The critical evaluation of the R&D innovation capability within the military manufacturing industry

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ABSTRACT

Since the end of World War II, most countries have accepted that a vital feature of national security policy is the military manufacturing industries (MMIs). Previous studies have shown that innovating both organizationally and technologically is historically the most promising approach in increasing military power and effectiveness. In this endeavour, MMIs are striving to become more innovative to satisfy military needs.

Published studies have described various inhibitors to innovation in military organisations and military culture. The close interaction between the military entities and MMIs and the involvement of military veterans in MMIs' R&D processes lead to the hypothesis that the innovation capability within the MMIs might be negatively affected. Nevertheless, there is a gap in the literature examining the innovative capability of organisations within MMIs. Therefore, this study critically evaluates the innovation capability of research and development (R&D) within the MMI sector. The aims of this study are to a) experimentally examine the MMI's R&D innovation capability to contribute to the formulation of the diagnostic baseline for performance improvement, b) narrow the gap in the literature regarding the influence of the 'military culture/environment' of the stakeholders on MMI innovation and c) conceptualise factors that could potentially hinder innovation in MMIs.

In this study, the *Innovation Phase Assessment Instrument* (IPAI) was used to determine the extent to which the investigated MMI was aligned to the states of the antecedents that favour innovation. Results show that the overall alignment for the investigated MMI was 67.92% which is good alignment relative to ideal innovation. Furthermore, results highlight a weakness in the press dimension, which represents the alignment of the organisational culture/environment to the ideal status for innovation. Finally, employees having a military background had no significant effect on the innovation capacity for the investigated MMI.

KEYWORDS:

Research and development, innovation, military manufacturing industry, defence industry, Innovation Phase Assessment Instrument

ABBREVIATIONS

AMD	Aerospace, Maritime & Defence Industry Association
IPM	Innovation Phase Model
IPAI	Innovation Phase Assessment Instrument
MMI	Military Manufacturing Industry
MOD	Ministry of Defence
R&D	Research and Development
SA	South Africa
SD	Standard deviation
SPSS	Statistical Package for Social Sciences
SWOT	Strengths, weaknesses, opportunities and threats
NCACC	National Conventional Arms Control Committee
NDIC	National Defence Industry Council
4Ps	Person, Process, Product, and Press

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CHAPTER 1 INTRODUCTION

1.1 Background

Recently, innovation has become an essential determinant of organisational growth and performance (Shanker, Bhanugopan, van der Heijden, & Farrell, 2017). The sentiment of the catchphrase 'innovate or die' is widely accepted by organisations, and innovation management has become a primary concern for organisational leaders (Cropley D. , 2016). The debate concerning innovation and what contributes to innovative performance started a century ago. Schumpeter (1942) argues that modern firms equipped with research and development (R&D) laboratories had become the central innovation actors. Since his work, others have contributed to the debate, e.g. (Cohen & Levinthal, 1990; Pisano, 2012).

However, to work with an organisation's innovation capability, one has to consider the innovation process and structure as they are differed significantly between industries. The differences are in the areas of development, rate of technological change, access to knowledge, organisational structure and institutional factors (Malerba, 2005). In addition, the patterns and determinants of innovation associated with various perspectives of capabilities, including but not limited to, the individual, team and organisation capabilities (Eriksen, 2015).

1.1.1 The Military Manufacturing Industry (MMI)

The terms' '*military manufacturing industry'* (MMI), '*defence industry'*, the '*armaments industry*' and '*defence suppliers*' are all recognised as the groups and organisations within the public sector that are directly and indirectly involved in providing services and goods to the defence forces (Government, 2019).

While no MMI is precisely defined as a discrete industrial division, it is clear that the manufacturing of armaments for use by the defence forces is a unique type of industry, as emphasised in the book *The Defence Industrial Triptych* by Heidenkamp, Louth, and Taylor (2015). The authors consider the significance of MMIs is their prominent role in advancing the military competencies as well as a critical national democracy factor. As such, MMI's are also mandated to participate in other economy building blocks. Acknowledging this MMI characterisation assists in imagining its nature, conceptualised in light of the following ideas:

1. The relationship between MMIs and the government as a customer, sponsor and regulator, as proposed in *The Defence Industrial Triptych*.

2. The close association with the Ministry of Defence (MOD) makes MMIs part of the military environment (Dombrowski & Ross, 2008).
3. The MMIs recruitment of military veterans as they are field experts and are correspondingly capable of representing the end-users for the products.

Accordingly, while the MMIs are not typically characterised as military organisations, it is clear that the co-operative relationship between the MMIs and the MOD to identify future needs for technology (market pull) and future capabilities and opportunities (technology push) provide reasonable grounds to claim that the MMIs are not isolated from the military organisations' environment and culture.

1.1.2 The Military Organisational Culture

According to Elsmore (2017), organisational culture refers to a set of shared norms, values that guide the understanding and the way employees act or behave under different circumstances within organisations. This culture is usually passed on to new employees who join the organisation. They are taught to feel, think and behave according to organisational values and norms (Bailey, Benson, & Bruner, 2019).

The nature of military culture has been described as one that hinders innovation and creativity (Ferrara, 2017), which could be attributed to the fact that the military values uniformity, hierarchy and many more standard procedures of operation (Eriksen, 2015). Kamara (2015) adds that the military is governed by strict rules, regulations, boundaries and norm-compliance that are viewed as being incompatible with the norm-breaking nature required for innovation and creativity. Additionally, several studies (Holmberg & Alvinius, 2019; Meredith, et al., 2017), suggested that the military culture is resistant to change, while the ability to change is an essential component for effective innovation. Hill (2015), highlights this challenge by stating that:

> *Bureaucracies thrive on consistent, standard approaches to resolving familiar problems. Militaries are bureaucracies that depend on standardisation of tools, training, methods, and organisation. Innovation subverts this standardisation and consistency, first, in the exploration of a new approach (the introduction of variance into the system), and then (if the innovation is successful enough) in the eventual replacement of the existing approach throughout the organisation. The generalisation of an innovation requires organisational change, which in turn may require cultural change.*

Regardless of the usefulness of the described military culture in achieving the objectives of military systems, what is important here is to create a picture of the nature of culture in the military organisations and military personnel who make up the largest segment of MMI's stakeholders. For instance, researchers have recently illustrated that employees that have a military service background often exhibit lower levels of agreeability than their civilian counterparts after the completion of their service (Sandwith, Cropley, & Chandler, 2017). The lower levels of agreeableness, an example of incompatible norms for innovation (Rossberger, 2014), are instrumental in a military setting.

