obtrusiveness and reactivity (Bowen, 2009).

For the purpose of this research study a content thematic analysis of the BEMC Physics and Extrication subject guides were done. This entailed a document review of the relevant subject guides through which meaningful and relevant passages of text or other data was identified in line with the stated objectives of the research study as described above in this chapter. The content analysis process and results is discussed in Chapter 6 of the research thesis.

3.10 LEGITIMATION CODE THEORY (SEMANTIC DIMENSION)

A case for LCT and the Semantic dimension has been made in Chapter 2. As explained, LCT builds from the work on knowledge building (educational theories) of Bernstein and provides a theoretical basis for its methodological use.

The purpose of a translation device is to “complement the LCT discourses with a focus on their practices through which it offers a means of additionally analysing the discourse through which those practices may be (at least partly)” expressed (Maton & Doran, 2017). In a study of Systemic Functional Linguistics (SFL) by Maton & Doran (2017) it is stated that the translation device as used provided a means for “translating between the higher–order concepts of epistemic-semantic density and English discourse”. In this study of Maton & Doran (2017), the translation device offered a series of typological categories at different levels of discourse that represented different strengths of epistemic-semantic density and epistemological condensation. The typologies were stated as not being linguistic concepts but as sociological concepts for revealing an attribute of knowledge (Maton & Doran, 2017).

The translation device which was developed based on the definitions of semantic gravity (SG) and semantic density (SD) is not a replica (it was not reproduced) from other research studies which utilized a translation device using the Semantic concepts of LCT. In Chapter 6 a more detailed explanation to the development and application of the translation device is provided. LCT does not just merely provide a theoretical evidence base for its use as an educational and theoretical framework but the Semantic concepts contribute by means of the definition of its SG and SD through the use of a translation device (cf. Table 13 & 14 of Chapter 6). The context and condensation with reference to its strength or weakness could be explored in order to identify the knowledge pertaining to the subjects’ unit of study which has been identified through the document analysis. Through the use of the translation device based on the LCT, Semantic concepts, validation (reproducibility) of the research can be obtained. This would possibly further validate the theoretical and educational framework for LCT as an educational research theory within emergency medical care, medical rescue and physics that could further strengthen the need for the re-contextualization of the physics within curricula if identified as such.

3.11 ETHICAL CONSIDERATIONS

Participation in the study was voluntary for the Delphi participants with prospective participants informed via an information leaflet and ascent/consent form provided through which they may wish to withdraw from the research study at any point without the risk of reprisals (cf. Appendix A and B). Participants were made aware of the process regarding the reporting of any concerns during the research.

Participants' personal information was kept confidential during the storing, collection and recruiting phase of the research study. Participants were required to provide their names; surname and place where document was signed for consent and ascent purpose for participation in the study (cf. Appendix B). The research questionnaire did not require any completion of personal information (cf. Appendix C). Participants were coded on their questionnaire following the process of consent to participate, with the researcher and the supervisors being the only persons who were able to identify participants through means of the unique code provided to participants.

Coding of the participant questionnaire was done to ensure that the correct questionnaire was sent to participants who would be required to participate in the following rounds of the Delphi panels. Only relevant information pertaining to participant's experience, status, professional rescue and emergency medical qualifications was included in the writing and reporting of the thesis and for future dissemination of research findings.

Information collected via the various rounds of the Delphi process from the questionnaire (cf. Appendix C) from the various participants was kept in a secure location (cloud platform, external hard drive and computer) with access to each platform and method password protected and accessible only by the researcher. All information collected was stored in the secure location until such a time as prescribed by the code of ethics and practice for research by the CPUT Health and Wellness Research Ethics Committee (H&WS REC).

Ethical approval for the conducting of the study was obtained from the CPUT H&WS REC (cf. Appendix D) and departmental site approval from the Emergency Medical Sciences was obtained for the document analysis of the rescue and sciences curricula (cf. Appendix E). Questionnaire and interview templates were submitted as part of the institutional ethics approval process during the proposal submission phase.

The aim and purpose of seeking ethics and site approval was to ensure that the rights of participants were protected and that the study would ascribe to the principles of research which is deemed fit for the qualifications and purpose for which it is sought.

3.12 CONCLUSION

The linkage of concepts from vehicle extrication to other rescue contexts such as urban search and rescue, water rescue, etc. is documented although it is seen as individual or stand-alone rescue disciplines or fields of specialization (Dunbar, 2011b). The frequency of motor vehicle accidents trumps other rescue contexts on frequency probability and makes for a valid case study. The need for sound research methodologies to explain, investigate or understand the practices of medical rescue is needed in order to ensure that the rescue profession is able to hold relevance and credibility upon which its own practices is built.

Using a modified Delphi technique, the researcher, by means of consensus findings from an expert panel, defined a typical theme of a motor vehicle accident, from which a ‘case’ can be designed. With the aid of process tracing, different aspects of the case under study were evaluated to identify which conceptual principles of physics are implicit through these methods and the similarities which presented.

Having identified the conceptual physics, the researcher evaluated curricula for underpinning of physics within, using a thematic content analysis of the BEMC curricula documentation, which highlighted whether there exists alignment or misalignment to the curricula. How and what students are taught are intended to translate into practice and therefore the document analysis of the curricula provided a basis to evaluate what is the operational practice. Through the implementation of a translation device based on the definition of the Semantic dimension using LCT, the horizontal and vertical discourse of the principles of physics were evaluated for relationship of the principles of physics to the field of context or theory in being either strong or weak.

CHAPTER FOUR

DELPHI ANALYSIS AND RESULTS

4.1 INTRODUCTION

The aim of Chapter four is to present the results, findings and narrow discussion of the Delphi technique. The process of the Delphi methodology with each rounds results and the importance of each section as it related to the development of the typical case scenario will be discussed. The structure in presenting the process and findings of my research in using the modified Delphi process for this chapter was based on previous emergency care research: "*A framework for articulation between the emergency care technician certificate and the emergency medical care professional degree*"[49] (Vincent-Lambert, 2011). The content of the Delphi and the analysis I employed remains novel.

The below section will discuss how each round of the Delphi process was administered once the questionnaire had been completed and the receiving of information. The analysis/ scoring of the individual Delphi expert participants responses per statement and determination of a consensus finding or non-finding is discussed. An explanation is provided regarding the administration of each round and the influences towards it. The purpose of this Chapter is to explain how the typical and atypical case was developed without duly influencing and/or contributing to the manufacturing of consensus amongst participants.

4.2 DELPHI QUESTIONNAIRE ROUND 1

The format, structure, thought process, rationale, criteria and process in formulating and designing the 1st round Delphi questionnaire has been discussed and described in the previous sections of Chapter 3. The questionnaire was send in an electronic format via e-mail individually to all participants whom provided consent to participate within the study (cf. Appendix C).

As previously explained in components of this chapter the participants were provided guidance within the document as to how to complete the documents with the principal investigator post emailing the documents following up with Delphi expert panel participants

[49] This was toward a PhD in Health Professions Education and has direct methodological relevance for this study as the context was also South African EMS.

regarding their progress and providing clarity and further support to aid in the completion of the Delphi 1st round questionnaire.

Initially 12 participants submitted their responses within the requested timeframe for the administration of the 1st round Delphi panel expert participation process of the questionnaire with 1 participant submitting their response after the requested period and prior to the completion of the 3rd round questionnaire process. Due to the decision to include the late response of the participant the results slightly varied in the formulation of the 2nd round of the Delphi process as will be explained further below in the next section with the 3rd round used as a means of further triangulation and validation of the final case narrative for the typical motor vehicle rescue case.

Table 2 is a breakdown of the results post the 1st round submission of the Delphi panel participants whom had provided consent and who had returned the completed Delphi 1st round questionnaire within the required timeframe for inclusion of the analysis, findings, results and development of the next component of the Delphi process. The principal investigator evaluated each Delphi expert panel participants completed questionnaire post submission of the 1st round process and for each individual statement/criteria area a (i) was placed on document similar to the 1st round Delphi questionnaire which was provided to the Delphi expert panel participants individually. This process of assigning a (i) in the individual Delphi expert panel participants corresponding response per individual criteria/statement for Section A to D was done for all 12 initial and 1 subsequent late submission received from the participants.

The individual comment area in the corresponding criteria/statement per different Sections was then calculated to determine whether a majority consensus of greater than 80% was reached per individual statement/criteria in either the “agree” or “undecided/neutral” or “disagree” response. Each individual statement/criteria was assigned a final calculated total out of the initial 12 which participated (due to the 2nd round Delphi expert panel questionnaire largely had been based on the majority finding at that point of the study and data collection process). The 1 participant which had submitted their 1st round Delphi expert panel questionnaire late was included during the completion of the 3rd Delphi panel expert questionnaire distribution and administration phase. As per Table 2. herewith below the areas in the comment section of the various different individual sections which is highlighted by a complete yellow block or in part is where a majority consensus of greater than 80% was obtained with either the 12 (10/12 ; 83%) participants responses initially or at the very end of the collation of the 13 (11/13 ; 85%) participants response of the 1st round of the Delphi expert panel participants responses.

Table 2 is a breakdown of the results post the 1st round submission of the Delphi panel participants whom had provided consent and who had returned the completed Delphi 1st round questionnaire within the required timeframe for inclusion of the analysis, findings, results and development of the next component of the Delphi process

	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A1.	Cribbing (2x4)	1iiiiiiiiii	2ii	3i	83%(10/12) 77% (10/13)
A2.	Cribbing (4x4	1iiiiiiiiii	2ii	3i	75% (9/12) 77% (10/13)
A3.	Wedges	1iiiiiiiiiiii	2i	3	92%(11/12) 92% (12/13)
A4.	Stepchocks	1iiiiiiiiiiiii	2	3	100%(12/12) 100% (13/13)
A5.	Pneumatic struts	1iiii	2iiiiii	3iii	50% (6/12) 46% (6/13)
A6.	Mechanical struts	1iiiii	2iiiii	3iii	42% (5/12) 38% (5/13)
A7.	Ratchet strapping	1iiiiiiiii	2ii	3ii	67% (8/12) 69% (9/13)
A8.	Chain with J-hooks	1iiii	2iiiii	3iiii	33% (4/12) 38% (5/13)
A9.	Strut Head (Cone shaped)	1ii	2iiiiiiii	3iii	58% (7/12) 62% (8/13)
A10.	Strut head (L-shaped)	1iii	2iiiiiii	3iii	58% (7/12) 54% (7/13)
A11.	Strut base plate	1iiii	2iiiiii	3iii	50% (6/12) 46% (6/13)
A12.	V- Strut	1iii	2iiiiii	3iiii	50% (6/12) 46% (6/13)

	Hand Tools				
A13.	Halligan Tool	1iiiiiiiiiiiii	2	3	100%(12/12) 100% (13/13)
A14.	Axe (Flathead)	1iiiiiii	2iii	3iii	50% (6/12) 54% (7/13)
A15.	Axe (Pickhead)	1iiii	2ii	3iiiiiii	50% (6/12) 54% (7/13)
A16.	Boltcutter	1iiiiiiiiii	2ii	3i	75% (9/12) 77% (10/13)
A17.	Pliers (channel lock type)	1iiiiiiiiii	2i	3ii	75% (9/12) 77% (10/13)
A18.	Pliers (side cutters)	1iiiiiiiii	2ii	3ii	67% (8/12) 69% (9/13)
A19.	Srewdriver (Flat)	1iiiiiiiii	2ii	3ii	67% (8/12) 69% (9/13)
A20.	Crow bar	1iiiiiiiiii	2iii	3	83%(10/12) 77% (10/13)
A21.	Springloaded punch	1iiiiiiiii	2ii	3ii	75% (9/12) 69% (9/13)
A22.	Webbing	1iiiiii	2iiiiii	3i	50% (6/12) 46% (6/13)
A23.	Come-along tool	1iiiiii	2iiiii	3ii	50% (6/12) 46% (6/13)
A24.	Hacksaw	1iiiiiii	2ii	3iiii	58% (7/12) 54% (7/13)
A25.	Seatbelt cutter	1iiiiiiiii	2ii	3ii	67% (8/12) 69% (9/13)
A26.	Scissor (serrated edge type)	1iiiiiiiiii	2iii	3	75% (9/12) 77% (10/13)
A27.	Rescue knife	1iiiiiiiiiii	2i	3i	83%(10/12) 85% (11/13)
A28.	Reciprocating saw	1iiiiiiiiiiii	2i	3	92%(11/12) 92% (12/13)
A29.	Windshield saw	1iiiiiiiiii	2ii	3i	75% (9/12) 77% (10/13)
A30.	Air chisel or gun cutting tool	1iiiiii	2iiiii	3ii	50% (6/12) 46% (6/13)
A31.	Shovel	1iiiiiiiiii	2iii	3	75% (9/12) 77% (10/13)
A32.	Broom	1iiiiiiiiiiii	2i	3	92%(11/12) 92% (12/13)
A33.	Airbag cover	1iiiiiiiiii	2ii	3i	75% (9/12) 77% (10/13)
	Power Rescue Tools				
A34.	Power plant (Fuel driven)	1iiiiiiiiiiii	2i	3	92%(11/12) 92% (12/13)
A35.	Spreader tool	1iiiiiiiiiiiii	2	3	100%(12/12) 100%(13/13)
A36.	Cutter tool	1iiiiiiiiiiii	2i	3	92%(11/12) 92% (12/13)
A37.	Ram tool	1iiiiiiiiiiii	2i	3	92%(11/12) 92% (12/13)
A38.	Pedal cutter tool	1iiiiiiiiii	2iii	3	75% (9/12) 77% (10/13)
A39.	Chains	1iiiii	2iiiii	3iii	42% (5/12) 38% (5/13)

A40.	Ram support (bracket/base plate)	1iiiiiiiiii	2iii	3	75% (9/12) 77% (10/13)
A41.	Lighting	1iiiiiiiiiii	2i	3i	83%(10/12) 85% (11/13)
A42.	Jacks (hi lift)	1iiiiiiiiiii	2i	3i	83%(10/12) 85% (11/13)
A43.	Jack (hydraulic)	1iiiiiiii	2ii	3iii	67% (8/12) 62% (8/13)
A44.	Vetter bags	1iiiiiiiii	2ii	3ii	67% (8/12) 69% (9/13)

	SECTION B~TYPE OF VEHICLE, DESIGN & HAZARDS *The aim of this section is to determine the type of vehicle, design and hazards that are prevalent (most commonly seen and/or found) at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
B0	Most typical RTA involves vehicles that have the new car technology (i.e. crumple zones, reinforced dashboards, micro alloy and boron steel, etc)	1iiiiiiii	2ii	3iii	58% (7/12) 62% (8/13)
B1.	Most typical RTA occur with unibody construction/design vehicles (unibody vehicle uses the body panels and floorpan to form its structure)	1iiiiiiii	2iii	3ii	58% (7/12) 62% (8/13)
B2.	Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)	1iiiiii	2iiii	3iii	42% (5/12) 46% (6/13)
B3	Most typical RTA occur with full frame construction /design vehicles (the body bolts to a welded frame and is the full length of the car)	1iiiii	2iiii	3iiii	42% (5/12) 38% (5/13)
B4.	Most typical RTA occur with vehicles that are petroleum fuel driven	1iiiiiiii	2i	3iiii	67% (8/12) 62% (8/13)
B5.	Most typical RTA occur with vehicles that are diesel fuel driven	1iii	2iiiii	3iiiii	42% (5/12) 38% (5/13)

B6.	Most typical RTA occur with vehicles that are liquefied petroleum gas (LPG) driven	1i	2ii	3iiiiiiiiii	83%(10/12) 77% (10/13)
B7.	Most typical RTA occur with vehicles that are Hybrid system driven	1	2iii	3iiiiiiiiii	83% (10/12) 77% (10/13)
B8.	Most typical RTA occur with vehicles that are petroleum fuel driven and are modified with some form of gas (e.g. nitrogen gas) affixed to enable and/or enhance performance	1ii	2iiii	3iiiiiii	58% (7/12) 54% (7/13)
B9.	Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})	1iiiiiiiiii	2	3ii	92%(11/12) 85% (11/13)
B10	Most typical RTA occur with light delivery vehicles (LDV) (include your ½ tonner bakkies to 1 tonner bakkies, double cabs)	1iiiii	2iii	3iiiii	42% (5/12) 38% (5/13)
B11	Most typical RTA involve busses (includes minibuses and larges busses whether for personal, commercial or public transport)	1iiiiii	2iii	3iiii	50% (6/12) 46% (6/13)
B12	Most typical RTA involve trucks (those over 10 ton capacity irrespective of amount of axles and whether it has a “horse & trailer”)	1ii	2iiiiii	3iiiii	50% (6/12) 46% (6/13)
B13	Most typical RTA involves trains which have collided with any other forms of road transportation that have occurred at a public or private road.	1iii	2iiii	3iiiiii	50% (6/12) 46% (6/13)
B14	Most typical RTA involves the transportation of a hazardous material.	1i	2iiii	3iiiiiiii	58% (7/12) 62% (8/13)
B15	Most typical RTA involve radiator fluid spills and/or leakages	1iiiiiiiiiii	2	3ii	83%(10/12) 85% (11/13)
B16	Most typical RTA involve fuel spills and/or leakages	1iiiiii	2iii	3iiii	50% (6/12) 46% (6/13)
B17	Most typical RTA involve oil fluid spills and/or leakages	1iiiiiiiii	2ii	3ii	67% (8/12) 69% (9/13)
B18	Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {“idling”}	1iiiiiiii	2i	3iiii	58% (7/12) 62% (8/13)
B19	Most typical RTA involves a fire to engines compartment	1iii	2iiii	3iiiiii	42% (5/12) 38% (5/13)
B20	Most typical RTA involves a fire to the passenger compartment	1	2iiii	3iiiiiiiii	75% (9/12) 69% (9/13)
B21	Most typical RTA involves undeployed airbags (irrespective if it is frontal and/or side impact airbags)	1iiiii	2i	3iiiiiii	50% (6/12) 54% (7/13)
B22	Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)	1iiiiii	2iii	3iiii	42% (5/12) 46% (6/13)

B23	Most typical RTA involves undeployed Automatic Roll Over Protection Systems (ROPS)	1ii	2iiiiiii	3iiii	58% (7/12) 54% (7/13)
B24	Most typical RTA involves deployed Automatic Roll Over Protection Systems (ROPS)	1ii	2iiiiiiii	3iii	67% (8/12) 62% (8/13)
B25	Most typical RTA involves electrical hazards (i.e. lamp standard, ESKOM power supply unit, etc)	1iiiiiii	2ii	3iiii	50% (6/12) 54% (7/13)

	SECTION C~RTA BY COLLISION KINETICS/CLASSIFICATION *The aim of this section is to classify road traffic accidents by collision kinetics and/or amount of vehicles involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
C1.	Most typical RTA involves frontal collisions (irrespective if it is full, half , quarter or partial frontal involvement)	1iiiiiiiii	2	3iiii	67% (8/12) 69% (9/13)
C2.	Most typical RTA involves side impact collisions	1iiiiiiii	2iiii	3i	58% (7/12) 62% (8/13)
C3	Most typical RTA involves roll over collisions	1iiiii	2iiii	3iiii	42% (5/12) 38% (5/13)
C4.	Most typical RTA involves under runs (irrespective what the object is that the vehicle ran underneath into e.g. truck, railing, etc)	1iii	2iiii	3iiiiii	50% (6/12) 46% (6/13)
C5.	Most typical RTA involves crush incidents (irrespective of what the object is that is creating a “crush” onto the vehicle e.g. wall, truck, container)	1iiiiiii	2iii	3iii	50% (6/12) 54% (7/13)
C6.	Most typical RTA involves collisions where it involves more than one type of collision kinetic/classification (i.e frontal collision that resulted in a roll over	1iiiiiiiii	2i	3iii	67% (8/12) 69% (9/13)
C7.	Most typical RTA involves two similar type of mode of transport (e.g. passenger vehicle vs passenger vehicle, minibus vs minibus)	1iiiiii	2i	3iiiiii	50% (6/12) 46% (6/13)

C8.	Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up)	1iiiiiiiii	2ii	3i	75% (9/12) 77% (10/13)
C9.	Most typical RTA involves single vehicle collisions with a stationary object.	1iiiii	2iii	3iiiii	42% (5/12) 38% (5/13)

	SECTION D~RESCUE RESPONSE *The aim of this section is to determine what are the responses required and/or involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
D1.	Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation	1iiiiiiii	2ii	3iii	67% (8/12) 62% (8/13)
D2	Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation	1iiiiiiiiiiii	2i	3	92%(11/12) 92% (12/13)
D3.	Most typical RTA involves the use of hydraulic spreading equipment to either “push and/or lift” metal and structures (irrespective if a spreader, rams, etc)	1iiiiiiiii	2ii	3ii	67% (8/12) 69% (9/13)
D4.	Most typical RTA involves the use of hydraulic spreading equipment to either “pull” metal and structures	1iiiii	2iiiiii	3ii	50% (6/12) 46% (6/13)
D5.	Most typical RTA involves the use of hydraulic cutting equipment to either “cut” metal and structures (irrespective if conventional cutter or mini cutter or combitool)	1iiiiiiiiiii	2i	3i	83%(10/12) 85% (11/13)
D6.	Most typical RTA involves the use of hydraulic equipment to either power and	1iiiiiiiii	2iii	3i	67% (8/12) 69% (9/13)

	operate hydraulic equipment (hydraulic motor pump, hydraulic hand pump, etc)				
D7.	Most typical RTA involves the use of hydraulic equipment to stabilize vehicle/'s and/or structures	1iiii	2ii	3iiiiiii	50% (6/12) 54% (7/13)
D8.	Most typical RTA involves the use of handtools to extricate patients from vehicle/'s (i.e. highlift jack, hacksaw, haligan tool, etc)	1iiii	2iiii	3iiiii	33% (4/12) 38% (5/13)
D9.	Most typical RTA involves the use of an axe to break/cut through laminated glass of a vehicle/'s	1iiii	2iiii	3iiiii	33% (4/12) 38% (5/13)
D10	Most typical RTA involves the use of an saw designed to cut through laminated glass e.g "Glass Master saw" to break/cut through laminated glass of a vehicle/'s	1iiiiiiii	2iii	3ii	67% (8/12) 62% (8/13)
D11	Most typical RTA involves the use of an axe to break laminated glass of a vehicle/'s	1iii	2ii	3iiiiiiii	58% (7/12) 62% (8/13)
D12	Most typical RTA involves the use of an reciprocating saw to break/cut through laminated glass of a vehicle/'s	1iiiiiii	2iii	3iii	50% (6/12) 54% (7/13)
D13	Most typical RTA involves the use of an axe and haligan tool to break tempered glass of a vehicle/'s	1ii	2iiiiii	3iiiii	50% (6/12) 46% (6/13)
D14	Most typical RTA involves the use of an sharp object for example a screwdriver to break tempered glass of a vehicle/'s	1ii	2iiiii	3iiiiii	42% (5/12) 46% (6/13)
D15	Most typical RTA involves the use of an springloaded centre punch to break tempered glass of a vehicle/'s	1iiiiiiii	2ii	3iii	58% (7/12) 62% (8/13)
D16	Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/'s	1iiiiiiiiiii	2i	3i	83% (10/12) 85% (11/13)
D17	Most typical RTA involves the use of highlift jacks to stabilize the vehicle/'s	1iiii	2ii	3iiiiiii	50% (6/12) 54% (7/13)
D18	Most typical RTA involves the use of wood and wedges to stabilize the vehicle/'s	1iiiiiiiii	2iii	3i	67% (8/12) 69% (9/13)
D19	Most typical RTA involves the use of pneumatic equipment/ shores to stabilize the vehicle/'s	1iiii	2iiii	3iiiii	33% (4/12) 38% (5/13)
D20	Most typical RTA involves the use of ratchet straps to stabilize the vehicle/'s	1iiiii	2ii	3iiiiii	50% (6/12) 46% (6/13)
D21	Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/'s	1iiiiiiii	2iiii	3i	67% (8/12) 62% (8/13)

Comment: The highlighted criteria in yellow from the comment section was to be used during the 2nd round Delphi questionnaire process to indicate to the individual participants within the Delphi panel expert 2nd round questionnaire process where they had contributed in reaching a majority consensus to a particular statement/criteria or where there was no particular majority (non-yellow highlighted area in comment section) consensus. The rationale was to provide an opportunity for the individual Delphi panel expert participant to either remain with their previous response or change it to align with either the other participant responses. The section below will provide further details in how the individual responses were used in the further analysis and obtaining of the results at the end of the 2nd round Delphi process.

4.3 DELPHI QUESTIONNAIRE ROUND 2

The Delphi expert panel participants was provided a brief explanation regarding the process which had been completed within the 1st round of the Delphi questionnaire. They were further guided as to what was required of them in order to ensure that the 2nd round Delphi questionnaire was completed and used in the manner for which it was intended and design. See (cf. Appendix G) for example of the guidance and further information which was provided to the individual participants to aid in understanding the 2nd round Delphi expert panel questionnaire and in the completion of the document.

Each 2nd round Delphi expert panel questionnaire document was individually compiled and completed by the principal investigator as the document required the individual expert panel participants to review their own responses. This was in relation to where a majority consensus was obtained in a particular statement/criteria where no further response (indicated by a greater than 80% and appropriate majority consensus corresponding total out of 12 was represented) was required. Where a statement/criteria was not blacked out their previous 1st round response was indicated with a (X) in the applicable column (cf. Appendix G).

Where they were not required to complete that particular statement/criteria which was blacked out due a majority finding/consensus which had been reached a pdf document (cf. Annexure H) was provided to the individual Delphi expert panel participant in order to review their own responses to that of the other participants. Through this process the individual Delphi expert panel participant could elect to either remain with her/his original 1st round questionnaire response where they had not provided a similar response to that of the other participants where no majority consensus or finding was obtained. An opportunity was provided during the 2nd round Delphi questionnaire process for the expert participants to elect to change their response to any of the options available.

On receipt of the 12 participant's completion of their individual 2nd round Delphi expert panel participant responses the information was analysed, collated and presented as per the below Table 3 titled "Final analysis and results at the end of the 2nd round Delphi questionnaire process". A similar process as explained in the previous Delphi expert panel participant round 1 process of this chapter was used with the assignment of a (i) per the individual participant's response per the individual statement/criteria with the corresponding scale/selection made as being either "agree" or "undecided/neutral" or "disagree". The final total per individual statement/criteria was completed out of the 12 participants whom had completed and submitted the 2nd round Delphi expert panel questionnaire at the end and completion of the 2nd round Delphi expert panel participant process.

Table 3 Final analysis and results at the end of the 2nd round Delphi questionnaire process.

	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A1.	Cribbing (2x4)	1iiiiiiiiii	2i	3i	83%(10/12)
A2.	Cribbing (4x4	1iiiiiiiiiii	2i	3	92% (11/12)
A3.	Wedges	1iiiiiiiiiii	2i	3	92%(11/12)
A4.	Stepchocks	1iiiiiiiiiiii	2	3	100%(12/12)
A5.	Pneumatic struts	1iiiii	2iiiii	3ii	42% (5/12)
A6.	Mechanical struts	1iiiii	2iiiii	3ii	42% (5/12)
A7.	Ratchet strapping	1iiiiiiiiiiii	2	3	100% (12/12)
A8.	Chain with J-hooks	1iiiii	2iiiii	3ii	42% (5/12)
A9.	Strut Head (Cone shaped)	1i	2iiiiii	3iiiii	50% (6/12)

A10.	Strut head (L-shaped)	1i	2iiiii	3iiiiii	50% (6/12)
A11.	Strut base plate	1iiiiii	2ii	3iiii	50% (6/12)
A12.	V- Strut	1iiiiii	2ii	3iiii	50% (6/12)
	Hand Tools				
A13.	Halligan Tool	1iiiiiiiiiiii	2	3	100%(12/12)
A14.	Axe (Flathead)	1iiiiii	2ii	3iiii	50% (6/12)
A15.	Axe (Pickhead)	1iiiiiiii	2	3iiii	67% (8/12)
A16.	Boltcutter	1iiiiiiiiii	2ii	3	83% (10/12)
A17.	Pliers (channel lock type)	1iiiiiiiiii	2ii	3	83% (10/12)
A18.	Pliers (side cutters)	1iiiiiiiiii	2ii	3	83% (10/12)
A19.	Srewdriver (Flat)	1iiiiiiiiiii	2i	3	92% (11/12)
A20.	Crow bar	1iiiiiiiiii	2ii	3	83%(10/12)
A21.	Springloaded punch	1iiiiiiiiiiii	2	3	100% (12/12)
A22.	Webbing	1iiiiiiii	2ii	3ii	67% (8/12)
A23.	Come-along tool	1iiiiiiii	2iii	3i	67% (8/12)
A24.	Hacksaw	1iiiii	2iiii	3iii	42% (5/12)
A25.	Seatbelt cutter	1iiiiiiiiiii	2	3i	92% (11/12)
A26.	Scissor (serrated edge type)	1iiiiiiiiii	2ii	3	83% (10/12)
A27.	Rescue knife	1iiiiiiiiii	2i	3i	83%(10/12)
A28.	Reciprocating saw	1iiiiiiiiiii	2i	3	92%(11/12)
A29.	Windshield saw	1iiiiiiiiiii	2	3i	92% (11/12)
A30.	Air chisel or gun cutting tool	1iii	2iiiii	3iiii	42% (5/12)
A31.	Shovel	1iiiiiiiiii	2ii	3	83% (10/12)
A32.	Broom	1iiiiiiiiiii	2i	3	92%(11/12)
A33.	Airbag cover	1iiiiiiiiiii	2i	3	92% (11/12)
	Power Rescue Tools				
A34.	Power plant (Fuel driven)	1iiiiiiiiiii	2i	3	92%(11/12)
A35.	Spreader tool	1iiiiiiiiiiii	2	3	100%(12/12)
A36.	Cutter tool	1iiiiiiiiiii	2i	3	92%(11/12)
A37.	Ram tool	1iiiiiiiiiii	2i	3	92%(11/12)
A38.	Pedal cutter tool	1iiiiiiiiii	2ii	3	83% (10/12)
A39.	Chains	1iiiiiiii	2i	3iii	67% (8/12)
A40.	Ram support (bracket/base plate)	1iiiiiiiiii	2ii	3	83% (10/12)
A41.	Lighting	1iiiiiiiiii	2i	3i	83%(10/12)
A42.	Jacks (hi lift)	1iiiiiiiiii	2i	3i	83%(10/12)
A43.	Jack (hydraulic)	1iiiiiiii	2i	3iii	67% (8/12)
A44.	Vetter bags	1iiiiiiiii	2i	3ii	75% (9/12)

	SECTION B~TYPE OF VEHICLE, DESIGN & HAZARDS *The aim of this section is to determine the type of vehicle, design and hazards that are prevalent (most commonly seen and/or found) at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral

	3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
B0	Most typical RTA involves vehicles that have the new car technology (i.e. crumple zones, reinforced dashboards, micro alloy and boron steel, etc)	1iiiiiiiii	2ii	3i	75% (9/12)
B1.	Most typical RTA occur with unibody construction/design vehicles (unibody vehicle uses the body panels and floorpan to form its structure)	1iiiiiiii	2iii	3i	67% (8/12)
B2.	Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)	1iiiiiii	2iii	3ii	58% (7/12)
B3	Most typical RTA occur with full frame construction /design vehicles (the body bolts to a welded frame and is the full length of the car)	1iiiiii	2ii	3iiii	50% (6/12)
B4.	Most typical RTA occur with vehicles that are petroleum fuel driven	1iiiiiiiiiii	2i	3	92% (11/12)
B5.	Most typical RTA occur with vehicles that are diesel fuel driven	1iii	2iii	3iiiiii	42% (5/12)
B6.	Most typical RTA occur with vehicles that are liquefied petroleum gas (LPG) driven	1i	2i	3iiiiiiiiii	83%(10/12)
B7.	Most typical RTA occur with vehicles that are Hybrid system driven	1	2ii	3iiiiiiiiii	83% (10/12)
B8.	Most typical RTA occur with vehicles that are petroleum fuel driven and are modified with some form of gas (e.g. nitrogen gas) affixed to enable and/or enhance performance	1i	2iiii	3iiiiiii	67% (8/12)
B9.	Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})	1iiiiiiiiii	2	3i	92%(11/12)
B10	Most typical RTA occur with light delivery vehicles (LDV) (include your ½ tonner bakkies to 1 tonner bakkies, double cabs)	1iiiiiii	2iii	3ii	58% (7/12)
B11	Most typical RTA involve busses (includes minibuses and larges busses whether for personal, commercial or public transport)	1iiiiiiiii	2ii	3i	75% (9/12)
B12	Most typical RTA involve trucks (those over 10 ton capacity irrespective of	1ii	2iiiiii	3iiii	50% (6/12)

	amount of axles and whether it has a "horse & trailer")				
B13	Most typical RTA involves trains which have collided with any other forms of road transportation that have occurred at a public or private road.	1ii	2ii	3iiiiiiii	67% (8/12)
B14	Most typical RTA involves the transportation of a hazardous material.	1	2ii	3iiiiiiiiii	83% (10/12)
B15	Most typical RTA involve radiator fluid spills and/or leakages	1iiiiiiiiii	2	3ii	83%(10/12)
B16	Most typical RTA involve fuel spills and/or leakages	1iiiiiiiii	2iii	3	75% (9/12)
B17	Most typical RTA involve oil fluid spills and/or leakages	1iiiiiiiiii	2ii	3	83% (10/12)
B18	Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {"idling"}	1iiiiiiii	2i	3iii	67% (8/12)
B19	Most typical RTA involves a fire to engines compartment	1iiii	2ii	3iiiiii	50% (6/12)
B20	Most typical RTA involves a fire to the passenger compartment	1	2ii	3iiiiiiiiii	83% (10/12)
B21	Most typical RTA involves undeployed airbags (irrespective if it is frontal and/or side impact airbags)	1iiiii	2ii	3iiiii	42% (5/12)
B22	Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)	1iiiiiiii	2i	3iii	67% (8/12)
B23	Most typical RTA involves undeployed Automatic Roll Over Protection Systems (ROPS)	1i	2iiiiiiii	3iii	67% (8/12)
B24	Most typical RTA involves deployed Automatic Roll Over Protection Systems (ROPS)	1ii	2iiiiiiiii	3i	75% (9/12)
B25	Most typical RTA involves electrical hazards (i.e. lamp standard, ESKOM power supply unit, etc)	1iiiiiiiii	2ii	3i	75% (9/12)

SECTION C~RTA BY COLLISION KINETICS/CLASSIFICATION

The aim of this section is to classify road traffic accidents by collision kinetics and/or amount of vehicles involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.

Please indicate your response to the following statements is according to the following scale:
1 = Agree
2 = Undecided / Neutral
3 = Disagree
Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).

		Agree	Undecided	Disagree	Comments
C1.	Most typical RTA involves frontal collisions (irrespective if it is full, half , quarter or partial frontal involvement)	1iiiiiiiiiii	2i	3	92% (11/12)
C2.	Most typical RTA involves side impact collisions	1iiiiiiii	2iii	3i	67% (8/12)
C3	Most typical RTA involves roll over collisions	1iiiiiii	2iii	3ii	58% (7/12)
C4.	Most typical RTA involves under runs (irrespective what the object is that the vehicle ran underneath into e.g. truck, railing, etc)	1ii	2iii	3iiiiiii	58% (7/12)
C5.	Most typical RTA involves crush incidents (irrespective of what the object is that is creating a “crush” onto the vehicle e.g. wall, truck, container)	1iiiiiiii	2iiii	3	67% (8/12)
C6.	Most typical RTA involves collisions where it involves more than one type of collision kinetic/classification (i.e frontal collision that resulted in a roll over	1iiiiiiiiii	2i	3i	83% (10/12)
C7.	Most typical RTA involves two similar type of mode of transport (e.g. passenger vehicle vs passenger vehicle, minibus vs minibus)	1iii	2ii	3iiiiiii	58% (7/12)
C8.	Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up)	1iiiiiiiiiii	2i	3	92% (11/12)
C9.	Most typical RTA involves single vehicle collisions with a stationary object.	1iiiii	2ii	3iiiii	42% (5/12)

	SECTION D~RESCUE RESPONSE *The aim of this section is to determine what are the responses required and/or involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).

		Agree	Undecided	Disagree	Comments
D1.	Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation	1iiiiiiiiii	2	3ii	83% (10/12)
D2	Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation	1iiiiiiiiiii	2i	3	92%(11/12)
D3.	Most typical RTA involves the use of hydraulic spreading equipment to either “push and/or lift” metal and structures (irrespective if a spreader, rams, etc)	1iiiiiiiiiii	2i	3	83% (11/12)
D4.	Most typical RTA involves the use of hydraulic spreading equipment to either “pull” metal and structures	1iiii	2iiiii	3ii	50% (6/12)
D5.	Most typical RTA involves the use of hydraulic cutting equipment to either “cut” metal and structures (irrespective if conventional cutter or mini cutter or combitool)	1iiiiiiiiii	2i	3i	83%(10/12)
D6.	Most typical RTA involves the use of hydraulic equipment to either power and operate hydraulic equipment (hydraulic motor pump, hydraulic hand pump, etc)	1iiiiiiiii	2i	3ii	75% (9/12)
D7.	Most typical RTA involves the use of hydraulic equipment to stabilize vehicle/’s and/or structures	1iii	2ii	3iiiiiii	58% (7/12)
D8.	Most typical RTA involves the use of handtools to extricate patients from vehicle/’s (i.e. highlift jack, hacksaw, haligan tool, etc)	1iiiii	2iii	3iiii	42% (5/12)
D9.	Most typical RTA involves the use of an axe to break/cut through laminated glass of a vehicle/’s	1iiii	2i	3iiiiiii	58% (7/12)
D10	Most typical RTA involves the use of an saw designed to cut through laminated glass e.g “Glass Master saw” to break/cut through laminated glass of a vehicle/’s	1iiiiiiiiii	2	3ii	83% (10/12)
D11	Most typical RTA involves the use of an axe to break laminated glass of a vehicle/’s	1i	2i	3iiiiiiiiii	83% (10/12)

D12	Most typical RTA involves the use of an reciprocating saw to break/cut through laminated glass of a vehicle/'s	1iiiiiiii	2iii	3i	67% (8/12)
D13	Most typical RTA involves the use of an axe and haligan tool to break tempered glass of a vehicle/'s	1ii	2iiiiii	3iiii	50% (6/12)
D14	Most typical RTA involves the use of an sharp object for example a screwdriver to break tempered glass of a vehicle/'s	1	2iiiii	3iiiiiii	58% (7/12)
D15	Most typical RTA involves the use of an springloaded centre punch to break tempered glass of a vehicle/'s	1iiiiiiiiii	2ii	3	83% (10/12)
D16	Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/'s	1iiiiiiiiii	2i	3i	83% (10/12)
D17	Most typical RTA involves the use of highlift jacks to stabilize the vehicle/'s	1ii	2ii	3iiiiiiii	67% (8/12)
D18	Most typical RTA involves the use of wood and wedges to stabilize the vehicle/'s	1iiiiiiiiii	2	3ii	83% (10/12)
D19	Most typical RTA involves the use of pneumatic equipment/ shores to stabilize the vehicle/'s	1iii	2ii	3iiiiiii	58% (7/12)
D20	Most typical RTA involves the use of ratchet straps to stabilize the vehicle/'s	1ii	2i	3iiiiiiiii	75% (9/12)
D21	Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/'s	1iiiiiiiiii	2	3ii	83% (10/12)

Comment: The individual statements/criteria were then evaluated for majority consensus finding of greater than 80%. It was further evaluated pertaining to whether participants had a majority consensus as being either 'agreed' which was deemed as being valid for the inclusion within the construction of the case narrative for the typical motor vehicle related rescue. The blacked out areas were those where a previous majority consensus finding was obtained at the end of the 1st round Delphi questionnaire participant process and where the majority finding remained unchanged at the end of the analysis of the 2nd round Delphi questionnaire participant process. The yellowed areas were the statements/criteria where a majority consensus was reached at the end of the 2nd round Delphi questionnaire participant process only. The areas which remained unchanged as per their previous colour was those where no majority consensus for any of the scales or where a majority consensus was obtained by the participants as being either "undecided/neutral" or "disagree" with respect to any particular individual criteria/statement.

The results which was obtained at the end of the 2nd round of the Delphi expert panel participants questionnaire submission was used in the developments and construction of the

3rd round Delphi expert panel questionnaire as detailed in previous section above and below in this chapter.

4.4 DELPHI QUESTIONNAIRE ROUND 3

As detailed and explained in Chapter 3 dealing with the process of the 3rd round of the Delphi expert panel participant questionnaire, guidance and information was provided to the individual participants in order to ensure that participants complete the questionnaire in the manner in which it had been designed and intended to be used.

4.4.1 The typical case typology for motor vehicle related rescue with analysis, results and consensus findings

The following below case typology narrative was developed initially based on criteria/statements from the previous two rounds of Delphi questionnaire process where participants had majority (+ 80%) consensus on statements/criteria where they indicated to agree. This case which was developed at the end of the 2nd Round Delphi process was used as part of the 3rd round of the Delphi expert panel participant's questionnaire in order to request the individual participants to indicate whether they agree or disagree. See below section in inverted commas regarding the case narrative at the end of the 2nd round process of the Delphi where a majority consensus was obtained which formed part of the 3rd round Delphi questionnaire process which was circulated to the individual participants.

The Delphi result that describes a typical case presentation for motor vehicle collisions is:

"The typical motor vehicle related rescue case involves a vehicle which is petrol driven which is a passenger vehicle such as a sedan, station wagon, sport utility vehicle, etc. with radiator and oil fluid spills and/or leakages; which has been involved in a frontal collision (irrespective if it is a full, half, quarter or partial frontal involvement) with more than one type of collision kinetic/classification (i.e. frontal collision that resulted in rear-end and/or roll over and/or side impact, etc.) with involvement of a different type of mode of transport (e.g. passenger vehicle vs minibus; 10 ton truck vs bakkie/pick-up, etc.) requiring rescue personnel using equipment that requires lowering and lifting requiring the use of musculoskeletal and body system function operation; with the use of hydraulic spreading equipment to either "push and/or lift" metal and/or structures (irrespective if a spreader, ram, etc.); with use of hydraulic equipment

to either cut metal and/or structures (irrespective if conventional cutter or minicutter or combitool, etc.); with the use of a saw designed to cut through laminated glass; with the breaking of tempered glass using a springloaded centre punch; and the use of wedges, wood 4x4 cribbing and stepchocks to stabilize the vehicle."

The 3rd round process was used to validate the previous two rounds where the expert panel participants were to indicate once again their responses in order to obtain or determine whether a majority consensus was reached at the end of the completion of the 3rd round process of the Delphi questionnaire. The individual statements/criteria formed part of Section A of the 3rd round process as explained and detailed in a previous section of this chapter where the 3rd round Delphi expert panel participant questionnaire process, structure and rationale is discussed. This was to further strengthen the triangulation and validation process of the case narrative of the typical motor vehicle rescue related case. The 3rd round Delphi expert panel questionnaire (cf. Appendix I) Section A which dealt with the criteria/statement where a majority consensus was reached at the end of the 2nd Round.

The below Table 4 denotes the final results as obtained from the 3rd round questionnaire responses per the individual statements below as calculated by the principal investigator after the submission of all the 13 participants within the 3rd round Delphi expert panel participant process. Only those areas where a majority consensus of greater than 80% (11/13 ; 85%) was to be included in the development of the final case narrative of the typical motor vehicle rescue related case at the end of the 3rd round of the Delphi expert panel participant final individual submissions analysis and compiling of the results. Areas where previously a majority consensus (greater than 80% majority agreement) was obtained at the end of the 2nd round Delphi expert panel participation process and no majority consensus (less than 80% majority agreement) was obtained at the end of the 3rd round process of the Delphi expert panel participation process will be excluded from the final case narrative of the typical motor vehicle rescue related incident and will be included in defining the atypical motor vehicle rescue related incident.

Table 4 Final results as obtained from the 3rd round questionnaire responses

	SECTION A In Section A of the 3rd round of the questionnaire you as the Delphi panel participant/expert is required to indicate whether you agree or disagree with the theme/topic/statement as being prevalent within the typical motor vehicle related case. Please read the narrative above with regards to the themes/topics/statements contained within the previous two rounds of the Delphi process questionnaire where a majority consensus was reached and obtained. This process is used to validate the consensus which has been obtained during the previous two rounds of the Delphi process of the questionnaire.			
	Please mark the appropriate block with an X. Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Disagree			
		Agree	**Disagree**	**Comments**
A29.	Most typical RTA occur with vehicles that are petroleum fuel driven	**1 iiiiiiiiiiii**	**2i**	**(12/13)** 92%
A30.	Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})	**1 iiiiiiiiiiii**	**2i**	**(12/13)** 92%
A31.	Most typical RTA involve radiator fluid spills and/or leakages	**1 iiiiiiiiiiii**	**2i**	**(12/13)** 92%
A32.	Most typical RTA involve oil fluid spills and/or leakages	**1 iiiiiiiiii**	**2iii**	**(10/13)** 77%
A33.	Most typical RTA involves frontal collisions (irrespective if it is full, half , quarter or partial frontal involvement)	**1 iiiiiiiiiii**	**2ii**	**(11/13)** 85%
A34.	Most typical RTA involves collisions where it involves more than one type of collision kinetic/classification (i.e. frontal collision that resulted in a roll over	**1 iiiiiiii**	**2iiiii**	**(8/13)** 61%
A35.	Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up)	**1 iiiiiiiii**	**2iiii**	**(9/13)** 69%

A36.	Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation	1 iiiiiiiiii	2iii	**(10/13)** 77%
A37.	Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation	1 iiiiiiiiiii	2ii	**(11/13)** 85%
A38.	Most typical RTA involves the use of hydraulic spreading equipment to either "push and/or lift" metal and structures (irrespective if a spreader, rams, etc.)	1 iiiiiiiiii	2iii	**(10/13)** 77%
A39.	Most typical RTA involves the use of hydraulic cutting equipment to either "cut" metal and structures (irrespective of conventional cutter or mini cutter or combitool)	1 iiiiiiiiiiii	2i	**(12/13)** 92%
A40.	Most typical RTA involves the use of an saw designed to cut through laminated glass e.g. "Glass Master saw" to break/cut through laminated glass of a vehicle/'s	1 iiiiiiiii	2iiii	**(9/13)** 69%
A41.	Most typical RTA involves the use of an springloaded centre punch to break tempered glass of a vehicle/'s	1 iiiiiii	2iiiiii	**(7/13)** 54%
A42.	Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/'s	1 iiiiiiiiiiiii	2	**(13/13)** 100%
A43.	Most typical RTA involves the use of wood and wedges to stabilize the vehicle/'s	1 iiiiiiiiiii	2ii	**(11/13)** 85%
A44.	Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/'s	1 iiiiiiiii	2iiii	**(9/13)** 69%

Comment: The following criteria/statements in Section A 32 (10/13 ; 77%), 34 (8/13 ; 62%), 35 (9/13 ; 69%), 36 (10/13 ; 77%), 38 (9/13 ; 69%), 40 (9/13 ; 69%), 41 (7/13 ; 54%) and 44 (9/13 ; 69%) which formed part of the initial case narrative of the 3rd round Delphi expert panel participant process of the third round had no majority consensus obtained after the final submission, analysis and compiling of the results at the end of the 3rd round process of the Delphi panel expert participation process. These abovementioned sections where no majority consensus was reached by the Delphi expert panel participants at the end of the 3rd round Delhi questionnaire process was excluded from the final typical motor vehicle related rescue incident narrative.

At the end of the 3rd round of the Delphi panel expert participant's responses the experts did not by majority consensus agree as per previous Delphi expert panel participation rounds regarding the following criteria/statements which could easily be attributed to various factors. As with the Delphi expert panel participation 3rd round questionnaire where Section B allowed for the expert panel participants to provide further comments information regarding why they either "agree" or "disagree" this was not included as part of the Section A Delphi expert panel participant 3rd round questionnaire.

The criteria/statements where no majority consensus (a less than 80% agreement to the statement/criteria by the participants at the end of the 3rd round process) was obtained during the Delphi expert panel participants 3rd round process as indicated above by the relevant/corresponding Section and number were the following. A brief comment pertaining as to what could have been the factors and/or influences which could have contributed to no majority consensus being reached is provided:

Section A 32 - Most typical RTA involve oil fluid spills and/or leakages (10/13 ; 77%).