1.1.3 The Importance of Innovative Capability for MMI

Dincecco (2015), illustrated that the continual technological innovation is essential for militaries around the globe to improve their effectiveness. Superior armaments provide a distinct advantage to countries (Long & Reppy, 2015). Boot (2006) asserted that, if developed and correctly used, weapons are responsible for 99% of war victories. Cebul (2018) emphasised this fact at the recent defence news conference "*in the era of great power competition, the speed at which competing militaries are capable to innovate and evolve* [sic] *could determine who would win in a war*". Thus, many MMIs around the world are striving to become more innovative to satisfy their defence sector ambitions (Bitzinger, 2016; Lundmark, 2016). Therefore, the innovation capability of the MMIs becomes a critical element to meet the defence sector requirements. According to Carchedi (2018), R&D plays a significant role in innovation in which it is essentially an investment in technologies and future capabilities which are transformed into new military products, services and systems.

1.1.4 The Role of Research and Development (R&D) in the MMI

R&D specialises in conducting operational and scientific research in addition to testing and evaluating armaments and vehicles (Bellais, 2013). R&D in the MMI produce innovative technology products and services which are subject to stringent testing and evaluation procedures benchmarked with international standards (Harutyunyan Gayane, 2017). According to Burmaoglu and Sarıtas (2017), R&D reduces uncertainty through acquiring information. Hence, personnel are a vital aspect of an R&D system. Despite the growing use of sophisticated instrumentation, computers, and laboratory automation, the R&D is a labour-intensive process. Thus, choosing and managing human resources, such as the mix

of generalists, specialists, technical backgrounds, work styles and career skills, among others, have a significant impact on R&D innovation capability (Pisano, 2012).

1.2 Problem Statement

Since the end of World War II, most countries have accepted the fact that a vital feature of national security policy is the MMI. Findings from Marling (2002) show that innovating both organizationally and technologically is historically the most promising approach to increase military power and effectiveness. In this quest, MMIs around the world are striving to become more innovative to satisfy their military needs (Bitzinger, 2016; Lundmark, 2016).

However, studies have shown that the R&D capability is significantly and positively correlated with innovation performance (Akcali & Sismanoglu, 2015) and illustrates the role of individuals within R&D as a significant factor in performance (Pisano, 2012). Eriksen (2015) illustrates how the influence of individual factors on innovation is highly dependent on the situation, context and work environment. Furthermore, the innovation process and structure are differ significantly between industries and sectors as illustrated by Malerba (2005).

Several authors (Harris, 2006; Jungdahl & Macdonald, 2015) report that there exist various inhibitors to the innovation capability within the military organisational environment and culture. The close interaction between the military entities and the MMIs and the involvement of the military veterans in the MMIs' R&D processes (as discussed earlier) leads to the hypothesis that the innovation capability within MMIs might be impaired. Furthermore, while diagnosing innovation capability within an organisation serves as a starting point for the improvement of that organisations' capacity for innovation (Cropley D. , 2016), there appears to be a dearth in the literature of studies examining the innovation capability within the MMI sector.

Therefore, the problem to be solved in this study is to diagnose and explore the innovation capability within MMIs by applying a critical evaluation for the R&D innovation capability of one large MMI firm in South Africa. The study will also investigate the influence of the close interaction between the military entities and MMIs on MMI's R&D innovation capability.

1.3 Research Aims

The study intends to critically evaluate the innovation capability of R&D within the MMI sector. The aims of this study are to a) experimentally examine the MMI's R&D innovation capability to contribute to the formulation of the diagnostic baseline for performance improvement, b) contribute in closing the literature gap regarding the influence of the 'military's culture/environment' of the stakeholders on the MMI innovativeness and c) conceptualise factors that could potentially hinder innovation in MMIs.

1.4 Research Objectives

- To determine the level of alignment of the examined MMI to the ideal criteria for innovativeness.
- To assess the influence of the 'military culture/environment' on MMI innovativeness.
- To explore the relationship between employees with or without a military service history on R&D innovation capability.

1.5 Scope of the Research

This study focuses on a specific industry as the innovation processes differ significantly between industries. The differences are in the areas of development, rate of technological change, access to knowledge, organisational structure and institutional factors (Malerba, 2005). However, specifying the parameters of the military manufacturing industry is not straightforward, since militaries need a wide variety of goods and services, several of which are mainly civil or dual-use in character. The research focus is consequently limited to the systems and services that are specifically developed for defence, such as air, sea and land systems, and weapons and munitions that are primarily linked to military capability. Due to the nature and vast levels of diversity, even after considering the scope mentioned above, this research will be focused on the R&D sector of a single existing company with a wide range of activities in development, production and maintenance of defence equipment. This company produces armaments on a large scale for both domestic and international markets. The examined company specialises in the development, design and manufacture of large- and medium-calibre ammunition families and is a world leader in the field of artillery, mortar and infantry systems as well as plant engineering. The identity of the company will remain anonymous throughout the research for confidentiality purposes.

1.6 Contribution of the Study

The study will provide an outline of factors that could potentially hinder innovation in the MMI. It also intends to narrow the gap in the literature regarding the understanding of innovation capability within MMIs. Moreover, this study will help existing MMI aiming to promote innovation by determining the possible weaknesses in the innovation process. Ultimately, it will guide the management within this industry to apply the relevant measures and designate suitable policies.

1.7 Dissertation Outline

This dissertation is divided into five chapters, as outlined in the following subsections.

1.7.1 Chapter 1: Introduction

This chapter provides the research background, problem statement, research aim and objectives, research scope and contribution of the study.

1.7.2 Chapter 2: Literature Review

This chapter investigates the concepts of creativity and innovation within the scope of this research and the importance of managing their performance. This chapter provides an in-depth literature review of the creativity and innovation inhibitors within the military context. It will also provide insight into the phenomenon under investigation through an analysis of findings from similar studies.

1.7.3 Chapter 3: Research Methodology

This chapter will describe the research methodology applied to this study, i.e. study population, the process of data gathering, data analysis, the validity and reliability of the data collection instrument and the ethical considerations.

1.7.4 Chapter 4: Research Results and Discussion

This chapter will illustrate the results of the empirical investigation. It will also describe the variables used in the study. Furthermore, this chapter will provide a discussion of the results and interpretation based on the theoretical findings from the literature and the empirical findings from the empirical investigation.