COMMENT: As briefly explained various factors and/or influences could have contributed to the Delphi expert panel participants at the end of the 3rd round not reaching a majority consensus to this statement due to possibly that the typical motor vehicle rescue related case may have other types of fluid spills or leakages but not necessarily oil as a particular fluid. In the other sections which related similarly to investigation whether other types of fluids/spills and/or leakages of other substances or various fluids are present at the typical motor vehicle rescue related case there was a majority consensus.

Section A 34 -Most typical RTA involves collisions where it involves more than one type of collision kinetic/classification (i.e. frontal collision that resulted in a roll over (8/13 ; 62%).

COMMENT: In the typical case typology there was a majority consensus regarding the collision kinetic as being a frontal impact collision irrespective if it was a “full”, “half” or whether it involved a particular “side of the half” which was involved. The aim and purpose of this criteria/statement were to determine and/or identify whether the typical motor vehicle rescue related case involved more than one particular collision kinetic. For example, where it initially was a frontal collision which involved as a secondary collision kinetic in either being a “rear-ending” and/or “side impact whether with a pole/object other than a motor vehicle and/or with another motor vehicle that was not involved in the frontal collision” and/or, etcetera. Due to no majority consensus regarding the presence of a secondary collision kinetic type it would be safe to conclude that only a frontal collision is most prevalent at a typical motor vehicle rescue related case.

<u>Section A 35</u> -Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up (9/13 ; 69%).

COMMENT: Due to the variety of different types of motor vehicles being in use on the South African road it was imperative to establish whether a single type of motor vehicle is involved or whether a combination of different types of motor vehicles for example, minibus/taxi, heavy vehicles, pick-up/bakkie is commonly present/involved at the typical motor vehicle rescue related case.

<u>Section A 36</u> - Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation (10/13 ; 77%).

COMMENT: Various factors could have influenced the reason why during the end of the 3rd round of the expert Delphi panel participation no majority consensus was reached pertaining the lowering of equipment with the use of musculoskeletal systems and body functions or operations. It could be that some experts could have interpreted it that during the motor vehicle rescue typical case typology that they would seldom have to lower anything as it would relate to the extrication and/or creating of space/access to the patient process. Similarly, it could have been that with most typical case typologies the rescuer is required to lift as oppose to lower and in this respect could require the use of musculoskeletal system and/or body system function and/or operations.

Section A 38 - Most typical RTA involves the use of hydraulic spreading equipment to either "push and/or lift" metal and structures (irrespective if a spreader, rams, etc.) (9/13 ; 69%).

COMMENT: In the typical case typology rescuers could have felt that they "cut" more than what they would use a means of "pushing and/or lifting" using hydraulic equipment during the extrication and/or obtaining/creating access/ space to the entrapped victim/patient. Due to the dual nature of some hydraulic equipment it is not easy to determine whether certain tools/equipment would be exclusively used for a particular function and/or purpose. This could potentially require further investigation as to the purpose and/or function to which equipment is designed and how does rescuers predominantly utilize it within the context of the typical motor vehicle rescue related incident.

Section A 40 - Most typical RTA involves the use of a saw designed to cut through laminated glass e.g. "Glass Master saw" to break/cut through laminated glass of a vehicle/'s (9/13 ; 69%).

COMMENT: Similarly as to the previous statement to the hydraulic equipment it could be that rescuers might use a saw at a typical motor vehicle related incident such as a reciprocating saw which is able to cut through class, metal and/or wood (depending on the blade selection) but it may not predominantly be used for the cutting of laminated glass. As explained previously many of the equipment used within motor vehicle rescue has a more than one particular purpose and/or function which could possibly require further research as to its main uses and /or function within the context of the typical motor vehicle related incident.

Section A 41 - Most typical RTA involves the use of a spring-loaded centre punch to break tempered glass of a vehicle/'s (7/13 ; 54%).

COMMENT: No majority consensus was reached regarding the "use of a spring-loaded centre punch to break tempered class" within Section A. The Section regarding the equipment used within the typical case however had a majority consensus finding regarding the use of the spring-loaded centre punch. This could possibly be attributed to various methods and/or tools/equipment/s being used within the typical motor vehicle related rescue case when having to break tempered glass such as a haligan tool, screwdriver, etc. which provides not just an alternative tool but also an alternative method. As per previous comments some spring-loaded centre punches are designed to have a multi-purpose function and/or design with it having a component which allows for the tool to be able to cut through a seatbelt for example in addition. This could explain why rescuers could have indicated in the equipment section why they would use a particular tool and/or equipment at the typical motor vehicle rescue related incident but not reaching a majority consensus with regards to its exclusive use and/or function and/or purpose within the typical motor vehicle rescue related incident.

Section A 44 - Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/'s (9/13 ; 69%).

COMMENT: the expert Delphi participant panel reached a majority consensus regarding the use of wood, cribbing and step-chocks as being predominantly used to perform stabilization within the context of the typical motor vehicle rescue related incident. The use of 4x4 cribbing at the typical case as determined by majority consensus under the equipment section could be due to cribbing being used for example in the provision of a support base and/or platform from where lifting could be done but not necessarily where its main purpose is with respect to the stabilization of the vehicle post the collision event.

As previously expressed and detailed in the process tracing chapter 5 and Appendix K of this research document that the equipment utilized within the context of motor vehicle rescue has more than one particular function and/or use. This therefor make it difficult to investigate in a research project of this magnitude the exact use and/or function through the Delphi process with the end gaol in obtaining a majority consensus. This however would be viewed as a limitation in both the design and the tool of the research with recommendations being made by the principal investigator to potentially conduct further research to evaluate and investigate further/broader regarding the equipment and its associated uses and/or function thereof. These particular statements/criteria (in this section of the Chapter) was excluded from the final case narrative of the typical motor vehicle related rescue and included in the definition of the atypical motor vehicle rescue related case (as stated above).

In the conclusion section of this chapter the final case narrative for the typical motor vehicle rescue related case which will be used in the process tracing of the principles of physics will be defined based on those criteria/statements where a majority consensus was obtained at the end of the 3rd round process of the Delphi expert panel participation.

4.4.2 The equipment in use at a typical case typology for motor vehicle related rescue analysis, results and consensus findings

The individual equipment formed part of Section A of the 3rd round process as explained and detailed in a previous section of this chapter where the 3rd round Delphi expert panel participant questionnaire process, structure and rationale is discussed. During the 3rd round of the Delphi process of the research the expert panel (participants) was asked to indicate whether they either agreed or disagreed regarding the equipment being part of the typical motor vehicle rescue related incident. This was done in relation to Section A which focused on the equipment where a majority consensus was obtained at the end of the 2nd round process of the Delphi expert panel participant submissions, analysis and compiling of the results.

This 3rd round process was used to validate the previous two rounds where the expert panel participants were to indicate once again their responses in order to obtain or determine whether a majority consensus was to be reached at the end of the completion of the 3rd round process of the Delphi questionnaire. The 3rd round Delphi expert panel questionnaire (cf. Appendix I) Section A which dealt with the criteria/statement which was to be used in the identifying of the equipment which is predominantly used in the typical motor vehicle rescue related case which was distributed at the beginning of the 3rd round to all 13 expert Delphi panel participants.

The below Table 5 represents the final results of Section A which dealt with the equipment as obtained from the end of the 3rd round Delphi expert panel participation process on evaluation of the submitted individual questionnaire from the 13 participants. Only those areas where a majority consensus (greater than 80%- 11/13 ; 85%) per the individual equipment where to be included as the equipment predominantly used at the typical motor vehicle rescue related incident. These individual pieces of equipment were to be used within Chapter 5 for the process tracing of the themes of the principles of physics. Below is the individual equipment breakdown as calculated by the principal investigator after the submission of all the 13 participants at the end of the 3rd round Delphi expert panel participant process.

Table 5 Final results as obtained from the 3rd round questionnaire responses for Section A-Equipment

	SECTION A In Section A of the 3rd round of the questionnaire you as the Delphi panel participant/expert is required to indicate whether you agree or disagree with the theme/topic/statement as being prevalent within the typical motor vehicle related case. Please read the narrative above with regards to the themes/topics/statements contained within the previous two rounds of the Delphi process questionnaire where a majority consensus was reached and obtained. This process is used to validate the consensus which has been obtained during the previous two rounds of the Delphi process of the questionnaire.			
	Please mark the appropriate block with an X. Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Disagree			
		Agree	**Disagree**	**Comments**
A1.	Cribbing (2x4)	1iiiiiiiiiii	2i	(12/13) 92%
A2.	Cribbing (4x4	1iiiiiiiiiiii	2	(13/13) 100%
A3.	Wedges	1 iiiiiiiiiiii	2	(13/13) 100%
A4.	Stepchocks	1 iiiiiiiiiiii	2	(13/13) 100%
A5.	Ratchet strapping	1 iiiiiiiiii	2ii	(11/13) 85%
A6.	Halligan Tool	1 iiiiiiiiiiii	2	(13/13) 100%
A7.	Boltcutter	1 iiiiiiiiii	2ii	(11/13) 85%
A8.	Pliers (channel lock type)	1 iiiiiiiiii	2ii	(11/13) 85%
A9.	Pliers (side cutters)	1 iiiiiiiiiiii	2	(13/13) 85%
A10.	Screwdriver (Flat)	1 iiiiiiiiii	2ii	(11/13) 85%
A11.	Crow bar	1 iiiiiiiiiii	2i	(12/13) 92%
A12.	Springloaded punch	1 iiiiiiiiiiii	2	(13/13) 100%
A13.	Seatbelt cutter	1 iiiiiiiiiii	2i	(12/13) 92%
A14.	Scissor (serrated edge type)	1 iiiiiiiiii	2ii	(11/13) 85%
A15.	Rescue knife	1 iiiiiiiiiii	2i	(12/13) 92%

A16.	Reciprocating saw	1 iiiiiiiiiii	2ii	(11/13) 85%
A17.	Windshield saw	1 iiiiiiiiiiii	2	(13/13) 100%
A18.	Shovel	1 iiiiiiiiiiii	2	(13/13) 85%
A19.	Broom	1 iiiiiiiiiiii	2	(13/13) 100%
A20.	Airbag cover	1 iiiiiiiiiii	2i	(12/13) 92%
A21.	Power plant (Fuel driven)	1 iiiiiiiiiiii	2	(13/13) 100%
A22.	Spreader tool	1 iiiiiiiiiiii	2	(13/13) 100%
A23.	Cutter tool	1 iiiiiiiiiiii	2	(13/13) 100%
A24.	Ram tool	1 iiiiiiiiiiii	2	(13/13) 100%
A25.	Pedal cutter tool	1 iiiiiiiiii	2i	(12/13) 92%
A26.	Ram support (bracket/base plate)	1 iiiiiiiiii	2ii	(11/13) 85%
A27.	Lighting	1 iiiiiiiiiiii	2	(13/13) 85%
A28.	Jacks (hi lift)	1 iiiiiiiiiii	2i	(12/13) 92%

Comment: A majority consensus was reached again regarding all aspects as it related to the previous two rounds of the Delphi process pertaining to the Section A- Equipment at the end of the 3rd round of the Delphi process with no individual piece of equipment not obtaining a minority or disagree rating/score (less than 80%) even as a majority consensus finding.

4.4.3 Defining the atypical case typology for motor vehicle related rescue based on the analysis, results and consensus findings

The methodology and formulation of the individual statements/criteria which formed part of Section B of the 3rd round process as explained and detailed in a previous section of this chapter where the 3rd round Delphi expert panel participant questionnaire process, structure and rationale is discussed. During the 3rd round of the Delphi process of the research the expert panel (participants) was asked to indicate whether they either agreed or disagreed regarding the statement/criteria as it would relate to Section B. This Section focused on the various aspects of type, design, hazards, collision kinetics, rescue response, etc., where a majority consensus (greater than 80% ; 11/13 ; 85%) was obtained regarding being neutral/undecided or in disagreement or where no majority consensus (less than 80%) was obtained in either of the rating/scale at the end of the 2nd round process of the Delphi expert panel participant submissions, analysis and compiling of the results.

This 3rd round process was used to validate the previous two rounds where the expert panel participants were to indicate once again their responses in order to obtain or determine whether a majority consensus was to be reached at the end of the completion of the 3rd round process of the Delphi questionnaire. The 3rd round Delphi expert panel questionnaire (cf. Appendix I) Section B which dealt with the criteria/statement which focused on the various aspects of type, design, hazards, collision kinetics, rescue response, etc., which was to be used in the defining/identifying the atypical motor vehicle rescue related case at the end of the completion and submission of all 13 participant's individual responses of the 3rd round Delphi expert panel participant process.

The below Table 6 denotes the final results as obtained from the 3rd round questionnaire responses per the individual statements below as calculated by the principal investigator after the submission of all the 13 participants within the 3rd round Delphi expert panel participant process. Only those areas where a majority consensus of greater than 80% (11/13 ; 85% and greater) in terms of where the Delphi expert panel participants agreed to the prevalence of the individual criteria/statement was to be used in the development of the final case narrative of the typical motor vehicle rescue related case. Those individual criteria/statement where a majority consensus (greater than 80%) with respect to the rating/scale where there was disagreement or where no majority consensus (less than 80%) was obtained for any of the rating/scale pertaining to being in agreement and/or disagreement would be included in the definition of the atypical motor vehicle rescue related case at the end of the 3rd round of the Delphi expert panel participant final individual submissions analysis and compiling of the results.

Table 6 Example of the final results at the end of the Delphi 3rd round responses pertaining to Section B

SECTION B

In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.

In the Comments section indicate with respect to your response to Agree or Disagree the basis for your response using the options provided by indicating with a X according to the following scale:

1 = Agree
A = **Commonly seen/encountered** in typical motor vehicle related rescue case with **some and/or minimal** influences and/or factors on the rescue incident.
B = **Commonly seen/encountered** in typical motor vehicle related rescue case with **NO** influences and/or factors on the rescue incident.
2 = Disagree
C = **Uncommon and/or rarely seen/encountered** in typical motor vehicle related rescue case with influences and/or factors on the rescue incident.
D = **Uncommon and/or rarely seen/encountered** in typical motor vehicle related rescue case with **some and/or minimal** influences and/or factors on the rescue incident.
E = **Uncommon and/or rarely seen/encountered** in typical motor vehicle related rescue case with **NO** influences and/or factors on the rescue incident.

		Agree	**Comments**		**Disagree**	**Comments**			**Results**
B17.	Most typical RTA involves vehicles that have the new car technology (i.e. crumple zones, reinforced dashboards, micro alloy and boron steel, etc)	1iiiiiiiii	Aiiiiiii	Bii	2iii	C	Diii	E	10/13 77%
B18.	Most typical RTA occur with unibody construction/design vehicles (unibody vehicle uses the body panels and floorpan to form its structure)	1iiiiiiiii	Aiiiiii	Biii	2iii	Cii	D	Ei	10/13 77%
B19.	Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)	1iiiiiiiiii	Aiiiiiii	Biii	2ii	C	Di	Ei	11/13 85%
B20.	Most typical RTA occur with full frame construction /design vehicles (the body bolts to a welded frame and is the full length of the car)	1iiiiiiii	Aiiiiii	Bii	2iiii	Cii	D	Eii	9/13 69%
B21.	Most typical RTA occur with vehicles that are diesel fuel driven	1iiii	Aii	Bii	2iiiiiii	Cii	Diiiiii	E	8/12 66%

B22.	Most typical RTA occur with vehicles that are petroleum fuel driven and are modified with some form of gas (e.g. nitrogen gas) affixed to enable and/or enhance performance	1iii	Aii	Bi	2iiiiiiii ii	Ci	Diiiiii	Eiii	10/13 77%
B23.	Most typical RTA occur with light delivery vehicles (LDV) (include your ½ tonner bakkies to 1 tonner bakkies, double cabs)	1iiiiiii	Aiiiii	Bii	2iiiiii	Ciii	Dii	Ei	7/13 54%
B24.	Most typical RTA involve busses (includes minibuses and larges busses whether for personal, commercial or public transport)	1iiiiiiiii	Aiiiiii	Biii	2iii	Cii	Di	E	9/12 75%
B25.	Most typical RTA involve trucks (those over 10 ton capacity irrespective of amount of axles and whether it has a “horse & trailer”)	1iiii	Aii	Bii	2iiiiiiii i	Ciiiii	Diii	Ei	9/13 69%
B26.	Most typical RTA involves trains which have collided with any other forms of road transportation that have occurred at a public or private road.	1ii	Aii	B	2iiiiiiii iii	Ciiiiii	Diiii	Ei	11/13 85%
B27.	Most typical RTA involve fuel spills and/or leakages	1iiiiiiiiiii	Aiiiiiiiii	Bii	2ii	Ci	Di	E	11/13 85%
B28.	Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {“idling”}	1iiiiiiiiiiii	Aiiiiiiiii i	Bii	2i	C	Di	E	12/13 92%
B29.	Most typical RTA involves a fire to engines compartment	1iiiiiii	Aiiiii	Bii	2iiiiii	Cii	Di	Eiii	7/13 54%
B30.	Most typical RTA involves undeployed airbags (irrespective if it is frontal and/or side impact airbags)	1iiiiiiii	Aiiiiiii	Bi	2iiiii	Ciii	Di	Ei	8/13 62%
B31.	Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)	1iiiiiiiiiii	Aiiiiiiii	Biii	2ii	C	Dii	E	11/13 92%
B32.	Most typical RTA involves undeployed Automatic Roll Over Protection Systems (ROPS)	1iiiiiii	Aiiiiii	Bi	2iiiiii	Cii	Di	Eiii	7/13 54%

B33.	Most typical RTA involves deployed Automatic Roll Over Protection Systems (ROPS)	1iiiii	Aii	Biii	2iiiiiii	Ciii	Dii	Eiii	8/13 62%
B34.	Most typical RTA involves electrical hazards (i.e. lamp standard, ESKOM power supply unit, etc)	1iiiiiii	Aiiiiiii	B	2iiii	Ci	Diii	E	9/12 75%
B35.	Most typical RTA involves side impact collisions	1iiiiiiii	Aiiiiii	Bii	2iiii	Cii	Di	Ei	9/13 69%
B36.	Most typical RTA involves roll over collisions	1iii	Aiii	B	2iiiiiii ii	Ciiii	Dii	Eiii	10/13 77%
B37.	Most typical RTA involves under runs (irrespective what the object is that the vehicle ran underneath into e.g. truck, railing, etc)	1iiii	Aiii	Bi	2iiiiiii	Ciiii	Diii	E	9/12 75%
B38.	Most typical RTA involves crush incidents (irrespective of what the object is that is creating a "crush" onto the vehicle e.g. wall, truck, container)	1iiiii	Aiiii	Bi	2iiiiii	Ciiii	Dii	Ei	7/13 54%
B39.	Most typical RTA involves two similar type of mode of transport (e.g. passenger vehicle vs passenger vehicle, minibus vs minibus)	1iiiiii	Aiiii	Biii	2iiii	Cii	Dii	Ei	7/12 58%
B40.	Most typical RTA involves single vehicle collisions with a stationary object.	1iiiiii	Aiiii	Biii	2iiiii	Ciiii	D	Ei	7/13 54%
B41.	Most typical RTA involves the use of hydraulic spreading equipment to either "pull" metal and structures	1iiiiiii	Aiiiiii	Bi	2iiiii	Cii	Dii	Ei	8/13 62%
B42.	Most typical RTA involves the use of hydraulic equipment to either power and operate hydraulic equipment (hydraulic motor pump, hydraulic hand pump, etc)	1iiiiiiii	Aiiiiiii	Bi	2iii	Ci	Dii	E	10/13 77%
B43.	Most typical RTA involves the use of hydraulic equipment to stabilize vehicle/'s and/or structures	1iiiii	Aiii	Bii	2iiiiiii	Cii	Dii	Eiiii	8/13 62%
B44.	Most typical RTA involves the use of handtools to extricate patients from vehicle/'s (i.e. highlift jack, hacksaw, haligan tool, etc)	1iiiiiii	Aiiiiii	Bi	2iiiii	Ci	Dii	Eii	8/13 62%

B45.	Most typical RTA involves the use of an axe to break/cut through laminated glass of a vehicle/'s	1ii	Aii	B	2iiiiiiii iii	Ciiii	Diii	Eiii	11/13 85%
B46.	Most typical RTA involves the use of an reciprocating saw to break/cut through laminated glass of a vehicle/'s	1iiiiiiii	Aiiiii	Biii	2iii	Ci	Dii	E	9/12 75%
B47.	Most typical RTA involves the use of an axe and haligan tool to break tempered glass of a vehicle/'s	1iiiii	Aiiiii	B	2iiiiiii	Ciiii	Diii	Ei	8/13 62%
B48.	Most typical RTA involves the use of an sharp object for example a screwdriver to break tempered glass of a vehicle/'s	1iiiiii	Aiiiii	Bi	2iiiiii	Ciii	Dii	Eii	7/13 54%
B49.	Most typical RTA involves the use of highlift jacks to stabilize the vehicle/'s	1iii	Aiii	B	2iiiiiii ii	Ciii	Diii	Eiiii	10/13 77%
B50.	Most typical RTA involves the use of pneumatic equipment/ shores to stabilize the vehicle/'s	1iiii	Aiiii	B	2iiiiiii i	Cii	Diiiii	Eii	9/13 69%
B51.	Most typical RTA involves the use of ratchet straps to stabilize the vehicle/'s	1iiii	Aiii	Bi	2iiiiiii	Cii	Diii	Eiii	9/13 69%

Comments:

The following statements/themes within Section B at the end of the 3rd round Delphi expert panel participation process obtained a majority consensus (greater than 80%) agreement as was to be included in the typical motor vehicle rescue related case/incident.

Section B- 19 - Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and while it does provide structural support) (11/13 ; 85%).

COMMENT: The inclusion of this statement/criteria within the typical motor vehicle rescue related case could be that the Delphi expert panel participants experienced and exposure to the various vehicles which are predominantly involved in a typical road traffic accident being of this particular design. This would assist in the process tracing of the physics as it would provide further insight into the type of physics which are used in the construction and design of the safety systems and efficiencies within the passenger vehicle by the manufacturers.

Section B- 27 - Most typical RTA involves fuel spills and/or leakages (11/13 ; 85%).

COMMENT: Within Section A at the end of the 3rd round Delphi expert panel participation process it was determined that the typical motor vehicle related rescue incident involves a passenger vehicle which is driven by petroleum fuel. This will provide further insight into the type of hazards which is predominantly encountered at a typical motor vehicle rescue related incident. The size of the spill and/or method of containment and/or manner in which it is neutralized and/or mitigated does not form part of the criteria/statements which is to be investigated/evaluated within the typical motor vehicle rescue related case/incident as explained within the limitations and delineation of the scope of this research study.

Section B- 28 - Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle's ignition system is still active ["idling"}) (12/13 ; 92%).

COMMENT: These criteria/statement provide additional information pertaining to the considerations and hazards which the rescuer potentially would have to manage at the typical motor vehicle rescue related case/incident. Due to active power systems which could potentially influence the approach and/or considerations which has to be made pertaining to the minimizing/mitigation of other hazards/systems which are dependent on the power system of the vehicle by the rescuer and the incident.

Section B- 31 - Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag) (11/13 ; 85%).

COMMENT: Most motor vehicles come standard fitted with at least one airbag whether it is being located/stored within the steering wheel of the driver. This provide further opportunity to evaluate the themes of the principles of physics as it may relate to other aspects of the typical motor vehicle rescue related case/incident for other areas as it may relate to the field of medicine and kinematics of trauma.

Where there was a "spoiled" criteria/statement due to the individual Delphi expert panel participant failing to provide a response, further attempts were made by the principal investigator to contact the individual Delphi expert panel participant concerned requesting further input pertaining to the criteria/statement which was incomplete. After a certain period, which had lapsed with no desired response received from the individual Delphi panel expert participant pertaining to the request to provide further input a decision was taken by the principal investigator in consultation with the supervisors to keep the majority consensus as per the complete total of 13 participants i.e. where only 12 participants provided a response at least 11 of the participants had to agree in order for it to be viewed as a majority consensus. Where 10 of the 12 participants agreed pertaining to criteria/statement where a “spoiled” response was noted it was not considered as a majority consensus (even though 10/12 is equal to 83%) as all other criteria’s/themes/statements would have required a minimum of 11 participants being in agreement to the prevalence and inclusion of a particular criteria/statement within the typical MVR related case.

All other criteria/statements where no majority consensus (less than 80%) agreement or disagreement was obtained and those areas/criteria’s statements where a majority consensus (greater than 80%) disagreement was obtained was to be included in the definition of the atypical motor vehicle rescue related case/incident. Due to the limitations, delineation, scope, objectives and amount of information which is to be included in the atypical motor vehicle case the principal investigator will in conclusion of this chapter provide further comment pertaining to the definition of the atypical motor vehicle rescue related incident.

The information as per previous sections detailing the aim, purpose, use and methodology pertaining to the 3rd round questionnaire and the various Sections was explained. The component where the Delphi expert panel participant were required to provide a further response in addition to indicating whether they agree or disagree had no particular influence on the previous rounds of the Delphi process as well as the development of the final case narrative of the typical motor vehicle related rescue incident. The rationale and purpose was to strengthen the validation process and seek further information regarding what could be some of the influences and factors as it may relate to the statement/criteria within the context of the motor vehicle related rescue incident.

The principal investigator used a method and process of evaluating where the most (more than at least 7/13 ; 54%) selections was provided in the analysis of the responses (further information based on the experts experience/opinion/exposure) selected pertaining to whether the Delphi experts agreed or disagreed pertaining to the individual statement/criteria for Section B of the 3rd round Delphi expert panel participation process for the areas which related to the design/hazards/ collision kinetics/rescue response at the end of the 3rd round process.

The Delphi expert panel participants indicated that they agreed (even though no majority consensus finding was obtained at the end of the 3rd round for the indicated numbered sections following) regarding the statement/criteria selected for Section B with respect to it being a commonly seen/encountered theme/statement in the typical motor vehicle rescue case with some and/or minimal influences and/or factors on the rescue incident for following numbered Sections of B (- 17; -18; -20, -24; -30; -34; -35; -41; -42; -44 and -46).

Similarly, the Delphi expert panel participants indicated that they agreed (by majority consensus of greater than 80%) that the following selected numbered Section B (-19; -27; -28; -31) was commonly seen/encountered in typical motor vehicle related rescue cases with some and/or minimal influences and/or factors on the rescue incident. Where the Delphi expert panel participants disagreed (even though no majority consensus finding was noted of greater than 80%) to the following numbered Section B (-21 and -22) which was due to it being uncommon and/or rarely seen/encountered in typical motor vehicle related rescue case with some and/or minimal influences and/or factors on the rescue incident. No other statements/criteria presented in being mostly selected/indicated from the additional information which was sought based on either where the Delphi expert panel participants had agreed or disagreed irrespective of a majority consensus.

4.4.4 Defining the equipment in use at an atypical case typology for motor vehicle related rescue based on the analysis, results and consensus findings

The individual equipment formed part of Section B of the 3rd round process as explained and detailed in a previous section of this chapter where the 3rd round Delphi expert panel participant questionnaire process, structure and rationale is discussed. During the 3rd round of the Delphi process of the research the expert panel (participants) was asked to indicate whether they either agreed or disagreed regarding the equipment being part of the typical motor vehicle rescue related incident. This was done in relation to the Section A which focused on the equipment where a no majority consensus (less than 80% agreement or undecided/neutral or disagreement) or where a majority consensus (greater than 80%) pertaining to disagreement was obtained at the end of the 2nd round process of the Delphi expert panel participant submissions, analysis and compiling of the results.

This 3rd round process was used to validate the previous two rounds where the expert panel participants was to indicated once again their responses in order to obtain or determine whether no majority consensus (less than 80%) was to be reached pertaining to the Delphi expert panel participants being in agreement or disagreement with respect to the prevalence of the individual equipment for inclusion within the typical MVR related case at the end of the completion of the 3rd round process of the Delphi questionnaire.

The 3rd round Delphi expert panel participation questionnaire (cf. Appendix I) which was circulated to all 13 participants at the beginning of the 3rd round process which focussed on Section B which dealt with the equipment pertaining to the field and discipline of motor vehicle rescue where no majority consensus was obtained through the previous two rounds of the Delphi Expert panel participant process. The Delphi expert panel participants had to indicate whether they either agree or disagree with the individual piece of equipment/tool being prevalent within the typical motor vehicle rescue related case/incident. The 13 participants was then further required to indicate based on whether they agreed (to provide further information as to whether it is a SOP/Guidelines compliances or Not a SOP/ Guidelines requirement but a good tool) or disagree (where further information pertaining to this selection was to be provided as to whether in their expert opinion it was not an effective tool or whether it was effective and/or efficient tool but not available or whether it was due to the rescuers own [personal choice or training bias) which influenced their decision pertaining to the individual piece of equipment.

Below in Table 7 is the final analysed and calculated results as obtained at the end of the 3rd round Delphi expert panel questionnaire process for the Section B which dealt with the equipment which was to be used in the defining/identifying and inclusion of the typical case (where a greater than 80% majority consensus was reached) or atypical case (where no majority of less than 80% consensus was reached).

Table 7 Example of the final results at the end of the Delphi 3rd round pertaining to Section B for the equipment

SECTION B

In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.

In the **Comments** section indicate with respect to your response to **1 = Agree or 2 = Disagree** the basis for your response based on the options provided by indicate with a **X** according to the following scale:

1 = Agree
A= SOP/Guidelines Compliance
B = Not a SOP/Guideline compliance but a good tool
2 = Disagree
C = Not an effective or efficient tool
D = Effective and/or efficient tool but not available
E = Rescuer personal choice and/or training bias

		Agree	**Comments**		**Disagree**	**Comments**			**Results**
B1.	Pneumatic struts	1iiiiii	Aiiii	Bii	2iiiiiii	C	Diii	Eiiii	7/13 54%
B2.	Mechanical struts	1iiiiiiiiii	Aiiiii	Biiiii	2ii	C	D	Eii	10/12 83%
B3.	Chain with J-hooks	1iiiii	Ai	Biiii	2iiiiiiii	C	Di	Eiiiiiii	8/13 77%
B4.	Strut Head (Cone shaped)	1iiiiiii	Aiiii	Biii	2iiiii	C	Di	Eiiii	7/12 58%
B5.	Strut head (L-shaped)	1iiiiiii	Aiii	Biiii	2iiiii	C	Dii	Eiii	7/12 58%
B6.	Strut base plate	1iiiiiiiii	Aiiiiiii	Bii	2iiii	Ci	Di	Eii	9/13 69%
B7.	V- Strut	1iiiiiii	Aiiii	Biii	2iiiiii	C	Diii	Eiii	7/13 54%
B8.	Axe (Flathead)	1iiiiiiii	Aiiiiiii	B	2iiiii	Cii	D	Eiii	8/13 62%
B9.	Axe (Pickhead)	1iiiiiii	Aiiiiiii	B	2iiiiii	Ci	Di	Eiiii	7/13 54%
B10.	Webbing	1iiiiiii	Aiiiiii	Bi	2iiiiii	C	D	Eiiiiii	7/13 54%
B11.	Come-along tool	1iiiiii	Aiiiii	Bi	2iiiiiii	Cii	Dii	Eiii	7/13 54%
B12.	Hacksaw	1iiiiiiii	Aiiiii	Biii	2iiiii	Ci	D	Eiiii	8/13 62%
B13.	Air chisel or gun cutting tool	1iiiiiii	Aiiii	Bii	2iiiiii	C	Diii	Eiii	7/13 54%

B14.	Chains	1iiiiii	Aiiii	Bii	2iiiiiii	C	Di	Eiiiiii	7/13 54%
B15.	Jack (hydraulic)	1iiiiiiiii	Aiiiiiii	Bii	2iii	C	D	Eiii	10/13 77%
B16.	Vetter bags	1iiiiiiiii	Aiiiiiiii	Bi	2iii	Ci	Di	Ei	10/13 77%

Comment: There was no majority consensus (greater than 80%) pertaining to where the Delphi expert panel participants agreed to the use of an individual piece of equipment inclusion to the typical motor vehicle rescue related case. There was further no majority consensus finding pertaining to the disagreement pertaining to any criteria/areas related to the 3rd round Delphi expert panel participant Section B which related to defining the equipment in use at an atypical motor vehicle related rescue case at the end of the 3rd round Delphi process.

The following individual numbers per Section B (-2; -4; -5) was “spoiled” due to some Delphi expert panel participants failing to indicate at an individual piece of equipment their response/selection. As previously explained based on consultation by the principal investigator and the supervisors it was decided not to include those individual piece of equipment within the typical motor vehicle rescue related incident if there had not been at least 11 out of the 12 participants which had provided a response indicating that they agree to the prevalent use of the individual piece of equipment.

The component within the 3rd round Delphi questionnaire process where the Delphi expert panel participant were required to provide a further response/selection in addition to indicating whether they agree or disagree had no particular influence on the previous rounds of the Delphi process as well as the development of the final case narrative of the typical motor vehicle related rescue incident. As explained the rationale and purpose was to strengthen the validation process and seek further information regarding what could be some of the influences and factors as it may relate to the statement/criteria within the context of the MVR related incident.

The researcher used a method and process of evaluating where the most (more than at least 7/13 ; 54%) responses was provided in the analysis (further information based on the experts experience/opinion/exposure). This was based on whether the Delphi experts agreed or disagreed pertaining to the individual statement /criteria for Section B of the 3rd round Delphi expert panel participation process for the areas which related to the Section B-equipment response at the end of the 3rd round process.

The Delphi expert panel participants indicated that they agreed (even though no majority consensus finding was obtained at the end of the 3rd round for the indicated numbered sections following) regarding the Section B –equipment response with respect to it being a SOP/Guidelines Compliance as an influence and/or factor on the rescue incident for following numbered Sections of B (- 6; -8; -9; -15 and -16).

Similarly, the Delphi expert panel participants indicated that they disagreed (with more than 7/13 responses) that the numbered Section B -3 was based on the rescuers personal choice and/or training bias. No other numbered areas of Section B- equipment where no majority consensus was reached at the end of the 3rd round Delphi expert panel participation process presented in a manner where there was a 7/13; 54% and/or more consensus regarding the additional information which was sought based on either where the Delphi expert panel participants had agreed or disagreed.

4.5 CONCLUSION

Chapter 4 discussed the various aspects as it would have related to the aims, objectives, design of the Delphi questionnaire rounds, the processes, as well as how the analysis was done in terms of determining if a- or no – majority consensus was obtained as well as what the various findings was pertaining to the rounds. Comments and further explanations was provided as to how each component mentioned above influenced and/or contributed to the Delphi research method employed.

Below is the typical motor vehicle rescue related case which was developed through the various rounds of the Delphi expert panel participation process which was based on the majority agreement findings post the 3rd round process. The equipment in use at the typical motor vehicle rescue related incident as identified at the end of the 3rd round process of the

Delphi expert panel participation process is further defined and discussed using the process tracing in Chapter 5 of this research document.

"The typical motor vehicle related rescue case involves a vehicle which is petrol driven with a body over frame construction/design (body is attached to the frame which provides structural support) which is a passenger vehicle such as a sedan, station wagon, sport utility vehicle, etc. with an active power system (i.e. the battery has not been disconnected and/or the vehicle system is still active ["idling"); with radiator and fuel spills and/or leakages; which has been involved in a frontal collision (irrespective if it is a full, half, quarter or partial frontal involvement) with deployed airbags (irrespective if it is a frontal and/or side impact airbag); the use of wedges and step-chocks to stabilize the vehicle; with the use of hydraulic equipment to either cut metal and/or structures (irrespective if conventional cutter or mini-cutter or combitool, etc.); which requires rescue personnel to use equipment that requires lifting through the use of musculoskeletal and body system function operations."

The atypical motor vehicle case has been defined utilizing the remaining criteria/statement and the equipment section where no majority consensus finding was obtained at the end of the 3rd Delphi expert panel participation process. The atypical case was not written in a manner which would be utilized in the following Chapter 5 of the process tracing as per the typical MVR related incident/case as the scope and purpose (sub-questions) of the research design was to merely define the atypical case.

Much needed further research is required in developing other aspects as it would relate to the typical MVR related incident as the scope and magnitude of this study was not enabled to go beyond that as which was described within the limitations and delineation of this study which is discussed in the other chapters and sections of this document. This development of the typical case for the MVR related incident has however provided a platform and basis from which other research could be done within the discipline utilizing a similar methodology and approach, or where this case could be further developed to investigate other aspects to it.

CHAPTER FIVE

PROCESS TRACING- ANALYSIS & FINDINGS

5.1 INTRODUCTION

The physics related to the phases of a motor vehicle collision and what occurs during the collision with both the vehicles and the occupants, is well documented within some physics and emergency medical care textbooks. In the literature review the physics related to the respective phases, and the motivation for its use as an explanatory tool for motor vehicle rescue, is discussed. The inclusion of physics within a professional bachelor's degree for Emergency Medical Care with reference to its educational rationale and strength in addressing the professional discourse with respect to rescue is discussed in Chapter 2 of the Literature Review.

In this Chapter, the typical case narrative which emanated from the modified Delphi process discussed in Chapter 4, will be analysed using a thematic analysis of the process tracing. The analysis of the typical case and equipment for the principles of physics would address the research question as described in Chapter 3 of the Research Methodology. A methodological argument has been made for process tracing in Chapter 3. The process tracing used in this study is confined to those factors within the delineated scope discussed in Chapter 1. An expert in theoretical physics was consulted to screen themes for omissions or unqualified leaps of logic.

5.2 PROCESS TRACING AND THEMATIC ANALYSIS OF THE PRINCIPLES OF PHYSICS WITHIN THE TYPICAL MOTOR VEHICLE RESCUE CASE

Table 8 below is a brief inventory of the predominant themes which address the principles of physics pertaining to the respective phases that are identified for the typical case. The different phases are categorised into a; (i) static[50], (ii) pre-event[51], (iii) event[52] and, the (iv) post-event[53] phase. The ‘event’ in this description refers to the motor vehicle collision.

The inventory is designed to aid in describing and guiding the scope of the chapter. The analysis focused on the post-event phase. The process tracing only evaluates the typical case narrative and equipment as determined at the end of the third round of Delphi.

Table 8 Inventory of the predominant physics themes, with broad explanation, pertaining to the lineated phases of the MVR event.

Physics Themes	Static (standing still)	Pre-collision (moving)	Collision/Event	Post-collision
KINEMATICS	**distance** **displacement** **speed** **velocity** **acceleration** **Δ = 0 units** **Δ ≡ change in the value** **Δ = 0 implies no change in the relevant quantity.** **acceleration = Δvelocity / Δtime**	**distance** **displacement** **speed** **velocity** **Δ ≠ 0 units** **Δ acceleration = 0** vehicle is moving with constant velocity, forces acting on it are in equilibrium. or, **Δ acceleration ≠ 0** vehicle is moving with changing velocity, forces acting on it are not in equilibrium.	**distance** **displacement** **speed** **velocity** **acceleration** **Δ ≠ 0 units**	**distance** **displacement** **speed** **velocity** **acceleration** **Δ = 0 units** While there may not be movement on the scene after the collision, *Δ acceleration = 0*, implying a balance of forces, it does not imply stability in the post-collision phase. The instabilities may, after a short time manifest and forces become imbalanced, resulting in *Δ acceleration ≠ 0*, and therefore, motion.
FORCES	**Mass and inertia** Mass depends on inertia – the property of an object to resist changes in motion. **Centre-of-mass** Is the point in (or outside) an object or system (vehicle) representing the average location of mass.	**Mass and inertia** **Centre-of-Mass**	**Mass and inertia** **Centre-of-mass**	**Mass and inertia** **Centre-of-mass**

50 Where the vehicle is in a ‘state of rest’ and where the sum of forces acting on the vehicle is zero.
51 The vehicle has moved from its position of rest to being in motion irrespective of the speed at which movement is occurring and the direction of travel.
52 This would be the collision phase of the incident irrespective of the type of collision kinetic and/or factors involved.
53 This is the phase post the collision kinetics with the vehicle being in a “static” but presumed unstable state with the associated response from emergency and allied response agencies after having being activated.

FORCES	**Weight (force due to gravity)** = m x g, where m is the mass of the vehicle and g is the acceleration due to gravity.	**Weight**	**Weight**	**Weight**
	Normal force The reaction force of the surface pushing back up on the vehicle, and is perpendicular to the surface. This force is crucial in determining frictional forces.	**Normal force**	**Normal force**	**Normal force**
	Force of friction (between tyres and surface) = μ_{static} x **Normal force**, where μ_{static} is the coefficient of static friction, and depends on surfaces in contact. This is for the case when the vehicle is about to move, but not yet moving.	**Force of friction** (between tyres and surface) = $\mu_{kinetic}$ x **Normal force**, where $\mu_{kinetic}$ is the coefficient of kinetic friction, depends on surfaces in contact, and is for the case when the vehicle is already moving.	Both **static and kinetic frictional** forces are efficacious during the collision phase.	**Force of friction** Important to consider to prevent slipping, and may be compromised by **fluids** from the damaged vehicles leaking onto surfaces.
		Air resistance (drag) velocty^2 cross-sectional area of vehicle in direction of motion.		**Torque** ('twisting' force) causing rotation. **Levers** utiise torque **Tension ('**pulling force') transmitted axially in one dimension. **Torques and tensions** manifest in unstable metal structures. Also utilised by rescue tools.
DYNAMIC LAWS	**Newton's three laws of motion (NI, N2, and N3)** Describe the effect of forces (balanced and unbalanced) on motion. When a vehicle is not in motion, the forces acting on it are balanced.	**Newton's laws** **NI, N2,** and **N3.** (N3, for example, for analysing forces between tyres and surface). A vehicle may be moving with constant velocity, in which case the forces acting on it are balanced.	**Newton's laws** **NI, N2,** and **N3**. All three play a crucial role in the actual collision, in terms of the colliding vehicles, and motion of passengers, and objects in the vehicles.	**Newton's laws** **NI, N2,** and **N3**. In the post-collision scene, vehicles and structures need to be stabilised using different types of equipment. Stabilisation depends to a large extent on setting up 'triangles of stability', in which the forces in action balance, thus creating a condition of static equilibrium – necessary for stabilisation without motion. This is underpinned by Newton's laws using the concepts of **vectors** to represent the physics. The redirection of load forces to stable bases (as in the 'wine glass' principle) can be represented by vectors.
		Linear momentum = m x v **The law of conservation of linear momentum (COLM)** implies that, in a closed system, the momentum before a collision is equal to the momentum after. The faster the vehicle is moving, the greater its momentum will be going into a collision.	**Linear momentum** This type of collision would be an inelastic collision (colliding objects do not bounce off each other without a kinetic energy conversion). Kinetic energy is not conserved in an inelastic collision. It is converted to other forms of energy.	**Fluid dynamics** Notably, **Pascal's Principle**, which states that the pressure applied anywhere in a closed, incompressible fluid is transmitted equally in all directions throughout the fluid. This principle is utilised in **hydraulic rescue equipment,** such as the 'jaws of life'. Other fluid dynamic principles that may be utilised are the **equation of continuity** and **Bernoulli's principle**.
				Gas mechanics / laws The mechanics of compressed gases are utilised in **pneumatic** rescue tools such as; pneumatic chisels, struts and air lifting bag rescue systems.

ENERGY	**The law of conservation of energy** states that energy cannot be created or destroyed, only transformed from one form to another. In the next phases, the energy conversions are taken into account. The energy to move from the static phase to the next phase is derived from the **chemical potential energy** contained in the fuel. Energy conversions to kinetic energy take place during internal combustion processes, also involving the **electrical potential** of the battery which results in electrical current and voltage.	**Kinetic energy (Motion energy)** $= {}^{1}/_{2}\, mv^{2}$ The energy the vehicle will have by virtue of its motion. This energy is taken into the collision.	**Kinetic energy** Kinetic energy is converted, largely to energy used to deform the colliding vehicles' structure, (but also to other forms, such as heat energy and noise). **Impulse** Is equal to: **$F\ \Delta t = \Delta p$** and is a consequence of Newton's second law. This relates the force of impact, **F**, the time over which the impact occurs, **t**, and the change in momentum, **Δp**. **Work done/Energy transferred** The energy transferred in moving an object by a net force acting in the direction of the displacement, such as the displacement of vehicles from their course during a collision, or, work done on the structure of a vehicle in a collision.	**Potential energy** Principle of minimum Potential energy implies that structures in the post collision phase not in its lowest potential energy state are unstable, and will tend to stability by converting potential energy to kinetic energy. **Work done/Energy transferred** e.g. in utilising rescue tools to move structure.

5.3 PROCESS TRACING FINDINGS OF THE PHYSICS THEMES WITHIN THE TYPICAL CASE

The following case typology narrative (italicised below) was developed at the end of the third round Delphi process where participants had reached a consensus (within +80%). This does not include the process tracing for the equipment findings which are presented in 5.4 further below.

> *"The typical motor vehicle related rescue case involves a vehicle which is petrol driven with a body over frame construction/design (body is attached to the frame which provides structural support) and which is a passenger vehicle such as a sedan, station wagon, sport utility vehicle, etc. with an active power system (i.e. the battery has not been disconnected and/or the vehicle system is still active ["idling"); with radiator and fuel spills and/or leakages. This vehicle has been involved in a frontal collision (irrespective if it is a full, half, quarter or partial frontal involvement) with deployed airbags (irrespective if it is a frontal and/or side impact airbag). The use of wedges and stepchocks is to stabilize the vehicle, and that of the hydraulic equipment is to either cut metal and/or structures irrespective if conventional cutters, minicutters, combitools, etc., are used. This requires rescue personnel to use equipment for lifting, through the use of musculoskeletal and body system function operations."*

The details of each criterion used in defining the typical motor vehicle case at the end of the third round Delphi process as well as the physics are presented in Annexure J (titled: Emerging Physics Themes Within the Typical Case Narrative for Motor Vehicle Related Rescue). Table 9 below summarises the themes for both the typical case narrative and equipment used.

5.4 PROCESS TRACING ANALYSIS OF THE PHYSICS FOR THE EQUIPMENT USED IN THE TYPICAL CASE

The details of each piece of equipment with its associated physics theme and principle identified at the end of the third round Delphi process is presented in Annexure K (titled "Emerging physics themes for the equipment in use within the typical case narrative for motor vehicle related rescue"). The description of the use of the equipment was based on the principal investigators own background and knowledge; and aided through the consultation of various textbooks such as the IFSTA, Principles of Vehicle Extrication, 3rd Edition Chapter 4 on Extrication Equipment (Fortney & Clausing, 2009). A literature search with respect to the rescue equipment and physics was done. A theoretical gap was identified pertaining to the evidence that underpins the principles and concepts on which the use of equipment is based.

5.5 SUMMARY OF EMERGING PHYSICS THEMES FOR THE TYPICAL CASE NARRATIVE AND EQUIPMENT

The delineation of the study excludes investigation of physics phenomena at a micro level and focused on those themes as outlined in the inventory Table 8. Similar physics themes emerged from the process tracing for the typical collision post event criteria as for the typical equipment used in the post event rescue. This is attributable to the collision post event criteria in the typical case narrative from which emerges a scenario that requires particular actions to achieve the objectives of the rescuers. The actions as described within the typical case scenario requires the use of particular equipment as those, for example identified by the experts as typical to the case narrative.

Table 9 provides a brief outline of the predominant physics themes with its respective concept which has a particular general contextual application or meaning to the typical motor vehicle related scenario and equipment used within. Therefore, the physics themes were explored as opposed to examining the mathematical formulations in the theoretical basis. The physics themes which have been identified through the process tracing of the case narrative will be used in the next Chapter for the document analysis and gap appraisal of the various BEMC physics and Extrication subject guides.

Table 9 Summary of emerging themes of physics identified through process tracing of physics within the typical case narrative and equipment used

Predominant Physics Themes[54]	**Physics Principle (Concept)**	**General meaning to context and/or application**
FORCES	Weight	Weight considerations are important in the collection, redirection and redistribution of load during stabilisation of vehicles and structure in the post-collision phase.
	Mass & Gravity [centre-of] (CM & G)	Assumption in post collision is that all structure is in an unstable state. CG & M is a consideration during the stabilisation of the vehicle. CG is also considered in the use of certain tools such as the shovel.
	Flexing / Torsional / Collision / Hydraulic / Pressure - [*Cutting \ Breaking \ Prying \ Sawing \ Rotational*]	Unbalanced forces exist post-collision. This may present in the form of the unstable vehicle which require stabilization and metal which are under tension, flexed or stretched. During the utilisation of rescue tools a force may be applied in order to enact a desired response.
	Friction	Various forms of friction may be experienced for example surface friction with flowing fluids, metal being cut, during walking where air resistance and gravitational friction is experienced, etc.
	Levers / Fulcrum	The use of components of the musculoskeletal system act in the form of levers during the lifting, lowering functions of equipment for example. The use of hand tools such as a shovel, haligan tool, crowbar, etc. requires correct hand placement in order to achieve its end goal lifting, carrying, prying (as applicable to context).