1.7.5 Chapter 5: Evaluation, Recommendations and Conclusion

This chapter will provide an evaluation of the study, recommendations for future MMI studies and the conclusion.

1.8 Summary

This chapter provided an insight into the research problem and served as the introductory chapter. The information in this chapter was fundamentally the motivation for the study. The author in this chapter highlighted the importance of the field of study and illustrated the role and value of the MMI's at national level. Furthermore, the R&D role within MMI in stimulating innovation was addressed. The following chapter will explore creativity and innovation as a philosophy and the importance of managing and maintaining its performance. Furthermore, it will demonstrate a comprehensive review of literature on the inhibitors of innovation and creativity within the military context.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

The purpose of this chapter is to provide a detailed description of the key concepts used in this study. The concepts of creativity and innovation within the scope of this research and the importance of managing their performance are addressed. Furthermore, a description of the research context and a demonstration of how the current study fits into the overall scheme of studies that focus on the R&D of the MMI are illustrated. This literature review enables the author to realise the gaps in the investigation and obtain a more holistic view of the topic.

2.2 Defining Innovation, Creativity and Organisational Innovation Capability

The term "innovation" comes from the Latin word ‘innovat’ which means ‘renewed’, where the verb ‘innovare’, from ‘in’ (into) + ‘novare’ (make new), from ‘novus’ (new). In essence, the meaning of the term has remained unchanged until now; however, in the sense of businesses, the concept still needs clarification (Gault, 2018). Several authors have described innovation in different ways, and as such, there is no standard definition of the term. In organisational literature, the term innovation can be used when referring to a new product, for example, a new device, service, or method (Dziallas & Blind, 2019). It can also refer to the process by which new products are developed, conveyed to the market, or put into practice (Cropley D. , 2016; Witell, Snyder, Gustafsson, Fombelle, & Kristensson, 2016). Furthermore, a majority of creativity researchers argue that if creativity is the generation of novel and useful ideas, innovation is the successful implementation of those ideas (Eriksen, 2015).

According to Vakanjac et al. (2019) the process of bringing new and imaginative ideas to life is what is known as creativity. The creativity can be described as the ability to view the world in different ways, to identify hidden patterns, to make associations between seemingly unrelated phenomena, and to produce solutions; where the thinking and then producing are the two steps in the creative process (Nakano & Wechsler, 2018).

Therefore, innovation cannot be achieved without prior creative endeavours as innovation is recognised as the implementation phase of useful ideas generated through creative behaviour (Eriksen, 2015).

Hereafter, organisational innovation capability refers to a firm's ability to generate innovation through continuous learning, knowledge transformation, creativity, and exploitation of internal and external resources available to the firm (Iddris, 2016). Assink (2006) describes innovation capabilities as "the internal driving energy to generate and explore radical, new ideas and concepts, to experiment with solutions for potential opportunity patterns detected in the market's white space and to develop them into marketable and effective innovations". Thereby highlighting the importance of the context and surrounding market in which the innovation is developed. When comparing different definitions, it becomes evident that authors have contrasting viewpoints regarding what degree of novelty that innovation capabilities should support it.

2.3 The Importance of Organisational Innovation Capability

According to Nussbaum (2013), innovation enables organisations to meet unmet needs in societies. Innovation is a vital force that supports an organisation in obtaining competitive advantage and increasing returns (Singh, 2011). Azar and Ciabuschi (2017) report that organisational innovation is linked to improved export performance. Wanaswa *et al.* (2017) reports that innovation improves '*commercial competitiveness*'. According to Rosenbusch *et al.* (2011), some of the tangible gains of organisational innovations benefits include new products, services and more process-oriented benefits, such as increased productivity, job satisfaction, employee commitment, reduced staff turnover, and attractiveness to potential investors. Cropley (2016) also reports multiple more indirect organisational benefits of innovations which include the capability to react to a crisis and enhanced teamwork and collaboration. According to Zhang *et al.* (2018), innovative behaviour leads to better planning processes and employees who are satisfied and intrinsically motivated. Therefore, the benefits of organisational innovation capability are not limited to the production, implementation, and marketing of products but also include factors such as a positive work environment, employee motivation and job satisfaction.

2.4 The Role of (R&D) in Promoting Organisational Innovation Capability

It is widely accepted that business and industry must innovate to prosper (Ali, Seny Kan, & Sarstedt, 2016). However, the debate regarding innovation and what contributes to innovative performance started a century ago. Schumpeter (1942) argued that modern firms equipped with R&D laboratories had become the central innovation actors. Since his work,

others have contributed to the debate, e.g. (Cohen & Levinthal, 1990; Pisano, 2012). A key concern is how to maintain and improve the organisation's innovativeness. In this quest, organisations rely on investing heavily in R&D capability (Zhang, Wu, Zhang, & Zhou, 2009).

Research and development (R&D) is recognised as processes that aim to develop new or improved technology that can give a business, sector, or country a competitive advantage. The process of technological advancement (of which R&D is the first phase) is complex and risky, despite the high potential rewards (Lederman & Maloney, 2003). The majority of R&D projects do not achieve the anticipated financial results, and the good projects (25 to 50 percent) must pay for the failed or prematurely terminated projects. Furthermore, the innovator of R&D cannot keep any of the advantages of its inventions to themselves; they must share them with consumers, the general public, and even rivals (Jones & Williams, 2000). Psychological theories provide insights on promoting innovation through the R&D. Akcali and Sismanoglu (2015) propose that R&D capability is significantly and positively correlated with organisational innovation performance. Pisano (2012) considers the role of individuals within R&D as a significant factor for innovation performance. Furthermore, Eriksen (2015) illustrates how the influence of individual factors on innovation is highly dependent on the situation, context and work environment. Hence, despite the growing use of sophisticated instrumentation, computers and laboratory automation, R&D is still a labour-intensive process, and people are indeed a vital aspect of an R&D system and consequently, innovation performance. Therefore, choosing and managing human resources, such as the mix of generalists, specialists, technical backgrounds, work styles and career skills, among others, have a significant impact on R&D innovation capability (Pisano, 2012).

Despite the heavy investments of military organisations in the R&D to acquire new military products, services and systems, the military R&D are often ineffective compared to civilian (Bellais, 2013). Continued investment in R&D among military institutions points to an ever-increasing demand for creativity and innovativeness in the MMI. Therefore, the innovation capability of the MMIs becomes a critical element to meet the defence sector requirements.