[54] The reference to 'theme' within this study includes laws, principles, definitions or topics of emergent physics from the typical case narrative.

DYNAMIC LAWS	Newton's 1st Law	During the static state post collision the vehicle and associated rescue operations would remain in a position of rest until it undergoes change due to a net force which is being applied. For example, the "dead man handle" which is a feature of some manufacturer equipment in an operational hydraulic system would only cause the tool to function if the handle is being operated and would continue to operate whilst the net force (operators hand) acts on the handle in the direction of desired function.
	Newton's 3rd Law	Rescue operations such as cutting, spreading, lifting of a material which is under tension, flexion or torsion could result in either an equal (where resistance is met) or opposite reaction (un- or desired outcome). Similarly it could be explained for all other actions which would be conducted during the use of equipment within the typical case narrative.
	Law of Conservation of Momentum	We apply the principle of linear momentum when considering motor vehicle collision. In terms of the equipment for example the use of a centre punch (springloaded) would require a greater momentum to create a sufficient force which would enable the breaking of the window.
	Fluid Mechanics	Principles of fluids mechanics govern the operation of hydraulic equipment such as spreaders and cutters.
	Human Mechanics	In any incident, human mechanics, such as the operating of rescue equipment, requires the application of the sound ergonomic principles which contribute to good safety practices.
KINEMATICS	Impulse	A change in momentum would result in impulse for example during the cutting of metal under tension.
	Velocity (Speed)	The equipment used and the performance of human mechanics (actions) would be completed at various speeds to achieve a particular objective.
	Momentum (Motion)	Momentum would be produced due to the equipment possessing mass and operating at various speeds (motion).
	Torque	This would be in relation to the rotational counterpart of the forces during the screwing and/or unscrewing process of the nut or bolt as power is being applied.
ENERGY	Potential / Kinetic / Electrical / etc.	All energy from the collision phase would be converted into potential energy during the post – collision. The vehicle and equipment in the post collision phase possess potential energy until acted upon by an external force.
	Power	Effort is required to change the energy state of the equipment and human mechanics. This transfer of energy will be conducted over a time and may result in movement (distance).

5.6 RESULTS OF EMERGING PHYSICS THEMES FOR THE TYPICAL CASE NARRATIVE AND EQUIPMENT

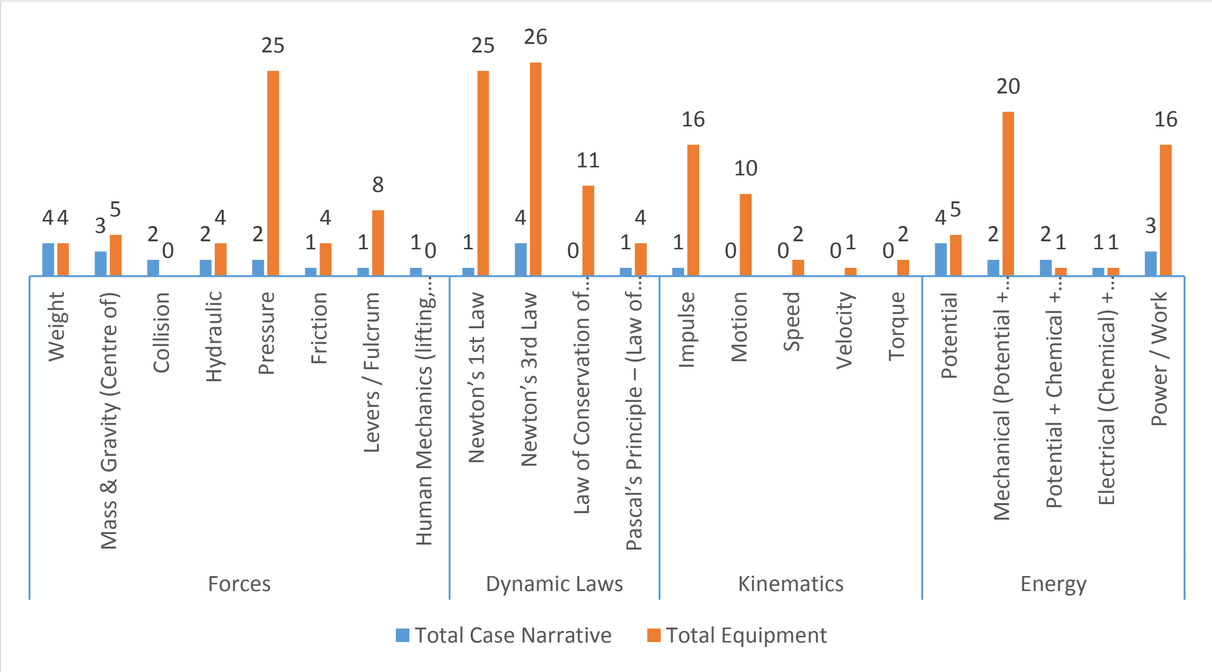
Figure 10 represents the number of times a particular concept of physics had been identified through the process tracing methodology as having relevance to both the typical case narrative and equipment. The Delphi experts had to indicate their responses during the various rounds of the questionnaire to a total of 44 items regarding equipment and 56 statements related to motor vehicle rescue incidents. A total of 28 pieces of equipment out of the 44, and 8 out of the 56 statements, obtained a majority consensus. This resulted in more equipment included in the process tracing.

The frequency with which a particular theme is represented in Figure 10 (1) emerges from the process tracing, (2) is an indication of the relevance to both the subjects of Physics and Extrication of the BEMC curriculum and, (3) is a possible indication of the domains of relative overlap of the Physics as a subject and the rescue experience[55].

The physics concepts of pressure, Newton's Laws, impulse, mechanical energy and power/work, were the predominant themes which emerged for equipment. Other themes which have not emerged as strongly as others, does not presuppose that they are not relevant. As well, the results may be a reflection of the delineation of the study.

[55] This implies that what is taught within the classroom should have relevance to the students' contextual experiences.

Figure 10 Physics from process tracing of typical case and equipment of Delphi process



5.7 CONCLUSION

Physics does not play a role solely in the development, design and improvement of the safety features, speed, aerodynamics and technology, but also has considerations for the post collision rescue scene. This can be ascribed to the explanatory power and contextual relevance of physics to everyday occurrences. Contextually, rescue scenes are inherently different, and this depends on a host of factors. Therefore, it is important for the medical rescue practitioner to have a firm understanding of the embedded principles underpinning the developed procedures. This may contribute to rescuers responding in a more comprehensive manner to contextually different scenarios.

Procedural knowledge is contextually bound, and may therefore lack the ability to adapt to nuanced, atypical situations. Theoretical and evidence based knowledge is required to transition the procedural[56] to the principled[57]. The development of cumulative knowledge is enhanced by such a transition.

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[56] Procedural knowledge refers to that which is protocol or context bound.
[57] Principled knowledge also refers to procedure underpinned by theoretical and evidence based-knowledge.

The professional degree in its nature, contributes to the development of graduates who are able to apply their knowledge within their studied fields. One of the corner stones of such a degree is to develop graduates with greater principled knowledge.

CHAPTER SIX

DOCUMENT ANALYSIS AND GAP APPRAISAL

6.1 INTRODUCTION

The aim of this chapter was to conduct a document analysis of the subject guide with reference to the written unit of study[58] of the BEMC Physics (EBS100A) and Extrication (EMR203M) subject. The process and methodology which was used in the document (content/thematic) and gap (educational knowledge–appraisal) analysis will be discussed further in this Chapter.

6.2 BACHELOR OF EMERGENCY MEDICAL CARE (BEMC) PHYSICS AND EXTRICATION SUBJECT GUIDE (2014)

The BEMC Extrication (EMR203M) subject has 8 credits and Physics (EBS100A) has 12 credits within the 480 credit professional degree qualification. Various notional hours are allocated per subject for teaching, learning and assessment. Each of those components contribute in various forms towards the purpose and exit level outcomes required of a professional degree. This is to develop graduates who, it is envisaged, will become critical thinkers, reflective practitioners, professionals and lifelong learners. The BEMC Physics (EBS100A) subject is offered at a National Qualifications Framework (NQF) level 5 within the 1st year of study and the Extrication (EMR203M) subject at an NQF level 6 of the second year. Below in Table 10 is a brief breakdown of the subject offering of the Physics and Extrication subject within the BEMC programme with respect to contact sessions.

Table 10 Physics and Extrication subject offering in the BEMC programme

Subject	**Year of Study**	**Timetable (Contact Time)**	**Academic[59] contact sessions (Approximate)**			
			1ST Term	2ND Term	3RD Term	4TH Term
Physics (EBS100A)	1st YEAR	1h30 (1x day a week)	Yes (8)	Yes (8)	Yes (6)	Yes (7)
Extrication (EMR203S)	2nd YEAR	8 hours (1x full day a week)	No (0)	No (0)	Yes (6)	Yes (4)

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58 A “unit of study” in this research thesis will refer to those written assessment outcomes and/or objectives and/or themes and/or topics which is contained within the respective BEMC Physics and Extrication subject guides/curricula.

59 Academic would refer to the scheduled approximate number of 1h30 (Physics) and 8hrs (Extrication) contact sessions over the term period as per the departmental timetable for the year of study irrespective of the mode of delivery of content.

Basic Sciences subjects such as Physics and Chemistry are foundational within the professional BEMC degree due to its placement within the health sciences domain. Core subjects include emergency medical care, rescue, pharmacology and diagnostics. School-leaving subjects such as Mathematics, Life Sciences and Physical Sciences serve as entrance requirements in accessing the BEMC degree programme by prospective applicants. Core subjects, by design, should be able to draw from its foundational subjects. The BEMC curriculum should therefore demonstrate the links and integration of the various sciences into the core subjects such as emergency medical care and pharmacology to enable the scaffolding of knowledge for cumulative knowledge building.

In the use and evaluation of the alignment of the Bloom's taxonomies of learning (demonstrated level of knowledge) to the NQF level the learner has to demonstrate the ability to selectively recall, apply to a specific and/or many- context and/or familiar- and/or unfamiliar problems; and synthesise relevant subject knowledge and applying the synthesized knowledge to a specific context. This study did not focus on analysing the units of study with respect to their alignment to the NQF level descriptors as the focus was to investigate the themes contained within the unit of study pertaining to its stated relevance to the context of physics within the field of extrication and MVR incidents.

Drawing from Bernstein's pedagogic discourse, discussed in Chapter 2 of the literature review, which relates to fields of practice using the example of where physics has a field of production (within the labs where physicist produce knowledge related to the field of physics), reproduction (where the physics would be reproduced for teaching and education practice) and re-contextualization (where the physics is developed for curricula to have a social and moral order relevance to the field of study/practice). The aim of the study was not to highlight the physics as within the field of production. The study interest was how physics is re-contextualised for the field of practice as within the motor vehicle related incident without breaking the conceptual spine of the discipline. The educational theories around knowledge building and curricula were to provide a theoretical framework that would strengthen and support the need and validation of the study.

The document analysis of the BEMC 2014 Physics (EBS100A) subject guide was to evaluate and analyse the strength of the dominant themes of physics as identified in the process tracing. Below is a summary of the gap appraisal of the content analysis after comparison of the BEMC Physics subject guide and the themes (principles) of physics which emerged at the end of the process tracing methodology (contained within Chapter 5).

6.3 DOCUMENT- AND GAP-ANALYSIS APPRAISAL

6.3.1 Introduction

The identified themes of physics which has relevance to the typical MVR related case as developed through the modified Delphi process (explained in Chapter 4) and process tracing methodologies (explained in Chapter 5) were compared with the BEMC Physics and Extrication subject guides. This is to appraise the thematic content gap with regard for the applied educational theories around curriculum development and knowledge building.

6.3.2 Document- and Gap-Analysis (for content relevance) of the BEMC Physics (EBS100A) and Extrication (EMR203M) subject guide

The content relevance provided insight as to what was contained within the subject guides of the BEMC Physics (EBS100A) and Extrication (EMR203M) pertaining to the context of motor vehicle related rescue. Due to the scope limitation of this study, not all themes of physics could be explored as explained in Chapter 5.

The themes of physics which emerged at the end of the process tracing (as summarised in Table 9 of Chapter 5 and Annexures J and K) was compared with those units of study contained within the BEMC Physics and Extrication subject guide. A thematic content analysis was used to explore the units of study for themes of physics. Below are the findings and a brief discussion based on the comparative thematic document analysis.

The BEMC Physics (EBS100A) subject guide (CPUT DEMS, 2014d) (cf. Appendix L) contained a column[60] titled: “physics sections”, “mechanics”, “fluids”, “gas laws”, “temperature and heat”; and “electrostatics and electricity”. These columns were divided into rows with themes such as the topic of mechanics was further divided into kinematics,

[60] This is the stated heading for the column as per the CPUT DEMS (2014) Physics (EBS100A) subject guide.

dynamics (Newton's laws, forces), energy, power energy, rotation and torque. The theme of kinematics was sub-divided into a key –theme of vehicle motion and ballistics. These key themes had what appear to be units of study[61] such as "describe motion using represent – ations[62] of kinematics, equations of motion", "apply to vehicle motion" and "apply to ballistics". Completing a comparative thematic document analysis of the BEMC Physics (EBS100A) subject guide was partially difficult due to the manner in which it was constructed and written. Identified themes of physics from the process tracing were compared to the BEMC Physics (EBS100A) subject guide. The headings, key-themes and units of study from the Physics (EBS100A) subject guide were analysed.

The BEMC Extrication (EMR203M) (CPUT DEMS, 2014b) subject guide was written in a more structured and coherent manner which allowed for differentiation between the subject content, study unit outcomes, teaching events, learning and assessment outcomes. This made for easier identification of what the intended purpose or relation of the themes within the subject guide related to. A similar methodology as described above for the Physics (EBS100A) subject guide was used for Extrication (EMR203M).

Within the heading of "study unit outcomes "for "lifting and shoring" under the "teaching event" column of the BEMC extrication (EMR203M) subject a single reference to a theme of physics was identified. This was the phrase "centre of gravity". Similarly, within the assessment criteria outcomes it was stated that the learner should be able to "Explain the three types of collision that occur during a rapid deceleration incident" but with no further guidance and/or explanation available within the unit of study and/or teaching event was noted. During the analyses for further details pertaining where written units of study existed for example for the associated assessment criteria where it was stated that the learner should be able to "Explain the physics behind vehicle stability", with the "study unit outcomes" section for "lifting and shoring" was evaluated. In the section for the "teaching event" it however does not clearly state nor explain how the learner should be able to apply

[61] No heading was provided for the column on the far right within the CPUT DESM (2014) Physics (EBS100A) subject guide. The principal investigator assumed that it would be representative of the written unit of study as no other information was present that could exclude the basis of this assumption.

[62] It is assumed that the word should read as 'representations' and not 'represent-ations' as it was noted during the thematic analysis process within the BEMC Physics (EBS100A) subject guide 2014.

these principles aside for the mentioning of centre of gravity, triangle of stability, building up a shore and struts.

This prevented the unpacking and further exploration of the written information within the various sections contained within the respective subject guides. Curricula, Subject and learner guides play a particular role within a programme. During the design and implementation phase of any qualification these documents should be quality assured in terms of its intended purpose. A uniform approach to the structure and standards for content description is well documented within HEI's to ensure that it is robust and fit for purpose.

6.3.3 Results of the Document- and Gap-Analysis (for content relevance) of the BEMC Physics (EBS100A) and Extrication (EMR203M) subject guide

Table 11 below contains the units of study which was extracted from the BEMC Physics (EBS100A) and Extrication (EMR203M) subject guide during the thematic content analysis. A total of fifty-one (n = 51; 100%) units of study was identified and used from the BEMC Physics and Extrication subject guides in the comparative thematic analysis. Of the fifty-one (n=51; 100%) there was fifteen (n=15; 29.4%) which contained a descriptor within the written unit of study which made reference to an aspect of motor vehicle related incident. There were ten (n = 10; 19.6%) identified units of study from the BEMC Physics subject guide and five (n = 5; 9.8%) from the BEMC Extrication subject guide. The remainder of the BEMC physics which contained no reference or descriptor related to the motor vehicle rescue related incident totalled thirty-six (n = 36; 70.5%).

Table 11 Phrases extracted from relevant subject guide evaluated during document analysis

Number	BEMC Physics (EBS100A) Subject Guide 2014 (unit of study relevant to motor vehicle rescue)
1	Apply Newton's laws to impact forces
2	Describe motion using representations of kinematics.
3	Describe motion using equations of motion
4	Apply kinematics to vehicle motion
5	Identify forces acting on body
6	Apply Newton's laws to vehicle dynamics
7	Apply Newton's laws to specific rescue situations such as rescue extraction
8	Conservation laws applied to collisions
9	Rotation And Torque (Leverage/Stabilizing)- balanced applied to rescue scenarios such as stabilising a vehicle rolled on its side
10	Fluid Static –"jaws of life" equipment

Number	BEMC Physics Subject Guide 2014 (remainder of the physics units of study)
11	Represent physical situations using vectors
12	Resolve physical problems using vectors
13	Apply kinematics to ballistics
14	Apply Newton's laws to ballistics
15	Conservation Laws applied to explosions
16	Conservation Laws applied to ballistics
17	Gas Laws applied to partial pressures of atmospheric gasses
18	Gas Laws applied to partial pressures of gasses in the lungs
19	Gas Laws applied to diffusion of gasses (O_2 and CO_2 across alveolar (lung) membrane into the blood
20	Gas Laws applied to pressure changes inside the lungs and chest during normal respiration
21	Gas Laws applied to pressure inside oxygen cylinders and calculating how long oxygen in a tank will last
22	Gas Laws applied to pressure changes during aircraft patient transfers. (all air filled balloons should be replaced with water)
23	Gas Laws applied to barotrauma
24	Gas Laws applied to altitude mediated sickness
25	Fluid Statics – buoyance control devices
26	Fluid dynamics (Fluid flow)- streamline vs. turbulent flow
27	Fluid dynamics (Fluid flow)- flow rates
28	Fluid dynamics (Fluid flow)- understanding Bernoulli's
29	Fluid dynamics (Air flow)- Venturi effect
30	Fluid dynamics (Air flow)- Venturi face mask
31	Fluid dynamics (Fluid flow)- Reynolds number
32	Fluid dynamics (Fluid flow)- Fick's law
33	Fluid dynamics (Fluid flow)- Laplace's law
34	Fluid dynamics (Fluid flow)- Poiseuille's law
35	Heat transfer applied to – body temperature and transfer of heat
36	Heat transfer applied to - environmental emergencies (patient becoming hypothermic due to exposure)
37	Heat transfer applied to – environmental emergencies (heat stroke)
38	Heat transfer applied to –warming of patients (e.g. the reflective blanket)
39	Electricity applied to – electric conductivity of the heart
40	Electricity applied to – automated external defibrillator (AED)
41	Electricity applied to – delivering electric shocks to a patient in ventricular fibrillation rhythm via the paddles of an ECG monitor
42	Electricity applied to – electric conductivity of the body
43	Electricity applied to – impulse generation in a cell (nerve or heart)
44	Electricity applied to – electrolytes in blood plasma
45	Electricity applied to – nerve electric conduction
46	Electricity applied to – electric shock

Number	Extrication (EMR203M) -(MVR) Subject Guide 2014 (units of study with descriptor with reference to physics)
47	Explain the principle of pneumatic power
48	Making use of a diagram explain the principle of generating hydraulic power.
49	Explain how an electrical generator operates (Dynamo effect)
50	Explain the physics behind vehicle stability
51	Explain the tree types of collision that occur during a rapid deceleration incident.

Table 12 is a representation of the predominant themes of physics which was compared and analysed from the BEMC respective subject guides and that which emanated from the process tracing.

Table 12 Thematic document analysis and comparison of the BEMC Physics and Extrication subject to the identified predominant physics themes from the Process tracing

BEMC Physics (EBS100A) Subject Guide Themes	
S I Unit	
Unit Conversions	
Scientific Notation	
Basic Maths	
Vectors	
Mechanics	Kinematics – Vehicle Motion
	Kinematics – Ballistics
	Dynamics (Forces, Newton's Laws) – Vehicle Dynamics
	Dynamics (Forces, Newton's Laws) – Ballistics
	Dynamics (Forces, Newton's Laws) – Resultant Impact Forces
	Dynamics (Forces, Newton's Laws) – Pulleys
	Dynamics (Forces, Newton's Laws) – Anchor Point Physics
	Dynamics (Forces, Newton's Laws) –High Angle Rescue
	Work, Energy Power Energy – Collision / Impacts
	Work, Energy Power Energy - Ballistics
	Rotation & Torque - Leverage
	Rotation & Torque – Stabilising Rescue Scenarios

Process Tracing Predominant Physics Themes from Delphi process	
Forces	Weight
	Mass & Gravity (Centre of)
	Flexing
	Torsional
	Collision
	Hydraulic
	Pressure -Cutting
	Pressure – Breaking
	Pressure – Prying
	Pressure - Sawing
	Pressure -Rotational
	Friction
	Levers / Fulcrum
Dynamic Laws	Newton's 1st Law
	Newton's 3rd Law
	Law of Conservation of Momentum
	Pascal's Principle – (Law of incompressible fluids)

BEMC Extrication (EMR203M) Subject Guide Teaching Themes	
Introduction to vehicle Rescue	
Vehicle design& Construction	
Equipment	Hand tools
	Pneumatics
	Hydraulics
	Electrical
	Lifting, Shoring & Tilting
	Miscellaneous
Incident command & control	
Vehicle rescue operations	
Specialised extrication	Heavy rescue
	Rail related
	Construction
	Agricultural
	Industrial entrapments

Gas Laws	Physics of Breathing	
Fluids	Fluid Static – Rescue Systems	
	Fluid Static – Sinking / Floating Objects	
	- Airflow	
	Fluid Dynamics (Fluid Flow) – Intravenous Fluid Flow	
	Fluid Dynamics (Fluid Flow) – Rheology of Blood	
Temperature & Heat	Body Temperature and Transfer of Heat	
Electricity	Electro Statics – Electricity and the Body	
	Electric Current	
	Electric Fields – Electricity and the Body	
	Circuits – Electricity and the Body	
	Electrical Energy & Power – Electricity and the Body	

Kinematics	Impulse
	Motion
	Speed
	Velocity
	Torque
Energy	Potential
	Mechanical (Potential + Kinetic))
	Potential + Chemical + Kinetic + Thermal / Heat + Electrical
	Electrical (Chemical) + Thermal + Potential

In BEMC Extrication (EMR203M) descriptors were poorly stated (especially where meaning to context was very abstract and the condensation was weak). For example, in the unit of study “Explain the physics behind vehicle stability” there could be many themes within the subject of physics which could be related to the condensed (terminology) meaning (for example centre of gravity/mass, force(s), Newton’s Laws, conservation of energy, etc.). This does not clearly articulate what should be covered during the teaching and learning. This could adversely affect the teaching and learning of the above unit of study.

In the BEMC Physics (EBS100A) and Extrication (EMR203M) subject guides mention was made of aspects which may have relevance and application to the context of MVR related incidents and the physics respectively. This is further identified, analysed and discussed in this Chapter using the developed LCT Semantic code translation device and Semantic profile. The themes used by the principal investigator could have further contributed in limiting the evaluation and analysis of the thematic principles of physics within the respective BEMC Physics (EBS100A) and Extrication (EMR203M) subject guides. There is no uniform manner in which to write themes of physics pertaining to its context (for a particular meaning).

6.3.4 Document and Gap (Educational knowledge) Appraisal using LCT Semantic dimension

6.3.4.1 Introduction

This was a gap appraisal with respect to identifying the sequence of knowledge in the curricula structure of the BEMC Physics (EBS100A) and Extrication (EMR203M) using the developed translation device from the Semantic dimension of LCT. This was examined in relation to how the meaning of the unit of study of Extrication (EMR203M) relates to SG (context / practice) and that of Physics (EBS100A) to SD (condensed / abstraction). The rationale was to identify and profile the various identified units of study within the curricula using LCT, Semantic concepts. Appraisal of the knowledge gap using educational theory with powerful grammar[63], like LCT, for medical rescue education and practice would validate, and strengthen knowledge development[64] in this field. An argument for LCT Semantic concepts as a methodological choice and its suitability as an educational theory (framework) for the evaluation of knowledge claims (segmented and cumulative knowledge building) has been made in Chapter two (Literature Review) and three (Research Design and Methods).

6.3.4.2 Development of LCT Semantic Translation Device

The LCT translation device was developed with respect to the Semantic code (SG and SD) concepts. The Semantic concepts demonstrate the relationship between theory and practice. A case for the use of the Semantic dimension was made in Chapter three (Research Design and Methods). The use of a translation device is a practically implementable feature of LCT. It allows for the interpretation and framing of data from a variety of fields and contexts. The individual units of study[65] identified through the thematic document analysis of the respective BEMC Physics and Extrication subject guides, were interrogated through the respective LCT translation device developed for this study. In Table 13 and 14 below, are the concepts, definitions and ratings scale with an example based on the Semantic dimension, which form the basis of the LCT translation device used in this study. The purpose of the translation device is to evaluate the concepts of Physics theory and Extrication practice to the defined Semantic dimension. This was to enable the rating of

[63] Grammar refers to ability to explain something other than itself with precision.
[64] This is what Maton (2014) calls cumulative knowledge building and is key if we are to achieve epistemic justice.
[65] The author is making reference to the written statement from the respective BEMC Physics and Extrication subject guide as it would be presented as an assessment criterion, study unit/ outcome or teaching objective within.

the various units of study from the respective subject guide over time to trace a Semantic profile.

The time would be representative of the manner through which the content would be covered during the contact sessions following a particular order. Time therefore is not an exact scale with reference to the period over which the respective subject content was covered for an academic year. The principal investigator consulted the subject lecturers responsible for the delivery of the content for guidance with respect to the flow as well as other evidence such as lesson outlines and plans. Due to the Semantic code not being scientific or mathematical, the translation device will explore a unit of study over time which would generate a semantic profile (wave or flat line).

Table 13 Rating scale of Semantic Gravity Translation Device with examples for use in BEMC Extrication subject guide (developed)

Concept		**Definition**	
Practice [SG] (Rescue)		*Describes the level of abstraction or complexity to the world of practice; in this it specifically refers to the teaching of Rescue from the simple, basic protocol and highly procedural to the very atypical, complex and specialized case (world of practice).*	
RATING SCALE			**Example from BEMC Extrication Subject guide**
WEAK	1.	Atypical case which is complex where multiple approaches is required. Higher order thinking and knowledge would be required for example problem solving, specialised skills, etc. The frequency of such cases lends itself to contribute to the complex nature thereof.	Explain why stabilization of a specialized vehicle may require additional resources
	2.	Atypical case which is simple where the understanding of the concepts and principles is required. Protocols and guidelines may not be sufficient as a deeper understanding is required.	Explain how to trouble shoot a system that is not functioning properly
	3.	Typical case which is complex where the understanding of the application of rules, protocols, procedures would be sufficient in achieving the basics. The Practitioner might have to draw understanding from multiple sources (steps, protocols, etc.) as well as some of the concepts and principles which is embedded.	Operate a chain shortener system to pull a heavy load in a safe and efficient manner
	4.	Typical case which is simple, basic in nature and specific to its context. Requires the following and completion of steps, rules, protocol and procedures. A standard approach is sufficient.	Don and doff the appropriate protective gear correctly
STRONG	5.	Case which is simple and basic which is generalizable in nature. May be solved requiring the following and completion of steps, rules, protocol and procedures.	Identify and locate the primary and secondary structures of a light motor vehicle

Table 14 Rating scale of Semantic Density Translation Device with examples for use in BEMC Physics subject guide (developed)

Concept	**Definition**		
Theory [SD] (Physics)	*Describes the level of complexity or the level of intellectual challenge; in this study it specifically refers to the level of difficulty with regard to the teaching of EMC or Physics related concepts.*		
RATING SCALE			**Example from BEMC Physics Subject guide**
WEAK	1.	Complex and abstract concepts. Very difficult to describe or define. Meaning is contextually bound which is described using highly theoretical specialised languages and codes. Fewer meaning is derived from the symbol or practice.	Gas Laws applied to diffusion of gasses (O2 and CO2 across alveolar (lung) membrane into the blood
	2.	Elements of the theoretical principles and concepts are described using a language where it is re-contextualized for the field of study which is related to specific aspect within the field.	Apply Newton's laws to pulleys
	3.	Symbolic and may require some calculation to explain or describe or define concepts which is generalizable.	Describe motion using equations of motion
	4.	A basic description and explanation is provided of the concepts and principles using terminology applicable to the field of study	Heat transfer applied to –warming of patients (e.g. the reflective blanket)
STRONG	5.	Simple, basic and generic concepts which is descriptive. Able to be explained through the use of common day language terms and definitions with meaning able to be applied to many contexts.	Heat transfer applied to – body temperature and transfer of heat

6.3.4.3 Application of the LCT Translation Device

From the thematic document analysis of both the BEMC Physics and Extrication 2014[66] subject guides the selected individual unit of study was grouped and placed in the order in which it would be covered. As previously indicated the subject lecturers was consulted to ascertain the order and grouping in which the individual unit of study would be presented over time within the pedagogy of the respective subjects. The respective subject guides

[66] The data collection took place in 2014; hence 2014 data sources were used. Incidentally, these documents remain largely unchanged to date and the analysis remains relevant.

where analysed, using the applicable LCT translation device. For the analysis and interpretation of the respective LCT translation device, an example is provided per rating grade from the respective subject guide.

Table 19 & 20 (cf. in Annexure N & O) contains is a detailed breakdown of the grouping and implementation of the respective developed LCT translation device. Further comments are provided below in this Chapter based on the results and findings identified through the use and application of the LCT translation device as an analytical tool. The rating was placed into a graph based on the order in which it would be presented over time within the respective units of study. This enabled the profiling of the Semantic code concepts.

6.3.4.4 Results of BEMC Physics and Extrication Subject Guides using the LCT Semantic Code Translation Device

The development, methodological relevance, suitability of LCT's Semantic dimension and the translation device has been discussed in Chapter 2 (Literature Review) and Chapter 3 (Research Methodology & Design). The results that were obtained through the application of the developed respective LCT Semantic dimension translation device were placed within a Microsoft Excel document from which a line chart emerged. As explained above the aim was to trace the profile of the various units of study based on the strength of its LCT Semantic code concept represented over time based on the order of covering during the academic year.

The Semantic code profile of the Physics (cf. Figure 11) and Extrication (cf. Figure 12) subject guides units of study reveals that waving and weaving occurs over time as the units of study is not covered in a linear manner which would have created a flat line. The waving pattern is an indication that the respective subject's units of study are not bound within a range whether weak or strong pertaining to the Semantic code concepts respectively over the entire duration of the subjects covering. Maton (2014) describes the use of translation devices within curricula, classroom and teaching practices through which processes of change are analysed over time using the LCT dimensions and concepts as being applicable to the fields of production, recontextualisation and reproduction. These changes over time demonstrate the relationship (condensed meaning) between a practice gravity and density

(Maton, 2014) and how these codes enable or constrain knowledge building (segmented or cumulative).

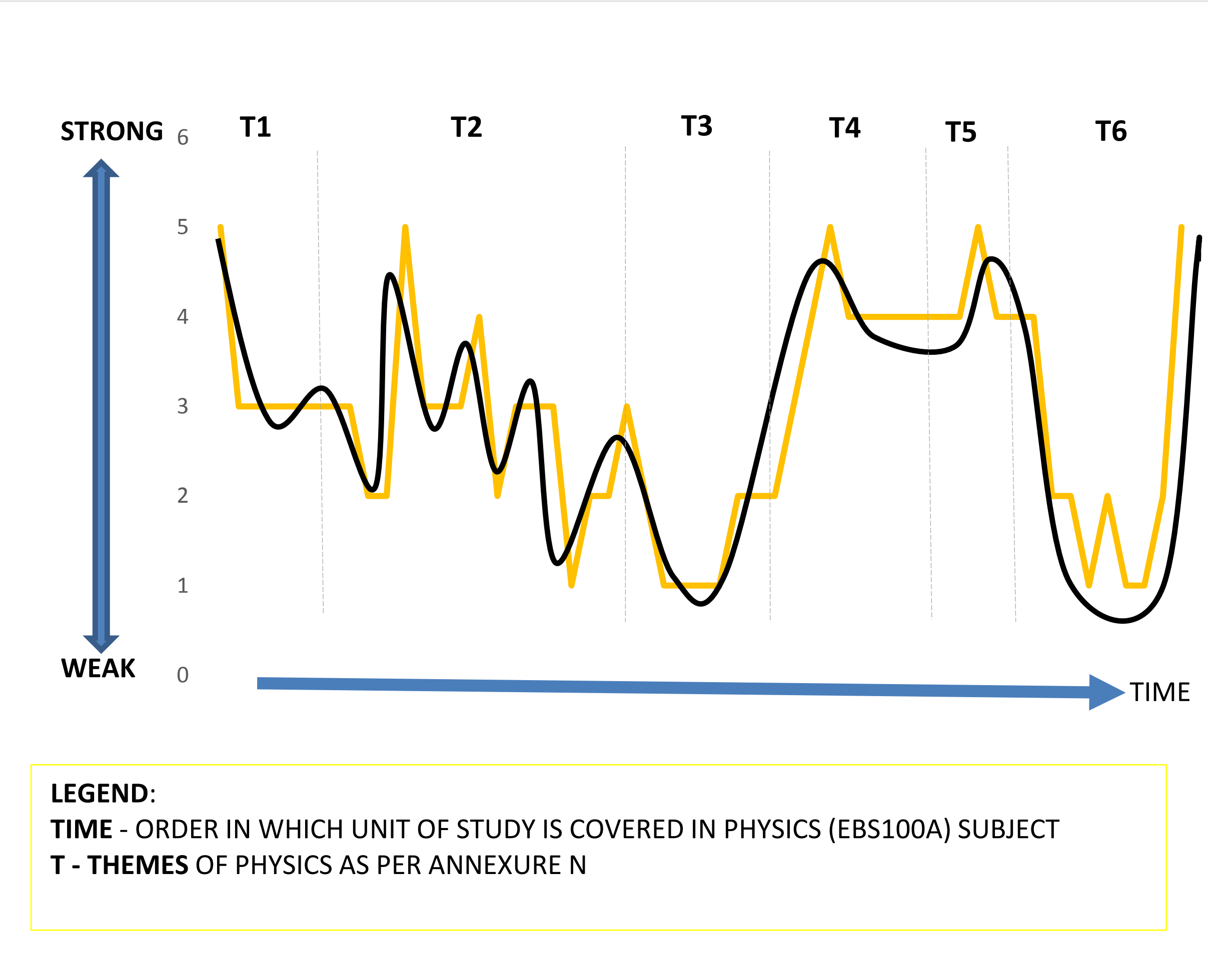
Themes by and large are not equally ordered in terms of the amount of units of study for both the Physics (EBS100A) and Extrication (EMR203M) subjects. The profile which emerges across themes may be skewed as it may appear that some are mainly weak or strong which may appear as a flatline whereas other may have good waving and weaving. This may be attributable due to previous themes which may build onto the next in terms of the scaffolding of knowledge. During the document analysis of the subject guide no evidence emerged strongly to support or refute this claim of scaffolding which may enable or constrain knowledge building.

The Physics subject (EBS100A) emerges with strong density at the start where the units of study is said to be symbolic where concepts can be defined using equations and calculations. These involve the basic concepts such as maths, scientific notations and vectors. The manner in which these basic concepts are written within the subject provides no context and therefor many meanings are able to be derived from it. This may constrain the educator during the pedagogy as no further guidance is provided to ensure that constructive alignment is attained. Segmentalism is further enabled due to the incoherent manner in which the subject guide is written and structured.

Theme 1 which consist of the Physics tools which consist of the maths, vectors and scientific notation concepts continue into the Mechanics theme of physics which consist of kinematics, Newton’s Laws, etc. Theme 2 wave and weave between the symbolic concepts which requires defining using calculations to those abstract and complex concepts which are contextually bound in meaning. As stated above, the manner in which the units of study are represented within the subject guide does not clearly indicate whether the concepts required for example ‘Apply motion to equations of motion’ and ‘Apply Newton’s laws to vehicle dynamics’ is covered or introduced in the earlier physics section (Theme 1).

Similarly, Theme 3 (Gas Laws) and 6 (Electricity) is mostly weak in terms of its density which could mean that it is complex and abstract which is bound to context thereby meaning is reduced. Theme 4 and 5 is seen as being mostly strong in terms of its density which consist of basic and simple concepts where meaning is either able to be generalised or descriptive of the field of study.

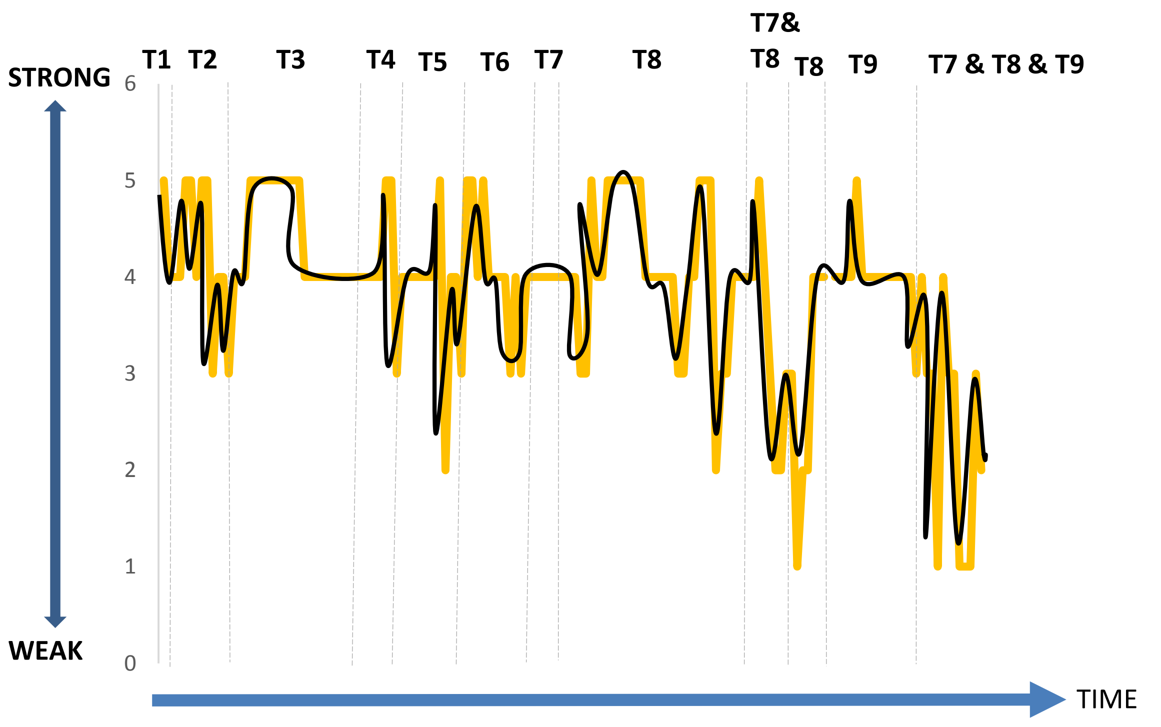
Figure 11 Semantic Density Profile of the Physics (EBS100A) Subject



Similar observations as for the Physics (EBS100A) was noted for the Extrication (EMR203M) subject during the analysis of the Semantic gravity by means of the applied LCT translation device. The similarities are mainly pertaining to the structure and coherency of the written units of study and subject guide, as well as those related to the LCT Semantic profile which emerged across themes.

The initial themes (from 1 to 8 [in part]) for the Extrication subject ranged mostly within the strong semantic gravity range where the case is simple, basic to typical which is managed using protocols, guides, etc. This could be attributable to the procedural and technical knowledge which is embedded within the qualification and represented as study units within the subject guide. Theme 9 (Specialised Vehicle Rescue) weakens the gravity due to complex and specialised nature in which the units of study is represented. Similarly, the abstract concepts from which these specialised vehicle rescue is to draw theoretical and principled knowledge that is embedded is assumed to be within previous themes as the units of study does not clearly state or indicate the relationships to previous themes except for certain words such as stabilisation.

Figure 12 Semantic Gravity Profile of the Extrication (EMR203M) Subject



LEGEND:
TIME - ORDER IN WHICH UNIT OF STUDY IS COVERED IN PHYSICS (EBS100A) SUBJECT
T - THEMES OF PHYSICS AS PER ANNEXURE O

Knowledge building is said to be made possible across different context over time by Maton (2014) when decontextualisation and recontextualisation of knowledge is enabled. Winberg (2018) suggest that the professional degree student ideally should be introduced to a problem (concrete) after which the physics tools (abstract) are provided through which the solution (concrete) may be obtained. As stated above, the incoherent and poorly structured subject guide does not sufficiently provide guidance whether this would be the delivery model by which the pedagogy would be offered. A further analysis of the pedagogy would be required through which a deeper view of the enabling or constrains to knowledge building is evaluated.

6.4 CONCLUSION

Both the BEMC Physics (EBS100A) and Extrication (EMR203S) 2014 subject guides were analysed for elements of principles of physics highlighted through the process tracing of the typical case typology narrative and the equipment used.

The thematic document content analysis of the BEMC Physics and Extrication subject guides revealed that some units of study where deficient in the following manner. The placement of some objectives was not coherent. Some objectives were of little value due to the lack of suitable descriptors or verbs. The articulation of the subject guide was reduced to broad themes and phrases that do not serve to inform standardised teaching and learning or assessment outcomes. There is therefore a strong likelihood that threshold concepts within physics are neither a standardised or comprehensive feature of teaching, learning or assessment of medical-rescue education. The concern would be that the physics deficiency may lead to segmented rather than cumulative learning and this may hold similarly true for the Extrication subject.

In order to determine a more accurate Semantic code profile of the respective subject guides a more detailed analysis would be required which would need to involve the pedagogy. The limitation of the use of the units of study is that the manner in which it is written is for example not an accurate representation of the teaching or learning event as the lecturer may cover the content using various methodologies and information. This would require further (future) research both for the BEMC Extrication subject and other subjects within the BEMC qualification if a holistic view is sought in terms of identifying whether the BEMC curricula (all subjects from a first to a fourth year level within the qualification) contribute towards a well-balanced and located curricula which supports cumulative knowledge building and which is both horizontally and vertically structured in terms of the knowledge pedagogy.

CHAPTER SEVEN

DISCUSSION

7.1 INTRODUCTION

Chapter 7 will be briefly discussing some of the finding from the various methodologies which was used within the research. It would only address some of the key points based on the research objectives as it is stated within Chapter 3 (Research Methodology and Design). The aim is not to repeat that which was mentioned in the various chapters pertaining to the results, analysis, findings and brief discussions. Linkages and inferences will be made between the literature review, research objectives and findings. A self-evaluation and critique of the research using a criteria utilised in the evaluating of qualitative research is to be applied.

7.2 DISCUSSION

7.2.1 "Typical" cases and "Atypical" cases within motor vehicle related rescue scenario typologies

Purpose of this objective was to develop a typical case from which further and future research is to be conducted which would strengthen and legitimize the research. It is foolish to assume that all cases (incidents and scenarios) present in a similar manner but further research into the atypical case could also be developed. Within Chapter 1 (Background and Motivation for the study) and Chapter 2 (Literature Review)) a case was made for motor vehicle rescue as a legitimate case, having relevance in terms of its frequency and contribution to the burden of disease, both from a South African context and global perspective.

There are many variables, factors and influences involved in the MVR related incident (as detailed in the mind map (cf) Annexure F which was used in the development of the Delphi questionnaire). These could be present from the static phase (pre-incident) up until the post-collision phase (where the incident has been successfully mitigated by all relevant responding agencies) and may either by dynamic or fixed in nature. Dunbar (2013) and Morris (2009b) highlighted that the MVR related incident may either be in the form of a single or combination collision kinetic. Other variables such as the vehicle's orientation post the collision phase being statistically on all four wheels has also been noted by Dunbar (2013).

With no MVR incident being the same, the development of a typical case was required from which to investigate and evaluate the principles of physics (as was the aim and objective of this research study) that underpin[67] it.

Evidence to support and concur with those finding from the Delphi process is poorly documented and recorded. This is due to most research related to the field of MVR contained within trade journals which lacks the rigour, peer review, reliability and validity which is attributed to those in a scientific publication. Textbooks such as 'Vehicle Extrication 1-2-3' form Moore (2011), 'Holmatro's Vehicle Extrication Techniques' of Morris (2009b) and 'Vehicle Extrication Techniques' from Dunbar (2013) as explained previously is very procedural in terms of explaining the various processes and phases of managing the MVR incident but lacks the knowledge which underpin or provide 'deeper meaning'. This could be seen as a limitation in terms of validating the constructs of the typical case narrative drawing from empirical data and evidence.

Equipment by design and its use draws from the field of physics as highlighted within the Literature Review of Chapter 2. This therefore strengthened the case for the inclusion of the equipment within the development of a typical case narrative for MVR related incidents due to its relationship and the explanatory power which physics lends to it. The delineation, methodology and rationale for the selection of equipment to be included as part of the study was explained in Chapter 2 and 4 of this study.

The need for further inclusion was further strengthened based on the diverse utilisation and associated application of equipment during the post event phase of a motor vehicle related collision. The comprehensive nature and detail of the equipment in the typical case narrative is weakened due to the very nature and intended purpose of the equipment being diverse within the MVR related field. The focus of equipment in its use and application may not necessarily be only to aid in the removal of the trapped victims, but may also be to the end in creating space around the patient in order to render medical care and/or allow the patient to perform a self-extrication.

[67] That which is inherent and implicit within the case.

The varied nature of the equipment further limits the extent and scope to which the study was able to investigate. Rescue textbooks and trade journals which was consulted as explained above provided a range of different equipment which are commonly found within the MVR related environment with some focusing on a particular brand or product which the authors are at times affiliated to. Similarly, weak supporting evidence was noted for the equipment section of the typical case narrative developed in the validation thereof.

Dunbar (2013) stated that most MVR related training occur with the vehicle in the upright orientation on all four wheels. This manner of frequent training may restrict rescue practitioners from moving beyond their ‘typical’ training knowledge when the situation presents atypical. The atypical case constructs could contribute in establishing secondary and tertiary case typologies or insights as to the knowledge which inform the rescue practitioner’s response during the atypical case narrative. The atypical case constructs which was identified during the Delphi process was not evaluated during the process tracing methodology of this research. Neither was the atypical case constructs written in a manner which forms a coherent (logical) scenario.

7.2.2 Principles of physics that are implicit in typical motor vehicle related rescue scenarios

Students entering into a health sciences qualification should have a firm knowledge basis pertaining to the threshold concepts of physics. A case for physics has been made pertaining to the explanatory power it has in describing and providing meaning to every day phenomena[68]. Physics does not only provide an educational, theoretical and contextual relevance, and framework in elevating the discourse of the BEMC Physics and Extrication subjects, but it bodes well for other related BEMC subjects which require students to draw knowledge from the physical sciences field in order to understand basic scientific concepts.

The BEMC graduate should at the end of their qualification have attributes which would see them become lifelong learners which are able to produce new knowledge, be reflective practitioners, critical thinkers, etc. which are able to move beyond just the simple knowledge (meanings) which brings little understanding. Subjects within the qualifications should

[68] The ability of physics to explain everyday occurrences and phenomena has been stated within Conceptual Physics textbooks such as those from Cutnell & Johnson (2013) and Hewitt (2014).

provide meaningful contributions in developing students in these graduate attributes as it would not necessarily be sufficient to develop it through their experiential learning phase or post qualification when entering the world of work. It is therefore of paramount importance that qualifications and the subjects contained within has content which are constructively aligned, relevant, based on sound educational and theoretical frameworks.

Similar physics themes emerged during the process tracing of the typical case narrative and equipment for MVR related incident as discussed in Chapter 5. The themes which emerged could guide educators and those responsible for the development of curricula in identifying threshold concepts for the physics subject as it relates to the field of emergency medical care and rescue. Physics is seen as foundational and therefore is required to support the core subjects of emergency medical care and medical rescue (CPUT DEMS, 2014a). Students should be able to transfer their knowledge from the foundational science subjects to the core within the qualification. Scaffolding, integration and the transference of knowledge between foundational and core subjects would further legitimize the existence and inclusion of such when done and structured correctly.

Themes of physics for example such as pressure, force, energy, power, work, etc. are everyday terms which is used within many everyday task where the principle is applied without thinking for example during the process of cutting or breaking of an object. The application of these principles within everyday task within a particular context may never require the understanding or explanation of these phenomena. However, this may restrict for example the development of new knowledge and the ability to critique. Hence when faced for example with a certain situation which are beyond that which is normal we tend to instinctively draw from these principles, if it is understood, to develop another plan or manner in which to overcome the set back.

Where procedural knowledge is not underpinned by a principle, segmented learning may develop. MVR as stated by Dunbar (2013) may not present always in a similar manner and with training undertaken mostly with the vehicle in a particular orientation, the procedural knowledge could further contribute to segmented learning. The understanding of a principle which underpin a procedure may lend to knowledge transference into the atypical MVR related incident.

The same could be said about how we carry equipment or maintain our posture when performing certain task. We use different components of our musculoskeletal system to act as levers and fulcrums to either lift or lower an object without necessarily thinking about measuring the forces and angles for example, to ensure efficiency and prevent any associated risk which may cause harm. Practitioners instinctively would apply principles of good carrying or lifting practice which have been developed from the use of physics to ensure that the end goal is achieved as highlighted through the research conducted by Lavender *et al*,. (2000) and Schottke (2016).

7.2.3 Alignment/Misalignment of the principles of physics implicit in motor vehicle related rescue within medical rescue education

Curricula form the foundation and cornerstone of a qualification as stated by Coetzee (2007), Prideaux (2007) and Luckett (2010). They have highlighted the importance of it contributing towards the development of the students' knowledge as well as being a guide which details what is to be expected and done. The processes which are involved during the development and evaluation of curricula requires much thought as expressed by Luckett (2010) and Coetzee (2007), which should be holistic and based on sound educational theory.

The thematic document analysis of the BEMC Physics (EBS100A) and Extrication (EMR203M) subject guide is void of certain principles of physics and human mechanics. As was discussed within Chapter 6 the respective subject guides lacked the necessary coherency which is required for a professional degree. A hypotheses pertaining to the content and structure may be formulated of these subject guides. The rationale would be on the basis that it lacks threshold concepts and structure which would allow for the student to move between the theory (abstract nature) and the context (professional and vocational) knowledge. Due to rescue in its current form within the subject guide lending towards a procedural and very technically detailed pedagogy, it could contribute to segmented learning. This segmented learning approach would be further aided by the prescribed textbooks which lack the theoretical underpinning knowledge which would guide learners into developing and progressing beyond the procedural and technical detail.

If what is contained within the Extrication (EMR203M) subject guide is mostly from textbooks such as Moore (2011) 'Vehicle Extrication 1-2-3' and Dunbar (2013) 'Vehicle Extrication

Techniques', which are procedural and technical, it may lack the required rigour pertaining to addressing the horizontal (breath) and vertical (depth) discourse. This could constrain how and what learners are taught, which does not bode well for a profession which esteems to have an evidence-based and –informed practice.

7.3 SELF EVALUATION AND CRITIQUE OF THE RESEARCH

7.3.1 Introduction

A self-evaluation and critique of the study is done by the principal researcher using the Northcote (2012) guiding principles and criteria. The criteria have been designed in guiding the novice researcher by means of questions in reflecting on the design and manner in which qualitative research was conducted. It enables the appraisal of the quality of the study based on criteria which is reflective of research which is qualitative in nature. The purpose is not to justify or "self-validate" the research in its design and conduct.

7.3.2 Contribution in advancing wider knowledge or understanding

Medical rescue education currently has a procedural and technical bias with very little evidence to underpin its theoretical and practical knowledge. As medical rescue is a broad field of application, the scope of the study was delineated to motor vehicle rescue. This is of relevance as motor vehicle rescue is a common mode of rescue considering the high incidence of motor vehicle collisions and related mortality worldwide.

The conceptual framework for this study was accepted and presented in the form of an oral presentation at the South African Association of Health Educationalists (SAAHE) conference (Bosman et al,. 2013) which was held in Durban, South Africa, and; the Applied Human Factors and Ergonomics Conference (Bosman et al,. 2015b) held in Las Vegas, United States of America, validating scholarly relevance of the topic. The theoretical framework for this study was accepted and presented at the Legitimation Code Theory (LCT) Colloquium in Cape Town, South Africa, during June 2017 where the findings and analysis was presented (Bosman et al,. 2015a).

Through the use of Delphi research method, a typical case typology for motor vehicle rescue has been developed through which the threshold concepts of physics were identified by means of process tracing. An appraisal of the educational knowledge gap, through the content analysis of the relevant subject guides, emerged. The use of LCT, Semantic code concepts provided the further exploration of the units of study within the respective subject guides in establishing a profile related to the degree of contextual and theoretical "boundness". The knowledge contribution extends to the use of methods not common to medical rescue research. On good authority[69] this constitutes the first application of LCT to medical rescue education.

Curricula should ideally undergo periodic review and where possible should be supported by evidence. Opportunities exist for the replicating of the methodologies within other subjects of the EMC qualification as similar shortcomings are likely to exist for other medical rescue specialisations. Research challenges the *status quo* with respect to 'what we know' and 'what informs what we know' especially in a field where very little evidence exists to support certain procedural knowledge.

The future focus of the research related to EMC requires a structured approach and purposeful agenda to ensure that all research contribute in advancing knowledge and healthcare delivery. The meaning and contribution which this thesis has and will make would potentially be seen through the uptake from the various stakeholders who are responsible for the generating of standards, curriculum review, developing of student content, etc. post the dissemination process.

7.3.3 Rigour in the conducting of research

The research process followed a pre-determined flow as described and illustrated by the figure within Chapter 3. The modified Delphi process was designed, applied and analysed using various methodology which include the use of mind-maps, flow diagrams and explanatory information as detailed within the Annexures of the thesis. This allowed the data and research design to be delineated, tracking simplified, interpretation and computing to be standardised.

[69] This emerged from discussions with Prof K. Maton, the architect of LCT.

The modified Delphi process with other methodology was completed over a period of 2 years to allow for sufficient engagement with experts both in the EMC field (rescue for Delphi) and methodology (physicist for process tracing and LCT). A development of an inventory of physics for the process tracing of the typical case and related equipment further allowed the focus of the research to remain within its scope and boundaries. A LCT- validated translation device provided a critical distance to manage the researchers own bias towards the evidence.

South African experts on LCT were consulted on the use of LCT tools and analysis, to ensure appropriate application and interpretation, by the principal researcher. The principal researcher and supervisors was afforded various opportunities to engage with the architect and experience researchers form within LCT community through various platforms such as the biennial LCT colloquium, workshops, etc. These opportunities allowed for further development, feedback and engagement around LCT, and the field of Emergency Care and Rescue.

7.3.4 Defensibility of the research design

The modified Delphi uses a majority consensus by which agreement is attained which was set at 80%. It involved three (3) rounds of participation from the individual experts through which the typical case constructs was developed. This design and approach minimises the researchers' bias and influence. It was not known what amount of experts was required to develop a valid and reliable enough case. Hence the inclusion criteria were broadened to be inclusive and had a national reach. The complexity of the research question required a sophisticated design. Process tracing and document analysis as a methodology served to address the research aim.

7.3.5 Credibility and significance of the evidence generated

An 80% consensus per statement and criteria was required for inclusion the typical case narrative in the modified Delphi process with three (3) rounds administered. The theoretical and conceptual framework was validated at a conference in terms of education (SAAHE) and LCT community. None of the outcomes to date was published in a peer reviewed journal of which would occur post the submission for examination as this is a requirement in part of the fulfilment of the Master's degree qualification. Based on the analysis and findings of the research, the evidence and data support claims of knowledge building which may contribute to segmentalism and the reviewing of the respective subject guides. The principal researcher is not a physicist in terms of educational qualification and therefore consulted one of the appointed supervisors who holds a Doctor of Philosophy (PhD) in Physics. Further supporting evidence related to the process tracing of the physics within the typical case narrative of the MVR incident was obtained from various textbooks. Rescue information contained within Chapter 2 of the Literature Review was mostly from trade journals which lack the scholarly and academic quality needed for a thesis study. This thereby limited the rigour and standard of evidence to support certain claims. The complexity of the study design negates such limitations.

7.3.6 Affective nature of researcher and participants

The medical rescue experts were exited to participate during the various rounds of the modified Delphi process and expressed interest in the final thesis document during the dissemination thereof on completion. Various LCT researchers[70] has expressed interest in the future opportunities related to the use of the dimensions of LCT and the related aspect of EMC. The principal researcher has a passion for rescue and had a long career as a firefighter. He was stationed within the geographical area of the Cape Metropole where the busiest national and arterial roads were found of which motor vehicle collisions formed a great deal of the workload. During the educational experience the principal researcher noted the lack of discourse of rescue and evidence to support the practical basis within the undergraduate qualifications being offered. As a professional within the emergency medical care field and educator in the higher education arena the motivation was borne to contribute in exploring the hypothesis and claims related to addressing the educational gap.

7.4 CONCLUSION

A case has been made for the need for research methodologies which would contribute in moving the emergency care and rescue field from a historically bounded practice to one which is evidence-based and -informed. No motor vehicle related rescue incident is deemed similar. Curricula are to be relevant and appropriately aligned for its context where

[70] Associate Professor Karl Maton (architect of LCT) expressed interest to the principal researcher via email correspondence pertaining to the final thesis and its finding. Other notable researchers and experts on LCT with whom the principal researcher consulted similarly expressed interest around future collaborations pertaining to LCT and the field of EMC.

knowledge is to be used post qualification and this may further be strengthened through the development of typical case scenarios from experts within the field of EMC & rescue.

BEMC Physics and Extrication subject guides are void of certain principles of physics as identified within the typical case typology. This could possibly lead to very few principles of physics for learners to draw from in order to move from segmented knowledge building towards cumulative knowledge building. Professional degree subjects should ideally have subject guides which has a better flow pertaining to the semantic profiles (waving and weaving). It should flow from abstract to concrete pertaining to its density and context independent to dependent pertaining to its gravity.

Developing curricula that is underpinned by sound theoretical evidence base which is supported by rigorous evidence and research would provide to the credibility of a qualification. Curricula by design inform the teaching, learning and the competencies which would ultimately be assessed. Professional degrees contribute towards developing practitioners whom would graduate with the knowledge and competencies to adapt to situations. In addition, graduate attributes of lifelong learning, reflective practice and the ability to contribute to the development of new knowledge is secondary to the qualification as an end goal.

CHAPTER EIGHT

RECOMMENDATION & CONCLUSION

8.1 INTRODUCTION

The purpose of this chapter is to make recommendations based on the findings from the research objectives as it would relate to the motivation of the study and the associated implications and/or application and/or relevance which it holds for the emergency medical care and rescue field (from a professional, educational and operation practice perspective). These recommendations (and thesis on completion of the fulfilments of the Master's qualification) would be disseminated and made available to the relevant statutory -, standards generating -, professional societies – bodies, educational institutions, organizations research, etc. involved in emergency medical and rescue. A way forward in terms of building onto the educational and theoretical framework (constructs) from this research thesis which hold value for other research opportunities within the field of emergency medical care and rescue field is also highlighted and discussed.

The chapter concludes with a summary of the main points and ideas which the research has been able to identify/highlight through the literature review, analysis and discussion of the findings from the various research methodologies which was employed towards the research question and its objectives.

8.2 RECOMMENDATIONS

8.2.1.1 Emergency Medical Care and Rescue practitioner

The emergency medical care profession with regards to the medical rescue discipline requires reviewing. Different qualifications are offered at various levels by current services within the medical rescue arena. Rescue in its current format as a specialty is poorly regulated when compared to the emergency care component by the HPCSA.

A well-defined and evidence-based scope, international bench marking, etc. are some of the factors which would contribute in ensuring that the emergency care practitioner is fit for purpose and possess the necessary attributes which would contribute to the South African community and workforce. Student development could be hindered if qualifications are poorly constructed and aligned as highlighted through the document and gap appraisal through this research. The debate in Higher Education is centered around developing curricula and qualification which are decolonized and Africanised (Luckett, 2010).

Qualifications therefor should be underpinned by curricula and pedagogy which is informed by theory as stated respectively by Luckett (2010) and Prideaux (2007). This requires a holistic approach with input from all stakeholder from those developing qualification (educational institutions), standards generating bodies (statutory and regulatory bodies), professional societies, relevant national governing departments, industry, etc.

A sound evidence base[71] is required in the provision of emergency medical care and rescue training. A theoretical and educational argument has been made for the placement of knowledge within curricula which would contribute to cumulative building which would further develop practitioners (graduates) abilities to become 'lifelong learners'. As a profession we should aspire to develop true experts based on the definition of LindstrØm (2010) and a model for attaining competency (from novice to expert) by Dreyfus & Dreyfus (2005). Experience is necessary for expertness but not necessarily is sufficient to be deemed an expert.

A more student centred approach is required with educators having the required qualifications, skills and attributes to contribute in developing transformative curricula, good teaching and learning practices, etc. and graduates who are fit for purpose. As highlighted in Chapter 2 of the Literature Review this requires a partnership between the educator and student as both parties play a role in ensuring

[71] Qualifications should hold relevance and fulfil its purpose. Educational theories should inform curricula which is grounded in theory which is "transformative" to the social needs of the community for which it is intended.

that the desired outcomes and objectives is achieved as stated by Biggs (2002) and Houghton (2004).

8.2.1.2 Curriculum development and Advanced Certificate in (Medical) Rescue (Technology)

The current debate and move within higher education is to develop curricula which is transformative and 'Africanized' (Luckett, 2010). The field of emergency medical care and rescue is not immune nor exempted from recurriculating its own curricula and ensuring that it would meet the needs of the African society. In the recurriculation of the emergency care and rescue qualifications the opportunity also exists to evaluate the content not only pertaining to its relevance for the African society but also to evaluate its pedagogic fit in contributing to graduate attributes such as developing new knowledge through research, lifelong learning (through knowledge building which is cumulative), professionals, etc. (CPUT BEMC Curriculum, 2018).

Within Chapter 6 of the document analysis it was noted that the CPUT BEMC Physics Subject (EBS 100A) guide was poorly structured. Furthermore, it was noted that the CPUT BEMC Extrication (EMR203M) guide mainly lacked the principles which underpin the discipline of motor vehicle related rescue and appeared to lend to proceduralised knowledge. This research study has identified some implications for the current BEMC Physics and Extrication subject guide with regards to its content relevance and the constrains it has to knowledge building. This would hopefully inform and provide a basis for reviewing of these subject guides/curricula. These findings and suggested recommendations has implications and application for the new proposed Advanced Certificate in Medical Rescue which would require consideration during the development and finalization of its own subject's guides.

Subject guides and curricula should be reviewed in terms of its ability to provide meaning and guidance to educators. Poorly written subject guides and curricula could potentially lead to poor teaching and learning practices as stated by Coetzee (2007). Departments are to ensure that they not only benchmark the content for suitability and relevance. Curricula should be constructively aligned to enable good teaching, learning and assessment practices (Biggs, 2002). Quality assurance departments within educational and training organizations could guide departments in ensuring that there exists uniformity in the structure of subject guides to ensure that both educators and learners (students) have sufficient guidance in ensuring that they fulfill their respective roles and responsibilities.

8.2.1.3 Physics and human mechanics

Rescue is inherently dangerous and due to the nature of it, it lends itself to be a field or discipline which places workers at severe risk of harm and injury (Dunbar, 2013) and (Calland, 2006). Physics and human mechanics has the potential to contribute in improving efficiency & safety around motor vehicle related rescues (Lavender et al; 2000) and (Schotke, 2016). When looking at the hierarchy regarding safety and how safety is mitigated the provision of PPE is the last on the list within order from highest to lowest is elimination (removing of the hazard) followed substitution (replacement of the hazard) followed by engineering (isolating people from the hazard) and second last by administrative control (change the way people work) (Manuele, 2005).

Changing people's behavior and culture can be influenced by not just changing the administrative controls in putting policies in place to enforce compliance which is not supported by evidence (Manuele, 2005). Rescuers over time may become complacent due to the nature and frequency by which they are involved in certain things but through the engagement of the rescue community in research and providing the evidence to change behavior more could be done to facilitate better (in terms of effective and efficient) and safer working environments.

Occupational injuries contribute not just to a loss in man hours but have huge implications when rescuers are not skilled in the application of principles when procedural knowledge is limiting them in being able to do their job (Lavender et al, 2000; Schottke, 2016). When practitioners start to apply procedural knowledge out of context it could potentially influence patient outcomes (as seen by the golden hour and platinum ten rules) which could potentially have an effect on the efficiency by which things are done on scene.

Incorporating human (body) mechanics into our curricula and the way we train could contribute to potentially less musculoskeletal injuries, newer innovative ways in how we support the rescue technician during the performance of certain tasks on the rescue scene and/or having greater safety awareness.

8.2.1.4 Research as contributor of funding for training and development

Training, development and budget constraints may impede emergency medical care and rescue organizations abilities to obtain suitable resources on which to keep their students and staff with the required training and currency. Through the development of research and development center's which is equipped to produce evidence based, innovative and scientific research the profession and qualifications obtained through it would gain the much needed professional status. Training and development center's budgets could be supported through the obtaining of research grants (local, private/donor, international, etc.) and thus would see sustainability and longevity of these training centers. Research grants provide not just the opportunity to obtain resources and contribute in ongoing maintenance but also to develop staff as researchers in developing their expertise and capabilities which improve the field/discipline and the profession as such.

HEI and those organizations (statutory bodies, etc.) involve in the emergency medical care and rescue education need to play a closer role in meeting the needs of the industry. They should not be seen as separate entities which exist for their own purpose and goals but, they should strive to develop relationships which are symbiotic in nature where both benefit through well thought through and structured agreements. These memorandums of understanding and/or structured agreements could involve funding (in terms of student bursaries, purchasing of much needed resources, etc.), providing of expertise (from teaching, research, advisory, etc.), work placement (during work integrated learning, post qualification positions, etc.), etc. HEI and training organizations play a multifactorial role not just in graduating emergency medical care and rescue practitioners which are skilled and competent but, also ensuring that graduates contribute to the society for which they have been trained.

8.2.1.5 Developing credible research tools and methodologies

Rescue as a specialization and discipline within South Africa is mostly reliant on the international arena for information, standards and guidance. This could be in part due to the field which lack the necessary regulating (rescuers do not have to be registered with a statutory body to work within the rescue environment), credible qualifications (most qualifications are not NQF aligned and with poor quality assurance processes). Furthermore, most services do not have dedicated positions which are for rescue specialist (very few post exist both in the private and government sector for practitioners to be employed within a rescue specialist capacity). Most rescue related journals with a few exceptions to those which relate to the fire sciences are not peer reviewed and are trade journals with mostly opinions written by experts from the field of discipline or industry.

In South Africa no formal rescue qualification exists to date with some universities in process of offering rescue at an advanced certificate level. Proposed qualifications do not include a research related component as its intended focus is to produce skilled and competent labour (workforce) practitioners. Lending form our sister qualifications and professions from both the medical field and education could provide a research platform from which to develop a research agenda for rescue based on already existing and developed tools and methodologies.

Much needed research is required within the field of Medical Rescue and the continuation of the study may be a vehicle to research other areas of unknown especially within the area of knowledge building in terms of moving from segmented to cumulative. Other areas of research within emergency medical rescue may include what are the current needs within the context of the South African landscape. This may hold value towards the development of a qualification which is not only internationally benchmarked but that is transformed and relevant for the needs of the local South African industry which fits well into a functioning EMS and Health system.

8.2.1.6 Evidence-based research and evidence-informed practice to guide SGB's and Professional bodies

Standards generating-, professional – and statutory bodies, and professional associations should play their meaningful role and take up the responsibilities to contribute in more than just the obligatory requirements for example keeping practitioners accountable to maintain currency (continuous professional development and annual registration-where applicable). They should contribute towards the establishment of a research agenda and the development of credible systems which would contribute towards data which could be available and to be used in a defined scope of practice and qualifications which are evidence based (for the South African and African context and continent).

They should create opportunities for research and/or provide funding and/or develop systems which would encourage not just compliance but quality assurance of all areas as it would relate to the field of emergency medical care and medicine. Rescue as such which is currently poorly regulated and standardised leaves much to be desired and hence the need for greater input and participation from all stakeholders to.

8.2.1.7 Professionalizing Emergency Medical Rescue Practice

The field and profession of emergency medical rescue is in need of research due to a lot of what is being done based on experience (through at times the invitation of an international ‘expert’ to provide some ‘train the trainer’ training) and which is not supported by strong evidence (knowledge and content is mostly from textbooks which are very procedural). Emergency medical rescue qualifications as such lack educational and theoretical rigour which underpin and provide explanatory powers to inform curricula, teaching, and learning and assessment practices.

Procedural knowledge will only be able to take you so far and works well in a field where there are a few ways in which to correct and/or mitigate a particular new development for example in the aviation industry where a pilot would experience a particular problem s/he would be able to go through a serious of pre-determined process/systems check/procedures which has been developed through various test and studies and possible research in order to reach an end goal or decision or objective which would have a beneficial outcome.

In the emergency medical care and rescue field and the discipline of motor vehicle rescue is very unique with no situation to a minute level being similar which would require a similar type of approach and mitigation (Dunbar, 2011d; Van Rensburg & Fleischman, 2017). With the changes in motor vehicle industry and the motor vehicle rescue related incident not being similar the rescuer would have to possess knowledge which would take them beyond the procedural knowledge. Therefore it is recommended the subject guides and curricula is to be reviewed to ensure that the content contribute towards cumulative knowledge which is underpinned by principles which provides more explanatory powers towards the management of these nuanced situations.

8.3 CONCLUSION

Through the literature review a case has been made for the importance of science as a field from which new knowledge is possible to be developed within the field of context as sciences provide a basis and explanatory power which underlies very much the fundamental principle of everything. This would see not just an increase in knowledge production but that through the use of science we are able to provide meaning to what and how we do things.

The prevalence of motor vehicle rescue suggests it is a legitimate field of study for further and future research. In order to move forward in achieving true professionalization, any field/qualification/vocation would have to move beyond the historical and cultural boundary which can so easily keep practitioners "stuck" without any real progress seen. A typical case has been developed from which other research could be undertaken to engage the motor vehicle rescue community.

This study as an objective was able to analyse the extent to which the physics within the extrication subject guide was represented and constitutes a novel finding upon which to predicate redress and evaluation. Within motor vehicle rescue there are very many aspects which relate not only to the field of motor vehicle rescue such as stabilization, use of hydraulic and/or pneumatic equipment for lifting, pushing, cutting, etc. but that these are concepts which are used within confined space rescue, trench rescue, structural collapse, agricultural and machinery rescue with these underlying principles having relevance to most other rescue related disciples/fields.

The use of process tracing based on the literature which has been reviewed could be used as a methodology to evaluate and provide more information (detail) in understanding motor vehicle related and associated rescue disciplines. This form of methodology could contribute towards a theoretical basis or explanation for why we do things (even if it is done currently in a procedural manner and/or evaluating the atypical incident). Due to the dynamic nature of rescue very few incidents would be a replica of each other but most incidents would have certain elements (principles) that would be inherently be present at most incidents.

The use of LCT dimensions holds value in better understanding and identifying how knowledge is constructed and build as an educational and theoretical framework for the field of emergency medical care and rescue. The power of LCT, Semantic dimension, as an educational theory for knowledge building and suitability in the evaluation of the curricula, teaching and learning praxis through the profiling of its density and gravity to “waving and weaving” has the potential to explain how knowledge is transformed and brought together.

Other sister and associated fields would continue to evolve and grow as a result of the influences which the production of new knowledge through structured relevant post graduate qualifications (Masters, Doctorate and post-doctoral fellowships). The ultimate aim and objective of producing new knowledge should be based on sound methodologies which are academically reviewed. These post graduate qualifications have the further opportunity to contribute towards disseminating of their research into a wider platform and audience through publication (in full or part) within electronic and/or paper based media and/or journals. Moving from ‘historical’ and ‘dogma’ manners towards a more structured and aligned profession is to be pursuant of in terms of qualifications, scope of practice, research agenda, etc.

The purpose and focus of this research was not on the patient and the associated outcomes that is to be expected. Further opportunities for other research exist as no rescue would be needed if there is no patient that requires assistance or is in need of some help. Theory and practice within the field of emergency medical care is reliant on a reciprocal[72] relationship. Within a close non-transformative system, procedural knowledge may suffice but in an open transformative system where professionalization reside, rescue ideology must influence pedagogy and pedagogy must influence rescue ideology.

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[72] This is on the premise of a positive feedback mechanism where the theory is powerful to support practice and where practice is based on theory which is underpinned by evidence.

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APPENDIX A: **RESEARCH INFORMATION LEAFLET**

Cape Peninsula
University of Technology

RESEARCH INFORMATION SHEET

UNIVERSITY:	Cape Peninsula University of Technology (CPUT)
FACULTY:	Health & Wellness Sciences
DEPARTMENT:	Emergency Medical Sciences
STUDENT:	Mr Justice S. Bosman (204173035)
EMAIL ADDRESS:	bosmanjs@cput.ac.za
CONTACT NUMBER:	0219538457 / 0833824429
SUPERVISOR:	Dr Mark Marais
EMAIL ADDRESS:	maraism@cput.ac.za
CO-SUPERVISOR:	Mr Navindhra Naidoo
EMAIL ADDRESS:	naidoon@cput.ac.za
CONTACT NUMBER:	0219538408
ETHICAL APPROVAL REF NO:	NHREC:REC- 230408-014

Dear prospective participant:

You are hereby invited to take part in a research project. Please take some time to read the information presented here, which will explain the details of this project. Please ask the study investigator any questions about any part of this project that you do not fully understand. It is very important that you are fully satisfied and that you clearly understand what this research entails and how you could be involved. Also, your participation is **entirely voluntary** and you are free to decline to participate. If you say no, this will not affect you negatively in any way whatsoever. You are also free to withdraw from the study at any point, even if you do agree to take part.

This study has been approved by the **Faculty of Health and Wellness Research Ethics Committee of the Cape Peninsula University of Technology** and will be conducted according to the ethical guidelines and principles of the international

Declaration of Helsinki and the Medical Research Council (MRC) Ethical Guidelines for Research.

What is this research study all about?

The aim of the study is to investigate the principles of physics implicit in emergency medical rescue education and operational practice through a case study of motor vehicle related rescue.

The objective of this study is to define a case typology of motor vehicle related rescue through consensus findings from an expert panel within the field of emergency medical rescue. To evaluate the case typologies for underpinnings of conceptual/applied physics and through document analysis evaluate the alignment of curricula pertaining principles of conceptual/applied physics.

Why have you been invited to participate?

You are recognised by this study as an expert in the field of emergency medical care particularly in the field of motor vehicle related rescue within a South African context.

What will your responsibilities be?

You will be required to respond to a questionnaire to be sent to you by the investigator, completing and returning the relevant documents within the set timeframe. The responses are brief and the timeframe is approximately one month (from time of consent to consensus findings amongst experts).

Will you benefit from taking part in this research?

Your contribution to this study will document your expert input defining a typical case for motor vehicle related rescue. Out of these case definitions a classification of rescues may emerge. There is no other direct benefit to you.

Are there any risks involved in your taking part in this research?

There should be no personal risk to you through your participation.

Your individual autonomy and expert opinion will be respected and confidentiality will be ensured.

If you do not agree to take part now, what alternatives do you have?

Additional information will be sent to you, if requested.

You may reconsider participation at any time during the study, and will be allowed to provide input up to the final data collection date; this will also be reflected in the interpretation and analysis of the data related to the study.

Who will have access to your information and participation?

Information collected will be treated as confidential and protected on a personal password protected computer.

If the information is used in a publication, your identity will remain anonymous.

Will you be paid to take part in this study and are there any costs involved?

No you will not be paid to take part in the study. There should be no costs to you, if you do or do not take part, except for your time expended.

Is there anything else that you should know or do?

You can contact the principle investigator if you have any further enquiries or encounter any problems or wish to report any adverse events.

You can contact the Faculty of Health and Wellness Research Ethics Committee of the Cape Peninsula University of Technology if you have any concerns or complaints or to report any adverse events.

You will receive a copy of the consent form for your own records.

Yours faithfully

Justice Bosman

APPENDIX B: PARTICIPANT CONSENT FORM

Cape Peninsula
University of Technology

Title of Study

Principles of physics implicit in emergency medical rescue education and operational practice- a case study of motor vehicle related rescue.

Participant Consent/Assent Form

UNIVERSITY:	Cape Peninsula University of Technology (CPUT)
FACULTY:	Health & Wellness Sciences
DEPARTMENT:	Emergency Medical Sciences
STUDENT:	Mr Justice S. Bosman (204173035)
EMAIL ADDRESS:	bosmanjs@cput.ac.za
CONTACT NUMBER:	0219538457 / 0833824429
SUPERVISOR:	Dr Mark Marais
EMAIL ADDRESS:	maraism@cput.ac.za
CO-SUPERVISOR:	Mr Navindhra Naidoo
EMAIL ADDRESS:	naidoon@cput.ac.za
CONTACT NUMBER:	0219538408
ETHICAL APPROVAL REF NO:	NHREC:REC- 230408-014

Declaration by participant

By signing below, I *(name)* ……………………………………..…………. agree/ do not agree to take part in a research study entitled: *Principles of physics implicit in* *emergency medical rescue education and operational practice- a case study of motor vehicle related rescue.*

I declare that:

I have read or had read to me the participant information and consent form and it is written in a language with which I am fluent and comfortable.

I have had a chance to ask questions and all my questions have been adequately answered.

I understand that taking part in this study is voluntary.

I may choose to leave the study at any time and will not be penalised or prejudiced in any way.

Signed at (*place*) ....…........…………….. on (*date*) …………...……….. 2014

Signature of participant

Declaration by investigator

I *(name)* ………………………………………..……… declare that:

I explained the study information to ……………………………………..

I encouraged him/her to ask questions and took adequate time to answer them.

I am satisfied that he/she adequately understands all aspects of the research, as discussed above

I did/did not use an interpreter.

Signed at (*place*) ....…........…………….. on (*date*) …………...……….. 2014

....
Signature of investigator

APPENDIX C: 1ST ROUND QUESTIONNAIRE DELPHI PANEL/PARTICIPANT

Participant No. Insert Participant Number here

Cape Peninsula University of Technology

UNIVERSITY:	Cape Peninsula University of Technology (CPUT)
FACULTY:	Health & Wellness Sciences
DEPARTMENT:	Emergency Medical Sciences
STUDENT:	Mr. Justice S. Bosman (204173035)
EMAIL ADDRESS:	bosmanjs@cput.ac.za
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EMAIL ADDRESS:	naidoon@cput.ac.za
CONTACT NUMBER:	0219538408
ETHICAL APPROVAL REF NO:	NHREC: REC- 230408-014

Title of Study

Principles of physics implicit in emergency medical rescue education and operational practice- a case study of motor vehicle related rescue.

1st ROUND QUESTIONNAIRE FOR DELPHI PANEL

Please note. This questionnaire may not be utilized in any way or means without written consent of the author. Please note that no alterations and /or changes may be done to any part of the document/tools whilst completing the round of questionnaire.

This questionnaire is divided into sections, each section deals with a different theme indicated by the heading. The initial themes emerged and have been developed to define a typical case scenario / typology for motor vehicle related rescue (light and/or heavy).

The themes which do not have strong consensus and/or support will be used in developing an atypical case scenario and/or typology of a motor vehicle related rescue case.

In sections **A to D,** you will be required to provide your opinion regarding the various statements by indicating if you **agree, disagree** or are **undecided**.

In Section A please select the equipment that you most **agree** to being used at a typical motor vehicle related rescue incident (here you may **agree/disagree/undecided** to more than one option provided).

In Section B, C & D each different color area that is highlighted represents a question where you the respondent should select an answer from the area where you **agree** as to which of the options provided of the question/statement is most relevant/prevalent/correct on the basis of your expert opinion, thereby rendering the other questions/statements within the same color highlighted as either **disagree or undecided**

Indicate your selection by placing an "X" in the corresponding block. Please do not write in the comment column that is for me (*the researcher*) to indicate the consensus ratings.

If for any reason that uncertainty arises with the utilization and/or completion of this document/tool then feel free to contact the principal investigator on the contact details at the end of the questionnaire in order to ensure that the tools is applied and/or completed in the manner for which it has been designed and/or intended.

Please indicate within which group you qualify as a participant within this study. ***Indicate with a*** $\boxed{\text{X}}$ ***in the box provided.***

<u>Group 1</u> ☐

- Practitioners/experts within the field of medical and technical rescue that are either currently heads of a motor vehicle rescue training unit and/or service.

- Experts should have at least more than 5 years of operational experience relevant to the field of motor vehicle rescue.

- Participants should be registered with the Health Professions Council of South Africa (HPCSA) as a healthcare practitioner at an Intermediate life Support level (ILS) and higher; and possess a suitable rescue technician and/or a medical rescue qualification (preferably advanced).

- Participants should have relevant knowledge regarding operational and educational practices within the field and/or discipline of motor vehicle rescue (light and heavy).

Group 2 ☐

- Practitioners/experts within the field of medical and technical rescue that are either currently employed by a Local or Provincial or Private Emergency Medical and/or Rescue Service within the capacity of an operational rescue technician
- Experts should have at least more than 5 years of operational experience relevant to the field of motor vehicle rescue.
- Participants should be registered with the Health Professions Council of South Africa (HPCSA) as a healthcare practitioner at an Intermediate life Support level (ILS) and higher; and possess a suitable rescue technician and/or a medical rescue qualification (preferably advanced).
- Participants should have relevant knowledge regarding operational practices within the field and/or discipline of motor vehicle rescue.

	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A1.	Cribbing (2x4)	1	2	3	
A2.	Cribbing (4x4	1	2	3	
A3.	Wedges	1	2	3	
A4.	Stepchocks	1	2	3	
A5.	Pneumatic struts	1	2	3	
A6.	Mechanical struts	1	2	3	
A7.	Ratchet strapping	1	2	3	
A8.	Chain with J-hooks	1	2	3	
A9.	Strut Head (Cone shaped)	1	2	3	
A10.	Strut head (L-shaped)	1	2	3	
A11.	Strut base plate	1	2	3	
A12.	V- Strut	1	2	3	

	Hand Tools				
A13.	Halligan Tool	1	2	3	
A14.	Axe (Flathead)	1	2	3	
A15.	Axe (Pickhead)	1	2	3	
A16.	Boltcutter	1	2	3	
A17.	Pliers (channel lock type)	1	2	3	
A18.	Pliers (side cutters)	1	2	3	
A19.	Srewdriver (Flat)	1	2	3	
A20.	Crow bar	1	2	3	
A21.	Springloaded punch	1	2	3	
A22.	Webbing	1	2	3	
A23.	Come-along tool	1	2	3	
A24.	Hacksaw	1	2	3	
A25.	Seatbelt cutter	1	2	3	
A26.	Scissor (serrated edge type)	1	2	3	
A27.	Rescue knife	1	2	3	
A28.	Reciprocating saw	1	2	3	
A29.	Windshield saw	1	2	3	
A30.	Air chisel or gun cutting tool	1	2	3	
A31.	Shovel	1	2	3	
A32.	Broom	1	2	3	
A33.	Airbag cover	1	2	3	
	Power Rescue Tools				
A34.	Power plant (Fuel driven)	1	2	3	
A35.	Spreader tool	1	2	3	
A36.	Cutter tool	1	2	3	
A37.	Ram tool	1	2	3	
A38.	Pedal cutter tool	1	2	3	
A39.	Chains	1	2	3	
A40.	Ram support (bracket/base plate)	1	2	3	
A41.	Lighting	1	2	3	
A42.	Jacks (hi lift)	1	2	3	
A43.	Jack (hydraulic)	1	2	3	
A44.	Vetter bags	1	2	3	

	SECTION B~TYPE OF VEHICLE, DESIGN & HAZARDS *The aim of this section is to determine the type of vehicle, design and hazards that are prevalent (most commonly seen and/or found) at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).

		Agree	Undecided	Disagree	Comments
B0	Most typical RTA involves vehicles that have the new car technology (i.e. crumple zones, reinforced dashboards, micro alloy and boron steel, etc)	1	2	3	
B1.	Most typical RTA occur with unibody construction/design vehicles (unibody vehicle uses the body panels and floorpan to form its structure)	1	2	3	
B2.	Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)	1	2	3	
B3	Most typical RTA occur with full frame construction /design vehicles (the body bolts to a welded frame and is the full length of the car)	1	2	3	
B4.	Most typical RTA occur with vehicles that are petroleum fuel driven	1	2	3	
B5.	Most typical RTA occur with vehicles that are diesel fuel driven	1	2	3	
B6.	Most typical RTA occur with vehicles that are liquefied petroleum gas (LPG) driven	1	2	3	
B7.	Most typical RTA occur with vehicles that are Hybrid system driven	1	2	3	
B8.	Most typical RTA occur with vehicles that are petroleum fuel driven and are modified with some form of gas (e.g. nitrogen gas) affixed to enable and/or enhance performance	1	2	3	
B9.	Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})	1	2	3	
B10	Most typical RTA occur with light delivery vehicles (LDV) (include your ½ tonner bakkies to 1 tonner bakkies, double cabs)	1	2	3	
B11	Most typical RTA involve busses (includes minibuses and larges busses whether for personal, commercial or public transport)	1	2	3	
B12	Most typical RTA involve trucks (those over 10 ton capacity irrespective of amount of axles and whether it has a “horse & trailer”)	1	2	3	
B13	Most typical RTA involves trains which have collided with any other forms of road transportation that have occurred at a public or private road.	1	2	3	
B14	Most typical RTA involves the transportation of a hazardous material.	1	2	3	
B15	Most typical RTA involve radiator fluid spills and/or leakages	1	2	3	

B16	Most typical RTA involve fuel spills and/or leakages	1	2	3	
B17	Most typical RTA involve oil fluid spills and/or leakages	1	2	3	
B18	Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {“idling”}	1	2	3	
B19	Most typical RTA involves a fire to engines compartment	1	2	3	
B20	Most typical RTA involves a fire to the passenger compartment	1	2	3	
B21	Most typical RTA involves undeployed airbags (irrespective if it is frontal and/or side impact airbags)	1	2	3	
B22	Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)	1	2	3	
B23	Most typical RTA involves undeployed Automatic Roll Over Protection Systems (ROPS)	1	2	3	
B24	Most typical RTA involves deployed Automatic Roll Over Protection Systems (ROPS)	1	2	3	
B25	Most typical RTA involves electrical hazards (i.e. lamp standard, ESKOM power supply unit, etc)	1	2	3	

	SECTION C~RTA BY COLLISION KINETICS/CLASSIFICATION *The aim of this section is to classify road traffic accidents by collision kinetics and/or amount of vehicles involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
C1.	Most typical RTA involves frontal collisions (irrespective if it is full, half , quarter or partial frontal involvement)	1	2	3	
C2.	Most typical RTA involves side impact collisions	1	2	3	
C3	Most typical RTA involves roll over collisions	1	2	3	
C4.	Most typical RTA involves under runs (irrespective what the object is that the vehicle ran underneath into e.g. truck, railing, etc)	1	2	3	
C5.	Most typical RTA involves crush incidents (irrespective of what the object is that is creating a “crush” onto the vehicle e.g. wall, truck, container)	1	2	3	

C6.	Most typical RTA involves collisions where it involves more than one type of collision kinetic/classification (i.e frontal collision that resulted in a roll over	1	2	3	
C7.	Most typical RTA involves two similar type of mode of transport (e.g. passenger vehicle vs passenger vehicle, minibus vs minibus)	1	2	3	
C8.	Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up)	1	2	3	
C9.	Most typical RTA involves single vehicle collisions with a stationary object.	1	2	3	

	SECTION D~RESCUE RESPONSE *The aim of this section is to determine what are the responses required and/or involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
D1.	Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation	1	2	3	
D2	Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation	1	2	3	
D3.	Most typical RTA involves the use of hydraulic spreading equipment to either “push and/or lift” metal and structures (irrespective if a spreader, rams, etc)	1	2	3	
D4.	Most typical RTA involves the use of hydraulic spreading equipment to either “pull” metal and structures	1	2	3	
D5.	Most typical RTA involves the use of hydraulic cutting equipment to either “cut” metal and structures (irrespective if conventional cutter or mini cutter or combitool)	1	2	3	
D6.	Most typical RTA involves the use of hydraulic equipment to either power and operate hydraulic	1	2	3	

	equipment (hydraulic motor pump, hydraulic hand pump, etc)				
D7.	Most typical RTA involves the use of hydraulic equipment to stabilize vehicle/'s and/or structures	1	2	3	
D8.	Most typical RTA involves the use of handtools to extricate patients from vehicle/'s (i.e. highlift jack, hacksaw, haligan tool, etc)	1	2	3	
D9.	Most typical RTA involves the use of an axe to break/cut through laminated glass of a vehicle/'s	1	2	3	
D10	Most typical RTA involves the use of an saw designed to cut through laminated glass e.g "Glass Master saw" to break/cut through laminated glass of a vehicle/'s	1	2	3	
D11	Most typical RTA involves the use of an axe to break laminated glass of a vehicle/'s	1	2	3	
D12	Most typical RTA involves the use of an reciprocating saw to break/cut through laminated glass of a vehicle/'s	1	2	3	
D13	Most typical RTA involves the use of an axe and haligan tool to break tempered glass of a vehicle/'s	1	2	3	
D14	Most typical RTA involves the use of an sharp object for example a screwdriver to break tempered glass of a vehicle/'s	1	2	3	
D15	Most typical RTA involves the use of an springloaded centre punch to break tempered glass of a vehicle/'s	1	2	3	
D16	Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/'s	1	2	3	
D17	Most typical RTA involves the use of highlift jacks to stabilize the vehicle/'s	1	2	3	
D18	Most typical RTA involves the use of wood and wedges to stabilize the vehicle/'s	1	2	3	
D19	Most typical RTA involves the use of pneumatic equipment/ shores to stabilize the vehicle/'s	1	2	3	
D20	Most typical RTA involves the use of ratchet straps to stabilize the vehicle/'s	1	2	3	
D21	Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/'s	1	2	3	

Thank you for participating thus far in the study and completing the questionnaire. The principal investigator will contact you shortly in the event of further rounds of the Delphi process.

Kindest regards

Justice Bosman
(Student number 204173035)
(Investigator)
0833824429 (cell)
0219538457 (office)
bosmanjs@cput.ac.za (email)

APPENDIX D: HEALTH AND WELLNESS SCIENCES ETHICS COMMITTEE ETHICAL CLEARANCE CERTIFICATE & EXTENSION

Cape Peninsula
University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (HW-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
Symphony Road Bellville 7535
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Email: danielso@cput.ac.za

27 June 2013
CPUT/HW-REC 2013/H23

Faculty of Health and Wellness Sciences
Emergency Medical Sciences Department

Dear Mr Justice Selvyn Bosman

APPLICATION TO THE HW-REC FOR ETHICAL CLEARANCE

Approval was granted on 13 June 2013 by the Health and Wellness Sciences-REC to Justice Selvyn Bosman for your application. This approval is for research activities related to a Master of Emergency Medical Care at this institution.

Title: Principles of physics implicit in emergency medical rescue education and operational practice- a case study of motor vehicle related rescue.

Internal Supervisor:	**Dr Mark Marais**
Internal Co-supervisor:	**Mr N Naidoo**

Comment:
Approval will not extend beyond 27 June 2014. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

Note:
The investigator(s) should understand the conditions under which they are authorized to carry out this study and they should be compliant to these conditions. **It is required that the investigator(s) complete an annual progress report that should be submitted to the HW-REC in December of that particular year, for the HW-REC to be kept informed of the progress and of any problems you may encounter.**

Kind Regards

Zuleika Nortje
CHAIRPERSON – ETHICS RESEARCH COMMITTEE
FACULTY OF HEALTH AND WELLNESS SCIENCES

Cape Peninsula
University of Technology

HEALTH AND WELLNESS SCIENCES RESEARCH ETHICS COMMITTEE (HW-REC)
Registration Number NHREC: REC- 230408-014

P.O. Box 1906 • Bellville 7535 South Africa
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Email: danielso@cput.ac.za

13 June 2014
REC-230408-014-RA Level 01
H04

Emergency Medical Sciences Department

Dear Mr JS Bosman

APPLICATION TO THE HW-REC FOR ETHICAL CLEARANCE EXTENSION

Approval was granted by the Health and Wellness Sciences-REC on 11 June 2014 to Justice Selvyn Bosman for ethical clearance extension. This approval is for research activities related to a Master of Emergency Medical Care qualification at this institution.

TITLE: Principles of physics implicit in emergency medical rescue education and operational practice – a case study of motor vehicle related rescue.

Supervisor:	**Dr Mark Marais**
Co-supervisor:	**Mr N Naidoo**

Comment:
Approval will not extend beyond 13 June 2015. An extension should be applied for 6 weeks before this expiry date should data collection and use/analysis of data, information and/or samples for this study continue beyond this date.

The investigator(s) should understand the conditions under which they are authorized to carry out this study and they should be compliant with these conditions. **It is required that the investigator(s) complete an annual progress report with their application for an extension and a final report on completion of the study.**

Kind Regards

CHAIRPERSON – ETHICS RESEARCH COMMITTEE
FACULTY OF HEALTH AND WELLNESS SCIENCES

APPENDIX E: **CPUT DEMS SITE APPROVAL**

Cape Peninsula University of Technology

FACULTY: HEALTH & WELLNESS SCIENCES
Department: Emergency Medical Sciences
Contact: Ms N Deliwe (DeliweN@cput.ac.za)
Telephone: 021 953 8408 Fax: 021 959 6190

Ref: 184/EMC/13
Date: 07 May 2013

Student Number: **204173035**
Student Name: Mr Justice S Bosman
79 Gladioli Street
Soneike
Kuils River
7580

Dear Mr Bosman

Re: Proposed MEMC study at CPUT, EMS

Your application to this department to pursue Master: EMC study and to use the Department of Emergency Medical Sciences as a study site has reference.

Your study titled: *"An investigation into the principles of physics implicit in emergency medical rescue education and practice- a case study of motor vehicle related rescue."* is of great relevance to the profession and to the Department. Your application has been studied and Departmental permission is hereby granted to collect data from the analysis of our rescue- related curricula and from our rescue personnel on the following conditions:

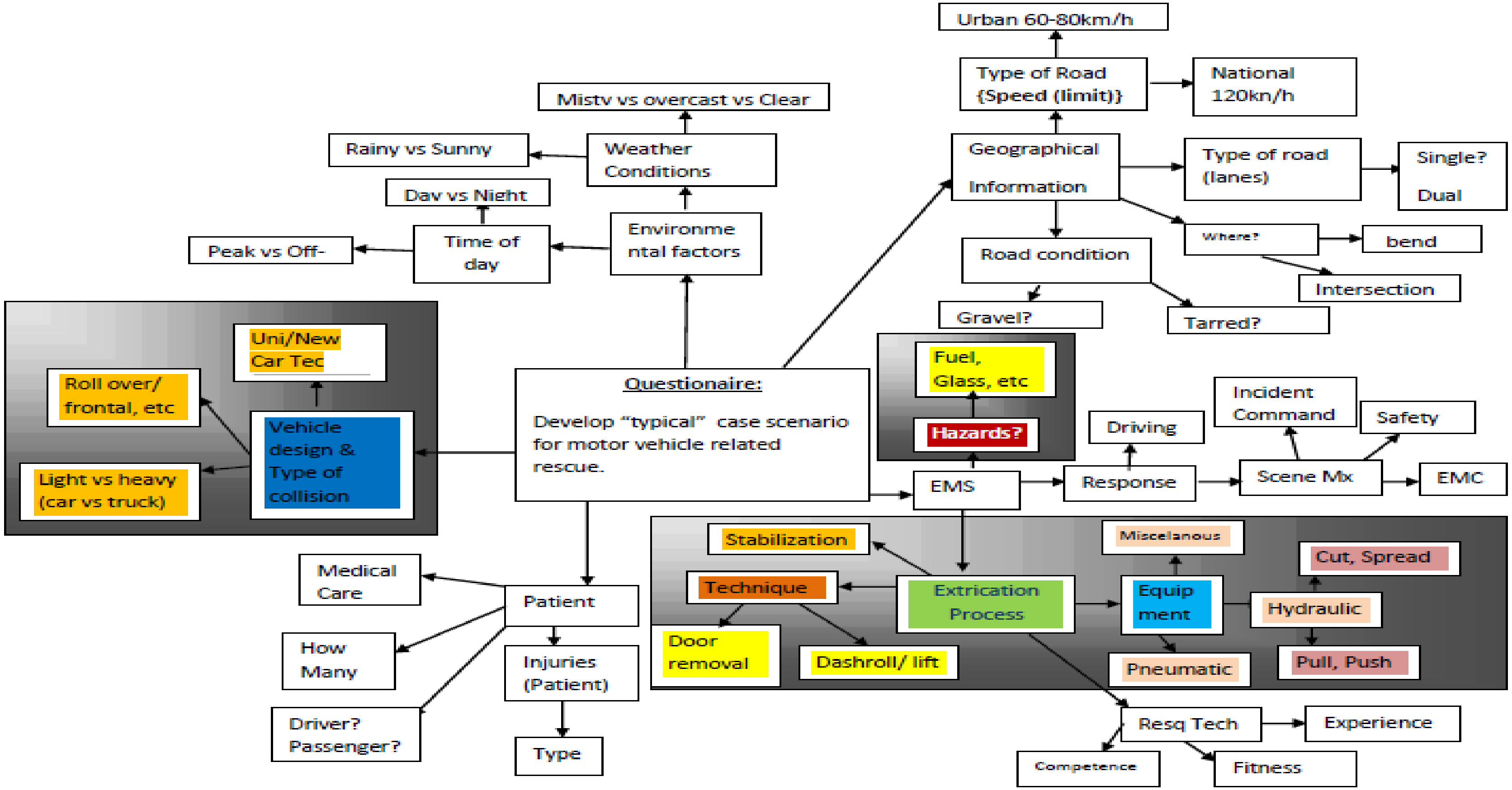
1. Participation is voluntary and informed consent will be attained.
2. There will be no unauthorized disruption of the learning programme.
3. You attain Faculty Research and Ethics Committee approval as well.
4. That due consideration is given to the principle of group harm.