2.5 Managing Innovation Capability

Previous studies have shown that the processes, motivation and management styles that promote the creation and implementation of new products are usually contradictory or paradoxical (Kačerauskas, 2016). This idea implies the fact that there is no simple universal

model that make businesses or industries innovation capability ideal. However, diagnosing innovation capability within an organisation serves as a starting point for the improvement of that organisations' capacity for innovation (Cropley D. , 2016).

Cropley and Cropley (2010) developed a theoretical framework by mapping psychological factors, such as cognitive processes and motivation, into phases. This framework makes it possible to identify the strengths and weaknesses of a specific organisation, to make recommendations, and provide guidance for researchers in the field. This framework is based on three essential ideas in creativity theory:

(i) the 4Ps of creativity,

(ii) the paradoxes of creativity and

(iii) the phases of creativity.

2.5.1 The 4Ps of creativity

The creativity relies upon an individual's ability to develop different thoughts and improvise based on the possible factors. The ability to create new ideas that arrive at a better solution compared to the existing ones. Creativity also aims at reducing wastage of resources and time when reaching the same answer to a problem as the current techniques. Measuring creativity must entail factors that promote or support creativity.

The 4Ps approach has been used to study creativity (see Figure 2-1). This approach focuses on the *Person*, which is describing the psychological resources of individuals; the *Process*, which is the thinking styles that result in novel products; the *Product*, which is the tangible artefacts or service; and the *Press*, which is the pressure of the organizational environment (Cropley D. , 2016).

Cropley and Cropley (2010) consider the idea of Person in the 4Ps approach is too general to serve as the foundation for a differentiated discussion of non-cognitive factors in creativity, as it confounds some *personality traits* (such as self-confidence and openness to novelty), *motivational states* (for instance, willingness to take risks) and *feelings* (such as pleasant expectation versus anxiety in the face of incongruity and optimism versus pessimism).

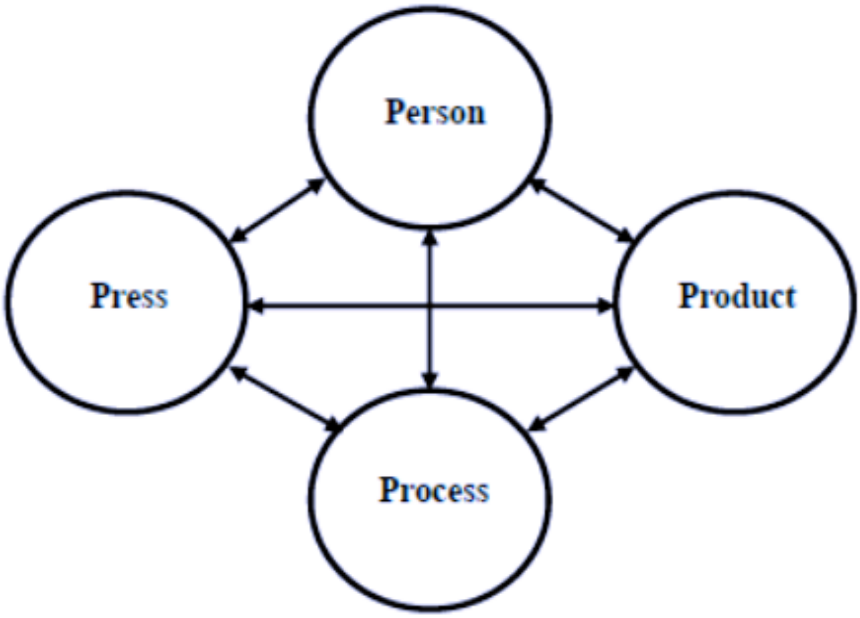

Figure 2-1: The 4Ps of Creativity - Adapted from D. Cropley (2016).

2.5.2 The Paradoxes of Creativity

Psychological research has shown that human properties and environmental conditions are not generally favourable or unfavourable (Cropley D. , Cropley, Chiera, & Kaufman, 2013). Something that serves a facilitator under some circumstances may be an inhibitor under others. Storr (1972) was the first to coin this phenomenon as the 'paradox' of creativity. Cropley (1995) describes creativity as a '*bundle of paradoxes*'. Cropley and Cropley (2010) further divides Person into personal *properties*, personal *motivation,* and personal *feelings*, thereby redefining creativity as a *six P*s framework which includes 'Process', 'Personal properties', 'Personal Motivation', 'Personal Feelings', 'Product' and 'Press'.(see Table 2-1).

Table 2-1: Examples of paradoxical aspects of the six Ps - Adapted from Cropley and Cropley (2010)

P	Paradox	
Process	***Divergent Thinking*** ***vs.*** ***Convergent Thinking***	
	Involves: -conceptualizing a situation broadly -asking unexpected questions -making remote associations -seeing unexpected links - finding problems - restructuring problems -generating solution criteria -communicating a situation to others in a loose and general way	Involves: -conceptualizing a situation precisely -accepting the way a situation is presented -reapplying the already known -recognizing familiar patterns in material -working on the problem as presented -accepting existing problem definitions -working according to existing criteria -communicating a situation to others clearly and precisely
Personal properties	***Innovative personality*** ***vs.*** ***Conforming personality***	
	A person is: -tolerant of ambiguity -flexible -independent -non-conforming -inner-directed -open-minded	A person is: -eager to eliminate ambiguity -inclined to do things in known ways -eager to win the agreement of others -accepting of prevailing norms - inclined to go along with others - closed-minded
Personal Motivation	***Proactive motivation*** ***vs.*** ***Reactive motivation***	
	A person is driven by: -the urge to push ahead -risk taking -low drive for closure -drive to seek the new/surprising -the urge to generate variety	A person is driven by: -the urge to cooperate with others -risk avoidance -drive for rapid closure -drive to avoid the new/surprising -the urge to get it right
Personal Feelings	***Generative feelings*** ***vs.*** ***Conserving feelings***	
	A person feels: -pleasure in finding a novel solution -excitement in the face of uncertainty/a delayed solution -optimism when problems arise -the desire to do more when successful -enjoyment of the challenge when unsuccessful	A person feels: -pleasure in already having an easy solution -anxiety in the face of uncertainty/a delayed solution -pessimism if problems arise -relief and feeling of closure when successful -disappointment and discouragement when unsuccessful
Product	***Radical product*** ***vs.*** ***Routine product***	
	A product is: -novel -elegant -seminal -germinal	A product is: -relevant (matches task specification) -correct -effective
Press	***Low management demand*** ***vs.*** ***High management demand***	
	A manager: -defines tasks broadly -assigns responsibilities loosely -offers opportunities for acquiring broad knowledge and skills -makes time available for thinking things over -is open to novelty -rewards generation of novelty -delays sanctions against lack of success -respects and protects those who do not conform -stands up to external pressure	A manager: -defines tasks narrowly -assigns highly specific responsibility -insists on deep specialized knowledge -demands rapid solutions -is suspicious of novelty -rewards “not rocking the boat” -quickly sanctions lack of success -sidelines or ridicules those who do not conform -gives in to external pressure