We wish you well on your post-graduate endeavor.

Kind regards

Mr. Lloyd Christopher
Head of Department: EMC

APPENDIX F: MINDMAP OF RESEARCH QUESTIONNAIRE DEVELOPMENT (HIGHLIGHTED BY COLOUR CODED SECTIONS)



APPENDIX G: **2ND ROUND QUESTIONNAIRE DELPHI PANELIST/PARTICIPANTS WITH 1ST ROUND RESPONSE- EXAMPLE**

Participant No. Example

UNIVERSITY:	Cape Peninsula University of Technology (CPUT)
FACULTY:	Health & Wellness Sciences
DEPARTMENT:	Emergency Medical Sciences
STUDENT:	Mr. Justice S. Bosman (204173035)
EMAIL ADDRESS:	bosmanjs@cput.ac.za
CONTACT NUMBER:	0219538457 / 0833824429
SUPERVISOR:	Dr Mark Marais
EMAIL ADDRESS:	maraism@cput.ac.za
CO-SUPERVISOR:	Mr. Navindhra Naidoo
EMAIL ADDRESS:	naidoon@cput.ac.za
CONTACT NUMBER:	0219538408
ETHICAL APPROVAL REF NO:	NHREC: REC- 230408-014

Title of Study

Principles of physics implicit in emergency medical rescue education and operational practice- a case study of motor vehicle related rescue.

2nd ROUND QUESTIONNAIRE FOR DELPHI PANEL

Important information to please note:

This questionnaire may not be utilized in any way or means without written consent of the author/researcher. Please note that no alterations and /or changes may be done to any part of the document/tools whilst completing the round of questionnaire.

The 2nd round of the questionnaire is designed/developed to re-evaluate your own response to those responses of the other Delphi panel participants.

This particular document titled "**2nd Round Questionnaire for Delphi Panel**" which will reflect **your unique participation number** is to be used in conjunction with the **pdf document** titled "**2nd Round Questionnaire Delphi Panel/Participant Responses**" with particular focus on the statements where you as the Delphi panel/participant will be required to evaluate your own response to those of the other Delphi panel/participants.

The aim of the round of questionnaires is to obtain a **majority (+80%)** finding/consensus amongst the Delphi panel with regards to the responses provided as per each individual statement. The sections in this document which has been **darkened/blacked out** is where a majority consensus (+80%) has been obtained and therefore **does not require you to provide a response** to those sections.

Please compare your response to those of the other Delphi panelist and where your response was not in line with the majority response (**e.g. for a particular statement where there is a 58% (7/12) response to agree to a statement and your response as per your questionnaire was that you either disagreed or you were undecided/neutral**) consider changing your response or you may exercise your right to remain on your current view or response or opinion.

Indicate your selection (change in your response) to the 2nd round of the Questionnaire by placing an "X" in the corresponding block and highlighting it in **RED.**

Please do not write in the comment column which is reserved for me (*the researcher*) to indicate the consensus ratings.

This questionnaire is divided into sections, each section deals with a different theme indicated by the heading. The initial themes emerged and have been developed to define a typical case scenario / typology for motor vehicle related rescue (light and/or heavy).

The themes which do not have strong consensus and/or support will be used in developing an atypical case scenario and/or typology of a motor vehicle related rescue case.

If for any reason that uncertainty arises with the utilization and/or completion of this document/tool then feel free to contact the principal investigator on the contact details at the end of the questionnaire in order to ensure that the tools is applied and/or completed in the manner for which it has been designed and/or intended.

Where you as the Delphi panel/participant in the 1st Round of the questionnaire had not indicated with a (X) your response to a statement it was assumed by the researcher that your response was undecided/neutral and it was noted as such within the analyzing of the responses.

Below is a flow diagram which will assist/guide you to ensure correct completion of the 2nd Round of the Questionnaire of the Delphi Panel.

Statements where +80% majority agreement finding has been obtained

Example of excerpt taken from pdf document titled "2nd Round Questionnaire Delphi Panel/Participant Responses"

	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A1.	Cribbing (2x4)	1iiiiiiiii	2i	3i	83%(10/12)

No response required from you as the Delphi panel participant

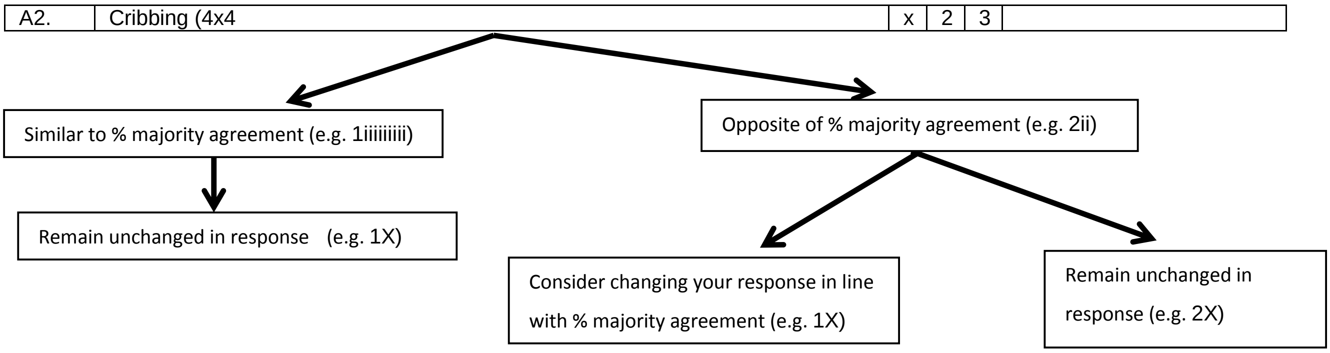
Statements where a less than -80% majority agreement finding has been obtained

Example of excerpt taken from pdf document titled "2nd Round Questionnaire Delphi Panel/Participant Responses"

	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A2.	Cribbing (4x4	1iiiiiiiii	2ii	3i	75% (9/12)

Evaluate **your response** (as pictured in the example below) and compare it to the %majority finding (as pictured above)

A2.	Cribbing (4x4	x	2	3	



	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).

		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A1.	Cribbing (2x4)	x	2	3	
A2.	Cribbing (4x4	x	2	3	
A3.	Wedges	x	2	3	
A4.	Stepchocks	x	2	3	
A5.	Pneumatic struts	1	x	3	
A6.	Mechanical struts	1	x	3	
A7.	Ratchet strapping	x	2	3	
A8.	Chain with J-hooks	1	2	x	
A9.	Strut Head (Cone shaped)	1	x	3	
A10.	Strut head (L-shaped)	1	x	3	
A11.	Strut base plate	1	x	3	
A12.	V- Strut	1	x	3	
	Hand Tools				
A13.	Halligan Tool	x	2	3	
A14.	Axe (Flathead)	1	2	x	
A15.	Axe (Pickhead)	1	2	x	
A16.	Boltcutter	x	2	3	
A17.	Pliers (channel lock type)	x	2	3	
A18.	Pliers (side cutters)	x	2	3	
A19.	Srewdriver (Flat)	x	2	3	
A20.	Crow bar	x	2	3	
A21.	Springloaded punch	x	2	3	
A22.	Webbing	1	x	3	
A23.	Come-along tool	x	2	3	
A24.	Hacksaw	1	2	x	
A25.	Seatbelt cutter	1	2	x	
A26.	Scissor (serrated edge type)	x	2	3	
A27.	Rescue knife	x	2	3	
A28.	Reciprocating saw	x	2	3	
A29.	Windshield saw	x	2	3	
A30.	Air chisel or gun cutting tool	1	2	x	
A31.	Shovel	x	2	3	

A32.	Broom	x	2	3	
A33.	Airbag cover	x	2	3	
	Power Rescue Tools				
A34.	Power plant (Fuel driven)	x	2	3	
A35.	Spreader tool	x	2	3	
A36.	Cutter tool	x	2	3	
A37.	Ram tool	x	2	3	
A38.	Pedal cutter tool	x	2	3	
A39.	Chains	1	2	x	
A40.	Ram support (bracket/base plate)	x	2	3	
A41.	Lighting	x	2	3	
A42.	Jacks (hi lift)	x	2	3	
A43.	Jack (hydraulic)	1	2	x	
A44.	Vetter bags	1	2	x	

	SECTION B~TYPE OF VEHICLE, DESIGN & HAZARDS *The aim of this section is to determine the type of vehicle, design and hazards that are prevalent (most commonly seen and/or found) at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
B0	Most typical RTA involves vehicles that have the new car technology (i.e. crumple zones, reinforced dashboards, micro alloy and boron steel, etc)	x	2	3	
B1.	Most typical RTA occur with unibody construction/design vehicles (unibody vehicle uses the body panels and floorpan to form its structure)	1	x	3	
B2.	Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)	1	2	x	
B3	Most typical RTA occur with full frame construction /design vehicles (the body bolts to a welded frame and is the full length of the car)	1	x	3	
B4.	Most typical RTA occur with vehicles that are petroleum fuel driven	x	2	3	
B5.	Most typical RTA occur with vehicles that are diesel fuel driven	1	2	x	

B6.	Most typical RTA occur with vehicles that are liquefied petroleum gas (LPG) driven	1	2	x	
B7.	Most typical RTA occur with vehicles that are Hybrid system driven	1	2	x	
B8.	Most typical RTA occur with vehicles that are petroleum fuel driven and are modified with some form of gas (e.g. nitrogen gas) affixed to enable and/or enhance performance	1	2	x	
B9.	Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})	x	2	3	
B10	Most typical RTA occur with light delivery vehicles (LDV) (include your ½ tonner bakkies to 1 tonner bakkies, double cabs)	1	2	x	
B11	Most typical RTA involve busses (includes minibuses and larges busses whether for personal, commercial or public transport)	x	2	3	
B12	Most typical RTA involve trucks (those over 10 ton capacity irrespective of amount of axles and whether it has a "horse & trailer")	1	2	x	
B13	Most typical RTA involves trains which have collided with any other forms of road transportation that have occurred at a public or private road.	1	2	x	
B14	Most typical RTA involves the transportation of a hazardous material.	1	2	x	
B15	Most typical RTA involve radiator fluid spills and/or leakages	x	2	3	
B16	Most typical RTA involve fuel spills and/or leakages	1	2	x	
B17	Most typical RTA involve oil fluid spills and/or leakages	1	2	x	
B18	Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {"idling"}	1	2	x	
B19	Most typical RTA involves a fire to engines compartment	1	2	x	
B20	Most typical RTA involves a fire to the passenger compartment	1	2	x	
B21	Most typical RTA involves undeployed airbags (irrespective if it is frontal and/or side impact airbags)	1	2	x	
B22	Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)	1	2	x	
B23	Most typical RTA involves undeployed Automatic Roll Over Protection Systems (ROPS)	1	2	x	
B24	Most typical RTA involves deployed Automatic Roll Over Protection Systems (ROPS)	1	x	3	
B25	Most typical RTA involves electrical hazards (i.e. lamp standard, ESKOM power supply unit, etc)	x	2	3	

	SECTION C~RTA BY COLLISION KINETICS/CLASSIFICATION *The aim of this section is to classify road traffic accidents by collision kinetics and/or amount of vehicles involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).

		Agree	**Undecided**	**Disagree**	**Comments**
C1.	Most typical RTA involves frontal collisions (irrespective if it is full, half , quarter or partial frontal involvement)	x	2	3	
C2.	Most typical RTA involves side impact collisions	1	x	3	
C3	Most typical RTA involves roll over collisions	1	2	x	
C4.	Most typical RTA involves under runs (irrespective what the object is that the vehicle ran underneath into e.g. truck, railing, etc)	1	2	x	
C5.	Most typical RTA involves crush incidents (irrespective of what the object is that is creating a “crush” onto the vehicle e.g. wall, truck, container)	x	2	3	
C6.	Most typical RTA involves collisions where it involves more than one type of collision kinetic/classification (i.e frontal collision that resulted in a roll over	x	2	3	
C7.	Most typical RTA involves two similar type of mode of transport (e.g. passenger vehicle vs passenger vehicle, minibus vs minibus)	1	2	x	
C8.	Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up)	x	2	3	
C9.	Most typical RTA involves single vehicle collisions with a stationary object.	1	2	x	

	SECTION D~RESCUE RESPONSE *The aim of this section is to determine what are the responses required and/or involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
D1.	Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation	x	2	3	
D2	Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation	x	2	3	
D3.	Most typical RTA involves the use of hydraulic spreading equipment to either “push and/or lift” metal and structures (irrespective if a spreader, rams, etc)	x	2	3	
D4.	Most typical RTA involves the use of hydraulic spreading equipment to either “pull” metal and structures	1	2	x	
D5.	Most typical RTA involves the use of hydraulic cutting equipment to either “cut” metal and structures (irrespective if conventional cutter or mini cutter or combitool)	x	2	3	
D6.	Most typical RTA involves the use of hydraulic equipment to either power and operate hydraulic equipment (hydraulic motor pump, hydraulic hand pump, etc)	x	2	3	
D7.	Most typical RTA involves the use of hydraulic equipment to stabilize vehicle/’s and/or structures	1	2	x	
D8.	Most typical RTA involves the use of handtools to extricate patients from vehicle/’s (i.e. highlift jack, hacksaw, haligan tool, etc)	1	2	x	
D9.	Most typical RTA involves the use of an axe to break/cut through laminated glass of a vehicle/’s	1	2	x	
D10	Most typical RTA involves the use of an saw designed to cut through laminated glass e.g “Glass Master saw” to break/cut through laminated glass of a vehicle/’s	x	2	3	

D11	Most typical RTA involves the use of an axe to break laminated glass of a vehicle/'s	1	2	x	
D12	Most typical RTA involves the use of an reciprocating saw to break/cut through laminated glass of a vehicle/'s	x	2	3	
D13	Most typical RTA involves the use of an axe and haligan tool to break tempered glass of a vehicle/'s	1	x	3	
D14	Most typical RTA involves the use of an sharp object for example a screwdriver to break tempered glass of a vehicle/'s	1	2	x	
D15	Most typical RTA involves the use of an springloaded centre punch to break tempered glass of a vehicle/'s	x	2	3	
D16	Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/'s	x	2	3	
D17	Most typical RTA involves the use of highlift jacks to stabilize the vehicle/'s	1	2	x	
D18	Most typical RTA involves the use of wood and wedges to stabilize the vehicle/'s	x	2	3	
D19	Most typical RTA involves the use of pneumatic equipment/ shores to stabilize the vehicle/'s	1	2	x	
D20	Most typical RTA involves the use of ratchet straps to stabilize the vehicle/'s	1	2	x	
D21	Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/'s	x	2	3	

Thank you for participating thus far in the study and completing the questionnaire. The principal investigator will contact you shortly in the event of further rounds of the Delphi process.

Kindest regards

Justice Bosman
(Student number 204173035)
(Investigator)
0833824429 (cell)
0219538457 (office)
bosmanjs@cput.ac.za (email)

APPENDIX H: **2^{ND} ROUND QUESTIONNAIRE DELPHI PANEL/PARTICIPANT OVERAL RESPONSES FOR COMPARISION- PDF EXAMPLE**

Participant Responses

Cape Peninsula University of Technology

UNIVERSITY:	Cape Peninsula University of Technology (CPUT)
FACULTY:	Health & Wellness Sciences
DEPARTMENT:	Emergency Medical Sciences
STUDENT:	Mr. Justice S. Bosman (204173035)
EMAIL ADDRESS:	bosmanjs@cput.ac.za
CONTACT NUMBER:	0219538457 / 0833824429
SUPERVISOR:	Dr Mark Marais
EMAIL ADDRESS:	maraism@cput.ac.za
CO-SUPERVISOR:	Mr. Navindhra Naidoo
EMAIL ADDRESS:	naidoon@cput.ac.za
CONTACT NUMBER:	0219538408
ETHICAL APPROVAL REF NO:	NHREC: REC- 230408-014

Title of Study

Principles of physics implicit in emergency medical rescue education and operational practice- a case study of motor vehicle related rescue.

2^{nd} ROUND QUESTIONNAIRE FOR DELPHI PANEL/PARTICIPANT RESPONSES

The 2^{nd} round of the questionnaire for you as the Delphi panel is designed/developed to re-evaluate your own response to those responses of the other Delphi panel participants.

This particular document titled "**2^{nd} Round Questionnaire Delphi Panel/Participant Responses**" is for you as the Delphi panel/participant to use in conjunction with your own "**2^{nd} Round Questionnaire for Delphi Panel**" with your unique participant number with a particular focus on the statements where you as the Delphi

panel/participant will be required to evaluate your own response to those of the other Delphi panel/participants.
Below is a flow diagram which will assist/guide you to ensure correct completion of the 2nd Round of the Questionnaire of the Delphi Panel.

<u>Statements where +80% majority agreement finding has been obtained</u>

Example of excerpt taken from pdf document titled "2nd Round Questionnaire Delphi Panel/Participant Responses"

	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A1.	Cribbing (2x4)	1iiiiiiiiii	2i	3i	83%(10/12)

<u>No response</u> required from you as the Delphi panel participant

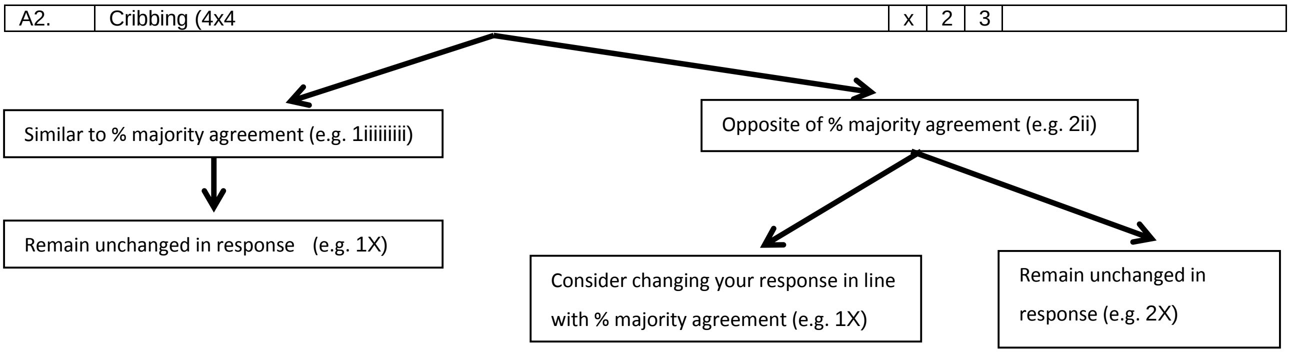
<u>Statements where a less than -80% majority agreement finding has been obtained</u>

Example of excerpt taken from pdf document titled "2nd Round Questionnaire Delphi Panel/Participant Responses"

	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A2.	Cribbing (4x4	1iiiiiiiii	2ii	3i	75% (9/12)

Evaluate **your response** (as pictured in the example below) and compare it to the %majority finding (as pictured above)

A2.	Cribbing (4x4	x	2	3	



	SECTION A~Equipment *The aim of this section is to determine which piece and/or pieces of combination of equipment is typically used at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
	Stabilization Tools				
A1.	Cribbing (2x4)	1iiiiiiiiii	2i	3i	83%(10/12)
A2.	Cribbing (4x4	1iiiiiiiii	2ii	3i	75% (9/12)
A3.	Wedges	1iiiiiiiiiii	2i	3	92%(11/12)
A4.	Stepchocks	1iiiiiiiiiiii	2	3	100%(12/12)
A5.	Pneumatic struts	1iiii	2iiiiii	3ii	50% (6/12)
A6.	Mechanical struts	1iiii	2iiiii	3iii	42% (5/12)
A7.	Ratchet strapping	1iiiiiiii	2ii	3ii	67% (8/12)
A8.	Chain with J-hooks	1iiii	2iiii	3iiii	33% (4/12)
A9.	Strut Head (Cone shaped)	1ii	2iiiiiii	3iii	58% (7/12)
A10.	Strut head (L-shaped)	1ii	2iiiiiii	3iii	58% (7/12)
A11.	Strut base plate	1iii	2iiiiii	3iii	50% (6/12)
A12.	V- Strut	1ii	2iiiiii	3iiii	50% (6/12)
	Hand Tools				
A13.	Halligan Tool	1iiiiiiiiiiii	2	3	100%(12/12)
A14.	Axe (Flathead)	1iiiiii	2iii	3iii	50% (6/12)
A15.	Axe (Pickhead)	1iiii	2ii	3iiiiii	50% (6/12)
A16.	Boltcutter	1iiiiiiiii	2ii	3i	75% (9/12)
A17.	Pliers (channel lock type)	1iiiiiiiii	2i	3ii	75% (9/12)
A18.	Pliers (side cutters)	1iiiiiiii	2ii	3ii	67% (8/12)
A19.	Srewdriver (Flat)	1iiiiiiii	2ii	3ii	67% (8/12)
A20.	Crow bar	1iiiiiiiiii	2ii	3	83%(10/12)
A21.	Springloaded punch	1iiiiiiiii	2i	3ii	75% (9/12)
A22.	Webbing	1iiiiii	2iiiii	3i	50% (6/12)
A23.	Come-along tool	1iiiiii	2iiiii	3i	50% (6/12)
A24.	Hacksaw	1iiiiiii	2ii	3iii	58% (7/12)
A25.	Seatbelt cutter	1iiiiiiii	2ii	3ii	67% (8/12)
A26.	Scissor (serrated edge type)	1iiiiiiiii	2iii	3	75% (9/12)
A27.	Rescue knife	1iiiiiiiiii	2i	3i	83%(10/12)
A28.	Reciprocating saw	1iiiiiiiiiii	2i	3	92%(11/12)
A29.	Windshield saw	1iiiiiiiii	2ii	3i	75% (9/12)
A30.	Air chisel or gun cutting tool	1iiii	2iiiiii	3ii	50% (6/12)
A31.	Shovel	1iiiiiiiii	2iii	3	75% (9/12)

A32.	Broom	1iiiiiiiiiii	2i	3	92%(11/12)
A33.	Airbag cover	1iiiiiiiii	2ii	3i	75% (9/12)
	Power Rescue Tools				
A34.	Power plant (Fuel driven)	1iiiiiiiiiii	2i	3	92%(11/12)
A35.	Spreader tool	1iiiiiiiiiiii	2	3	100%(12/12)
A36.	Cutter tool	1iiiiiiiiiii	2i	3	92%(11/12)
A37.	Ram tool	1iiiiiiiiiii	2i	3	92%(11/12)
A38.	Pedal cutter tool	1iiiiiiiii	2iii	3	75% (9/12)
A39.	Chains	1iiiii	2iiii	3iii	42% (5/12)
A40.	Ram support (bracket/base plate)	1iiiiiiiii	2iii	3	75% (9/12)
A41.	Lighting	1iiiiiiiiii	2i	3i	83%(10/12)
A42.	Jacks (hi lift)	1iiiiiiiiii	2i	3i	83%(10/12)
A43.	Jack (hydraulic)	1iiiiiiii	2i	3iii	67% (8/12)
A44.	Vetter bags	1iiiiiiii	2ii	3ii	67% (8/12)

	SECTION B~TYPE OF VEHICLE, DESIGN & HAZARDS *The aim of this section is to determine the type of vehicle, design and hazards that are prevalent (most commonly seen and/or found) at a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
B0	Most typical RTA involves vehicles that have the new car technology (i.e. crumple zones, reinforced dashboards, micro alloy and boron steel, etc)	1iiiiiii	2ii	3iii	58% (7/12)
B1.	Most typical RTA occur with unibody construction/design vehicles (unibody vehicle uses the body panels and floorpan to form its structure)	1iiiiiii	2iii	3ii	58% (7/12)
B2.	Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)	1iiiii	2iiii	3iii	42% (5/12)
B3	Most typical RTA occur with full frame construction /design vehicles (the body	1iiiii	2iii	3iiii	42% (5/12)

	bolts to a welded frame and is the full length of the car)				
B4.	Most typical RTA occur with vehicles that are petroleum fuel driven	1iiiiiiii	2i	3iii	67% (8/12)
B5.	Most typical RTA occur with vehicles that are diesel fuel driven	1iii	2iiii	3iiiii	42% (5/12)
B6.	Most typical RTA occur with vehicles that are liquefied petroleum gas (LPG) driven	1i	2i	3iiiiiiiiii	83%(10/12)
B7.	Most typical RTA occur with vehicles that are Hybrid system driven	1	2ii	3iiiiiiiiii	83% (10/12)
B8.	Most typical RTA occur with vehicles that are petroleum fuel driven and are modified with some form of gas (e.g. nitrogen gas) affixed to enable and/or enhance performance	1ii	2iii	3iiiiiii	58% (7/12)
B9.	Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})	1iiiiiiiiiii	2	3i	92%(11/12)
B10	Most typical RTA occur with light delivery vehicles (LDV) (include your ½ tonner bakkies to 1 tonner bakkies, double cabs)	1iiiii	2iii	3iiii	42% (5/12)
B11	Most typical RTA involve busses (includes minibuses and larges busses whether for personal, commercial or public transport)	1iiiiii	2iii	3iii	50% (6/12)
B12	Most typical RTA involve trucks (those over 10 ton capacity irrespective of amount of axles and whether it has a "horse & trailer")	1ii	2iiiiii	3iiii	50% (6/12)
B13	Most typical RTA involves trains which have collided with any other forms of road transportation that have occurred at a public or private road.	1iii	2iii	3iiiiii	50% (6/12)
B14	Most typical RTA involves the transportation of a hazardous material.	1i	2iiii	3iiiiiii	58% (7/12)
B15	Most typical RTA involve radiator fluid spills and/or leakages	1iiiiiiiiii	2	3ii	83%(10/12)
B16	Most typical RTA involve fuel spills and/or leakages	1iiiiii	2ii	3iiii	50% (6/12)
B17	Most typical RTA involve oil fluid spills and/or leakages	1iiiiiiii	2ii	3ii	67% (8/12)
B18	Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {"idling"}	1iiiiiii	2i	3iiii	58% (7/12)
B19	Most typical RTA involves a fire to engines compartment	1iii	2iii	3iiiiii	42% (5/12)
B20	Most typical RTA involves a fire to the passenger compartment	1	2iii	3iiiiiiiii	75% (9/12)

B21	Most typical RTA involves undeployed airbags (irrespective if it is frontal and/or side impact airbags)	1iiiii	2i	3iiiiii	50% (6/12)
B22	Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)	1iiiii	2iii	3iiii	42% (5/12)
B23	Most typical RTA involves undeployed Automatic Roll Over Protection Systems (ROPS)	1i	2iiiiiii	3iiii	58% (7/12)
B24	Most typical RTA involves deployed Automatic Roll Over Protection Systems (ROPS)	1ii	2iiiiiiii	3ii	67% (8/12)
B25	Most typical RTA involves electrical hazards (i.e. lamp standard, ESKOM power supply unit, etc)	1iiiiii	2ii	3iiii	50% (6/12)

	SECTION C~RTA BY COLLISION KINETICS/CLASSIFICATION *The aim of this section is to classify road traffic accidents by collision kinetics and/or amount of vehicles involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
C1.	Most typical RTA involves frontal collisions (irrespective if it is full, half , quarter or partial frontal involvement)	1iiiiiiii	2	3iiii	67% (8/12)
C2.	Most typical RTA involves side impact collisions	1iiiiiii	2iiii	3i	58% (7/12)
C3	Most typical RTA involves roll over collisions	1iiiii	2iii	3iiii	42% (5/12)
C4.	Most typical RTA involves under runs (irrespective what the object is that the vehicle ran underneath into e.g. truck, railing, etc)	1ii	2iiii	3iiiiii	50% (6/12)
C5.	Most typical RTA involves crush incidents (irrespective of what the object is that is creating a "crush" onto the vehicle e.g. wall, truck, container)	1iiiiii	2iii	3iii	50% (6/12)
C6.	Most typical RTA involves collisions where it involves more than one type of collision	1iiiiiiii	2i	3iii	67% (8/12)

	kinetic/classification (i.e frontal collision that resulted in a roll over				
C7.	Most typical RTA involves two similar type of mode of transport (e.g. passenger vehicle vs passenger vehicle, minibus vs minibus)	1iiiii	2i	3iiiiii	50% (6/12)
C8.	Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up)	1iiiiiiii	2ii	3i	75% (9/12)
C9.	Most typical RTA involves single vehicle collisions with a stationary object.	1iiiii	2ii	3iiiii	42% (5/12)

	SECTION D~RESCUE RESPONSE *The aim of this section is to determine what are the responses required and/or involved with respect to a motor vehicle accident which requires extrication of a victim and/or victims irrespective of the manner of the entrapment.*				
	Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Undecided / Neutral 3 = Disagree Please mark the appropriate block with an X. Only mark one of the three choices (Agree, Undecided or Disagree).				
		Agree	**Undecided**	**Disagree**	**Comments**
D1.	Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation	1iiiiiiii	2i	3iii	67% (8/12)
D2	Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation	1iiiiiiiiiii	2i	3	92%(11/12)
D3.	Most typical RTA involves the use of hydraulic spreading equipment to either "push and/or lift" metal and structures (irrespective if a spreader, rams, etc)	1iiiiiiii	2ii	3ii	67% (8/12)
D4.	Most typical RTA involves the use of hydraulic spreading equipment to either "pull" metal and structures	1iiiii	2iiiiii	3i	50% (6/12)
D5.	Most typical RTA involves the use of hydraulic cutting equipment to either "cut" metal and structures (irrespective if	1iiiiiiiiii	2i	3i	83%(10/12)

	conventional cutter or mini cutter or combitool)				
D6.	Most typical RTA involves the use of hydraulic equipment to either power and operate hydraulic equipment (hydraulic motor pump, hydraulic hand pump, etc)	1iiiiiiii	2iii	3i	67% (8/12)
D7.	Most typical RTA involves the use of hydraulic equipment to stabilize vehicle/'s and/or structures	1iiii	2ii	3iiiiii	50% (6/12)
D8.	Most typical RTA involves the use of handtools to extricate patients from vehicle/'s (i.e. highlift jack, hacksaw, haligan tool, etc)	1iiii	2iiii	3iiii	33% (4/12)
D9.	Most typical RTA involves the use of an axe to break/cut through laminated glass of a vehicle/'s	1iiii	2iiii	3iiii	33% (4/12)
D10	Most typical RTA involves the use of an saw designed to cut through laminated glass e.g "Glass Master saw" to break/cut through laminated glass of a vehicle/'s	1iiiiiiii	2iii	3i	67% (8/12)
D11	Most typical RTA involves the use of an axe to break laminated glass of a vehicle/'s	1iii	2ii	3iiiiiii	58% (7/12)
D12	Most typical RTA involves the use of an reciprocating saw to break/cut through laminated glass of a vehicle/'s	1iiiiii	2iii	3iii	50% (6/12)
D13	Most typical RTA involves the use of an axe and haligan tool to break tempered glass of a vehicle/'s	1ii	2iiiiii	3iiii	50% (6/12)
D14	Most typical RTA involves the use of an sharp object for example a screwdriver to break tempered glass of a vehicle/'s	1ii	2iiiii	3iiiii	42% (5/12)
D15	Most typical RTA involves the use of an springloaded centre punch to break tempered glass of a vehicle/'s	1iiiiiii	2ii	3iii	58% (7/12)
D16	Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/'s	1iiiiiiiiii	2i	3i	83% (10/12)
D17	Most typical RTA involves the use of highlift jacks to stabilize the vehicle/'s	1iiii	2ii	3iiiiii	50% (6/12)
D18	Most typical RTA involves the use of wood and wedges to stabilize the vehicle/'s	1iiiiiiii	2iii	3i	67% (8/12)
D19	Most typical RTA involves the use of pneumatic equipment/ shores to stabilize the vehicle/'s	1iiii	2iiii	3iiii	33% (4/12)
D20	Most typical RTA involves the use of ratchet straps to stabilize the vehicle/'s	1iiii	2ii	3iiiiii	50% (6/12)
D21	Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/'s	1iiiiiiii	2iii	3i	67% (8/12)

Thank you for participating thus far in the study and completing the questionnaire. The principal investigator will contact you shortly in the event of further rounds of the Delphi process.

Kindest regards

Justice Bosman
(Student number 204173035)
(Investigator)
0833824429 (cell)
0219538457 (office)
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APPENDIX I: **3RD ROUND QUESTIONNAIRE DELPHI PANEL/PARTICIPANT -EXAMPLE**

Participant No: EXAMPLE

UNIVERSITY:	Cape Peninsula University of Technology (CPUT)
FACULTY:	Health & Wellness Sciences
DEPARTMENT:	Emergency Medical Sciences
STUDENT:	Mr. Justice S. Bosman (204173035)
EMAIL ADDRESS:	bosmanjs@cput.ac.za
CONTACT NUMBER:	0219538457 / 0833824429
SUPERVISOR:	Dr Mark Marais
EMAIL ADDRESS:	maraism@cput.ac.za
CO-SUPERVISOR:	Mr. Navindhra Naidoo
EMAIL ADDRESS:	naidoon@cput.ac.za
CONTACT NUMBER:	0219538408
ETHICAL APPROVAL REF NO:	NHREC: REC- 230408-014
H&WS ETHICS COMMITTEE CONTACT TEL:	(021) 953 - 6917

Title of Study

Principles of physics implicit in emergency medical rescue education and operational practice- a case study of motor vehicle related rescue.

3rd ROUND QUESTIONNAIRE FOR DELPHI PANEL PARTICIPANT/EXPERT

Please note:

This questionnaire may not be utilized in any way or means without written consent of the author. Please note that no alterations and /or changes may be done to any part of the document/tools whilst completing the round of questionnaire.

Your path in the research process this far:

1st Round of Delphi Questionnaire

The 1st round of the questionnaire for you as the Delphi panel participant/expert was to indicate your agreement or undecided/neutral or disagreement to certain themes/topics/statements pertaining to aspects related to a motor vehicle accident. This questionnaire was divided into sections, each section dealt with a different theme indicated by the heading. The initial themes emerged and had been developed to define a typical case scenario / typology for motor vehicle related rescue (light and/or heavy). During the 1st round of the questionnaire your responses was contrasted to those of the other Delphi panel participants/experts in order to determine whether majority (+ 80%) consensus was obtained

2nd Round of Delphi Questionnaire

The 2nd round of the questionnaire for you as the Delphi panel was designed/developed to re-evaluate your own response to those responses of the other Delphi panel participants in the areas where there was no majority (+ 80%) consensus and to consider whether you would like to exercise the right to either remain unchanged in your response or either change your response.

You are here in the

3rd Round of Delphi Questionnaire

The 3rd round of the questionnaire is designed/developed for you as the Delphi panel participant/expert to validate/confirm whether you agree to the typical motor related case which had evolved from the themes/topics/statements where majority (+ 80%) consensus was obtained during the 1st and 2nd round of the Delphi process.

Section A

In Section A of the 3rd round of the questionnaire you as the Delphi panel participant/expert is required to indicate whether you agree or disagree with the theme/topic/statement as being prevalent with the typical motor vehicle related case.

Section B

In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.

Section C

In Section C of the 3rd round of the Delphi questionnaire you as the panel participant/expert can provide any feedback and/or comment that you feel would be of value to note and/or potentially contributory towards the design and/or development of the typical motor vehicle

	SECTION A In Section A of the 3rd round of the questionnaire you as the Delphi panel participant/expert is required to indicate whether you agree or disagree with the theme/topic/statement as being prevalent within the typical motor vehicle related case.			
	Please mark the appropriate block with an X. Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Disagree			
		Agree	**Disagree**	**Comments**
A1.	Cribbing (2x4)	1	2	

Indicate whether you **Agree** or **Disagree** in presence of typical motor vehicle related case

	SECTION A In Section A of the 3rd round of the questionnaire you as the Delphi panel participant/expert is required to indicate whether you agree or disagree with the theme/topic/statement as being prevalent within the typical motor vehicle related case.			
	Please mark the appropriate block with an X. Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Disagree			
		Agree	**Disagree**	**Comments**
A1.	Cribbing (2x4)	1X	2	

Continue similarly for the remainder of **Section A**

	SECTION A In Section A of the 3rd round of the questionnaire you as the Delphi panel participant/expert is required to indicate whether you agree or disagree with the theme/topic/statement as being prevalent within the typical motor vehicle related case.			
	Please mark the appropriate block with an X. Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Disagree			
		Agree	**Disagree**	**Comments**
A1.	Cribbing (2x4)	1X	2	
A2.	Cribbing (4x4	1X	2	
A3.	Wedges	1X	2	

When you have completed with all of the themes/topics/statements in Section A continue on to Section B

SECTION B

In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.

In the **Comments** section indicate with respect to your response to **1 = Agree or 2 = Disagree** the basis for your response based on the options provided by indicate with a **X** according to the following scale:

1 = Agree
A= SOP/Guidelines Compliance
B = Not a SOP/Guideline compliance but a good tool
2 = Disagree
C = Not an effective or efficient tool
D = Effective and/or efficient tool but not available
E = Rescuer personal choice and/or training bias

		Agree	Comments		Disagree	Comments		
B1.	Pneumatic struts	1	A	B	2	C	D	E

Indicate whether you **Agree** or **Disagree** in presence of typical motor vehicle related case

SECTION B

In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.

In the **Comments** section indicate with respect to your response to **1 = Agree or 2 = Disagree** the basis for your response based on the options provided by indicate with a **X** according to the following scale:

1 = Agree
A= SOP/Guidelines Compliance
B = Not a SOP/Guideline compliance but a good tool
2 = Disagree
C = Not an effective or efficient tool
D = Effective and/or efficient tool but not available
E = Rescuer personal choice and/or training bias

		Agree	Comments		Disagree	Comments		
B1.	Pneumatic struts	1X	A	B	2X	C	D	E

Choose a response/comment based on whether you Agreed or Disagreed using the options provided based on factors and/or influences.

SECTION B

In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.

In the **Comments** section indicate with respect to your response to **1 = Agree or 2 = Disagree** the basis for your response based on the options provided by indicate with a **X** according to the following scale:

1 = Agree
A= SOP/Guidelines Compliance
B = Not a SOP/Guideline compliance but a good tool
2 = Disagree
C = Not an effective or efficient tool
D = Effective and/or efficient tool but not available
E = Rescuer personal choice and/or training bias

		Agree	Comments		Disagree	Comments		
B1.	Pneumatic struts	1X	A	BX	2	C	D	E

Continue with the remaining of the topics/themes/statement contained in Section B in a similar manner.

Continue on to Section C when you have completed Section B:

SECTION C
In Section C of the 3rd round of the Delphi questionnaire you as the panel participant/expert can provide any feedback and/or comment that you feel would be of value to note and/or potentially contributory towards the design and/or development of the typical motor vehicle related rescue case.
Comment:

Typical Motor vehicle related rescue case Narrative (based on themes/topics/statements from previous two rounds of Delphi questionnaire process where participants/experts had majority (+ 80%) consensus on themes/topics/statements where they indicated to agree)

The typical motor vehicle related rescue case involves a vehicle which is petrol driven which is a passenger vehicle such as a sedan, station wagon, sport utility vehicle, etc. with radiator and oil fluid spills and/or leakages; which has been involved in a frontal collision (irrespective if it is a full, half, quarter or partial frontal involvement) with more than one type of collision kinetic/classification (i.e. frontal collision that resulted in rear-end and/or roll over and/or side impact, etc.) with involvement of a different type of mode of transport (e.g. passenger vehicle vs minibus; 10 ton truck vs bakkie/pick-up, etc.) requiring rescue personnel using equipment that requires lowering and lifting requiring the use of musculoskeletal and body system function operation; with the use of hydraulic spreading equipment to either "push and/or lift" metal and/or structures (irrespective if a spreader, ram, etc.); with use of hydraulic equipment to either cut metal and/or structures (irrespective if conventional cutter or minicutter or combitool, etc.); with the use of a saw designed to cut through laminated glass; with the breaking of tempered glass using a springloaded centre punch; and the use of wedges, wood 4x4 cribbing and stepchocks to stabilize the vehicle.

	SECTION A In Section A of the 3rd round of the questionnaire you as the Delphi panel participant/expert is required to indicate whether you agree or disagree with the theme/topic/statement as being prevalent within the typical motor vehicle related case. Please read the narrative above with regards to the themes/topics/statements contained within the previous two rounds of the Delphi process questionnaire where a majority consensus was reached and obtained. This process is used to validate the consensus which has been obtained during the previous two rounds of the Delphi process of the questionnaire.			
	Please mark the appropriate block with an X. Please indicate your response to the following statements is according to the following scale: 1 = Agree 2 = Disagree			
		Agree	**Disagree**	**Comments**
A1.	Cribbing (2x4)	1	2	
A2.	Cribbing (4x4	1	2	
A3.	Wedges	1	2	
A4.	Stepchocks	1	2	
A5.	Ratchet strapping	1	2	
A6.	Halligan Tool	1	2	
A7.	Boltcutter	1	2	
A8.	Pliers (channel lock type)	1	2	

A9.	Pliers (side cutters)	1	2	
A10.	Screwdriver (Flat)	1	2	
A11.	Crow bar	1	2	
A12.	Springloaded punch	1	2	
A13.	Seatbelt cutter	1	2	
A14.	Scissor (serrated edge type)	1	2	
A15.	Rescue knife	1	2	
A16.	Reciprocating saw	1	2	
A17.	Windshield saw	1	2	
A18.	Shovel	1	2	
A19.	Broom	1	2	
A20.	Airbag cover	1	2	
A21.	Power plant (Fuel driven)	1	2	
A22.	Spreader tool	1	2	
A23.	Cutter tool	1	2	
A24.	Ram tool	1	2	
A25.	Pedal cutter tool	1	2	
A26.	Ram support (bracket/base plate)	1	2	
A27.	Lighting	1	2	
A28.	Jacks (hi lift)	1	2	
A29.	Most typical RTA occur with vehicles that are petroleum fuel driven	1	2	
A30.	Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})	1	2	
A31.	Most typical RTA involve radiator fluid spills and/or leakages	1	2	
A32.	Most typical RTA involve oil fluid spills and/or leakages	1	2	
A33.	Most typical RTA involves frontal collisions (irrespective if it is full, half , quarter or partial frontal involvement)	1	2	
A34.	Most typical RTA involves collisions where it involves more than one type of collision kinetic/classification (i.e. frontal collision that resulted in a roll over	1	2	
A35.	Most typical RTA involves two different type of mode of transport (e.g. passenger vehicle vs, minibus; 10 ton truck vs bakkie/pick up)	1	2	
A36.	Most typical RTA involves Rescue personnel using equipment that requires lowering requiring some use of musculoskeletal and body system function/operation	1	2	
A37.	Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation	1	2	
A38.	Most typical RTA involves the use of hydraulic spreading equipment to either “push and/or lift” metal and structures (irrespective if a spreader, rams, etc.)	1	2	
A39.	Most typical RTA involves the use of hydraulic cutting equipment to either “cut” metal and structures (irrespective of conventional cutter or mini cutter or combitool)	1	2	
A40.	Most typical RTA involves the use of an saw designed to cut through laminated glass e.g. “Glass Master saw” to break/cut through laminated glass of a vehicle/’s	1	2	
A41.	Most typical RTA involves the use of an springloaded centre punch to break tempered glass of a vehicle/’s	1	2	
A42.	Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/’s	1	2	
A43.	Most typical RTA involves the use of wood and wedges to stabilize the vehicle/’s	1	2	
A44.	Most typical RTA involves the use of wood 4x4 cribbing and wedges to stabilize the vehicle/’s	1	2	

SECTION B
In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.
In the **Comments** section indicate with respect to your response to **1 = Agree or 2 = Disagree** the basis for your response based on the options provided by indicate with a **X** according to the following scale: **1 = Agree** **A**= SOP/Guidelines Compliance **B** = Not a SOP/Guideline compliance but a good tool **2 = Disagree** **C** = Not an effective or efficient tool **D** = Effective and/or efficient tool but not available **E** = Rescuer personal choice and/or training bias

		Agree	**Comments**		**Disagree**	**Comments**		
B1.	Pneumatic struts	1	A	B	2	C	D	E
B2.	Mechanical struts	1	A	B	2	C	D	E
B3.	Chain with J-hooks	1	A	B	2	C	D	E
B4.	Strut Head (Cone shaped)	1	A	B	2	C	D	E
B5.	Strut head (L-shaped)	1	A	B	2	C	D	E
B6.	Strut base plate	1	A	B	2	C	D	E
B7.	V- Strut	1	A	B	2	C	D	E
B8.	Axe (Flathead)	1	A	B	2	C	D	E
B9.	Axe (Pickhead)	1	A	B	2	C	D	E
B10.	Webbing	1	A	B	2	C	D	E
B11.	Come-along tool	1	A	B	2	C	D	E
B12.	Hacksaw	1	A	B	2	C	D	E
B13.	Air chisel or gun cutting tool	1	A	B	2	C	D	E
B14.	Chains	1	A	B	2	C	D	E
B15.	Jack (hydraulic)	1	A	B	2	C	D	E
B16.	Vetter bags	1	A	B	2	C	D	E

SECTION B
In Section B of the 3rd round of the Delphi questionnaire there is an opportunity to provide a response and/or comment as to what were the factors/influences which contributed to no majority consensus in either agree or neutral/undecided or disagree.
In the Comments section indicate with respect to your response to Agree or Disagree the basis for your response using the options provided by indicating with a X according to the following scale: **1 = Agree** **A** = **<u>Commonly seen/encountered</u>** in typical motor vehicle related rescue case with **<u>some and/or minimal</u>** influences and/or factors on the rescue incident. **B** = **<u>Commonly seen/encountered</u>** in typical motor vehicle related rescue case with **<u>NO</u>** influences and/or factors on the rescue incident. **2 = Disagree** **C** = **<u>Uncommon and/or rarely seen/encountered</u>** in typical motor vehicle related rescue case with influences and/or factors on the rescue incident. **D** = **<u>Uncommon and/or rarely seen/encountered</u>** in typical motor vehicle related rescue case with **<u>some and/or minimal</u>** influences and/or factors on the rescue incident. **E** = **<u>Uncommon and/or rarely seen/encountered</u>** in typical motor vehicle related rescue case with **<u>NO</u>** influences and/or factors on the rescue incident.