2.5.2.1 Divergent Versus Convergent Thinking (Processes)

According to Shao *et al.* (2019), the common belief in the western world is that creativity involves the production of novelty. Several authors (Lee, Walsh, & Wang, 2015; Milbrandt & Milbrandt, 2011; Zhou, Wang, Song, & Wu, 2017) have argued that creativity is so novel that it is unparalleled and is not correlated to all that went before. Jaarsveld and Lachmann (2017) add that, while intuitively, production of such unparalleled novelty would be anticipated to necessitate divergent thinking (e.g. conceptualising a situation extensively, asking unanticipated questions and making remote associations). Several studies (Chamorro-Premuzic & Reichenbacher, 2008; Chermahini & Hommel, 2012) emphasise the significance of convergent thinking (e.g. conceptualising a situation precisely, accepting how a situation is presented, reapplying the already known, recognising familiar patterns in material and working on the problem as presented). This dichotomy can be regarded as on the one hand, recognising problems and on the other, the different approaches for reducing them (Cropley & Cropley, 2010).

In addition, new knowledge appears to be closely linked to old knowledge. Shambaugh *et al.* (2017) reports that the majority of new patents in the United States of America were improvements from the old patents. Trapido (2015) indicates how existing knowledge could be converted into useful novelty. This paradoxical link between creativity and existing knowledge can simply be explained in terms of a bipolar contrast between a group of cognitive processes included under ‘divergent’ and another group of ‘convergent’ processes (Cropley & Cropley, 2008). These two groups are essential for creativity, even though they seem to be diametric opposites (Leung, et al., 2018).

2.5.2.2 Personal Properties

Personal properties exhibit paradoxes similar to those of creativity. According to Frolova (2016), the role in the creativity of a ‘complex’ personality that brings together paradoxes for example agreeableness occurring together with disagreeableness (Miron-Spektor & Erez, 2017; Stierand, et al., 2019). A creative personality appears to be at the same time stereotypically ‘masculine’ (independent, confident, strong) and stereotypically ‘feminine’ (sensitive, instinctive, responsible). There are several paradoxes in the personal properties that facilitate creativity (Cropley & Cropley, 2008). Some examples include egocentricity combined with altruism, self-doubt with self-confidence and tension with being relaxed (Beghetto, 2019). These two poles can simply be referred to the bipolar dimension of

‘innovative’ vs ‘adaptive’ personal properties; both are essential for creativity (Cropley & Cropley, 2015).

2.5.2.3 Motivation

Several studies (Da Costa, Páez, Sánchez, Garaigordobil, & Gondim, 2015; Liu, Jiang, Shalley, Keem, & Zhou, 2016; Wang, Kim, & Lee, 2016) show that *motivation* plays an essential role in creativity. Park and Jang (2005) explore motivation for scientific creativity through interviews with both theoretical and applied physicists. They report that, along with feelings, such as curiosity, these scientists were likewise affected by what they refer to as *cognitive motives* (Park & Jang, 2005). These scientists identify the following as cognitive motives for creativity: acknowledging that existing knowledge is incomplete and a drive to bring to completeness emerging novelty and identification of paradoxes in recognised knowledge (Park & Jang, 2005).

There is a general assumption that only intrinsic motivation is ideal for creativity (Amabile, 2016). However, multiple studies (Feng, Zhang, Liu, Zhang, & Han, 2018; Hur, Moon, & Jun, 2016; Luria & Kaufman, 2017) show that extrinsic motivation has both negative and positive effects on creativity, while some show that effects are mixed (Feng, Zhang, Liu, Zhang, & Han, 2018). Some studies report that extrinsic motivation is not inevitably fatal to creativity (Steele, McIntosh, & Higgs, 2017). Jovanovic and Matejevic (2014) add that both intrinsic and extrinsic motivation could foster creativity, depending on the kind of task, the way the task is presented and the kind of performance that is rewarded.

According to Unsworth (2001), there are four different types of motivation in creativity. Responsive creativity by which an individual is motivated to responds to a specific situation in a closed-problem field (the person is externally motivated with some constrains over problem-solving choices). The second type is expected creativity, in which an individual is self-motivated, but the problem is defined externally. Contributory creativity is when an individual is self-determined and motivated to help in solving a problem (helping behaviours). The last type is the proactive creativity by which an individual is internally-motivated and actively search for problems to solve.

Eventually, the individual creativity impulse by different forms of motivation whether it was self-motivation to fix self-defined problems (proactive motivation) or external motivation to problems imposed (reactive motivation), and there will be ‘mixed’ between these two poles (Cropley & Cropley, 2015).

2.5.2.4 Feelings

According to Shalley et al. (2015), the mood is a precursor to creativity. There is a general belief that positive mood is required for one to be creative, and a negative mood is not ideal for creativity. De Dreu *et al.* (2008) describes three aspects to the mood and creativity relationship: *hedonic tone,* which is essentially positive versus negative feelings, *level of activation*, which refers to the activating versus deactivating effect of mood, and *effect on focus* which is the promotion versus prevention.

De Dreu *et al.* (2008) divide creative output into the development of ideas (multiple ideas), insight (one idea) and creative products (literary works, other artistic products, designs and work performance, among others). They found that some moods influence some aspects of creativity but no other aspects and that some moods have a more significant effect on creativity than others. There was no overarching tendency towards positive effects.

Shalley et al. (2015) add that there was no universal tendency for positive affect to promote creativity more than negative mood, but good moods do indeed lead to more creativity once the assignment is viewed as fun and intrinsically motivating. On the other hand, less creativity occurs when the assignment is viewed as serious and extrinsically motivating, and performance expectations are stressed (Shalley, Hitt, Zhou, & Kaufmann, 2015). Consequently, a new paradox critical to creativity is emerging between all ‘generative’ emotions, for example, the ‘chase rush’ when confronting a challenge, a feeling of excited expectation when creating innovation, or a sense of accomplishment after producing a successful novel product (George & Zhou, 2002), and ‘conserving’ feelings such as distress in the face of uncertainty, dissatisfaction when progress is hindered, or frustration when a product is not approved (Baggott, 2015).