		Agree	**Comments**		**Disagree**	**Comments**		
B17.	Most typical RTA involves vehicles that have the new car technology (i.e. crumple zones, reinforced dashboards, micro alloy and boron steel, etc)	1	A	B	2	C	D	E
B18.	Most typical RTA occur with unibody construction/design vehicles (unibody vehicle uses the body panels and floorpan to form its structure)	1	A	B	2	C	D	E
B19.	Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)	1	A	B	2	C	D	E
B20.	Most typical RTA occur with full frame construction /design vehicles (the body bolts to a welded frame and is the full length of the car)	1	A	B	2	C	D	E
B21.	Most typical RTA occur with vehicles that are diesel fuel driven	1	A	B	2	C	D	E
B22.	Most typical RTA occur with vehicles that are petroleum fuel driven and are modified with some form of gas (e.g. nitrogen gas) affixed to enable and/or enhance performance	1	A	B	2	C	D	E
B23.	Most typical RTA occur with light delivery vehicles (LDV) (include your ½ tonner bakkies to 1 tonner bakkies, double cabs)	1	A	B	2	C	D	E

B24.	Most typical RTA involve busses (includes minibuses and larges busses whether for personal, commercial or public transport)	1	A	B	2	C	D	E
B25.	Most typical RTA involve trucks (those over 10 ton capacity irrespective of amount of axles and whether it has a “horse & trailer”)	1	A	B	2	C	D	E
B26.	Most typical RTA involves trains which have collided with any other forms of road transportation that have occurred at a public or private road.	1	A	B	2	C	D	E
B27.	Most typical RTA involve fuel spills and/or leakages	1	A	B	2	C	D	E
B28.	Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {“idling”}	1	A	B	2	C	D	E
B29.	Most typical RTA involves a fire to engines compartment	1	A	B	2	C	D	E
B30.	Most typical RTA involves undeployed airbags (irrespective if it is frontal and/or side impact airbags)	1	A	B	2	C	D	E
B31.	Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)	1	A	B	2	C	D	E
B32.	Most typical RTA involves undeployed Automatic Roll Over Protection Systems (ROPS)	1	A	B	2	C	D	E
B33.	Most typical RTA involves deployed Automatic Roll Over Protection Systems (ROPS)	1	A	B	2	C	D	E
B34.	Most typical RTA involves electrical hazards (i.e. lamp standard, ESKOM power supply unit, etc)	1	A	B	2	C	D	E
B35.	Most typical RTA involves side impact collisions	1	A	B	2	C	D	E
B36.	Most typical RTA involves roll over collisions	1	A	B	2	C	D	E
B37.	Most typical RTA involves under runs (irrespective what the object is that the vehicle ran underneath into e.g. truck, railing, etc)	1	A	B	2	C	D	E
B38.	Most typical RTA involves crush incidents (irrespective of what the object is that is creating a “crush” onto the vehicle e.g. wall, truck, container)	1	A	B	2	C	D	E
B39.	Most typical RTA involves two similar type of mode of transport (e.g. passenger vehicle vs passenger vehicle, minibus vs minibus)	1	A	B	2	C	D	E
B40.	Most typical RTA involves single vehicle collisions with a stationary object.	1	A	B	2	C	D	E

B41.	Most typical RTA involves the use of hydraulic spreading equipment to either “pull” metal and structures	1	A	B	2	C	D	E
B42.	Most typical RTA involves the use of hydraulic equipment to either power and operate hydraulic equipment (hydraulic motor pump, hydraulic hand pump, etc)	1	A	B	2	C	D	E
B43.	Most typical RTA involves the use of hydraulic equipment to stabilize vehicle/’s and/or structures	1	A	B	2	C	D	E
B44.	Most typical RTA involves the use of handtools to extricate patients from vehicle/’s (i.e. highlift jack, hacksaw, haligan tool, etc)	1	A	B	2	C	D	E
B45.	Most typical RTA involves the use of an axe to break/cut through laminated glass of a vehicle/’s	1	A	B	2	C	D	E
B46.	Most typical RTA involves the use of an reciprocating saw to break/cut through laminated glass of a vehicle/’s	1	A	B	2	C	D	E
B47.	Most typical RTA involves the use of an axe and haligan tool to break tempered glass of a vehicle/’s	1	A	B	2	C	D	E
B48.	Most typical RTA involves the use of an sharp object for example a screwdriver to break tempered glass of a vehicle/’s	1	A	B	2	C	D	E
B49.	Most typical RTA involves the use of highlift jacks to stabilize the vehicle/’s	1	A	B	2	C	D	E
B50.	Most typical RTA involves the use of pneumatic equipment/ shores to stabilize the vehicle/’s	1	A	B	2	C	D	E
B51.	Most typical RTA involves the use of ratchet straps to stabilize the vehicle/’s	1	A	B	2	C	D	E

SECTION C

In Section C of the 3rd round of the Delphi questionnaire you as the panel participant/expert can provide any feedback and/or comment that you feel would be of value to note and/or potentially contributory towards the design and/or development of the typical motor vehicle related rescue case.

Comment:

Thank you for participating thus far in the study and completing the questionnaire. The principal investigator will contact you shortly in the event of further rounds of the Delphi process.

Kindest regards

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APPENDIX J: **EMERGING PHYSICS THEMES WITHIN THE TYPICAL CASE NARRATIVE FOR MOTOR VEHICLE RELATED RESCUE**

Introduction:

The principles of physics within the typical case narrative as developed through the modified Delphi process was identified through the use of the process tracing methodology. The predominant themes which emerged as per the Inventory table in Chapter 5 developed through the literature review and process tracing was utilised to guide the researcher and physics expert. The predominant physics themes was utilized as a basis to describe its applicability and relevance to the statement within the typical case narrative.

The below Table 15 is the results from the process tracing of the Section A statements with respect to its themes of physics which relate to the typical case narrative. The statement derived from the Delphi questionnaire process is briefly explained within the context of the typical case narrative to demonstrate its relevance. The applicable physics theme and its relationship to the statement within the context of the motor vehicle rescue typical case narrative is then presented. Each statement briefly highlights the considerations and principles which underpin the principle of physics as it would relate to the statement.

An abbreviated and condensed version of this Appendix document is explained in Chapter 5 of the thesis document.

Table 15 Process tracing results derived from the Delphi Questionnaires categorised in the context of the physics themes

SECTION A	
Number of the statement in the Delphi questionnaire	**Statement derived from the Delphi questionnaire related to the typical MVR case**
B19	**Most typical RTA occur with body over frame construction /design vehicles (body attaches to the frame and, while it does provide structural support)**
Physics principle themes underpinning the derived statement above	
WEIGHT- The body over frame design is much heavier than the unibody/space frame design vehicle, and different materials are potentially used in these designs. The weight distribution of the vehicle type	

and frame design will affect where the centre–of–gravity is located. This requires consideration during the decision making of stabilizing the vehicle. **FORCES–** The lateral and cross member bracing of body over frame vehicle design provides resistance to lateral forces, and increase the torsional rigidity. There is a need to develop an index of suspicion regarding possible injuries sustained during the motor vehicle collision on the basis of the deformity of vehicle structure resulting from torsional forces. Vehicle components which are deformed post collision, may possess torsion- potential energy, which when converted to kinetic energy, may pose a hazard during rescue operations. The increase in reinforcement to the vehicle structure may pose challenges during the extrication process. This may require particular consideration regarding where rescuers may cut or spread using hydraulic equipment where there may be an increase in resistive forces. **ENERGY** Body over frame construction does not have built-in crumple zones (which allow for dissipation of energy), which means more energy is transferred to the passenger compartment during the collision phase. The kinetic energy from the pre-collision phase goes largely into deforming the structures of the vehicle. **NEWTON'S LAWS OF MOTION** Knowing the vehicle frame design allows for better predictions of the interplay of forces. Unbalanced forces acting on a vehicle post collision will result in movement of the vehicle and/or its components. Knowing the vehicle design and the consequences of unbalanced forces may aid in better stabilisation decision making.

A29.	**Most typical RTA occur with vehicles that are petroleum fuel driven**

ENERGY The kinetic energy during the pre-collision phase is derived from the release of energy during combustion processes in the engine. A certain fraction of the combustion derived energy would also be released as heat energy. Hazards, post collision, may include; a vehicle set in motion, from a still active power system, and heat released from the engine. **POWER-** Petroleum driven engines possess the ability to generate power post collision. The vehicle may be in an idling state (see B-28 below). During rescue operations this poses a hazard. During the initial rescue operation phase care must be taken to deactivate the power systems of vehicles for example to prevent further motion.

A30.	**Most typical RTA occur with passenger vehicles (this includes sedans, station wagons and sports utility vehicles {SUV})**

WEIGHT- Vehicles are classified differently in terms of its weight (e.g. light motor vehicle vs heavy motor vehicles) and its design (sedan vs sport utility vehicle, etc.). The size, as well as the design of the vehicle and materials used in its construction will influence the weight and the location of the

centre-of-gravity. The vehicle's weight is to be considered within the typical case narrative within the context of stabilisation and other related processes. Other rescue operation could influence for example the centre of gravity of the vehicle; or the forces which would be required to "lift" or "push" components or structures. Most equipment used within the context of motor vehicle rescue is rated to a pre-determined weight or force capacity.

FORCES–

As explained under the design and construction the type of vehicles would influence the support which is provided to strengthen certain structures within the motor vehicle. The strengthening of these structures would influence rescue operations. These structures are designed either to provide some form of resistance and rigidity during a collision. The application of any external forces to the components of a vehicle which is either "bent", "flexed" or "stretched" could pose a considerable risk to rescuers during rescue operations.

B28	**Most typical RTA involves active power systems (i.e. the battery power has not been disconnected and/or the vehicle ignition system is still active {"idling"}**

ENERGY

As rescuers would be arriving on scene of a motor vehicle related rescue incident they would need to ascertain whether all electrical (power) systems has been neutralized and isolated. As part of the process they would need to disconnect the battery terminals (if possible and accessible) to ensure that the electrical (power) system is deactivated. Energy would be contained in various forms even if the electrical (power) system has been isolated of the vehicle as some vehicle components would have additional batteries or capacitors in which power (energy) is stored for "later" use. For example the airbags may possess potential electrical energy which is within a capacitor which could be triggered/activated by a central processing unit due to some activity by the vehicle or rescue incident which could cause the activation of the airbag post the collision event. Similarly when the rescuer would arrive on scene they may be required to open the doors or lower the windows which is dependent on the use of the electrical power from the motor vehicle. These would require the rescuer to remain vigilant and ensure that all precautionary measures are taken when dealing with vehicles in which the electrical (power) system has not been deactivated.

POWER –

During the "active power state" of the motor vehicle there could be the mechanical power which is generated by the combustion engine and the battery power which would drive the electrical components of the motor vehicle. Mechanical power is derived from the combustion engine through work done over time resulting in the maintenance of the electrical power from the battery aided by the alternator. Electrical current, and electrical power (the rate at which electrical energy is supplied), are provided by the battery system to ensure supply of electricity to the lights and other active and passive systems of the vehicle relying on electricity. If not isolated these components could pose a danger, risk or harm to both the emergency care personnel and victims. This could result in the activation of an un-deployed airbag for example which could cause injury to practitioners and victims who are in the impact zone.

A31.	**Most typical RTA involve radiator fluid spills and/or leakages**

FLUID MECHANICS-

Most motor vehicles contain some form of fluid such as radiator, oil, petroleum, etc. which is housed within specialised containers or systems (pipes/hoses). During a motor vehicle collision these containers or systems may sustain damage which would cause these fluids to leak and spill onto the surrounding surface. Fluid will take the path of least resistance and flow in a particular manner which would be influenced by its viscosity, density, surface in contact, volume, etc. The rescuer on scene would not just have to consider the type of fluid with respect to its fire risk in terms of containing and mitigating against it but these fluids may pose other health and slip hazards which would require possibly additional protective measures.

B27.	**Most typical RTA involve fuel spills and/or leakages**

FLUID MECHANICS-

Most motor vehicles contain some form of fluid such as radiator, oil, petroleum, etc. which is housed within specialised containers or systems (pipes/hoses). During a motor vehicle collision these containers or systems may sustain damage which would cause these fluids to leak and spill onto the surrounding surface. Fluid will take the path of least resistance and flow in a particular manner which would be influenced by its viscosity, density, surface in contact, volume, etc. The rescuer on scene would not just have to consider the type of fluid with respect to its fire risk in terms of containing and mitigating against it but these fluids may pose other health and slip hazards which would require possibly additional protective measures.

ENERGY

The hazardous nature of petroleum fuel, and the potential that exits for its chemical potential energy to be converted (through combustion) to heat/thermal energy, needs to be understood by rescuers in order for them to take preventative measures. Petroleum fuel has chemical potential energy which could be converted into heat energy due to its flammability and low ignition (flash) point in the presence of a naked (open) flame. This could be seen as posing to be a hazardous threat due to the nature of petrol with respect to the potential thermal energy which it possesses once it has been ignited.

A33.	**Most typical RTA involves frontal collisions (irrespective if it is full, half ,quarter or partial frontal involvement)**

ENERGY

Prior to the collision the vehicle during movement would possess mechanical energy (which is the potential energy or the kinetic energy or the sum thereof).Post the collision event the vehicle may possess potential energy which would be dependent on the amount of energy which is brought into the collision as well as the its final state (whether in a position of rest). In the event an external force is applied to the vehicle during the post collision phase the potential energy maybe converted into kinetic energy. The type of collision may particularly influence the amount of damage which is sustained to both the vehicle (and its affected components) and its victim. Practitioners would have to apply a high index of suspicion as the amount of damage sustained to the vehicle could be indicative of the amount of energy which has been involved during the collision phase. Crumple zones also dissipate much of the initial collision energy by converting kinetic energy going into a collision, into energy used to deform (or ‘crumple’) the metal. This implies less energy transferred to the passenger compartment. The case narrative was not able to define whether crumple zone would be present.

CHANGE IN MOMENTUM (impulse)

Motor vehicle collisions can also be described using momentum considerations (momentum (p) = mass x velocity). The law of conservation of momentum states that in a closed system, the momentum before an event, in this case the collision, is equal to the momentum after the event.

This allows for the estimation of velocities of vehicles involved in a collision, and colliding angles. During motor vehicle related incident investigations these principles are used to determine the speed at which the vehicle travelled for example and how the vehicle reacted during the collision event. This could assist the rescuers and practitioners during their scene size-up of the incident and evaluation of the victim when considering whether injury patterns are consistent with the type of collision kinetic (typology).	
B31	**Most typical RTA involves deployed airbags (irrespective if it is a frontal and/or side impact airbag)**
ENERGY During the post collision phase the deployed airbag has very little risk of further injury to both rescue personnel and the victim. Highlight that the emphasis is on the post collision phase. In terms of the consideration and decision making the deployed airbag provides mainly information pertaining to the high index of suspicion related to the mechanism of injury and possible injuries which the patient may have sustained.	
A37.	**Most typical RTA involves Rescue personnel using equipment that requires lifting requiring some use of musculoskeletal and body system function/operation**
LEVERS The body is replete with lever systems. Arms, legs, together with the back, act as lever systems during lifting and moving of rescue equipment. Rescuers could injure or harm themselves when equipment is lifted and or moved incorrectly. Practicing good body posture and human ergonomics could reduce for example, musculoskeletal injuries which may result from the incorrect handling of equipment at the typical motor vehicle related incident. **FORCES** Lifting and moving of equipment, objects and people, all require force. Without force there would be no motion. In so much as the rescuer exerts force to effect function, so too force is exerted on the rescuer in the process of handling rescue equipment. To overcome the weight of equipment, objects and victims in lifting or moving them, the rescuer needs to effectively utilise the body's musculoskeletal system in a manner which minimises the risk of self-injury. Rescuers should also be familiar with their own limitations as the weight of an object could require a greater amount of force for example to be applied during lifting or moving which could result in a musculoskeletal injury. **BASE OF SUPPORT** For the rescuer to have a stable base of support (or stance), is important for balance in safely handling rescue equipment, as well as for minimising risk of self-injury. A stable base of support relies on an equilibrated system of (balanced) forces, where the system includes both rescuer and equipment. Musculoskeletal injuries and an increase in risk or injury may result if a rescuer for example has to perform functions at the typical motor vehicle related incident where their own weight is not being supported due to them being unbalanced when operating heavy machinery (equipment).	

A39.	**Most typical RTA involves the use of hydraulic cutting equipment to either "cut" metal and structures (irrespective of conventional cutter or mini cutter or combitool)**

PASCAL'S PRINCIPLE- (LAW OF INCOMPRESSIBLE FLIUDS)

As the pressure is being exerted within the enclosed space/system of the hydraulic pump, pipes/hoses and the tool (cutters) during the operations of the hydraulic equipment the fluid is being transmitted in all directions within the interior containers. When the hydraulic tool has a sudden loss in power or functionality the understanding of the principle (concept) may enable the rescuer to easily troubleshoot what could be wrong by evaluating the system.

FORCE- (IN CUTTING)

Compression forces due to the cutters making contact with the metal/material which is to be cut and a force/pressure being exerted on an area and as the mechanical pressure/force would be increased by means of the driving force which is created by the hydraulic system. The compression force/pressure on the small area would see the tool/piece of equipment being able to cut through the material/metal. Motor vehicles and its associated components are constructed of different materials which all have a different cutting rating in terms of the force which is required to cut through it. Many rescue equipment manufacturers will provide specifications and a rating for their equipment but the car manufacturers would not necessary provide rescuers with the information in terms of where certain area as of the vehicle has been reinforced. Rescuers should develop a greater awareness in terms of how the cutting force and design for example of the tools blade (cutter) has been designed to improve the cutting ability and reduce the amount of force required by which to cut through a component or structure.

POWER

Power would be generated by means of a hydraulic pump (whether manual or fuel driven) which would be requiring some form of hydraulic pipe/hose to connect to the tool/equipment and as the tool is operated by a lever or handle with an "on/active" system resulting in momentum being seen in terms of the function of the tool/equipment (movement whether opening or closing or cutting). Understanding the generation of power and its principle would enable rescuers to troubleshoot when facing a situation during which the tool is not functioning to its capacity or optimally.

NEWTONS LAW (3rd LAW)

As cutting would be done through the different material/metal and depending on whether there is any or no tension/torsion/flexion within the metal there would be a particular reaction with the cutting action and hydraulic powered action of the system (whether through the opening or closing of the tool during operations). The rescuer should understand that metal which is either under tension, bend or stretched could react differently when being cut and should either anticipate that metal would have an opposite or equal reaction to the cutting forces. Therefor it would be of paramount importance to ensure that cutting with hydraulic equipment which are able to apply high forces should precede an inspection and evaluation of the site being cut to reduce risk or injury as a result of metal which was stretched, bend or tensioned that reacted unsafely. This would further ensure that rescuers utilize safe working practice where there is increased risk by placing protective equipment in place to minimize or mitigate the risk.

ENERGY (WITH A FOCUS ON THE CUTTING PROCESS and COMBUSTION ENGINE)

Energy is needed in order for the cutting to occur. Hence in a static (non-use/-operation state) the hydraulic tool (system) would possess potential energy which would be converted to kinetic energy once the tool and hydraulic system is activated and operated and as the tool is performing the cutting of the material/metal depending on the amount of force/pressure which is required there could potentially be thermal/heat energy which is released/created due to the friction between the cutting tool and the material/metal (which is also dependent on a lot of factors e.g. temperature, type of material/metal being cut, amount of force/pressure required/exerted, etc.). The hydraulic system may be dependent on a combustion engine which has mechanical potential energy to drive the hydraulic fluid from its compartment through the hoses to the tool which would perform the desired functions during operations. These combustion engines would as a by-product give off heat/thermal energy at for example the exhaust component which the rescuer should avoid during operations (especially prolonged) due to the toxic gas emissions and heat which could harm rescuers and bystanders alike when in contact with the component (that is heated).

A42.	**Most typical RTA involves the use of wedges and stepchocks to stabilize the vehicle/'s**

CENTRE OF MASS AND GRAVITY

During the stabilization considerations and process of the motor vehicle post the collision phase the rescuer should establish whether the methodology and equipment utilized would be sufficient to prevent the load from becoming unbalanced. The weight/load should be collected at the head (top) by the stabilization equipment (stepchocks supported by wedges) with the weight/load being re-directed down the “spine/length” of the stabilization equipment and eventually evenly distributed into the ground/surface over a larger area at the base of the stabilization equipment. The centre of mass and gravity of the vehicle should be supported by the base of the vehicle to ensure that it does not become an unbalanced object. If any form of stabilization is conducted the centre of mass and gravity should be considered to prevent the vehicle form becoming unbalanced as a result of the stabilization activities.

WEIGHT

When referring to the weight or load of the object the principal investigator is making reference to the mass multiplied by the gravitational forces/influences. Due to the vehicle and/or object possessing mass and due the nature of gravity and its influences the vehicle and/or object it would be assume that these forces (mass x gravity) has an effect on the vehicle and/or object either being termed and/or defined as being unstable post the collision event in the context of the typical motor vehicle related rescue incident. During the stabilization phase the rescuer should consider whether the equipment that is to be used would be rated for the weight of the vehicle/object which requires stabilization. Equipment should always be used within their defined specifications and manufactures recommendations.

NEWTON'S LAW (3rd LAW)

Whatever the stepchocks and wedges is stabilizing the aim is to continue to keep the object to remain at rest. The object and the stepchocks with wedges will only undergo changes in motion if a net force will act on it for example the vehicle is being raised/lifted with the stepchocks and/or wedges having to be re-adjusted/further stabilized/supported. During the stabilization and rescue operations the rescuers should periodically assess their stabilization equipment to ensure that it is still intact and functioning as required. This would minimize any surprises and/or risk where the vehicle/object has become unstable or where the equipment (stabilization) is no longer functioning correctly and poses a great danger to rescuers and bystanders.

ENERGY

Both the vehicle/object and the stepchocks with wedges would have potential energy due to the aim of stabilization would be to keep the vehicle/object in a state of rest. The rescuers should

periodically re-assess their stabilization equipment to ensure and confirm that it is functioning correctly and that the object/vehicle would remain in a position of rest which would see it possessing only potential energy.	
A43.	**Most typical RTA involves the use of wood and wedges to stabilize the vehicle/'s**

CENTRE OF MASS AND GRAVITY

During the stabilization considerations and process of the motor vehicle post the collision phase the rescuer should establish whether the methodology and equipment utilized would be sufficient to prevent the load from becoming unbalanced. The weight/load should be collected at the head (top) by the stabilization equipment (wood supported by wedges) with the weight/load being re-directed down the "spine" of the stabilization equipment and eventually evenly distributed into the ground/surface over a larger area at the base of the stabilization equipment. The centre of mass and gravity of the vehicle should be supported by the base of the vehicle to ensure that it does not become an unbalanced object. If any form of stabilization is conducted the centre of mass and gravity should be considered to prevent the vehicle form becoming unbalanced as a result of the stabilization activities.

WEIGHT

When referring to the weight or load of the object the principal investigator is making reference to the mass multiplied by the gravitational forces/influences. Due to the vehicle and/or object possessing mass and due the nature of gravity and its influences the vehicle and/or object it would be assume that these forces (mass x gravity) has an effect on the vehicle and/or object either being termed and/or defined as being unstable post the collision event in the context of the typical motor vehicle related rescue incident. During the stabilization phase the rescuer should consider whether the equipment that is to be used would be rated for the weight of the vehicle/object which requires stabilization. Equipment should always be used within their defined specifications and manufactures recommendations.

PRESSURE / FORCES

Cribbing is placed in a manner where the load/weight/forces/pressure is collected on the top of the cribbing (wood) with the load/weight/forces/pressure being redirected/transferred down the wood/stacks (placed in a particular manner) and the load/weight/forces being distributed across the surface/area which covers the base of the cribbing (wood). Wood cribbing which is generally used in motor vehicle rescue should have the grain running horizontal in the length of the wood. Due to the wood always being used in its breadth/with and placed horizontally/flat with the length on the ground the wood should be able to withstand the lateral forces which would act on the wood. This would prevent the wood from splitting when weight/pressure is placed on the cribbing across the width/breath and the forces being transferred through the length of the wood. Rescuers should take these factors into consideration when for example wood is used in the stabilization process to avoid risk of harm and injury during the incorrect placement, positioning and utilization of such equipment during rescue operations and stabilization.

NEWTON'S LAW (3rd)

When the cribbing (upward force to collect the load/weight/force/load/pressure and/or downward/gravitational force) is in contact with either wedges or the vehicle undercarriage (downward/ gravitational force) there is an equal or opposite reaction pertaining to the forces which is being applied. Whatever the cribbing (wood) is stabilizing the aim is to continue to keep the object to remain at rest. The object and the cribbing (wood) will only undergo changes in motion if a net force will act on it for example the vehicle is being raised/lifted with the cribbing having to be re-adjusted/further stabilized/supported or during the rescue operations the vehicle's centre of gravity and mass has changed with the vehicle becoming unbalanced/unstable. The rescuers should periodically re-assess their stabilization equipment to ensure and confirm that it is functioning correctly and that the object/vehicle has not become unstable/unbalanced.

ENERGY

Both the vehicle/object and the cribbing (wood) and wedges would have potential energy due to the aim of stabilization would be to keep the vehicle/object in a state of rest. The rescuers should periodically re-assess their stabilization equipment to ensure and confirm that it is functioning correctly and that the object/vehicle would remain in a position of rest which would see it possessing only potential energy.

APPENDIX K: EMERGING PHYSICS THEMES FOR THE EQUIPMENT IN USE WITHIN THE TYPICAL CASE NARRATIVE FOR MOTOR VEHICLE RELATED RESCUE

Introduction:

Equipment was grouped using those as defined by Dunbar (2013). This was based on the function and method through which operations is achieved. The predominant themes was utilised to guide the researcher and physics expert as per the Inventory table 8 in Chapter 5 of the thesis document. These themes emerged from the literature review process.

The below Table 16 represent the predominant physics themes with the explanation of the relationship and consideration in Table 17 further below in this document. The underlined equipment (name) will direct the reader to Table 18 where the description and use of the equipment is provided by entering the “Ctrl” with “Click” application (in the electronic format of the document) or alternatively the reader is to scroll further down to the applicable table.

Table 16 Process tracing results with predominant themes of physics for the Equipment from the Delphi Questionnaires process

Group	Delphi Questionnaire		Predominant Physics Themes			
	Reference Number	Equipment	Kinematics	Forces	Energy	Dynamic Laws
STABILISATION	A1	Cribbing (2x4)	• Impulse	• Mass & Gravity (Centre of) • Weight • Force (Pressure) • Friction	• Potential	• Newton 1 & 3
	A2	Cribbing (4x4)	• Impulse	• Mass & Gravity (Centre of) • Weight • Force (Pressure) • Friction	• Potential	• Newton 1 & 3

	A3	Wedges	• Impulse	• Force (Pressure) • Friction	• Potential	• Newton 3
	A4	Stepchocks	• Impulse	• Force (Pressure) • Friction • Mass & Gravity (Centre of)	• Potential	• Newton 1 & 3
HYDRAULIC	A22.	Spreader tool		• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • Pascal’s
	A23.	Cutter tool		• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • Pascal’s
	A24.	Ram tool		• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • Pascal’s
	A25.	Pedal cutter tool		• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • Pascal’s
ASSIST	A5	Ratchet strapping	• Motion • Speed	• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3
	A6.	Haligan Tool	• Impulse • Motion • Speed • Velocity?	• Force (Pressure) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • Law of Conservation of Momentum (LoCoM)

	A7.	Boltcutter	• Impulse • Motion	• Force (Pressure) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3
	A8.	Pliers (channel lock type)	• Impulse • Motion • Torque	• Force (Pressure) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3
	A9	Pliers (side cutters)	• Impulse • Motion	• Force (Pressure) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3
	A10.	Screwdriver (Flat)	• Impulse • Motion • Torque	• Force (Pressure) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3
	A11.	Crow bar	• Impulse • Motion	• Force (Pressure) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3
	A12.	Springloaded punch	• Impulse • Motion	• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3
	A13.	Seatbelt cutter	• Impulse • Motion	• Force (Pressure)	• Mechanical (potential + kinetic)	• Newton 1 & 3
	A14.	Scissor (serrated edge type)	• Impulse • Motion	• Force (Pressure) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • (LoCoM)
	A15.	Rescue knife	• Impulse	• Force (Pressure)	• Mechanical (potential + kinetic)	• Newton 1 & 3 • (LoCoM)

					• Power / Work	
	A16.	Reciprocating saw	• Impulse	• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • (LoCoM)
	A17.	Windshield saw	• Impulse	• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • (LoCoM)
	A18.	Shovel		• Weight • Force (Pressure) • Mass & Gravity (Centre of) • Levers / Fulcrum	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • (LoCoM)
	A19.	Broom		• Force (Pressure)	• Mechanical (potential + kinetic) • Power / Work	• Newton 1 & 3 • (LoCoM)
	A20.	Airbag cover		• Force (Pressure)	• Potential	• Newton 1 & 3 • (LoCoM)
	A21.	Power plant (Fuel driven)			• Potential + Chemical + Kinetic + Thermal + Electrical • Power / Work	• (LoCoM)
	A26.	Ram support (bracket/base plate)		• Force (Pressure)	• Mechanical (potential + kinetic)	• Newton 1 & 3 • (LoCoM)

	A27.	Lighting			• Electrical (Chemica l) +Thermal + Potential • Power / Work	
	A28.	Jacks (hi lift)		• Weight • Mass & Gravity (Centre of)	• Mechanic al (potential + kinetic) • Power / Work	• Newton 1 & 3 • (LoCoM)

Table 16 as explained above is a representation of the predominant physics themes as it relates to the respective equipment within the typical motor vehicle related incident case narrative pertaining to its use and application with reference to the concepts and/or principle of physics within it. These themes and principles was derived from the literature review and consultation with the physicist who was supervising the research. Table 16 above is the shortened version with Table 17 explaining the predominant theme of physics.

Table 17 Process tracing results derived from the Delphi Questionnaires categorised in the context of the physics themes

Predominant Physics Themes	Physics Principle (Concept)	MVR- Related Equipment (As identified through Delphi Process with corresponding number)	Principle in Application
FORCES	WEIGHT-	A1. Cribbing (2x4) A2. Cribbing (4x4) A28. Jacks (hi lift)	When referring to the weight or load of the object the principal investigator is making reference to the mass multiplied by the gravitational forces/influences. it would be assumed that these forces (mass x gravity) has an effect on the vehicle and/or object either being termed and/or defined as being unstable post the collision event in the context of the typical motor vehicle related rescue incident.
		A18. Shovel	In the context of the motor vehicle related incident the shovel would be used for example to collect and remove debris. The influence of the collected load mass and the gravitational effect on it is to be considered as the load will be collected and placed on the front end (round or square nose). If placed incorrectly the load may be unstable or if loaded beyond capacity it may be too heavy to lift or move for example.
	PRESSURE (CUTTING / BREAKING / PRYING / TURNING / SAWING) [FORCE]	A1. Cribbing (2x4) A2. Cribbing (4x4) A4. Stepchocks	Cribbing and/or stepchocks is placed in a manner where the load/weight is collected on the top with the load/weight/ being redirected down the wood or spine (when placed in a particular manner) and with the load/weight being distributed across the surface/area which covers the base of the cribbing or stepchocks. Wood cribbing which is generally used in motor vehicle rescue should have the grain running horizontal in the length of the wood. Due to the wood always being used in its breadth/with and placed horizontally/flat with the length on the ground the wood should be able to withstand the lateral forces which would act on the wood. This would prevent the wood from splitting when weight/pressure is placed on the cribbing across the width/breath and the forces being transferred through the length of the wood. If the weight of the

			vehicle (in an unstable position) is not managed through stabilization then the scene may be deemed as being unsafe.
		A6. Haligan Tool A11. Crow bar	The cutting, breaking, puncturing, prying, compression, striking, and/or shearing capabilities which the haligan tool and/or crow bar has could lend itself to the application of some type of force/pressure during any of its uses as what would be applicable. This would be due to the pressure which is being applied over an area to enable the performing of the function of either cutting, breaking, puncturing, etc.
		A7. Boltcutter A8. Pliers (channel lock type) A9. Pliers (side cutters) A13. Seatbelt cutter A14. Scissor (serrated edge type) A15. Rescue knife A17. Windshield saw	This would be due to the pressure which is being applied over an area to enable the performing of the function of cutting and where applicable the slicing through the material/metal/object. The rescuer is to be mindful that an external force would be required to enable the tool from performing it function.
		A16. Reciprocating saw	This would be due to the pressure which is being generated/created by the method of power supply (electrical or battery function) with the reciprocating saw blade applied over an area to enable the performing of the function of cutting/ slicing through the material/metal/object. Merely placing the saw at the object would not suffice to enable the cutting through of the object as additional force or pressure is to be applied during the cutting operation onto the surface of the object. If the tool is applied or used incorrectly when pressure or force is applied then the equipment could be damaged or the tool may fail to function or operate correctly.

		A10. Screwdriver (Flat)	This would be due to the pressure which is being applied over an area by the further most pointed ("flat") shaped part of the screwdriver (into the grooves of the nut or bolt with the "flat" head type but with respect to the type of screwdriver point matching the nut or bolt head) to enable the performing of the function of screwing and/or unscrewing of a nut or bolt. The breaking and/or puncturing and/or prying, capabilities which the screwdriver (flat) has could lend itself to the application of some type of force/pressure during any of its uses as what would be applicable for example in the breaking of a window or making a hole in metal or material (breaking and/or puncturing), creating a space to insert a tool (prying). This would be due to the pressure which is being applied over an area to enable the performing of the function of either, breaking and/or puncturing, etc. Due to the versatility of the tool the rescuer should be mindful that a tool should not be used beyond its intended purpose or design.
		A12. Springloaded punch	The breaking (compression and striking) capabilities which the springloaded punch through the pulling back of the spring mechanism generate, creates a force/pressure over a small area with the pointed area of the springloaded punch being in contact with the window (small area) which will see a potential end result of the tempered glass shattering. There is not a great force required in breaking a window when using a springloaded centre punch as oppose to the use of a screwdriver. The rescuer should select their equipment based on the design, purpose and where the least amount of work would be required to effect a positive result.
		A18. Shovel	As the weight (load) would be moved and/or collected and/or unloaded there would be some force (external) required to perform the various objectives as an end goal. Without the external force being applied to the shovel it would not serve much of a function in the context of the motor vehicle rescue related incident.
		A19. Broom	An external force (pressure) would be required to create some form of momentum that would be required to move the broom in a particular manner to achieve an end goal. Without the external force being applied to the broom it

			would not serve much of a function in the context of the motor vehicle rescue related incident.
		A20. Airbag cover	During the application (fitting) of the airbag cover some form of external force would be required to secure it correctly in place. There could be a further force which could be exerted on to the airbag cover during the deployment of a driver’s side (steering wheel) airbag whether it was intentional or unintentional. The rescuer should be aware of the risk or danger which an external force could pose during the unexpected deployment of a driver’s side airbag.
		A22. Spreader tool A23. Cutter tool A24. Ram tool A25. Pedal cutter tool	Compression forces due to the hydraulic equipment making contact with the metal/material/object which is to be spread and/or pushed and/or pulled and/or crushed and/ or cut. The force/pressure would be exerted on an area as the mechanical pressure/force would be increased by means of the driving force which is created by the hydraulic system. The compression force/pressure on the small area would see the tool/piece of equipment being able to spread/push/crush/pull/cut the material/metal/object. Different forces/pressures would be required to pull/push/lift/cut through different metal/objects with the rescuer being mindful of the limitations and specifications of their hydraulic equipment as well as the strength or rating of the various vehicle/object components.
		A26. Ram support (bracket/base plate)	During the application (fitting) of the ram support into the lower corner of the B-pillar (post) of the front driver and/or passenger compartment opening some form of force would be applied to a section/part of the ram support during the utilization of the ram support in providing a stable point from which the ram tool could be used during the performance of a procedure which would require the ram tool to push a metal/material/object. If the ram support tool is place incorrectly the force being applied onto it could the tool to shift from its place and potentially become a hazard or risk during operations. Rescuers should carefully evaluate the placement and the ongoing functioning of their equipment during rescue operations whenever there is a force being applied onto it.
		A28. Jacks (hi lift)	Jacks (hi-lift) is placed in a manner where the load/weight/forces is collected on the top of a particular area/component of the jack (hi-lift) with the load/weight/forces being redirected/transferred down the lengthwise metal structure/spine of the jack (hi-lift) with the load/weight/forces being distributed across the surface/area which covers the wider foot/base of the jack (hi-lift).

			The rescuer should with each application of force throught he use of the hi-lift jack re-assess and monitor the rescue operations to ensure that everything is occurring in a safe manner.
	FRICTION	A1. Cribbing (2x4) A2. Cribbing (4x4) A4. Stepchocks	Could be included under the other types of forces as friction will oppose any net force. Friction will exist between the stabilisation equipment and the surface as well as the object which is being stabilized. If the stabilisation equipment is made of a material which
	MASS & GRAVITY (CENTRE OF-)	A1. Cribbing (2x4) A2. Cribbing (4x4) A4. Stepchocks	If cribbing is placed in an correct manner for example in an unbalanced manner or at the incorrect place especially when it it is used in conjunction with other equipment and the load/weight/downward forces are not correctly collected due to no consideration how for example when lifting using cribbing and high pressure bags would cause a shift/change in the objects centre of gravity could see the object/vehicle either toppling or where the equipment which is being used could become a projectile and “shoot out” from underneath the object/vehicle.
		A18. Shovel	Due to the design and construction of the shovel the rescuer would have to be mindful of the placement of the load onto the shovel and the relationship of the hand placement/position in order to ensure that the load would be balanced and stable during the lifting and/or movement and/or unloading process.
		A28. Jacks (hi lift)	If a jack (hi-lift) is placed in an correct manner for example in an unbalanced manner or at the incorrect place especially when it is used in conjunction with other equipment (for example a base plate or wood cribbing) to provide further support and/ or stability with the load/weight/downward forces not correctly collected due to no consideration for a shift/change in the objects centre of gravity due to any activities or work being done at the incident or object/vehicle. This could see the object/vehicle either toppling or where the equipment which is being used could become a projectile and “shoot out” from underneath the object/vehicle.

	LEVERS / FULCRUM-	A6. Haligan Tool A10. Screwdriver (Flat) A11. Crow bar	Due to the hand positioning during the use and operation of the tool with respect to prying and cutting the rescuer would be utilizing a fulcrum and/or lever principle to generate enough force or pressure to enable to perform the task/duty/capability of that which is being sought.
		A7. Boltcutter A9. Pliers (side cutters) A14. Scissor (serrated edge type)	Due to the manner in which the boltcutter would be used at the handles to exert pressure over an area and as the pressure is increased in the handle the force by which cutting would be required to be done over the particular area would then be increased. The use of the handles will lend itself to a form of a lever or fulcrum being used.
		A8. Pliers (channel lock type)	This would be to enable and/or create sufficient power to provide torque when screwing and/or unscrewing a nut or bolt.
		A18. Shovel	During the collection and/or lifting and/or movement of the load the rescuer would be using a lever and fulcrum process by means of their hand placement to ensure that the load (weight) is stable and that minimum effort is used during the collection and/or load and/or carrying process.

DYNAMIC LAWS	NEWTON 1ST	A1. Cribbing (2x4) A2. Cribbing (4x4) A4. Stepchocks	Whatever the cribbing is stabilizing the aim is to continue to keep the object to remain at rest. The object and the cribbing will only undergo changes in motion if a net force will act on it for example the vehicle is being raised/lifted with the cribbing having to be re-adjusted/further stabilized/supported.
		A6. Haligan Tool A11. Crow bar	If the haligan tool is placed in position to perform a certain function/task/objective it would require an external force to generate/create enough force/pressure over the area which is being kept/placed into position to enact/allow for the desired intended function/end goal.
		A7. Boltcutter	If the boltcutter handles with the “mouth” (opening of the cutting side) is placed in position to perform a certain function/task/objective it would require an external force to generate/create enough force/pressure over the area which is being kept/placed into position to enact/allow for the desired intended function/end goal.
		A8. Pliers (channel lock type) A10. Screwdriver (Flat)	If no force is applied to either the nut or bolt by means of the pliers (channel lock type) then all pieces will remain in a state of rest. If no force is applied to either the nut or bolt by means of the screwdriver (flat) then all pieces will remain in a state of rest.
		A9. Pliers (side cutters) A13. Seatbelt cutter A14. Scissor (serrated edge type)	If the pliers (side cutters) handles with the “blade mouth” (opening of the cutting side) is placed in position to perform a certain function/task/objective it would require an external force to generate/create enough force/pressure over the area which is being kept/placed into position to enact/allow for the desired intended function/end goal.
		A12. Springloaded punch	If the springloaded punch is placed in position to perform a certain function/task/objective it would require an external force as per the spring mechanism which is to be pulled back sufficiently to generate/create enough force/pressure to travel down towards the sharp pointed part of the springloaded punch which is in contact with the tempered glass area where the

			springloaded punch is being kept/placed into position to enact/allow for the desired intended function/end goal of breaking the window.
		A15. Rescue knife	If the rescue knife is held at its handling component with the "sharp blade side" (where the cutting/slicing is to be done with) is placed in position to perform a certain cutting/slicing procedure it would require an external forwards and backwards motion/movement to generate/create enough force/pressure over the area which where it would be kept/placed into position to enact/allow for the desired intended function/end goal.
		A16. Reciprocating saw A17. Windshield saw	If the reciprocating saw is held at its handling component with the "sharp serrated blade side" (where the cutting/slicing is to be done with) is placed in position to perform a certain cutting/slicing procedure it would require the application of a power source (battery or electrical) to use a forwards and backwards motion/movement to generate/create enough force/pressure which is driven by the method of power over the area of the material/object/metal surface where it would be kept in-place/ position to enact/allow for the desired intended function/end goal.
		A18. Shovel	Even if the shovel has a load or if there is a need to collect a load there would be a requirement of an external force to be applied to effect the end goal of either collecting and/or moving and/or lifting and or unloading of the load.
		A19. Broom	In the static state the broom would remain in the state of rest until an external force would be applied to it that would be sufficient enough to change its state from rest.
		A20. Airbag cover	After the airbag has been fitted onto the steering wheel it would remain in a state of rest until such time the driver's side steering wheel airbag (force) is activated (intentional or unintentional) which would see it change from its state of rest.

		A22. Spreader tool A23. Cutter tool A24. Ram tool A25. Pedal cutter tool	Due to the “dead man handle” on the hydraulic tool the tool will only operate/function in terms of spreading/pulling/pushing/crushing when the actual handle is being operated to either close or open the tool during the operational activity. The hydraulic system may be active in terms of the hydraulic pump could be “on/active” but the tool would not operate/function unless the handle is being used/operated. This therefor would see the tool (in terms of its function remaining in a position or state of rest until the tool is operated by its handle with an “on/active” hydraulic system.
		A26. Ram support (bracket/base plate)	During the application (fitting) of the ram support into the lower corner of the B-pillar (post) of the front driver and/or passenger compartment opening an external force would be required to be applied to the ram support in order change it from its position of rest (that is to say if the ram support is placed correctly with no other factors influencing its ability to remain in a position or state of rest).
		A28. Jacks (hi lift)	Whatever the jack (hi-lift) is stabilizing the aim is to continue to keep the object to remain at rest. The object and the jack (hi-lift) will only undergo changes in motion if a net force will act on it for example the vehicle/object is centre of gravity or centre of mass shifting position for some reason and thus requiring a re-adjusted and/or further stabilization and/or support being provided.
	NEWTON 3RD	A1. Cribbing (2x4) A2. Cribbing (4x4)	When the cribbing (upward force to collect the load/weight/force/load and/or downward/gravitational force) is in contact with either wedges or the vehicle undercarriage (downward/ gravitational force) there is an equal or opposite reaction pertaining to the forces which is being applied
		A3. Wedges	Due to wedges being used in combination with for example stepchocks or cribbing it is therefore used to increase the pressure/forces which is needed to stabilize the object/vehicle. As wedges could be used in front and behind the wheels of the vehicle to prevent it from rolling or in between metal which has been cut or spread to prevent the metal from returning to its original position the forces acting on the wedges for example the wheels or the metal will see an equal or opposite force from being exerted by the wedges.

		A4. Stepchocks	When the stepchocks (upward force to collect the load/weight/force/load and/or downward/gravitational force) is in contact with either wedges or the vehicle undercarriage (downward/ gravitational force) there is an equal or opposite reaction pertaining to the forces which is being applied
		A5. Ratchet strapping	As the ratchet strapping and system would be under tension there would be either an equal or opposite force/tension which is to be exerted on the equipment/objects to which it is secured and/or the complete system in which the ratchets strapping would be required to function in order to aid in the creation of the triangle of stability for example.
		A6. Haligan Tool	During any of the capabilities and/or uses of the haligan tool with respect to the material and/or metal which is being either pried, cut, etc. there would be an action with an equal or opposite reaction in terms of how the tool would react in terms of performing as what would be required and whether the material and/or metal would react in a similar manner or oppose the action which is being exercised/performed. This would see rescuers having an increase awareness to potentially anticipate what the haligan tool would do in the event of it being struck by another tool in the process of either creating a puncture or access point in a piece of material or metal in terms of the response and/or action when both being struck and how it would react/respond when making contact with the metal/material when having to puncture or break/spread, etc.
		A7. Boltcutter	During any of the capabilities and/or uses of the boltcutter with respect to the material and/or metal which is being cut there would be an action with an equal or opposite reaction in terms of how the tool would react in terms of performing as what would be required and whether the material and/or metal would react in a similar manner or oppose the action which is being exercised/performed (if assuming the tool is used within the manufacturers recommended manner and specifications). This would see rescuers having an increase awareness to potentially anticipate what the boltcutter would do in as it would start with the process of cutting through a piece of material or metal.

		A8. Pliers (channel lock type)	As there would be a force and/or sufficient torque applied in the process of screwing and/or unscrewing of the nut or bolt there would be an expected reaction whether opposite (where the nut or bolt is not moving) or equal (where the nut or bolt moves with either the intention of being screwed or unscrewed) even though sufficient or insufficient torque/power/forces is being applied.
		A9. Pliers (side cutters) A14. Scissor (serrated edge type) A13. Seatbelt cutter A15. Rescue knife A16. Reciprocating saw A17. Windshield saw	During any of the capabilities and/or uses of the pliers (side cutters) with respect to the material and/or metal which is being cut there would be an action with an equal or opposite reaction in terms of how the tool would react in terms of performing as what would be required and whether the material and/or metal would react in a similar manner or oppose the action which is being exercised/performed (if assuming the tool is used within the manufacturers recommended manner and specifications). This would see rescuers having an increase awareness to potentially anticipate what the pliers (side cutter) would do in as it would start with the process of cutting through a piece of material or metal.
		A10. Screwdriver (Flat)	As there would be a force and/or sufficient torque applied in the process of screwing and/or unscrewing of the nut or bolt there would be an expected reaction whether opposite (where the nut or bolt is not moving) or equal (where the nut or bolt moves with either the intention of being screwed or unscrewed) even though sufficient or insufficient torque/power/forces is being applied by means of the application of the screwdriver (flat). Similarly this would be applicable when considering the effect of when a screwdriver would be used in combination with another piece of equipment to either break and/or pry and/or puncture an object or metal or material.

		A11. Crow bar	During any of the capabilities and/or uses of the crowbar with respect to the material and/or metal which is being either pried, broken, struck, etc. there would be an action with an equal or opposite reaction in terms of how the tool would react in terms of performing as what would be required and whether the material and/or metal would react in a similar manner or oppose the action which is being exercised/performed. This would see rescuers having an increase awareness to potentially anticipate what the crowbar would do (react) in the event of it striking and/or breaking and/or prying the metal/material.
		A12. Springloaded punch	During any of the use of the springloaded punch with respect to the tempered glass which is being broken (compressed or striked) there would be an action with an equal or opposite reaction in terms of how the tool would react in terms of performing as what would be required and whether the tempered glass would react in a similar manner or oppose the action which is being exercised/performed based on the area where the springloaded punch is placed and/or how far the spring mechanism is pulled back in order for a great enough force/pressure to have been generated/created. This would see rescuers having an increase awareness to potentially anticipate what the springloaded punch would do in the event of it being placed incorrectly and/or not sufficient force/pressure being generated/created during the pulling action on the spring mechanism.
		A18. Shovel	During any phase of the use of a shovel whether it be to collect and/or load and/or lift and/or move and/or unload there would be various factors which would be required to be in a state of equilibrium in order to ensure that the end goal is achieved. If for example the rescuer uses an incorrect hand placement this could potentially result in an unstable load or for example if the load is of a particular nature where it cannot be contained on the front end there would be a different reaction to what would have been the case with a different load.

		A19. Broom	As the broom would be either moved into position and/or during the sweeping (moving forwards and backwards motion) action to move a particular type of material/object it would be requiring a certain amount of force to move the material/object in relation to the type of material/object density and/or weight and/or the amount of friction between the material/object and the surface on which it is being moved. For example the lighter and less friction which is experienced by the material/object would see potentially less effort required in moving/sweeping the material/object.
		A20. Airbag cover	The reaction of a well fitted airbag cover over a steering wheel would be that as the driver's side (steering wheel) airbag is activated the force/impact which would be generated during the deployment of the airbag would be absorbed/dissipated/deflected in to the airbag cover which would see any potential injuries to the rescuer and/or the patient would be minimized. Likewise if the airbag cover is fitted incorrectly (for example to loosely) the impact and force during the deployment of a driver's side (steering wheel) airbag would result in less dissipation/absorption/deflection of the forces/pressure during the deployment process which could potentially result in more serious harm and/or injury to the patient and/or rescuer.
		A22. Spreader tool	As spreading/pushing/pulling/crushing would be done through the different material/metal/object and depending on whether there is any or no tension/torsion/flexion and/or resistance experienced within the metal/material/object there would be a particular reaction with the spreading or pushing or pulling or crushing action and/or the material/metal/object on which the force/pressure is being exerted and/or hydraulic powered action of the system (whether through the opening or closing of the tool during operations).
		A23. Cutter tool A25. Pedal cutter tool	As cutting would be done through the different material/metal and depending on whether there is any or no tension/torsion/flexion within the metal there would be a particular reaction with the cutting action and hydraulic powered action of the system (whether through the opening or closing of the tool during operations).

		A24. Ram tool	As pushing/lifting would be done onto the different material/metal/object and depending on whether there is any or no tension/torsion/flexion within the metal there would be a particular reaction with the pushing/pulling action and hydraulic powered action of the system (whether through the opening or closing of the tool during operations).
		A26. Ram support (bracket/base plate)	Once the ram support is applied/positioned into the lower corner of the B-pillar (post) of the front driver and/or passenger compartment opening some form of force would be applied to a section/part of the ram support during the utilization of the ram support in providing a stable point from which the ram tool could be used during the performance of a procedure which would require the ram tool to push a metal/material/object. The ability of the ram support to remain in place will depend on certain factors such as the contact between the ram support and the area where it has been placed in the lower corner of the B-pillar (post) and/or the influences of the ram tool in terms of the ram tools position and placement into the areas which is provided on the ram support and/or the metal/material/object which is being pushed action and/or reaction to the process and procedure which is being performed.
		A28. Jacks (hi lift)	When the jack (hi-lift) during the collection of the load/weight/force and/or the redirection of the downward/gravitational force/weight/load/pressure and the further distribution of that weight/load/pressure/force into the surface which is spread by the foot of the jack (hi-lift) or in support of the base plate being used there would be either equal or opposing forces being experienced. When the forces are stable and equal there would be the desired effect of either r lifting or spreading or stabilization but as soon as the forces are unequal there potentially would be a "give" or opposite reaction to what would have been desired or anticipated.
	LAW OF CONSERVATION OF MOMENTUM	A6. Haligan Tool	Prior to the use of the haligan tool for either prying, cutting, puncturing it would have no momentum similarly as when the rescuer picks up the haligan tool and hold the tool in a position from which s/he would want to start with the movement of striking an object or material or metal.

		A14. Scissor (serrated edge type)	Prior to the use of the scissors (serrated edge type) for the purpose of cutting it would have no momentum similarly as when the rescuer picks up the tool and hold the tool in a position from which s/he would want to start with the movement of applying force or pressure to the handle of the scissors (serrated edge type) which would eventually result in the cutting of the object or material or metal.
		A15. Rescue knife	Prior to the use of the rescue knife for the purpose of cutting/slicing it would have no momentum similarly as when the rescuer picks up the rescue knife and hold the tool in a position from which s/he would want to start with the forwards and backwards motion/movement of applying force or pressure to the handle and the area of the “sharp blade cutting side” of the rescue knife which is in contact with the material (soft) which would eventually result in the cutting/slicing of the material (soft).
		A16. Reciprocating saw A17. Windshield saw	Prior to the use of the reciprocating saw for the purpose of cutting/slicing it would have no momentum similarly as when the rescuer picks up the reciprocating saw and hold the tool in a position from which s/he would want to start machine powered (electrical or battery) forwards and backwards motion/movement of applying force or pressure to the area of the “sharp serrated blade cutting side” of the reciprocating saw which is in contact with the material/metal/object which would eventually result in the cutting/slicing of the material/metal/object.
		A18. Shovel	In the static state there would be no momentum which would be experienced by the shovel irrespective of the end goal as a force would be required to provide some form of acceleration in order to perform any of the task which would be possible with a shovel.
		A19. Broom	In the static state there would be no momentum which would be experienced by the broom irrespective of the end goal as a force would be required to provide some form of acceleration in order to perform any of the task which would be possible with a broom.
		A20. Airbag cover	In the static state there would be no momentum which would be experienced by the airbag cover as it is a passive preventative device with the end goal being a device which is to be already in place during the potential deployment

			of an active drivers side (steering wheel) airbag where a potential force would be generated as the airbag would deploy.
		A21. Power plant (Fuel driven)	During the inactive phase a machine (such as a fuel driven power plants) would have no momentum but a machine (such as a fuel driven power plant) is a device used for the multiplying of force or simply changing the direction of force which would only be activated during the starting and operating process and procedure.
		A26. Ram support (bracket/base plate)	In the static state there would be no momentum which would be experienced by the ram support as it is a passive device which is used mainly to provide added stabilization capacity and a good point from which to push of for the ram tool during the extrication process and procedure.
		A28. Jacks (hi lift)	During the ratchet like motion by means of the handle attached to the jack (hi-lift) for the purpose of raising or spreading a metal/material/object/vehicle there will be either an increase in the mechanism motion/movement speed (due to potentially not enough/sufficient tension in it) or decrease (as it would start taking the tension) due to the tension which would exist between the objects/material/vehicle/metal to which the jack (hi-lift) would be positioned.
	PASCAL'S PRINCIPLE- (LAW OF INCOMPRESSIBLE FLIUDS)-	A22. Spreader tool A23. Cutter tool A24. Ram tool A25. Pedal cutter tool	As the pressure is being exerted within the enclosed space/system of the hydraulic pump, pipes/hoses and the tool (spreaders) during the operations of the hydraulic equipment the fluid is being transmitted in all directions within the interior containers.

KINEMATICS	IMPULSE	A1. Cribbing (2x4) A2. Cribbing (4x4) A3. Wedges A4. Stepchocks	Due to the forces and the aim of stabilization with cribbing there is interaction between the forces of the unstable vehicle and the cribbing (where the aim is to stabilize the object/vehicle).
		A6. Haligan Tool A11. Crow bar	During the interaction of the haligan tool with either the object which would strike it or when it is used as an object to either strike another object or whether being used to pry open a metal or material there would be an experience of what the object and/or tool could provide which it may not yet possess in terms of the force to perform the desired end goal/task/objective.
		A7. Boltcutter A9. Pliers (side cutters) A13. Seatbelt cutter A14. Scissor (serrated edge type) A15. Rescue knife A16. Reciprocating saw A17. Windshield saw	During the interaction of the boltcutter with either the object which would require to be cut where no force or pressure is yet being applied to the handles of the tool there would be an experience of what the object and/or tool could provide which it may not yet possess in terms of the force to perform the desired end goal/task/objective.
		A8. Pliers (channel lock type)	During the interaction of the pliers (channel lock type) with either the nut or bolt which would require to be screwed and/or unscrewed where no force or pressure is yet being applied to the handles of the tool there would be an experience of what the object and/or tool could provide which it may not yet possess in terms of the force to perform the desired end goal/task/objective.

		A10. Screwdriver (Flat)	During the interaction of the screwdriver (flat) with either the nut or bolt which would require to be screwed and/or unscrewed where no force or pressure is yet being applied by means of the area where the rescuer would hold the tool in position to enact or perform the motion required to screw and/or unscrew there would be an experience of what the object and/or tool could provide which it may not yet possess in terms of the force to perform the desired end goal/task/objective. This would be similar for when the screwdriver would be used in combination with another tool to enact/ perform a function of either prying, breaking or puncturing metal, object or a material but where no contact or force/pressure has been applied to the screwdriver to reach the end goal/task as what would be required.
		A12. Springloaded punch	During the interaction of the springloaded punch with the sharp pointed component being in contact with either the tempered glass which would require the pulling of the spring mechanism in order to generate a force/pressure to move down onto the punch that would be transferred/directed onto the sharp point which is in contact with the area of the tempered glass there would be an experience being observed between all the objects/materials and the springloaded punch without the actual action/force/pressure having been created or generated.
	MOTION	A5. Ratchet strapping	During the ratchet like motion there will be either an increase in the mechanism motion/movement speed (due to potentially not enough/sufficient tension in it) or decrease (as it would start taking the tension) due to the tension which would exist between the objects to which the ratchet would be secured.
		A6. Haligan Tool A11. Crow bar	During the motion and movement of the haligan tool to potentially strike an object/ material or metal there would be mass and acceleration in order to generate a force/pressure enough to puncture/ break/ etc. the metal/object/material.

		A7. Boltcutter	Prior to the use of the boltcutter for the purpose of cutting it would have no momentum similarly as when the rescuer picks up the tool and hold the tool in a position from which s/he would want to start with the movement of applying force or pressure to the handle of the boltcutter which would eventually result in the cutting of the object or material or metal. Motion would be created by squeezing the handles to operate the cutting mechanism. During the motion and movement of the handle and the "blade mouth" (opening where cutting would be performed) there would be an increase in movement with the application of a force to the handle which would ultimately produce the cutting in the "blade mouth opening".
		A8. Pliers (channel lock type) A10. Screwdriver (Flat)	During the screwing and/or unscrewing process of the nut or bolt there would be momentum either seen in the nut or bolt or by which the pliers (channel lock type) is able to move with difficulty or with ease depending on the factors which would influence the screwing and/or unscrewing process.
		A9. Pliers (side cutters)	During the motion and movement of the handle and the "blade mouth" (opening where cutting would be performed) there would be an increase in movement with the application of a force to the handle which would ultimately produce the cutting of the material/metal in the "blade mouth opening".
		A12. Springloaded punch	During the backwards pulling motion and movement of the spring mechanism to generate a force/pressure enough when released to potentially strike an area on the tempered glass which is contact with the furthest sharp point of the springloaded punch.

		A13. Seatbelt cutter A14. Scissor (serrated edge type)	During the motion and movement of the handling component and the “blade opening” where cutting would be performed there would be an increase in movement with the application of a force to the handling component and on the seatbelt material which is in contact with the “blade opening: which would ultimately produce the cutting of the seatbelt material.
	SPEED	A5. Ratchet strapping	During the ratchet like motion there will be either an increase in the mechanism motion/movement speed (due to potentially not enough/sufficient tension in it) or decrease (as it would start taking the tension) due to the tension which would exist between the objects to which the ratchet would be secured.
		A6. Haligan Tool	During the motion and movement of the haligan tool to potentially strike an object/ material or metal there would be mass and acceleration in order to generate a force/pressure enough to puncture/ break/ etc. the metal/object/material.
	VELOCITY	A6. Haligan Tool	During the motion and movement of the haligan tool in a particular direction to potentially strike an object/ material or metal there would be mass and acceleration in order to generate a force/pressure enough to puncture/ break/ etc. the metal/object/material.
	TORQUE	A8. Pliers (channel lock type) A10. Screwdriver (Flat)	This would be in relation to the rotational counterpart of the forces during the screwing and/or unscrewing process of the nut or bolt as power is being applied.

ENERGY	POTENTIAL	A1. Cribbing (2x4) A2. Cribbing (4x4) A4. Stepchocks	Both the vehicle/object and the cribbing would have potential energy due to the aim of stabilization would be to keep the vehicle/object in a state of rest.
		A3. Wedges	Due to no movement being exerted on the wedges when in use there is potential energy.
		A20. Airbag cover	During the static state the airbag cover will possess potential energy and after the airbag cover has been fitted over the driver's side (steering wheel) airbag it would continue to possess only potential energy until such time during the active deployment of the driver's side (steering wheel) airbag where the potential energy would be converted into kinetic energy until the driver's side (steering wheel) airbag would reach its static state again where after the airbag cover would be converted back into potential energy.
	MECHANICAL (POTENTIAL + KINETIC)	A5. Ratchet strapping	When the ratcheting would commence the method/process would move from a potential energy to a kinetic energy state with some friction/thermal/heat energy being created through the process and at the completion of the process it would return to a potential energy state. Work (kinetic energy) is required to operate/create functioning of the ratchet device and system in order to create tension within the system where the ratchet would be used.
		A6. Haligan Tool	During its static state the haligan tool will possess potential energy and during the movement/momentum state it will be transferred/converted into kinetic energy with some conversion into thermal/heat/ friction energy and once it reaches its state of rest again it would be converted back into potential energy

		A7. Boltcutter A11. Crow bar	During its static state the boltcutter will possess potential energy and during the movement/momentum state it will be transferred/converted into kinetic energy with some conversion into thermal/heat/ friction energy (during the cutting of the material/metal) and once it reaches its state of rest (after the cutting has been successfully completed) again it would be converted back into potential energy.
		A8. Pliers (channel lock type) A10. Screwdriver (Flat)	During its static state the pliers (channel lock type) will possess potential energy and during the movement/momentum state as it will start with the screwing and/or unscrewing process/function where momentum is being generated it will be transferred/converted into kinetic energy with some conversion into thermal/heat/ friction energy (during the screwing and/or unscrewing of the material/metal which is in contact with the pliers and/or the nut or bolt) and once it reaches its state of rest (after the screwing and/or unscrewing has been successfully completed) again it would be converted back into potential energy.
		A9. Pliers (side cutters) A13. Seatbelt cutter A14. Scissor (serrated edge type) A15. Rescue knife A17. Windshield saw	During its static state the pliers (side cutters) will possess potential energy and during the movement/momentum state (as the handle is being pressed) it will be transferred/converted into kinetic energy with some conversion into thermal/heat/ friction energy (during the cutting of the material/metal) and once it reaches its state of rest (after the cutting has been successfully completed) again it would be converted back into potential energy.
		A12. Springloaded punch	During its static state the springloaded punch will possess potential energy and during the movement/momentum/pulling with the eventual release of the spring mechanism it will be transferred/converted into kinetic energy and once it all components (spring mechanism) has reached its state of rest again it would be converted back into potential energy.

		A18. Shovel A19. Broom	During the static state the shovel will possess potential energy but during the application of an external force there would a transfer of energy from potential to kinetic energy until it would reach the static state again where after it would be converted back into potential energy.
		A22. Spreader tool A23. Cutter tool A24. Ram tool A25. Pedal cutter tool	Energy is needed in order for the spreading/pulling/crushing/pushing to occur. Hence in a static (non-use/-operation state) the hydraulic tool (system) would possess potential energy which would be converted to kinetic energy once the tool and hydraulic system is activated and operated and as the tool is performing the spreading/pushing/crushing/pulling of the material/metal/object depending on the amount of force/pressure which is required there could potentially be thermal/heat energy which is released/transferred due to the friction between the tool and the material/metal/object (which is also dependent on a lot of factors e.g. temperature, type of material/metal being crushed/pushed, amount of force/pressure required/exerted, etc.).
		A26. Ram support (bracket/base plate)	During the static state (irrespective whether in contact with the ram tool and B-pillar and in place to perform a particular procedure) the ram support will possess potential energy and if the ram support remain in position it will continue to possess the potential energy but if it does come out of position for whatever reason the potential energy would be converted into kinetic energy and after any movement has occurred and it returns to a state of rest it will continue to possess potential energy.
		A28. Jacks (hi lift)	Both the material/metal/vehicle/object and the jack (hi-lift) would have potential energy due to the aim of stabilization and/or spreading and/or lifting would be to keep the vehicle/object/material/metal in a state of rest. When the ratcheting (by means of the handle which is attached to the jack (hi-lift) for the purpose of raising the “step”) would commence the method/process would move from a potential energy to a kinetic energy state with some friction/thermal/heat energy being created through the process and at the completion of the process it would return to a potential energy state.

	POTENTIAL + CHEMICAL + KINETIC + THERMAL/HEAT + ELECTRICAL	A21. Power plant (Fuel driven)	During the static (off and inactive non-use) phase the fuel driven power plant (machine and engine) will possess chemical potential energy where no power is being generated by the combustion engine (power plant /machine) and when the fuel driven power plant is activated/ during the running of the motor phase (irrespective of its starting procedure and mechanism) it would be converted into kinetic energy with some thermal/heat/friction energy being transferred/converted through the running of the engine components during the active and running phase of the fuel driven power plant and while the kinetic energy which is used to transfer/converted the kinetic into electrical energy which is being used to drive the electrical powered tools. Post the active/running phase/state of the fuel driven power plant the kinetic and electrical energy will be converted to potential energy with the thermal/heat energy which was produced over time being dissipated depending on other external factors such as weather/temperature of the environment for example.
	ELECTRICAL (CHEMICAL) + THERMAL + POTENTIAL	A27. Lighting	When no lighting is being provided (due to the non-activation of a switch and the non-provision or availability of a power source) the lighting unit/source would possess potential energy. It would require some form of power (whether battery or electrical) to allow for the conversion from potential energy to for example electrical or chemical (battery) and if the operation switch is activated the electrical or chemical energy would be converted to light energy with possible some heat/thermal energy which would also be converted. Once all lighting use processes has been stopped it would be converted back to potential energy.
		A16. Reciprocating saw	During its static state the reciprocating saw will possess potential chemical energy and during the activation state the chemical/electrical (battery) energy will cause a forward and backwards motion/movement in the mechanism which drive the blade with it transferred/converted into kinetic energy with some conversion into thermal/heat/ friction energy during the cutting/slicing of the material/metal/object and once it reaches its state of rest (after the cutting/slicing has been successfully completed) again it would be converted back into potential (chemical) energy.
	POWER/WORK	A5. Ratchet strapping	Due to change in energy which would see the energy being transferred from one (potential) form to another (kinetic) work/power would be created and/or generated.

		A6. Haligan Tool A7. Boltcutter A8. Pliers (channel lock type) A9. Pliers (side cutters) A10. Screwdriver (Flat) A11. Crow bar A12. Springloaded punch A13. Seatbelt cutter A14. Scissor (serrated edge type) A15. Rescue knife A16. Reciprocating saw A17. Windshield saw	The change/transfer/conversion of energy from potential to kinetic and back to potential with the movement/swinging generated/performed during the use of the tool to either for example strike an object or metal or material to either puncture, break, etc. as a means of an end goal.
		A18. Shovel	As there would be some effort required to collect and/or load and/or lift and/or move and/or unload whatever the end goal would have been there would be some energy required to perform the work.
		A19. Broom	As there would be some effort required to move/sweep whatever the end goal would have been there would be some energy required to perform the work

		A21. Power plant (Fuel driven)	As a change in energy is being experienced from potential to kinetic with electrical energy with some thermal/heat energy being released there would be work done by means of the combustion engine and components which would drive all processes. Fuel driven engines (power plants and machines) possess are utilized to generate power (force) which is to be used during any of the needs where an electrical source could be used for example in the provision of lighting to a scene and/or powering an electrically powered tool and/or providing charging capacity to a tool which uses a battery but requires an external source to provide an electrical charge.
		A22. Spreader tool A23. Cutter tool A24. Ram tool A25. Pedal cutter tool	Power would be generated by means of a hydraulic pump (whether manual or fuel driven) which would be requiring some form of hydraulic pipe/hose to connect to the tool/equipment and as the tool by its handle would be operated with an "on/active" system resulting in momentum being seen in terms of the function of the tool/equipment (movement whether opening or closing of the tool or spreading/pushing/chrushing/pulling).
		A27. Lighting	As the light will undergo the transferring of energy from a potential state to a power driven state to where it would ultimately provide lighting and where it would return to its state of rest work would be required/done. Due to the nature of energy being transferred and work being done through the process of providing light there would be the requirement of this light to be produced over a period of time hence the need for some form of power to ensure that the amount of work which is to be done can be sustained over the period of time which is to be equal to the amount of power needed.
		A28. Jacks (hi lift)	Work (kinetic energy) is required to operate/create functioning of the handle attached to the jack (hi-lift) device and system in order to create tension within the system. Due to a change in energy which would see the energy being transferred from one (potential) form to another (kinetic) work/power would be created and/or generated which would be required to be sustained over a period of time which would require the power and work to be equal.

The below Table 18 provides a general description of the typical motor vehicle related incident equipment as identified through the Delphi process. The description is based on the design and or various application which the equipment could be utilized for within the motor vehicle rescue related field. The below description was developed based on the textbooks from the literature review process where these equipment pieces were explained for example Moore (2003), etc. During the Delphi process the participants was not required to indicate the use and or application of the equipment. The reader will be taken to the below respective equipment when placing the cursor over the selected equipment which is underlined in Table 16 and proceeding to press “Ctrl” + “Clicking” the mouse (when using the electronic version of this document).

Table 18 Description and use of the Equipment/tool as defined within the typical motor vehicle rescue related case

SECTION A	
Number & Equipment	**Description and its use within motor vehicle related rescue**
A1. Cribbing (2x4)	Constructed of wood which is generally used for stabilization of vehicle. The 2x 4 refers to the size of the width of the cribbing which is 2” (38mm) x 4” (76mm). Could be used in conjunction with other equipment such as vetter bags (pneumatic lifting bags) where cribbing is used as a base (platform) and also with wedges (plastic or wood) to aid in the chocking (stabilization) of an object such as a vehicle.
A2. Cribbing (4x4)	Constructed of wood which is generally used for stabilization of vehicle. The 4x 4 refers to the size of the width of the cribbing which is 4” (76mm) x 4” (76mm). Could be used in conjunction with other equipment such as vetter bags (pneumatic lifting bags) where cribbing is used as a base (platform) and also with wedges (plastic or wood) to aid in the chocking (stabilization) of an object such as a vehicle.
A3. Wedges	This is triangular wedges of different sizes generally constructed from wood or plastic which is used in combination with stepchocks or cribbing in the stabilization of a vehicle and/or object. Wedges could at times be used in between areas where cuts or spreading of metal has been made to prevent the metal from returning to its original position (not a conventional method of use or application).
A4. Stepchocks	This is a step like piece of equipment which is generally constructed from wood or hardened plastic. It has a firm base support with the steps incrementally increasing to a certain height with each step having a bit of a surface area where the load could be collected. This piece of equipment is used either as a standalone piece of equipment in the stabilization of a vehicle or an object or could be used in combination with other equipment such as wedges.

A5. Ratchet strapping	Ratchet strapping consist of webbed piece of material which is flat and non-tubular and of different lengths. The flat piece of webbing is fed through a device which would allow the webbing to be coiled/rolled onto itself through a ratching (forward and backwards movement of a handle on the ratchet device) manner. The ratchet device and webbing is generally used to secure either an object such as a door or roof after it had been partially opened and not completely removed from the vehicle during the evolution process. It could also be used during the securing of a base plate or leg of a strut (mechanical or pneumatic or hydraulic) in support of the triangle of stability principle when stabilizing vehicles in a particular manner.
A6. Haligan Tool	It is a metal tool which has a multi-purpose function and application. The tool consist of components/parts such as a pointed side which allows for puncturing of a metal surface to allow for either the creation of a further cut into metal with the cutting side (on some variations) or using the claw side (on some variations) to twist or widen the initial hole which was created. It is a striking tool as well which is sometimes used in combination with an axe to further gain access to a particular area or forcibly gain entry into a structure. It has a wedged side (component) which could be used to pry open a particular area/door or when strike by another object such as a hammer a purchase point for additional equipment could also be facilitated.
A7. Boltcutter	This is a tool which is use for cutting of cables (for example battery cables), metal components (for example exposing the exterior door skin to gain access or create further space) and objects which are constructed of a mild to harden steel material (for example the sliding mechanism of the door on the hinge side of the door) found commonly within motor vehicle construction. It is essentially a big scissor which is designed and constructed to cut through materials and/or metals which would require a tool which is rated and able to cut through that type of metal and/or material.
A8. Pliers (channel lock type)	This is a tool which is able to unscrew nuts or bolts of various sizes (up to a certain range) and of a particular square or hexagon shape for instance. This tool is seen as a multi-purpose tool in its design for the unscrewing of a nut or bolt as you would not need to select a specific size. This is mainly used to disconnect the battery cables (terminals) when having to isolate the power source of the vehicle by unscrewing the nut or bolt which is used to fasten the battery cable onto the battery "head"/terminal. Other vehicle components which is bolted or fastened with a nut could also be unscrewed using this device.
A9. Pliers (side cutters)	This tool is mainly used for its cutting application of small electrical wiring which is found within the motor vehicle to either power certain electrical components such as the radio/stereo and/or windows which at times run through various structures of the motor vehicle. It is designed and constructed to cut through various materials and metals which is of a very soft to mild construction and/or composition.

A10. Screwdriver (Flat)	This tool could be used as a means of exposing the interior trim of the vehicle by pushing/pressing the flat part/structure of the screwdriver into the rubber and/or plastic component of the interior trim to either remove/displace it from its position. It could also be used in combination with a striking object such as a haligan tool or flat side of an axe to pierce metal surface which is constructed of a soft metal and/or puncture/pierce/strike either laminated and/or tempered glass during the evolution process in either gaining access or minimizing a potential hazard during the process. If there is a nut or bolt which has a particular structure or design which would allow for it to be unscrewed by means of utilizing a screwdriver then this provides an alternative method if that screw or bolt is required to be undone/removed in order to further aid in the extrication process.
A11. Crow bar	This tool is generally constructed of metal and predominantly used for its prying capabilities when having to for example forcible pry open the bonnet of the vehicle to gain access to the battery terminals/cables to discontinue the power supply of the vehicle. It can be used to create an initial purchase point for other tools to further either pry and/or cut and/or spread an object and/or metal.
A12. Springloaded punch	This a tool which is predominantly used in the breaking of tempered glass. It has a sharp metal point with a shaft design encased (covered) by a spring that when the spring is pulled back with the sharp point kept against the corner of the tempered glass that by releasing the spring which is pulled back a force is being generated which would be transferred through the metal shaft onto the sharp pointed part which is in contact with the tempered glass which would result in the breaking (shattering) of the tempered glass into tine (small) fragments.
A13. Seatbelt cutter	This tool comes in various forms, designs and construction. Most seatbelt cutters uses a sharp metal side with a blade design/structure in order to allow for the cutting of the web material of the seat belt with ease when the seatbelt cutter is pulled through the web type seatbelt. This would be for the type of seatbelt cutters which is commercially available within the South African context.
A14. Scissor (serrated edge type)	These scissors which are commonly referred to as rescue scissors are predominantly used to cut through various types of materials which are constructed of soft materials for example the interior trim (plastic and/or rubber and/or carpet type material components), patient clothing (of nylon, denim, polyester, etc. construction), seatbelt (which is a web type material construction), etc.. it may have a hardened plastic handle with a serrated metal v-shape front end with the material placed as close to the narrowest portion of the v-shape in the fully open position and the cutting taking place as the scissor is being moved through the material with the handle being moved from a open to close position to facilitate the cutting through the metal. This open and closing of the handle will depend on the amount of cutting which is required to meet the end goal.
A15. Rescue knife	The rescue knife within the motor vehicle application would be used to cut through various soft components found within the construction and

	design of the motor vehicle. Depending on the durability, construction, design and added features of the knife it could be used to cut through electrical wiring, seatbelt, seat (leather or vinyl material), interior trim, etc. This type of cutting is different in terms of its design as for example a scissor as the knife depending on the design or features would either be pulled through the material and/or object in a backwards and/or downwards and/or upwards and/or forward type of motion with some force being possibly applied throughout the process.
A16. Reciprocating saw	This is a device which is powered driven by either a battery or electricity (seldom the case). The saw is able to cut through various materials (metal, rubber, plastic, glass, etc.) and components (roof structure, pillar/s, etc.) of the motor vehicle depending on the type of blade selected and the limitations as per the manufacturer's recommendations and specifications. This tool when cutting through various materials and/or components will utilize a backwards and forwards motion with either a upwards and/or downwards force being applied to the material and/or component which is being cut.
A17. Windshield saw	There are various different types of brands available on the market for saws which are specifically designed to cut through glass such as the "Glass Master". The study did not attempt to determine the specific type of windshield saw as the general application and use of this particular saw would be generally the same irrespective of its name with some minor changes either due to its construction, design and/or added features within the motor vehicle rescue context but the manner in which it would be used basically always being the same. The windshield saw in its use and purpose would be to cut through laminated glass which is found on the front of the vehicle. This type of saw could be either hand operated such as the "Glass Master" or powered by a battery or pneumatics (which is not commercially available within the South African context). This study will focus on the hand operated windshield saw which utilizes a backwards and forwards type of motion with a downwards force being applied either onto the laminated glass during the motion cutting process. The saw has a serrated blade design and as explained some may have added features such as a component to puncture the laminated glass in order to introduce the serrated blade by which the cutting takes place into the laminated glass. None of the added features will be analyzed in the process tracing of the principles of physics as the main focus will be on the cutting action in the design and use of the windshield saw.
A18. Shovel	It is of metal construction in terms of the part which is used to scoop up (collect) and carry the material and/or components with a handle which could be of metal or wood construction. The shovel irrespective whether it is a round nose or square beak (front end) is generally used in conjunction with a broom to either collect (pick-up) debris during mop up (cleaning) operations and/or used as a stand-alone (individual piece of equipment) to collect (pick-up) some form of material (for example sand) which could be used during the covering of a spill or leak of some form of hazardous material which is generally associated with

	motor vehicle collisions and as has been identified in the development of the typical case narrative above.
A19. Broom	The broom is used to sweep together or disperse material (radiator fluids) and/ or components (debris such as glass from the motor vehicle) post the collision as part of managing hazards on scene as the incident evolves or at the end during the cleaning (mop-up) operations.
A20. Airbag cover	The airbag covers main purpose is to avoid a deployment of the steering wheel airbag during the rescuers extrication process. The airbag cover is either constructed of a soft material or plastic which is durable (strong) enough to absorb and dissipate the forces (energy) during the deployment of an airbag housed within the steering wheel during any phase of the extrication process. The manner by which it is secured to or around the steering wheel, the general construction and its design will not be the focus of this study in identifying the themes of physics as it would relate to the airbag but would focus on the intended use and end goal with respect to preventing further harm or injury during an accidental deployment of a steering wheel airbag during any phase of the extrication process.
A21. Power plant (Fuel driven)	This is a device (piece of machinery) which is used to provide electrical current to various tools such as lighting plants, battery chargers (for various tools which are battery driven), etc. The current (phase) which it would deliver and/or electrical tools which it would be required to power is neither the focus of this component of the study as the express purpose of this study is to evaluate the physics principle theme by which it would generate power and deliver power as a fuel driven combustion source.
A22. Spreader tool	The spreader tool would be safely assumed is a hydraulic powered tool which is mainly used to either provide spreading or crushing force capabilities to either displace and/or compact/compress metal and/or components of the motor vehicle such as a door and/or wheel fender for example within the context of the typical motor vehicle rescue incident. The strengths, weakness, and/or limitations of the tool is not the focus of this study with the aim being to evaluate and analyze the main physics principle themes which is embedded within the use of the tool.
A23. Cutter tool	The cutter tool would be safely assumed is a hydraulic powered tool which is mainly used to either provide cutting force capabilities when cutting through metal and/or various components of the motor vehicle such as a roof structure and/or pillar for example within the context of the typical motor vehicle rescue incident. The strengths, weakness, and/or limitations of the tool is not the focus of this study with the aim being to evaluate and analyze the main physics principle themes which is embedded within the use of the tool.
A24. Ram tool	The ram tool would be safely assumed is a hydraulic powered tool which is mainly used to either provide pushing force capabilities to either displace and/or move metal and/or components of the motor vehicle such as a dashboard by means of displacing the A- pillar

	(assuming that all other processes has been followed and in place to allow for this type of displacement/movement of the dashboard) and/or during the extrication (creating of space) of a vehicle on its roof post the collision event where a decision is made to separate the roof component and the floor/chassis component during the "oyster technique" (assuming various processes had been followed to allow for this type of use of the tool to displace or move the vehicle chassis from the roof) for example within the context of a motor vehicle rescue incident. The strengths, weakness, and/or limitations of the tool is not the focus of this study with the aim being to evaluate and analyze the main physics principle themes which is embedded within the use of the tool.
A25. Pedal cutter tool	The pedal cutter tool would be safely assumed is a hydraulic powered tool which is mainly used to either provide cutting force capabilities to cut through metal and/or components of the motor vehicle such as a pedal (irrespective if it's the braking and/or accelerating and or clutch pedal in a manual or automatic transmission vehicle) and/or any other unconventional manner such as cutting of the battery terminal or battery cable to discontinue the vehicles power supply for example within the context of the typical motor vehicle rescue incident. The strengths, weakness, and/or limitations of the tool is not the focus of this study with the aim being to evaluate and analyze the main physics principle themes which is embedded within the use of the tool.
A26. Ram support (bracket/base plate)	This is a metal device which is generally used in combination with a ram tool (which is powered by hydraulics) to avoid/prevent the ram tool from slipping from its position during the pushing and or displacement of metal and or components as described in an example above under the ram tool. This ram support tool is placed within either the lower part of the pillar of the vehicle where the non-extending head (butt) of the ram tool is placed into the ram support with the added benefit of placing the ram tool at a particular angle to ensure good distribution of the forces and contact of the tool with the various metals/and/or components of the vehicle during the operations of the ram tool. The strengths, weakness, and/or limitations of the tool is not the focus of this study with the aim being to evaluate and analyze the main physics principle themes which is embedded within the use of the tool.
A27. Lighting	Lighting tools or units could be in the simple form of a handheld battery operated torch and/or headlamp to a very much vehicle mounted lighting unit which is electrically driven (powered). The lighting tools purpose within the context of the motor vehicle rescue incident is to provide visibility to operations on scene during the various phases of the extrication process. Lighting units/tools are not necessarily only used during night time operations but may be required to provide better visibility within a specific area where the rescuer would for example be required to do a pre-inspection and/or evaluation prior to conducting a particular function due to decreased visibility. For the purpose of this component of the research process the physics principle themes as it would relate to lighting tools/units and the provision of light (increased visibility) would be the focus of this study without the emphasis on the manner in which the lighting source is being powered for example

	battery versus electrical, etc. and the amount of lumens of light which it is able to produce and the type of bulbs which is being used.
A28. Jacks (hi lift)	This is a hand- operated and -controlled device which uses a ratchet type of mechanism to lift and/or move (displace) either a metal and or object and/or component of the vehicle. The high lift jack could be used during the stabilization phase of the vehicle with the added support of a base plate to secure the base (foot) of the high lift jack and/or ensure that the forces is distributed into the surface in a manner which would not cause the tool be unsafe in the manner which it is to be used. The jack could also be used to spread metal and/or components of a motor vehicle in order to create space for example when placed within the window frame of a door or the rear window to create a bigger (larger) opening initially for access into the vehicle and/or a means of egress (removal) of the entrapped victim during the extrication process. The intended use within the context of the typical case of a motor vehicle related rescue incident will be the focus and not the associated equipment which is to be used in combination of the tool and/or the limitations and/or other tools which have superior qualities to that of the hi lift jack..

APPENDIX L: BACHELOR OF EMERGENCY MEDICAL CARE (BEMC) 2014 PHYSICS (EBS100A) SUBJECT GUIDE

Cape Peninsula
University of Technology

Department of Emergency Medical Science

Bachelor in Emergency Medical Care

Physics

SUBJECT GUIDE

2014

COURSE CODE: EBS 100A

Cape Peninsula University of Technology

Introduction

- BEMC Physics EBS 100A offers learners a course which underpins the physics encountered in emergency medical care situations.
- The course aims to develop the necessary:
    - Content knowledge,
    - Conceptual and Cognitive skills and,
    - Contextual articulation of Physics with the Emergency Medical Care programme, as well as,
    - to develop Problem Solving skills applied to real situations.

Contact Information

	Name	**Building**	**Email**	**Telephone no.**	**Consultation hours**
Lecturer	Dr M. Marais	Education Block – D - 16	maraism@cput.ac.za	021460 3953	By arrangement

Class Times

Tuesday Mornings – 9h00 to 12h00

Topics

- **Basic Maths**
- **Vectors**
- **Mechanics**
- **Fluids**
- **Gas Laws**
- **Temperature and Heat**
- **Electrostatics and Electricity**

(See COURSE CONTENT)

Objectives

At the end of this course the learner should be able to:

- Articulate a clear conceptual understanding of the physics principles.
- Apply this to a variety of emergency medical care situations as well as everyday situations.
- Apply explicitly taught physics problem solving techniques to a variety of rescue and related problems.

Assessments

Formative

Structured tutorial sessions form part of the course and provide learners with amongst other, opportunities for formative feedback on tutorials or worksheets.

Summative

The minimum pass requirement is 50% overall for the course.		
[redacted]		
Assessment Type	Weighted Percentage	Dates
Test 1	25	TBC
Project (See BRIEF):		
Working Model	12	TBC
Presentation (Video Clip)	13	TBC
Write-up	25	TBC
Final Test	25	TBC
TOTAL	**100**	

Resources: • Recommended Textbook: - Mosby's Paramedic Textbook, 4th Edition, Author: Mick J. Sanders. ISBN: 9780323072755

COURSE CONTENT

PHYSICS SECTIONS		
Tools & Skills 1	SI Units, Unit Conversions, Scientific Notation, Basic Maths	
Tools & Skills 2	Vectors	• Represent physical situations using vectors • Resolve physical problems using vectors

MECHANICS	PHYSICS OF THE MECHANISMS OF INJURY	
Kinematics	Key Themes: Vehicle Motion Ballistics	• Describe motion using represent--ations of kinematics, equations of motion • Apply to vehicle motion, • Apply to ballistics
Dynamics (Forces, Newton's Laws)	Key Themes: Vehicle Dynamics Ballistics Resultant Impact Forces Pulleys Anchor Point Physics High Angle Rescue	• Identify forces acting on bodies • Apply Newton's laws to vehicle dynamics, ballistics, impact forces, specific rescue situations such as rescue extraction, pulleys
Work, Energy Power Energy,	Key Themes: Collisions / Impacts Ballistics	• Conservation Laws applied to collisions, explosions, ballistics
Rotation & Torque	Key Themes: Leverage Stabilising Rescue Scenarios	• Leverage, stability, balance applied to rescue scenarios such as stabilising a vehicle rolled on its side

GAS LAWS	THE PHYSICS OF THE BREATHING	
	Key Themes: The Physics of Breathing	• Gas Laws applied to: • Partial pressures of atmospheric gases • Partial pressure of gasses in the lungs • Diffusion of gases (O_2 and CO_2) across alveolar (lung) membrane into the blood • Pressure changes inside the lungs and chest during normal respiration • Pressure inside oxygen cylinders and calculating how long oxygen in a tank will last • Pressure changes during aircraft patient transfers. (all air filled balloons should be replaced with water) • Barotrauma • Altitude mediated sickness

FLUIDS	THE PHYSICS OF THE FLUIDS	
FLUID STATICS	Key Themes: Rescue Systems Sinking / Floating Objects	• "Jaws of Life" equipment • Bouyancy Control Devices (BCD's)
FLUID DYNAMICS (FLUID FLOW)	Key Themes: Airflow Intravenous Fluid Flow Rheology of Blood	• Streamline vs. Turbulent flow • Flow rates • Understanding Bernoulli's • Venturi effect • Venturi face mask • Reynolds number • Fick's law • Laplace's law • Poiseuille's law

TEMPERATURE & HEAT		
	Key Themes: Body Temperature and Transfer of Heat	• Heat transfer applied to: • Body temperature and transfer of heat • Environmental emergencies ○ Patient becoming hypothermic due to exposure ○ Heat stroke • Warming of patients (e.g. the reflective blanket)

ELECTRICITY		
ELECTRO--STATICS; ELECTRIC CURRENT; ELECTRIC FIELDS; CIRCUITS; ELECTRICAL ENERGY & POWER	Key Themes: Electricity and the Body	• Applied to: • Electric conductivity of the heart • Automated External Defibrillator (AED) • Delivering electric shocks to a patient in ventricular fibrillation rhythm via the paddles of an ECG monitor • Electric conductivity of the body • Impulse generation in a cell (nerve or heart) • Electrolytes in blood plasma • Nerve electric conduction • Electric Shock

PROJECT BRIEF

The Project consists of 3 parts:

1. A Model (12%)
2. A Presentation (13%)
3. A Write-up (25%)

The final weighting of the Project towards the year-mark is 50%.
Rubrics (assessment schemes) for each of the parts above have been provided.

A key component of the assessment will be to test students' understanding of the physics principles underpinning the chosen topic.

The chosen topic must be linked to a topic or theme in any of the BEMC subjects.
The model must be a working model from which measurable readings can be obtained.

The following general rules apply:

1. Plagiarism of any kind will result in 0%.
2. Late submissions will be penalised at 5% per day.
3. Non-observance of formats, as described in the Rubrics, will be penalised.

The process towards a successful project involves the following steps:

1. Check that the proposed model:
   a) is do-able;
   b) demonstrates more that one instance of the principle involved;
   c) is not simplistic.
2. Consult with the lecturer/staff frequently.
3. Notify the lecturer/staff timeously of any problems encountered.
4. Give an abstract of your intended topic and, how you plan to demonstrate it, to the Project Manager.
5. Observe a) timelines, as decided in class and, b) the Rubrics.
6. Decide what form you presentation will take and consult with the physics lecturer concerning this.
7. Check and proof-read everything.
8. Make sure both partners have an active role in the presentation video.

GOOD-LUCK

May the force be with you

PROJECT RUBRICS

Student Names	**Topic**

MODEL

	Absent (0%)	Poor (25%)	1⭐ (50%)	2⭐ (60%)	3⭐ (75%)	4⭐ (80%)	5⭐ (100%)
Demonstrates Physics Principles well	0	1	2	2.4	3	3.2	4
Demonstrates more than one instance	0	1	2	2.4	3	3.2	4
Level of Complexity/Creativity	0	1	2	2.4	3	3.2	4
TOTAL (ex 12)							

Adjudicator:

____ / /2014

Student Names	**Topic**

PRESENTATION (7 minute video)							
	Absent (0%)	Poor (25%)	1⭐ (50%)	2⭐ (60%)	3⭐ (75%)	4⭐ (80%)	5⭐ (100%)
Clarity	0	1	2	2.4	3	3.2	4
Understanding of Physics Principles demonstrated well	0	1	2	2.4	3	3.2	4
Presentation tools used well	0	1	2	2.4	3	3.2	4
Interest/enthusiasm demonstrated by presenters	0	1	2	2.4	3	3.2	4
TOTAL (ex 13)							

Adjudicator:

____ / /2014

GUIDELINES for PROJECT WRITE-UP

- **All write-ups to be printed: ARIAL, 11 pt, 1.15 Spacing.**
- **ONLY hard-copies will be accepted.**
- **Late hand-ins will be penalised – 5% per day.**
- **Plagiarism will result in 0%.**

NAME NAME	TITLE					DATE
	Points to Check	Non-existent	Poor	Good	V. Good	%
Introduction:	• Brief Introduction to topic • Follow good referencing • Not longer than a quarter page	0	0.5	1.5	2	ex 2
Aim:	• The aim of this…is to…	0	0.5	1.5	2	2
Theory:	• Briefly go into the underpinnings your topic • Including relevant equations • Explain relevant symbols/letters • No longer than half a page	0	1	3	3	3
Apparatus:	• Itemise apparatus • Labelled diagrams • Labeled photos/scans	0	1	2	3	3
Method:	• Write descriptively, not prescriptively • Separate points • Number/bullet points	0	1	2	3	3
Results:	• Table(s) of results • Graph(s) of results • Tables/Graphs must be fully labeled and have descriptive headings	0	2	4	5	5
Calculations:	• Show relevant calculations • Don't forget units!	0	1	3	4	4
Conclusions	• Refer back to Aim, Results and Calculations	0	1	2	3	3
TOTAL						**25**

APPENDIX M: **BACHELOR OF EMERGENCY MEDICAL CARE (BEMC) 2014 EXTRICATION (EMR203M) SUBJECT GUIDE**

Cape Peninsula University of Technology

Faculty of Health and Wellness Sciences

Bachelors in Emergency Medical Care

Emergency Medical Rescue 2

(CESM Code 090718)

Extrication

SUBJECT GUIDE

2014

PREREQUISISTE SUBJECTS:

EMR100M or Recognition of Prior Learning

SUBJECT CODE: EMR203M

NQF LEVEL: 6

Contents

Organisational component

Introduction

Rescue operations require a high degree of training and proficiency due to the dangers with such operations and performed by rescue teams or organizations. However Emergency Medical Rescue is not a standalone entity but rather complimented by Emergency Medical Care as the goal, not only should the patient be accessed/retrieved but also managed appropriately to effect the outcome treated to make a change in the outcome.

Personal Protective Equipment is a prerequisite and not negotiable for participation in all practical simulations. To be read with the stipulations as set out in the *General Learner Guide*

General

Contact information

	Name	Building and room number	Telephone number	E-mail address	Consulting hours
Coordinator	Mr S van der Merwe	Education Building, E Block, E1.21	021 959 8604	Vandermerwe sc@cput.ac.z a	Tuesday Mornings
Co-convener	Mr JS Bosman	Education Building, E Block, E1.19	021 959 8408	bosmanjs@cp ut.ac.za	tbc
Lecturing Staff :					
Full-time Lecturer	Mr S van der Merwe	Education Building, E Block, E1.21	021 959 8604	Vandermerwe sc@cput.ac.z a	By appointement
Moderator	Mr JS Bosman	Education Building, E Block, E1.19	021 959 8408	bosmanjs@cp ut.ac.za	By appointement
Secretary	Ms Nandipa Deliwe	Education Building, E Block,	021 959 8408	deliwen@cput .ac.za	n/a

Time-table

Contact sessions as per the current published timetable for Second year BEMC students.
Academic venue:

CPUT Bellville Campus (Main)
Education Building
D Block
Room D18
Wednesdays 6:00 -18:00 (unless otherwise communicated by lecturer)

Due to the nature of the practical simulation for the different modules simulation venues will be confirmed for each study module upon the start of the module. As site booking and availability may vary, **limited transport will be available for equipment and students but not guaranteed.** Transport provided will be as a courtesy; however the onus is on the learner to travel to and from the site of experiential learning.

Learner Management System (LMS) – E-learning

Blackboard will the primary means of contact, please regularly visit the subject content page.

Study materials and purchases

In addition to the prescribed departmental uniform and personal protective equipment the following items is required to perform a safe rescue simulation:

a. Head lamp
b. Back pack (if not prescribed)
c. Eye protection (Clear)
d. Water bottle/Water bladder
e. Full finger gloves
f. Pocket knife/ tool
g. Helmet
h. Steel toe cap safety boots (ankle high)
i. Textbooks as addressed under the prescribed text section/blackboard

During the simulation of a rescue scenario the learner is expected to be self-sufficient for at least **24hrs** in terms of food water and shelter.

Subject/Module credits

Mother subject	Weighting	Credits	Daughter subjects / modules	Major Area	CESM Code	Weighting	Credits	NQF Level
Medical Rescue II	0.3	24	Rope Rescue	905	090718	0.1	8	6
			Hazmat and Fire Rescue	905	090718	0.1	8	6
			Extrication	905	090718	0.1	8	6

Assessment

Motor Vehicle Rescue			
T1	Practical	See blackboard	25%
T2 Multiple	Assignment	See blackboard	25%
	Work Task/Book	See blackboard	
T3	Theory Paper	See blackboard	50 %

Assessment policy and regulations

For all the assessments the minimum required pass mark would be 50% per assessment. As for projects minimum pass marks required would be 50%, late submission (past due date) will incur a mark penalty of **10% per day** *(also refer to general learner guide)*. Two types of assessment will be conducted throughout the year as set out in the assessment table below. Formative assessments are part of the instructional process. When incorporated into classroom practice, it provides the information needed to adjust teaching practice. In this sense, formative assessment informs both the lecturing staff and students about the students' understanding at a point when timely adjustments can be made. These adjustments help to ensure students achieve targeted standards-based learning goals within a set time frame. Although formative assessment strategies appear in a variety of formats, there are some distinct ways to distinguish them from summative assessments. Summative assessment is cumulative in nature and is utilized to determine whether students have met the course goals or student learning outcomes at the end of a course or program, all the summative assessment is listed below in the table.