2.5.2.5 Product

The product is the result of moving from ‘merely’ novelty creation to the actual implementation of innovation in industry, manufacturing, marketing and other fields (Jordanous, 2016). It is obvious that although goods have to be novel, they should also perform as expected and be accepted by potential consumers or clients (Montuori, 2017). However, there can be cases where novel products are highly productive and successful but contribute to failures of prosperous and well-run organisations due to a decline in consumers (Fryer, 2012). Therefore, it is necessary to move beyond a century of experimentation to generate creativity and innovative goods that must be new, original and

even surprising, normal, reliable and effective (Cropley & Cropley, 2015). This phenomenon produces the bipolar dimension ‘radical’ vs ‘routine’ products.

2.5.2.6 Environmental Press

According to Calic et al. (2019), there is a complex interaction between management pressure (Press) and creativity. In situations in which an individual has to carry out pre-defined steps, a *high* level of environmental pressure can facilitate performance (high Press). Nevertheless, if the individual has to explore possibilities, a low level of pressure could be facilitatory (Speklé, van Elten, & Widener, 2017). Therefore, assigning work ahead of time to individuals could be ideal for creativity (*low press*), and there are times when it is more appropriate to insist that production should be effective and within time constraints (Doyle, 2019). Thus, the last paradox includes the coinciding significance of both high and low managerial pressure (Shao, Nijstad, & Täuber, 2019).

2.5.3 The Phases Approach

The equal significance to innovation of mutually conflicting systems described in previous paragraphs presents significant challenges for managers who want to create an environment which promotes successful novelty development and exploitation (Haldma, Näsi, & Grossi, 2012). Companies have to encourage consistency and efficacy because new technologies have to work properly, or their businesses suffer significant harm (Cunha, Simpson, Clegg, & Rego, 2019). Innovation-friendly managers, however, do need to promote variety generation and understanding of potential applications of such creativity, involving divergent thought, creative personal properties, generative emotions, intrinsic motivation, unconventional products, and low environmental demand (Haldma, Näsi, & Grossi, 2012). Managers thus face the most difficult challenge of combining the impossible (Manzoni & Volker, 2017).

Cropley and Cropley (2010) provide a seven-phase approach as an answer to this challenge. This framework makes it possible to identify the strengths and weaknesses of a specific organisation to innovate. Figure 2-3 shows the extended phase framework of innovation by Cropley and Cropley (2010). The first five phases in the model involve obtaining information, observing problems, generating novelty, finding solutions and approving them, while the last two involve implementation of the novelty in real-life settings. Such phases do not necessarily reflect a lock-step progression of entirely separate steps

(Haldma, Näsi, & Grossi, 2012). This framework enables organisations to assist employees in mastering the processes that lead to the creation of novel products (Cropley & Cropley, 2010). False starts, early break-offs and restarts, bypassing a particular process, or different interactions can occur. These paths can include the outcome of one step forcing a return to an earlier one but with a different starting point originating from the now-abandoned period (Cropley & Cropley, 2010).

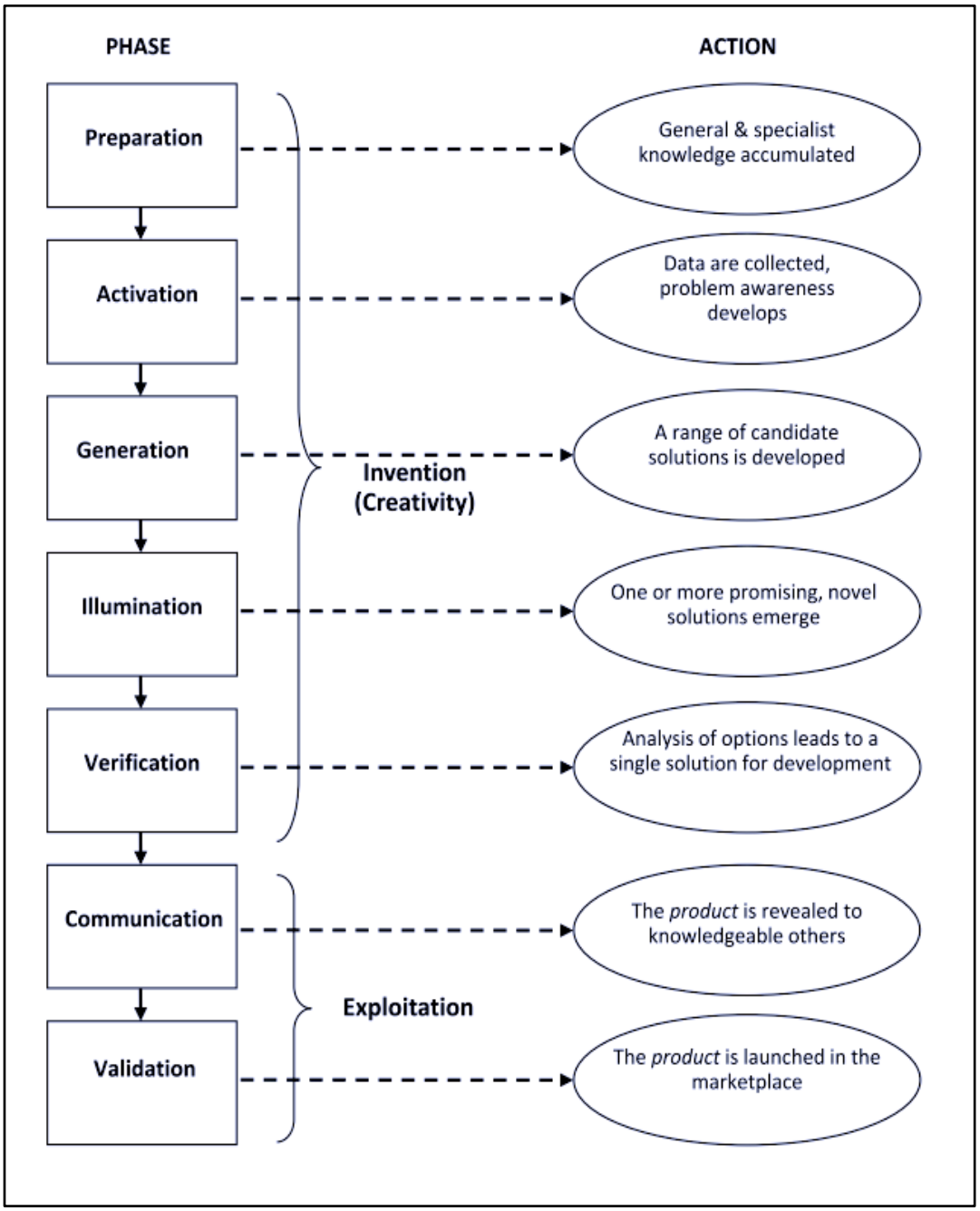

Figure 2-2: Extended phase framework of innovation by Cropley & Cropley (2010)

In summary, Cropley and Cropley (2010) illustrated that organisational innovation involves reconciling many contradictions or paradoxical aspects of the six Ps (Table 2.1); Then dividing the process of innovation into phases ranging from Activation to Validation (Figure 2.2). The combination of the seven phases and six psychological factors formulates the innovation Phase Model (Figure 2.3). Furthermore, the ideal theoretical conditions for innovation, defined in the Innovation Phase Model (Cropley & Cropley, 2015).This framework makes it possible to identify the strengths and weaknesses of a specific organisation to innovate.

The Innovation Phase Assessment Instrument (IPAI) developed in Cropley and Cropley (2012) and Cropley et al. (2013) was designed to assess organisations according to such an approach. At a practical level, it can be used to evaluate the strengths/weaknesses of organisations in a differentiated way and for making recommendations for improving their capacity for innovation. It is also a source of research questions for examining creativity and innovation in an organisational context.

Building Blocks	Phase / Poles	Preparation Knowledge, problem recognition	Activation Problem definition, refinement	Generation Many candidate solutions	Illumination A few promising solutions	Verification A single optimal solution	Communication A working prototype	Validation A successful product
Process	Convergent	Convergent			Convergent	Convergent		Convergent
	versus						Mixed	
	Divergent		Divergent	Divergent				
Person (motivation)	Reactive						Reactive	Reactive
	versus	Mixed				Mixed		
	Proactive		Proactive	Proactive	Proactive			
Person (properties)	Adaptive	Adaptive				Adaptive	Adaptive	Adaptive
	versus							
	Innovative		Innovative	Innovative	Innovative			
Person (feelings)	Conserving	Conserving				Conserving	Conserving	Conserving
	versus							
	Generative		Generative	Generative	Generative			
Product	Routine	Routine				Routine	Routine	Routine
	versus							
	Creative		Creative	Creative	Creative			
Press	High Demand	High				High	High	High
	versus							
	Low Demand		Low	Low	Low			

Figure 2-3: The innovation phase model (IPM) by (Cropley & Cropley, 2015)

2.6 Innovation Capability in Military Organisations

Despite the development of different theories of innovation specific to military organisations (Chen, 2005; O'Brien, 1997), none has focused on the psychological antecedents of innovation or been able to provide a framework for a critical evaluation of the organisational capacity for innovation. Eriksen (2015) highlighted the isolation of the innovation studies made on the military. Several authors (Harris, 2006; Jungdahl & Macdonald, 2015) report that there exist various inhibitors to the innovation capability within the military organisational environment and culture.

2.6.1 Military Organisational Environment and Culture

Ravasi and Schultz (2006) defined the organisational culture as a set of shared mental assumptions that guide interpretation and action in organisations by defining appropriate behaviour for different situations. This culture includes the pattern of collective behaviours that are taught to new organisational employees as a way of perceiving and even thinking and feeling (Anitha & Begum, 2016). The organisational culture has been recognised as a critical element of impact for evaluating organisations in different contexts (Laforet, 2016). Organisational culture can establish competitive advantages and impact on organisational performance (Dyson, 2019). Different theories have been developed to underpin research designs on organisational culture (Dauber, Fink, & Yolles, 2010). For this study, the organisational culture model of Dauber *et al.* (2012) was adopted (see Figure 2-4).

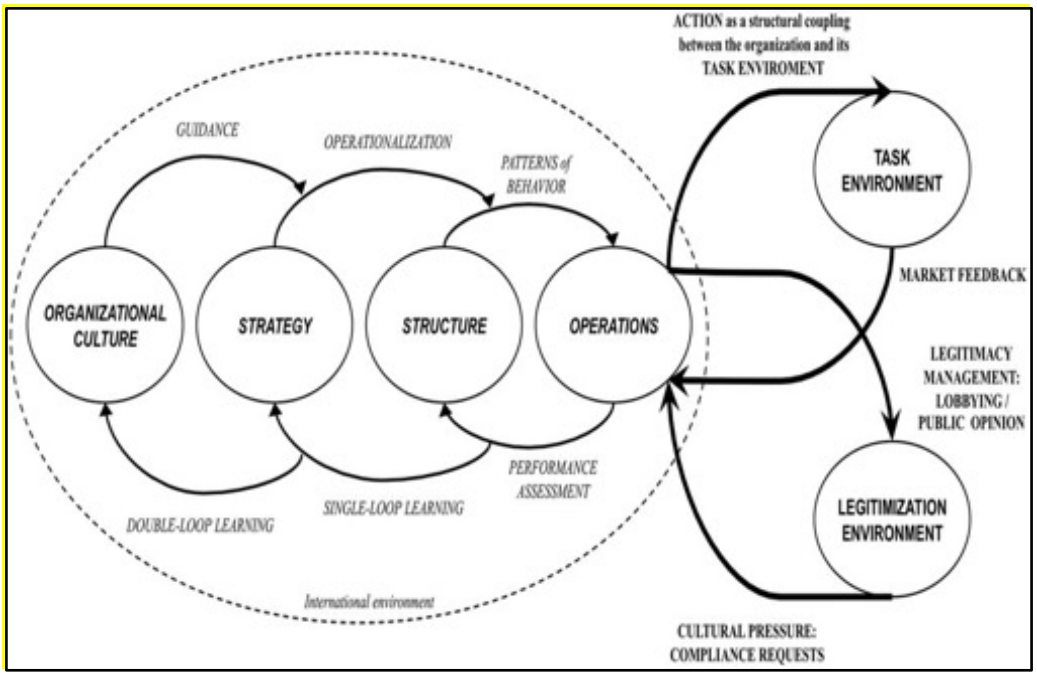

Figure 2-4: Model of organisational culture by Dauber et al. (2012)

The Dauber *et al.* (2012) model of organisational culture clearly explains how both the internal and external environment influences organisation performance. This impact forms the basis for two objectives of this study: to assess the influence of the 'military culture/environment' of the stakeholders on MMI innovativeness (*external environment*) and to explore the relationship between employees with or without a military service history on the R&D innovation capability (*internal environment*).