Plagiarism

It is unethical and illegal to submit someone else's work as your own - it is the same as stealing.

Plagiarism can take various forms. It can be blatant theft or accidental "borrowing". See the following examples:

- You submit an assignment done by another student (or from a paper mill) as your own.
- You pay another student to write an assignment for you and hand it in as your own work.
- You copy and paste sections from someone else's work and add it to your work without acknowledging the source.

Although this sometimes happens accidentally, it is still considered plagiarism:

- You have done a lot of reading and made notes for your assignment. At some point you find a good idea between your notes, but you can't remember whether it was your idea or someone else's. If you submit this as your own work and it turns out that it was not your idea, you have committed plagiarism.

- If you make use of someone else's work, you must make sure that you have the correct citation information and add it to your assignment.

Assessment opportunities: Administration

The policy of the university is one of continuous assessment which requires a mixed of formative and summative assessment which requires a mix of formative and summative assessment with a minimum of one summative per term. The final mark for the module will be made up of three assessments (T1 –practical assessments (individual and/or team)-, T2 –assignment and work task/book assessments & T3 –Final (theory paper). The final assessment (T3) integrates knowledge from the whole module and counts 50% of your total mark (knowledge from the lecture presentations, assignment, work task/book, practical skills/ team based learning).

Assignments will need to be completed as per the department standard with Harvard referencing. See Blackboard with regards to requirements and method of submission

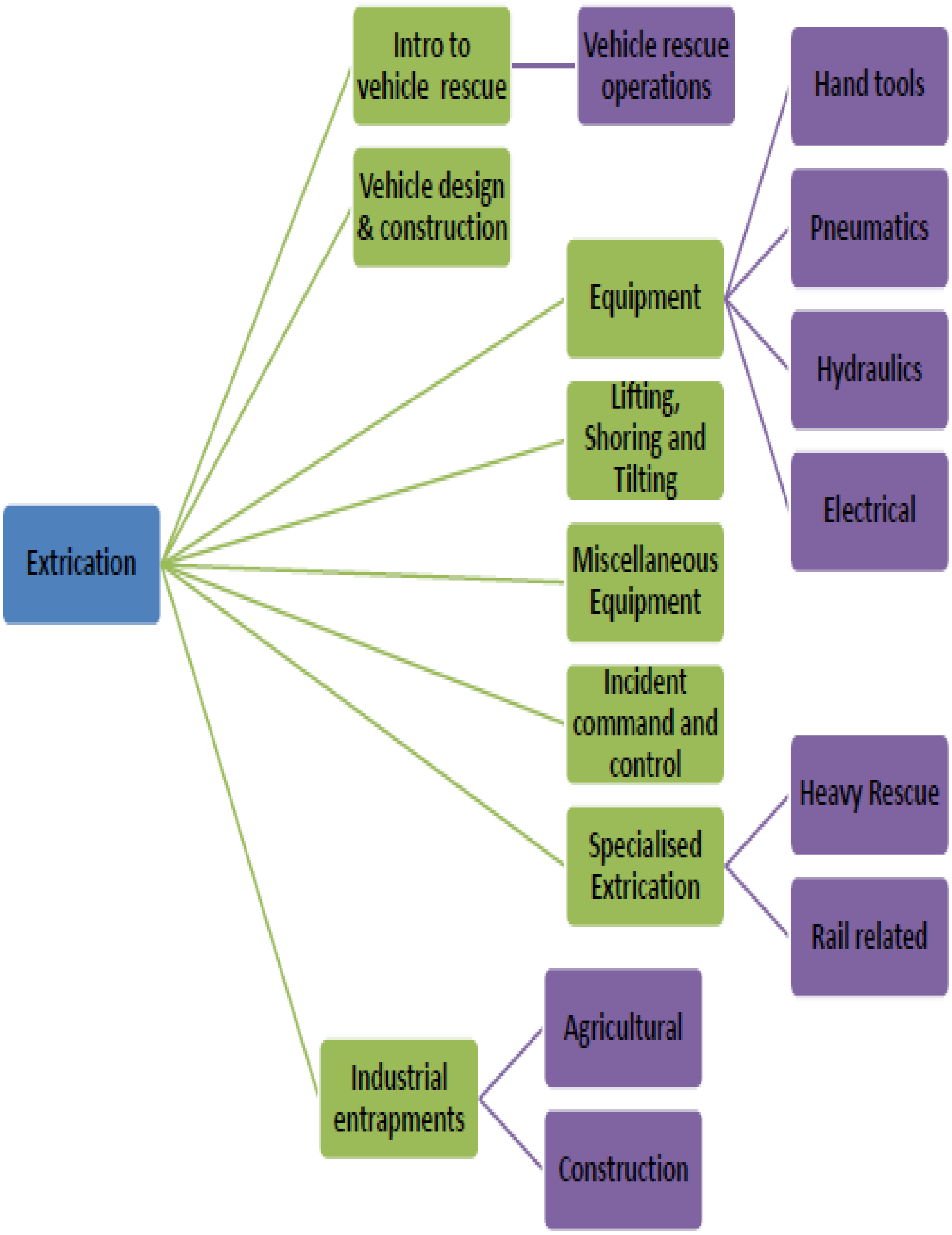
Additional information

Emergency Medical Rescue is one of the Core subjects for the Bachelor's Degree in Emergency Medical Care. Consisting of the following structure:

Mother subject name	Weighting	Credits	Daughter subjects / modules	Major Area	CESM Code	Weighting	Credits	NQF Level
Medical Rescue 1	0.1	12	Introduction to Medical Rescue	905	090718	0.04	2	5
			Rescue Systems	905	090718	0.03	5	5
			Rescue Principles	905	090718	0.03	5	5
Medical Rescue II	0.3	24	Rope Rescue	905	090718	0.1	8	6
			Hazmat and Fire Rescue	905	090718	0.1	8	6
			Extrication	905	090718	0.1	8	6
Medical Rescue III	0.3	24	Urban Search and Rescue	905	090718	0.1	8	6
			Wilderness Search & Rescue	905	090718	0.1	8	6
			Aquatic Rescue	905	090718	0.1	8	6
Medical Rescue IV	0.3	24	Disaster Risk Management	905	090718	0.1	8	7
			Aero Medical Rescue	905	090718	0.1	8	7
			Rescue Incident Management	905	090718	0.1	8	7

Due to the technical nature of Medical Rescue, skill attrition is often noticed between academic years. Staying current with the skills acquired in the previous year of study is imperative as you will progress from basic medical rescue into technical rescue and heavy rescue with the foundations set in the prior years.

Subject Specifications



Purpose and structure of the subject/modules

The modular structure is setup to gradually introduce and qualify the learner to the relevant topics. Initially the focus will be to strengthen vertical discourse which in the later modules or years will add the ability to form the basis for the practical nature of the rescue course.

Articulation with other modules in the programme

EMR200M comprise of three modules (A, B & C) which will be building on what was done in the previous year of study both medically and within Emergency Medical Rescue, with increased weighting per year with progression. Direct articulation to the National Certificate: Medical Rescue Technology on core components where aligned to the equivalent NQF placement.

Learning presumed to be in place

EMR100M credit or the Recognition of Prior Learning (Subject to Assessment).

Critical cross-field outcomes

- Identifying and solving problems using critical and creative thinking is demonstrated in the assessment and treatment of patients.
- Working effectively with others as a member of the team, group, organisation and community is demonstrated within the context of providing emergency care and supporting other services.
- Organizing and managing self and own activities responsibly and effectively is demonstrated in the preparation and provision of emergency care.
- Collecting, analyzing, organizing and critically evaluating information is demonstrated in the assessment and treatment of patients.
- Communicating effectively using visual, mathematical and/or language skills in the modes of oral and or written presentation is demonstrated through reports and the handover of patients to other services.
- Demonstrating effective use of science and technology is evidenced in all activities related to emergency care and rescue.
- Demonstrating an understanding of the world as a set of related systems

Study units/study themes

Subject content	Study unit outcomes	Teaching events	Learning activities	Assessments
Extrication	Introduction to vehicle rescue	• Need for light motor vehicle rescue • Personal protective gear • New Car technology	Equipment & techniques interaction and familiarization. Group work/individual exercise outside and within of the class room. Augmented by self-study.	See Blackboard
	Motor vehicle design & construction	• Chassis Vs space frame • Uni-body construction • Importance of beam stiffness and torsion stiffness • Roof • Floor pan • Fire wall • Fifth door conversions • Doors • Pillars • High Strength steel/alloys • Other structures • Glass used in automotive industry • Seats • Steering columns • Shock absorbing bumpers • Tyres • Crumple zones • Electrical systems • Air Bags • Catalytic converters • Drive train		
	Hand tools	• Hammers • Axes • Crowbar • Spring-loaded centre punch • Hacksaws • Screwdrivers • High lift jacks • Edge protection (Pillar and post covers) • Gwalas • Haligan tool	Equipment & techniques interaction and familiarization. Group work/individual exercise outside and within of	See Blackboard

		• Chocks, wedges, blocks and steps • Seat belt cutters • Spades and brooms • Utility ropes • Ratchet straps • Hot sticks • Polypropylene rope and throw blocks • Earthing spikes and chains • Rescue chain sling assembly and chain shorteners (come-along) • Come-along winch • Nylon slings	the class room. Augmented by self-study.	
	Pneumatic equipment	• Principle of generating pneumatic power • Sources of pneumatic power • PNEUMATIC POWER TOOLS	Equipment & techniques interaction and familiarization. Group work/individual exercise outside and within of the class room. Augmented by self-study.	See Blackboard
	Lifting and Shoring	• Terminology • Struts • Building up a shore • Triangle of stability • Centre of gravity		
	Hydraulic power equipment	• Principle of generating hydraulic power • Safety precautions when using hydraulic tools • Legislation governing the inspection and maintenance of hydraulic equipment • Importance of knowing and following manufacturer's recommended applications		
	Miscellaneous Equipment	• Chain saws • Reciprocating saws		See Blackboard

		• Gas cutters • Lighting		
	Vehicle rescue operations	• Crew Organization • Scene Safety and size-up • Stabilization • Door Removal • Side Removal • Third door conversion • Roof Removal • Dashboard roll • Foot well Access • Dashboard lift • Patient packaging and removal		
	Incident command and control	• Team leader / incident commander functions and responsibilities • Establishing a plan of action • Utilization of available resources • Post incident Debrief • Documentation		
	Specialised vehicle rescue	• Horse & Trailer general cargo transporters • Tankers • Refrigeration vehicles • Public transport (Buses / Taxis)		See Blackboard

Knowledge base

With reference to the table set out in point 8.1 to be read with the level descriptors for NQF level 6 as published by SAQA (South African Qualifications Authority) –Level Descriptors for the National Qualifications Framework-

Scope of knowledge, in respect of which a learner is able to demonstrate: detailed knowledge of the main areas of one or more fields, disciplines or practices, including an understanding of and the ability to apply the key terms, concepts, facts, principles, rules and theories of that field, discipline or practice to unfamiliar but relevant contexts; and knowledge of an area or areas of specialisation and how that knowledge relates to other fields, disciplines or practices.

Knowledge literacy, in respect of which a learner is able to demonstrate an understanding of different forms of knowledge, schools of thought and forms of explanation within an area of study, operation or practice, and awareness of knowledge production processes.
Method and procedure, in respect of which a learner is able to demonstrate the ability to evaluate, select and apply appropriate methods, procedures or techniques in investigation or application processes within a defined context.
Problem solving, in respect of which a learner is able to demonstrate the ability to identify, analyse and solve problems in unfamiliar contexts, gathering evidence and applying solutions based on evidence and procedures appropriate to the field, discipline or practice.*Ethics and professional practice*, in respect of which a learner is able to demonstrate an understanding of the ethical implications of decisions and actions within an organisational or professional context, based on an awareness of the complexity of ethical dilemmas.
Accessing, processing and managing information, in respect of which a learner is able to demonstrate the ability to evaluate different sources of information, to select information appropriate to the task, and to apply well-developed processes of analysis, synthesis and evaluation to that information.
Producing and communicating information, in respect of which a learner is able to demonstrate the ability to present and communicate complex information reliably and coherently using appropriate academic and professional or occupational conventions, formats and technologies for a given context.
Context and systems, in respect of which a learner is able to demonstrate the ability to make decisions and act appropriately in familiar and new contexts, demonstrating an understanding of the relationships between systems, and of how actions, ideas or developments in one system impact on other systems.
Management of learning, in respect of which a learner is able to demonstrate the ability to evaluate performance against given criteria, and accurately identify and address his or her task-specific learning needs in a given context, and to provide support to the learning needs of others where appropriate.
Accountability, in respect of which a learner is able to demonstrate the ability to work effectively in a team or group, and to take responsibility for his or her decisions and actions and the decisions and actions of others within well-defined contexts, including the responsibility for the use of resources where appropriate.

Assessment criteria

Associated Assessment Criteria for Extrication:

- Discuss the need for vehicle rescue technicians
- List and describe the functions of the protective gear that must be worn when undertaking vehicle rescue activities
- Don and doff the appropriate protective gear correctly

- Draw and label a typical light motor vehicle, indicating the gross anatomical structures that are relevant to the rescue operation
- Describe the uni-body construction of vehicles
- Describe the various types of glass that may be encountered by the rescuer as well as any hazards they may pose during the rescue operation
- Explain the purpose and location of energy absorbing bumper system
- Describe the phenomenon of a "loaded" bumper and its implications for the rescue worker
- Discuss the advantages and disadvantages as well as methods of tire deflation
- Discuss the advantages and disadvantages as well as methods of isolating the electrical system and battery
- Making use of diagrams briefly explain the activation sequence for an air bag
- Discuss the common driver / passenger injuries that may result from air bag deployment
- Explain how to disable or render an air bag safe during the rescue operation
- Explain the function, location and dangers associated with catalytic converters
- Identify and locate the primary and secondary structures of a light motor vehicle
- Identify the different types of automotive glass
- Distinguish between front and rear wheel drive vehicles
- Identify and locate a catalytic converter
- Explain the principle of pneumatic power
- Discuss the safety precautions relating to pneumatic power tools
- Discuss the legislation surrounding the use of pneumatic equipment
- Making use of a diagram explain the procedure for a hydrostatic test
- Label the gross anatomy of a compressor system
- Explain the safety precautions as well as regulations governing the use of a compressor for breathing air
- List the types of air cylinder
- Explain how a decanting system operates
- Explain how a vehicles exhaust system can be used for the generation of pneumatic power
- Discuss the various types of air bags with reference to:
  - Construction
  - Working pressures
  - Advantages and disadvantages
  - Maintenance and operating procedures

- Making use of a simple diagram explain how a pneumatic hammer / chisel operates

- Discuss the advantages, disadvantages, selection criteria, correct use and maintenance of any of the prescribed hand tools
- Correctly identify and utilize any of the prescribed hand tools in a safe and efficient manner
- Explain the correct air chisel operating procedures and pressures for different materials
- Discuss the basic inspection and maintenance procedures for a pneumatic chisel
    - Explain the advantages, disadvantages as well as correct operating procedures for:
    - Pneumatic saws
    - Chain saws
    - Gas cutters

- Safely and efficiently operate:
    - High, medium & low pressure air bags
    - Pneumatic chisels / hammers
    - Pneumatic saws
    - Compressed air cylinder decanting systems
    - Pneumatic rams and shores
    - A compressor to refill compressed air cylinders or power pneumatic tools

- Explain the relevance of the machinery and occupational safety act with regard to the use of power tools during rescue operations
- Describe the typical components of hydraulically powered tools
- Making use of a diagram explain the principle of generating hydraulic power
- List the safety precautions one should keep in mind when using hydraulic equipment
- Explain how to inspect a hydraulic system prior to use
- Discuss the general care & maintenance of hydraulic equipment
- Explain how to trouble shoot a system that is not functioning properly
- Safely and efficiently operate a hydraulic power system to push, pull, cut or spread
- Demonstrate the appropriate hand signals used when cutting, pushing or spreading
- Inspect an hydraulic power system for serviceability
- Correctly identify and correct common system faults

- Operate a chain shortener system to pull a heavy load in a safe and efficient manner
- List the advantages and disadvantages of abrasive cutters
- List the criteria for correct abrasive disc selection and replacement
- Discuss the use of the following items of rescue equipment:
    - Vehicle mounted winches and turfor winches
    - High lift jacks
    - Block and tackle systems

- Explain how an electrical generator operates (Dynamo effect)
- Discuss the correct methods of positioning lighting on scene
- Explain the advantages and disadvantages of illuminating balloons
- Explain the correct methods of lowering and securing pit lights
- Safely operate an abrasive cutter
- Inspect and replace abrasive cutter discs correctly
- Operate a chain saw safely
- Tension the chain on a chain saw correctly
- Safely and efficiently operate a gas cutting system
- Safely operate a vehicle mounted winch
- Correctly utilize a Turfor winch
- Operate a generator, position lighting equipment and secure pit lights to light up an incident or area of operation.
- Discuss the importance of correct mental and physical preparation for a vehicle rescue work
- List the nine steps of the Rescue Action Plan for extrication
- Explain what actions should be taken on route to a vehicle rescue call
- Discus how the location of an incident may affect the on route preparation and though processes
- Describe how to position an vehicle in the fend off position
- Explain the importance of positioning your vehicle appropriately when arriving on scene
- Discuss the use of a "circle" survey in order to gather information on arrival
- List the common on scene hazards one need to be aware of when working with motor vehicle accidents
- Making use of a diagram explain the concept of minimization of road time as well as the correct method for packing out road cones
- Discuss the advantages, disadvantages and correct use of the following:

- Flares
- Warning beacons
- Barrier tape
- Warning lights

- Explain the principle of crowd control as well as an appropriate, professional method for dealing with the public
    - Explain how you would extinguish the following fires:
    - Fire behind the dashboard
    - Fire under the bonnet
    - Fire in the boot
    - Fire in a vehicle seat

- Draw and label a typical hazchem placard indicating the various blocks as well as the possible information stored in each block
- List the limitations of the current hazchem system
- Explain the principles of dealing with downed electrical lines
- Explain why a tool staging area needs to be established on the extrication scene
- Explain the physics behind vehicle stability
- Explain the general procedure for stabilizing a vehicle after an accident
- Explain why vehicles in the upright position must be stabilized
- Explain how you would locate possible patients on scene
- Discuss the procedures for gaining access into a vehicle
- Discuss the importance of adequate patient protection during a rescue operation
- Explain why it is important to differentiate between a normal extrication, a confinement and an entrapment with regard to the medical procedures applied.
- Discuss the term mechanism of injury and explain its importance for rescue and medical personnel
- List the seven common mechanisms of injury that may be found in motor vehicle accident
- Explain the three types of collision that occur during a rapid deceleration incident
- Identify, describe and validate the use of the following extrication and packaging devices:
    - KED
    - Spine board
    - Collars and head immobilizer

- Discuss the importance of psychological support for the entrapped patient and or family of the patient on scene
- Compare the various common routes of egress with regard to time, simplicity and effectiveness
- List four reasons for performing an early roof displacement operation
- Explain why a steering wheel pull is no longer an effective technique
- Explain the factors contributing to the election of an "emergency" extrication
- List the complications / dangers associated with an "emergency" extrication
- Discuss the complications associated with, as well as the correct management of the following "special" situations
    - Vehicle on its side
    - Vehicle on roof
    - Vehicle under water
    - Vehicle under truck
    - Vehicle on fire

- Correctly complete an initial assessment including a circle survey
- Establish a tool staging area in an appropriate position
- Stabilize a vehicle safely and efficiently utilizing chocks, wedges, blocks, utility ropes and or air bags
- Gain access to entrapped patients quickly and safely
- Provide patient care and stabilization according to the rescuers medical scope of practice
- Interact with the public in a professional fashion with regard to crowd control
- Provide appropriate emotional / psychological support to persons associated with or involved in motor vehicle accidents
- Utilize barrier tape and road flares in the correct manner
- Perform the following evolutions safely and efficiently utilizing hand tool, power tools and or a combination of both:
    - Roof removal
    - Full roof flip front to back
    - Full roof flip back to front
    - ½ roof flip
    - Side flip (left and right)
    - Side swipe (left and right)
    - Dash push (half and full)

  - Dash roll
- Package a patient for removal in a safe and efficient manner
- Select an appropriate route of egress and remove the patient safely and efficiently
- Discuss the special considerations and precautions a rescuer needs to keep in mind when dealing with an incident involving a heavy vehicle
- Describe the procedure for tilting a cab forward on a horse and trailer
- Explain why cutting through the hydraulic hoses on any specialized vehicle may lead to instability and even make the situation worse
- Discuss the general principles that may be applied when dealing with vehicles and or persons who have become lodged underneath or between other large motor vehicles
- List the additional types of specialized equipment you may need to summon to an incident involving a specialized vehicle
- Explain how you would go about stopping a train
- Discuss the principles of dealing with an aircraft that has been involved in an accident
- List and describe the dangers that a downed aircraft may pose for the rescuer and or the public.
- Discuss some methods of stabilizing a railway coach that has been derailed
- Mention some of the limitations that your conventional rescue equipment may have in terms of accessing and or removing patients from specialized vehicles after an entrapment.
- Discuss the generic principles one should keep in mind when dealing with a bus accident involving multiple entrapments
- Explain why stabilization of a specialized vehicle may require additional resources
- List the applicable support services that may be summoned for an incident involving a specialize vehicle.

Self-study activities

See Blackboard for prescribed self-study items

Prescribed textbook

Vehicle Extrication Techniques. Ian Dunbar

Publisher: Holmatro

ISBN: 978-90-812796-0-4

Fire Raiders (Cape Town could order this book for you)

Other electronic resources would be made available for download via Blackboard

APPENDIX N: ANALYSIS OF THE PHYSICS (EBS100A) SUBJECT GUIDE WITH RESPECT TO SEMANTIC DENSITY USING THE TRANSLATION DEVICE

Table 19 Units of Study extracted from Physics (EBS100A) subject guide in order of content delivery for application within developed semantic density translation device

Number of Units of study	Grouped Theme Number	Lecture Topic	Themes from subject guide	Unit of study in order of delivery	Rating
1	THEME 1 (T1)	Physics Sections (Tools & Skills)	SI Units	SI Units	5
2		Physics Sections (Tools & Skills)	Unit Conversions	Unit Conversions	3
3		Physics Sections (Tools & Skills)	Scientific Notation	Scientific Notation	3
4		Physics Sections (Tools & Skills)	Basic Maths	Basic Maths	3
5		Physics Sections (Tools & Skills)	Vectors	Represent physical situations using vectors	3
6		Physics Sections (Tools & Skills)	Vectors	Resolve physical problems using vectors	3
7	THEME 2 (T2)	Mechanics (Kinematics)	Vehicle Motion	Describe motion using representations of kinematics.	3
8		Mechanics (Kinematics)	Vehicle Motion	Describe motion using equations of motion	3
9		Mechanics (Kinematics)	Vehicle Motion	Apply to vehicle motion	2
10		Mechanics (Kinematics)	Ballistics	Apply to ballistics	2
11		Mechanics (Dynamics [*Forces, Newton's Laws*])	Vehicle Dynamics, Ballistics, Resultant Impact Forces, Pulleys, Anchor Point Physics, High Angle Rescue	Identify forces acting on body	5
12		Mechanics (Dynamics [*Forces, Newton's Laws*])	Vehicle Dynamics	Apply Newton's laws to vehicle dynamics	3
13		Mechanics (Dynamics [*Forces, Newton's Laws*])	Ballistics	Apply Newton's laws to ballistics	3
14		Mechanics (Dynamics	Impact Forces	Apply Newton's laws to impact forces	3

		[*Forces, Newton's Laws*])			
15		Mechanics (Dynamics [*Forces, Newton's Laws*])	Vehicle Dynamics, Ballistics, Resultant Impact Forces, Pulleys, Anchor Point Physics, High Angle Rescue	Apply Newton's laws to specific rescue situations such as rescue extraction	4
16		Mechanics (Dynamics [*Forces, Newton's Laws*])	Pulleys	Apply Newton's laws to pulleys	2
17		Mechanics (Work, Energy, Power Energy)	Collision / Impacts	Conservation laws applied to collisions	3
18		Mechanics (Work, Energy, Power Energy)	Collision / Impacts	Conservation Laws applied to explosions	3
19		Mechanics (Work, Energy, Power Energy)	Ballistics	Conservation Laws applied to ballistics	3
20		Mechanics (Rotation & Torque)	Leverage	Leverage applied to rescue scenarios such as stabilising a vehicle rolled on its side	1
21		Mechanics (Rotation & Torque)	Stabilising Rescue Scenarios	Stability applied to rescue scenarios such as stabilising a vehicle rolled on its side	2
22		Mechanics (Rotation & Torque)	Stabilising Rescue Scenarios	Balance applied to rescue scenarios such as stabilising a vehicle rolled on its side	2
23	THEME 3 (T3)	Gas Laws	The Physics of Breathing	Gas Laws applied to partial pressures of atmospheric gasses	3
24		Gas Laws	The Physics of Breathing	Gas Laws applied to partial pressures of gasses in the lungs	2
25		Gas Laws	The Physics of Breathing	Gas Laws applied to diffusion of gasses (O_2 and CO_2 across alveolar (lung) membrane into the blood	1
26		Gas Laws	The Physics of Breathing	Gas Laws applied to pressure changes inside the lungs and chest during normal respiration	1
27		Gas Laws	The Physics of Breathing	Gas Laws applied to pressure inside oxygen cylinders and calculating how long oxygen in a tank will last	1
28		Gas Laws	The Physics of Breathing	Gas Laws applied to pressure changes during aircraft patient transfers. (all air filled balloons should be replaced with water)	1

29		Gas Laws	The Physics of Breathing	Gas Laws applied to barotrauma	2
30		Gas Laws	The Physics of Breathing	Gas Laws applied to altitude mediated sickness	2
31	THEME 4 (T4)	Fluids (Statics)	Rescue Systems	Fluid Static –“jaws of life” equipment	2
32		Fluids (Statics)	Sinking / Floating Objects	Fluid Statics – buoyance control devices	3
33		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow, Rheology of Blood	Streamline vs. turbulent flow	4
34		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow, Rheology of Blood	Flow rates	5
35		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow	Understanding Bernoulli’s	4
36		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow	Venturi effect	4
37		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow	Venturi face mask	4
38		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow, Rheology of Blood	Reynolds number	4
39		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow, Rheology of Blood	Fick’s law	4
40		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow, Rheology of Blood	Laplace’s law	4
41		Fluids (Dynamics [Fluid Flow])	Airflow, Intravenous Fluid Flow, Rheology of Blood	Poiseuille’s law	4
42	THEME 5 (T5)	Temperature & Heat	Body Temperature and Transfer of Heat	Heat transfer applied to – body temperature and transfer of heat	5
43		Temperature & Heat	Body Temperature and Transfer of Heat	Heat transfer applied to - environmental emergencies (patient becoming hypothermic due to exposure)	4
44		Temperature & Heat	Body Temperature	Heat transfer applied to – environmental emergencies (heat stroke)	4

			and Transfer of Heat		
45		Temperature & Heat	Body Temperature and Transfer of Heat	Heat transfer applied to – warming of patients (e.g. the reflective blanket)	4
46	THEME 6 (T6)	Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – electric conductivity of the heart	2
47		Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – automated external defibrillator (AED)	2
48		Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – delivering electric shocks to a patient in ventricular fibrillation rhythm via the paddles of an ECG monitor	1
49		Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – electric conductivity of the body	2
50		Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – impulse generation in a cell (nerve or heart)	1
51		Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – electrolytes in blood plasma	1

52		Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – nerve electric conduction	2
53		Electricity (Electro-statics, Electric Current, Electric Fields, Circuits, Electrical Energy & Power)	Electricity and the Body	Applied to – electric shock	5

APPENDIX O: ANALYSIS OF THE EXTRICATION (EMR203M) SUBJECT GUIDE WITH RESPECT TO SEMANTIC DENSITY USING THE TRANSLATION DEVICE

Table 20 Units of Study extracted from Extrication (EMR203M) subject guide in order of content delivery for application within developed semantic gravity translation device

Number of Units of study	Grouped Theme Number	Themes[73] from subject guide	Teaching Event	Unit of study[74] in order of delivery	Rating
1	THEME 1 (T1)	Introduction to vehicle rescue	Need for light motor vehicle rescue	Discuss the need for vehicle rescue technicians	5
2		Introduction to vehicle rescue	Personal protective gear	List and describe the functions of the protective gear that must be worn when undertaking vehicle rescue activities	4
3		Introduction to vehicle rescue	Personal protective gear	Don and doff the appropriate protective gear correctly	4
4	THEME 2 (T2)	Motor vehicle design & construction	Roof; Floor pan; Fire wall; Doors; Pillars; Other structures; Seats; Steering columns; Shock absorbing bumpers; Tyres; Crumple zones; Electrical systems; Air Bags; Catalytic converters; Drive train	Draw and label a typical light motor vehicle, indicating the gross anatomical structures that are relevant to the rescue operation	4
5		Motor vehicle design & construction	Roof; Floor pan; Fire wall; Doors; Pillars; Other structures; Seats; Steering columns; Shock absorbing bumpers; Tyres; Crumple zones; Electrical systems; Air Bags; Catalytic converters; Drive train	Identify and locate the primary and secondary structures of a light motor vehicle	5

[73] These are the written information within the Extrication (EMR203M) 2014 subject guide under the heading of “unit of study” which resembles that of a “theme or topic of study”.
[74] These were the written assessment criteria outcomes for the Extrication subject. The information contained within the Extrication (EMR203M) 2014 subject guide under the heading unit of study contained phrases which appeared as if it could be themes (topics).

6		Motor vehicle design & construction	Uni-body construction	Describe the uni-body construction of vehicles	5
7		Motor vehicle design & construction	Glass used in automotive industry	Describe the various types of glass that may be encountered by the rescuer as well as any hazards they may pose during the rescue operation	4
8		Motor vehicle design & construction	Glass used in automotive industry	Identify the different types of automotive glass	5
9		Motor vehicle design & construction	Shock absorbing bumpers	Explain the purpose and location of energy absorbing bumper system	5
10		Motor vehicle design & construction	Shock absorbing bumpers; Electrical systems	Describe the phenomenon of a “loaded” bumper and its implications for the rescue worker	3
11		Motor vehicle design & construction	Tyres	Discuss the advantages and disadvantages as well as methods of tire deflation	4
12		Motor vehicle design & construction	Electrical systems	Discuss the advantages and disadvantages as well as methods of isolating the electrical system and battery	4
13		Motor vehicle design & construction	Electrical systems; Air Bags	Making use of diagrams briefly explain the activation sequence for an air bag	3
14		Motor vehicle design & construction	Air Bags	Discuss the common driver / passenger injuries that may result from air bag deployment	4
15		Motor vehicle design & construction	Electrical systems; Air Bags	Explain how to disable or render an air bag safe during the rescue operation	4
16		Motor vehicle design & construction	Catalytic converters	Explain the function, location and dangers associated with catalytic converters	4
17		Motor vehicle design & construction	Catalytic converters	Identify and locate a catalytic converter	5
18		Motor vehicle design & construction	Drive train	Distinguish between front and rear wheel drive vehicles	5

19	THEME 3 (T3)	Pneumatic equipment	Principle of generating pneumatic power	Explain the principle of pneumatic power	5
20		Pneumatic equipment	Pneumatic power tools	Discuss the safety precautions relating to pneumatic power tools	5
21		Pneumatic equipment	Pneumatic power tools	Discuss the legislation surrounding the use of pneumatic equipment	5
22		Pneumatic equipment	Pneumatic power tools	Making use of a diagram explain the procedure for a hydrostatic test	5
23		Pneumatic equipment	Pneumatic power tools	Label the gross anatomy of a compressor system	5
24		Pneumatic equipment	Sources of pneumatic power	Explain the safety precautions as well as regulations governing the use of a compressor for breathing air	5
25		Pneumatic equipment	Sources of pneumatic power	List the types of air cylinder	5
26		Pneumatic equipment	Sources of pneumatic power	Explain how a decanting system operates	5
27		Pneumatic equipment	Sources of pneumatic power	Explain how a vehicles exhaust system can be used for the generation of pneumatic power	4
28		Pneumatic equipment	Pneumatic power tools	Discuss the various types of air bags with reference to: • Construction	4
29		Pneumatic equipment	Pneumatic power tools	• Working pressures	4
30		Pneumatic equipment	Pneumatic power tools	• Advantages and disadvantages	4
31		Pneumatic equipment	Pneumatic power tools	• Maintenance and operating procedures	4
32		Pneumatic equipment	Pneumatic power tools	Making use of a simple diagram explain how a pneumatic hammer / chisel operates	4
33		Pneumatic equipment	Pneumatic power tools	Explain the correct air chisel operating procedures and pressures for different materials	4
34		Pneumatic equipment	Pneumatic power tools	Discuss the basic inspection and maintenance	4

				procedures for a pneumatic chisel	
35		Pneumatic equipment	Pneumatic power tools	Explain the advantages, disadvantages as well as correct operating procedures for: • Pneumatic saws	4
36		Pneumatic equipment	Pneumatic power tools	Safely and efficiently operate: • High, medium & low pressure air bags	4
37		Pneumatic equipment	Pneumatic power tools	• Pneumatic chisels / hammers	4
38		Pneumatic equipment	Pneumatic power tools	• Pneumatic saws	4
39		Pneumatic equipment	Pneumatic power tools	• Compressed air cylinder decanting systems	4
40		Pneumatic equipment	Pneumatic power tools	• Pneumatic rams and shores	4
41		Pneumatic equipment	Pneumatic power tools	• A compressor to refill compressed air cylinders or power pneumatic tools	4
42	THEME 4 (T4)	Hand tools	Hammers; Axes; Crowbar; Spring-loaded centre punch; Hacksaws; Screwdrivers; High lift jacks; Edge protection (Pillar and post covers); Gwalas; Haligan tool; Chocks, wedges, blocks and steps; Seat belt cutters; Spades and brooms; Utility ropes; Ratchet straps; Hot sticks; Polypropylene rope and throw blocks; Earthing spikes and chains; Rescue	Discuss the advantages, disadvantages, selection criteria, correct use and maintenance of any of the prescribed hand tools	5

			chain sling assembly and chain shorteners (come-along); Come-along winch; Nylon slings		
43		Hand tools	Hammers; Axes; Crowbar; Spring-loaded centre punch; Hacksaws; Screwdrivers; High lift jacks; Edge protection (Pillar and post covers); Gwalas; Haligan tool; Chocks, wedges, blocks and steps; Seat belt cutters; Spades and brooms; Utility ropes; Ratchet straps; Hot sticks; Polypropylene rope and throw blocks; Earthing spikes and chains; Rescue chain sling assembly and chain shorteners (come-along); Come-along winch; Nylon slings	Correctly identify and utilize any of the prescribed hand tools in a safe and efficient manner	5
44		Hand tools	Rescue chain sling assembly and chain shorteners (come-along) Come-along winch	Operate a chain shortener system to pull a heavy load in a safe and efficient manner	3
45		Hand tools	Come-along winch	Discuss the use of the following items of rescue equipment: • Vehicle mounted winches and turfor winches	4
46		Hand tools		• High lift jacks	4
47		Hand tools		• Block and tackle systems	4
48		Hand tools	Come-along winch	Safely operate a vehicle mounted winch	4
49		Hand tools	Rescue chain sling assembly	Correctly utilize a Turfor winch	4

			and chain shorteners (come-along) Come-along winch		
50	THEME 5 (T5)	Hydraulic power equipment	Principle of generating hydraulic power	Making use of a diagram explain the principle of generating hydraulic power	4
51		Hydraulic power equipment	Importance of knowing and following manufacturer's recommended applications	Explain the relevance of the machinery and occupational safety act with regard to the use of power tools during rescue operations	4
52		Hydraulic power equipment	Importance of knowing and following manufacturer's recommended applications	Explain how to inspect a hydraulic system prior to use	5
53		Hydraulic power equipment	Importance of knowing and following manufacturer's recommended applications	Explain how to trouble shoot a system that is not functioning properly	2
54		Hydraulic power equipment	Importance of knowing and following manufacturer's recommended applications	Safely and efficiently operate a hydraulic power system to push, pull, cut or spread	4
55		Hydraulic power equipment	Importance of knowing and following manufacturer's recommended applications	Inspect an hydraulic power system for serviceability	4
56		Hydraulic power equipment	Importance of knowing and following manufacturer's recommended applications	Correctly identify and correct common system faults	3
57		Hydraulic power equipment	Safety precautions when using hydraulic tools	Describe the typical components of hydraulically powered tools	5
58		Hydraulic power equipment	Safety precautions when using hydraulic tools	List the safety precautions one should keep in mind when using hydraulic equipment	5
59		Hydraulic power equipment	Safety precautions when using hydraulic tools	Demonstrate the appropriate hand signals used when cutting, pushing or spreading	4

60		Hydraulic power equipment	Legislation governing the inspection and maintenance of hydraulic equipment	Discuss the general care & maintenance of hydraulic equipment	5
61	THEME 6 (T6)	Miscellaneous Equipment		List the advantages and disadvantages of abrasive cutters	4
62		Miscellaneous Equipment		List the criteria for correct abrasive disc selection and replacement	4
63		Miscellaneous Equipment		Safely operate an abrasive cutter	4
64		Miscellaneous Equipment		Inspect and replace abrasive cutter discs correctly	4
65		Miscellaneous Equipment	Lighting	Explain how an electrical generator operates (Dynamo effect)	3
66		Miscellaneous Equipment	Lighting	Discuss the correct methods of positioning lighting on scene	4
67		Miscellaneous Equipment	Lighting	Explain the advantages and disadvantages of illuminating balloons	3
68		Miscellaneous Equipment	Lighting	Explain the correct methods of lowering and securing pit lights	4
69		Miscellaneous Equipment	Chain saws	Operate a chain saw safely	4
70		Miscellaneous Equipment	Chain saws	Tension the chain on a chain saw correctly	4
71		Miscellaneous Equipment	Chain saws	Explain the advantages, disadvantages as well as correct operating procedures for: • Chain saws	4
72		Miscellaneous Equipment	Gas cutters	Explain the advantages, disadvantages as well as correct operating procedures for: • Gas cutters	4
73		Miscellaneous Equipment	Gas cutters	Safely and efficiently operate a gas cutting system	4
74		Miscellaneous Equipment	Lighting	Operate a generator, position lighting equipment and secure pit lights to light up an incident or area of operation.	4

75	THEME 7 (T7)	Incident command and control	Establishing a plan of action	List the nine steps of the Rescue Action Plan for extrication	4
76		Incident command and control	Establishing a plan of action	Explain what actions should be taken on route to a vehicle rescue call	4
77		Incident command and control	Establishing a plan of action	Discus how the location of an incident may affect the on route preparation and though processes	4
78		Incident command and control	Establishing a plan of action	Explain why a tool staging area needs to be established on the extrication scene	3
79	THEME 8 (T8)	Vehicle rescue operations	Crew Organization	Discuss the importance of correct mental and physical preparation for a vehicle rescue work	3
80		Vehicle rescue operations	Scene Safety and size-up	Describe how to position an vehicle in the fend off position	5
81		Vehicle rescue operations	Scene Safety and size-up	Explain the importance of positioning your vehicle appropriately when arriving on scene	4
82		Vehicle rescue operations	Scene Safety and size-up	Discuss the use of a “circle” survey in order to gather information on arrival	4
83		Vehicle rescue operations	Scene Safety and size-up	List the common on scene hazards one need to be aware of when working with motor vehicle accidents	5
84		Vehicle rescue operations	Scene Safety and size-up	Making use of a diagram explain the concept of minimization of road time as well as the correct method for packing out road cones	5
85		Vehicle rescue operations	Scene Safety and size-up	Discuss the advantages, disadvantages and correct use of the following: • Flares	5
86		Vehicle rescue operations	Scene Safety and size-up	• Warning beacons	5
87		Vehicle rescue operations	Scene Safety and size-up	• Barrier tape	5
88		Vehicle rescue operations	Scene Safety and size-up	• Warning lights	5

89		Vehicle rescue operations	Scene Safety and size-up	Explain the principle of crowd control as well as an appropriate, professional method for dealing with the public	5
90		Vehicle rescue operations	Scene Safety and size-up	Explain how you would extinguish the following fires: • Fire in a vehicle seat	4
91		Vehicle rescue operations	Scene Safety and size-up	• Fire behind the dashboard	4
92		Vehicle rescue operations	Scene Safety and size-up	• Fire under the bonnet	4
93		Vehicle rescue operations	Scene Safety and size-up	• Fire in the boot	4
94		Vehicle rescue operations	Scene Safety and size-up	Draw and label a typical hazchem placard indicating the various blocks as well as the possible information stored in each block	4
95		Vehicle rescue operations	Scene Safety and size-up	List the limitations of the current hazchem system	4
96		Vehicle rescue operations	Scene Safety and size-up	Explain the principles of dealing with downed electrical lines	3
97		Vehicle rescue operations	Stabilization; Terminology; Struts; Building up a shore; Triangle of stability; Centre of gravity	Explain the physics behind vehicle stability	3
98		Vehicle rescue operations	Stabilization; Terminology; Struts; Building up a shore; Triangle of stability; Centre of gravity	Explain the general procedure for stabilizing a vehicle after an accident	4
99		Vehicle rescue operations	Stabilization; Terminology; Struts; Building up a shore; Triangle of stability; Centre of gravity	Explain why vehicles in the upright position must be stabilized	4
100		Vehicle rescue operations	Patient packaging and removal	Explain how you would locate possible patients on scene	5
101		Vehicle rescue operations	Scene Safety and size-up Patient packaging and removal	Discuss the procedures for gaining access into a vehicle	5

102		Vehicle rescue operations	Patient packaging and removal	Discuss the importance of adequate patient protection during a rescue operation	5
103		Vehicle rescue operations	Patient packaging and removal	Explain why it is important to differentiate between a normal extrication, a confinement and an entrapment with regard to the medical procedures applied.	2
104		Vehicle rescue operations	Patient packaging and removal	Discuss the term mechanism of injury and explain its importance for rescue and medical personnel	3
105		Vehicle rescue operations	Patient packaging and removal	List the seven common mechanisms of injury that may be found in motor vehicle accident	3
106		Vehicle rescue operations	Patient packaging and removal	Explain the three types of collision that occur during a rapid deceleration incident	4
107		Vehicle rescue operations	Patient packaging and removal	Identify, describe and validate the use of the following extrication and packaging devices: • KED	4
108		Vehicle rescue operations	Patient packaging and removal	• Spine board	4
109		Vehicle rescue operations	Patient packaging and removal	• Collars and head immobilizer	4
110		Vehicle rescue operations	Patient packaging and removal	Discuss the importance of psychological support for the entrapped patient and or family of the patient on scene	4
111		Vehicle rescue operations	Patient packaging and removal	Compare the various common routes of egress with regard to time, simplicity and effectiveness	5
112		Vehicle rescue operations	Patient packaging and removal Roof Removal	List four reasons for performing an early roof displacement operation	4
113		Vehicle rescue operations	Dashboard roll; Foot well Access; Dashboard lift	Explain why a steering wheel pull is no longer an effective technique	3

114		Vehicle rescue operations	Patient packaging and removal	Explain the factors contributing to the election of an "emergency" extrication	2
115		Vehicle rescue operations	Patient packaging and removal	List the complications / dangers associated with an "emergency" extrication	2
116	THEME 7 & 8 (T7 & T8)	Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Stabilization	Discuss the complications associated with, as well as the correct management of the following "special" situations • Vehicle on its side	3
117		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Stabilization	• Vehicle on roof	3
118		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Stabilization	• Vehicle under water	1
119		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities;	• Vehicle under truck	2

			Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Stabilization		
120		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up;	• Vehicle on fire	2
121	THEME 8 (T8)	Vehicle rescue operations	Scene Safety and size-up	Correctly complete an initial assessment including a circle survey	4
122		Vehicle rescue operations	Establishing a plan of action; Crew Organization; Scene Safety and size-up;	Establish a tool staging area in an appropriate position	4
123		Vehicle rescue operations	Stabilization; Terminology; Struts; Building up a shore; Triangle of stability; Centre of gravity	Stabilize a vehicle safely and efficiently utilizing chocks, wedges, blocks, utility ropes and or air bags	4
124		Vehicle rescue operations	Scene Safety and size-up Patient packaging and removal	Gain access to entrapped patients quickly and safely	4
125		Vehicle rescue operations	Scene Safety and size-up Patient packaging and removal	Provide patient care and stabilization according to the rescuers medical scope of practice	4
126		Vehicle rescue operations	Scene Safety and size-up	Interact with the public in a professional fashion with regard to crowd control	4
127		Vehicle rescue operations	Scene Safety and size-up	Provide appropriate emotional / psychological support to persons associated with or involved in	4

				motor vehicle accidents	
128		Vehicle rescue operations	Scene Safety and size-up	Utilize barrier tape and road flares in the correct manner	5
129	THEME 7 & 8 (T 7 & T8)	Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Roof Removal	Perform the following evolutions safely and efficiently utilizing hand tool, power tools and or a combination of both: • Roof removal	4
130		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Roof Removal	• Full roof flip front to back	4
131		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Roof Removal	• Full roof flip back to front	4
132		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources;	• ½ roof flip	4

			Crew Organization; Scene Safety and size-up; Roof Removal		
133		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Side Removal	• Side flip (left and right)	4
134		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Side Removal	• Side swipe (left and right)	4
135		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action; Utilization of available resources; Crew Organization; Scene Safety and size-up; Foot well Access; Dashboard lift	• Dash push (half and full)	4
136		Incident command and control Vehicle rescue operations	Team leader / incident commander functions and responsibilities; Establishing a plan of action;	• Dash roll	4

			Utilization of available resources; Crew Organization; Scene Safety and size-up; Dashboard roll		
137	THEME 8 (T8)	Vehicle rescue operations	Patient packaging and removal	Package a patient for removal in a safe and efficient manner	4
138		Vehicle rescue operations	Patient packaging and removal	Select an appropriate route of egress and remove the patient safely and efficiently	4
139	THEME 9 (T9)	Specialised vehicle rescue	Horse & Trailer; general cargo transporters; Tankers; Refrigeration vehicles; Public transport (Buses / Taxis)	Discuss the special considerations and precautions a rescuer needs to keep in mind when dealing with an incident involving a heavy vehicle	3
140		Specialised vehicle rescue	Horse & Trailer	Describe the procedure for tilting a cab forward on a horse and trailer	4
141		Specialised vehicle rescue	Horse & Trailer; general cargo transporters; Tankers; Refrigeration vehicles; Public transport (Buses / Taxis)	Explain why cutting through the hydraulic hoses on any specialized vehicle may lead to instability and even make the situation worse	3
142		Specialised vehicle rescue	Horse & Trailer; general cargo transporters; Tankers; Refrigeration vehicles; Public transport (Buses / Taxis)	Discuss the general principles that may be applied when dealing with vehicles and or persons who have become lodged underneath or between other large motor vehicles	3
143		Specialised vehicle rescue	Horse & Trailer; general cargo transporters; Tankers; Refrigeration vehicles; Public transport (Buses / Taxis); Utilization of available resources	List the additional types of specialized equipment you may need to summon to an incident involving a specialized vehicle	1
144		Specialised vehicle rescue	General cargo transporters	Explain how you would go about stopping a train	4
145		Specialised vehicle rescue	General cargo transporters	Discuss the principles of dealing with an	3

				aircraft that has been involved in an accident	
146		Specialised vehicle rescue	General cargo transporters	List and describe the dangers that a downed aircraft may pose for the rescuer and or the public.	3
147		Specialised vehicle rescue	General cargo transporters	Discuss some methods of stabilizing a railway coach that has been derailed	1
148	THEME 7 (T7)	Incident command and control	Utilization of available resources	Mention some of the limitations that your conventional rescue equipment may have in terms of accessing and or removing patients from specialized vehicles after an entrapment.	1
149	THEME 7 & 8 (T7 & T8)	Incident command and control Vehicle rescue operations	Utilization of available resources Stabilization; Terminology; Struts; Building up a shore; Triangle of stability; Centre of gravity	Explain why stabilization of a specialized vehicle may require additional resources	1
150	THEME 7 (T7)	Incident command and control	Utilization of available resources	List the applicable support services that may be summoned for an incident involving a specialize vehicle.	3
151	THEME 9 (T9)	Specialised vehicle rescue	Public transport (Buses / Taxis)	Discuss the generic principles one should keep in mind when dealing with a bus accident involving multiple entrapments	2