This model also describes the relationship between 'strategy', 'structure', and 'operations'. 'Strategies' are defined as the overall orientation of an organisation for reaching present goals and objectives (Such & Mutrie, 2017), 'structures' provide the frame of reference for future information processing and strategic decision making and 'operations' simply refers to organisational behaviour and performance. Operations might be oriented toward both the internal and external environment (Dauber, Fink, & Yolles, 2012).

Militaries are governed by strict rules, regulations, boundaries and norm-compliance (Sandwith, Cropley, & Chandler, 2017). One can describe military organisations as hierarchical with multiple bureaucracies (Soeters, 2018). The bureaucratic nature of military organisations is sustained by consistency and standardised protocols of dealing with the usual problems (Hill, 2015). Furthermore, according to Miller (2014), militaries are unique organisations with their own methodologies, history, values and beliefs. Hence, the military culture is premised on the principles of shared history and values. Operative and strategic ideas of '*what works*' in the military environment cannot be separated from the principles of organisational status and individual identity (Miller, 2014). Murray (1996) describes that is because the military organisations have a culture of disciplined obedience wherein soldiers, sailors and airmen must always be steadfast even in life-threatening situations. Organisations with such discipline seldom place a high value on novel, untried concepts and innovations.

Accordingly, the close association between the military organisations and the MMIs to identify future needs for technology (market pull) and to identify future capabilities and opportunities (technology push) make reasonable grounds to claim that the MMIs are not isolated from the military organisations' environment and culture (*external environment)*. Furthermore, the MMI recruits military veterans as they are field experts and are correspondingly capable of representing the end-users for the products that convey a transfer of military culture to MMIs (*internal environment*).

Several studies (Caniëls & Veld, 2019; Montuori, 2017; Rehman, Ahmad, Allen, Raziq, & Riaz, 2019) have reported the importance of employee creativity, suggesting that they allow organisations to adapt to changing environmental conditions and maximise opportunities. Innovative work behaviour is the generation of ideas (creativity), the propagation of ideas, and the implementation of ideas (Caniëls & Veld, 2019). Innovative behaviour entails creating new and potentially valuable ideas. Employee creative activity refers to a crucial feature of organisational efficiency: designing, implementing and applying new ideas to improve performance in a company or organisation (Nafees, Khan, & Imran, 2019).

Problematically, the nature of the military culture has been described as one that hinders innovation and creativity (Ferrara, 2017). This description could be attributed to the fact that the military values uniformity, hierarchy and many more standard procedures of operation (Eriksen, 2015). Kamara (2015) adds that the military is governed by strict rules, regulations, boundaries and norm-compliance that are viewed as being incompatible with the norm-breaking nature required for innovation and creativity. Additionally, several studies (Holmberg & Alvinius, 2019; Meredith, et al., 2017), reported the military culture is resistant to change, while the ability to change is an essential component for effective innovation. This resistant to change of military organisations is sustained by consistency and standardised protocols of dealing with the usual problems (Hill, 2015).

Hill (2015) highlighted this challenge by stating that:

> *Bureaucracies thrive on consistent, standard approaches to resolving familiar problems. Militaries are bureaucracies that depend on standardisation of tools, training, methods, and organisation. Innovation subverts this standardisation and consistency, first, in the exploration of a new approach (the introduction of variance into the system), and then (if the innovation is successful enough) in the eventual replacement of the existing approach throughout the organisation. The generalisation of an innovation requires organisational change, which in turn may require cultural change.*

Meunier (2019) argues that major innovation in the military is stimulated largely by civilians who are free from the emotions and psychological issues that are associated with a lifetime of service in military organisations. Moreover, researchers have recently illustrated that employees that have a military service background often exhibit lower levels of agreeability, which is incompatible with the nature required for innovation and creativity (Rossberger,

2014), when compared to their civilian counterparts after the completion of their service (Sandwith, Cropley, & Chandler, 2017).

The literature has also highlighted the other aspect of this argument. Leske (2018) argues that in military systems, civilians play only minor roles in innovation. In most cases, it is visionary soldiers who have been the most effective champions of change within the military (Andrade, 2017). According to Leske (2018), radical innovation in the military is introduced by uniformed personnel only. Hill (2015) describes the inter-service competition as an ideal catalyst of innovation. Furthermore, Witzel (2014) focuses on organisational factors such as leadership attitudes and behaviours that contributed to innovation in the military. Some of the themes which were identified in his study include leader credibility, integrity, professionalism, collaboration and teamwork. Moreover, Tomes (2006), describes the innovation in the USA military as a social process influenced by several aspects such as technology, military operations and organisational factors. However, the present study empirically explored the innovation capability within MMIs in South Africa by diagnosing one of its large organisations in this context.

2.6.2 The Examined Military Manufacturing Industry in This Study

This study focus is consequently limited to the systems and services that are specifically developed for defence, such as air, sea and land systems, and weapons and munitions that are primarily linked to military capability. Due to the nature and vast levels of diversity, even after considering the scope mentioned above, this research will be limited on the R&D sector of a single existing company with a wide range of activities in development, production and maintenance of defence equipment. The investigated MMI is one of the main MMI organisations in South Africa; it produces armaments on a large scale for both domestic and international markets. The examined company specialises in the development, design and manufacture of large- and medium-calibre ammunition families and is a world leader in the field of artillery, mortar and infantry systems as well as plant engineering. The identity of the company will remain anonymous throughout the research for confidentiality purposes.

2.6.3 South African Military Manufacturing Industries

The history of the South African MMI dates back to 1939, the beginning of the Second World War (van der Waag, 2015). Since then, significant changes have been made within the military manufacturing industry (van der Waag, 2015). With the new political dispensation in

1994, South Africa was admitted again as a member of the international community, and any company could now tender for military business in the country; likewise, South African companies could also complete for business elsewhere (Botha, 2003). Following the attainment of independence, the South African government managed to develop an independent military manufacturing industry (Botha, 2003). This action coincided with a surge in the country's overall industrial capacity, much of it premised on strategic considerations, for instance, the substitution of goods that the country could no longer import (Botha, 2003). The terms' *military manufacturing industry'* (MMI) and '*defence industry'*, also referred to as the '*armaments industry*' and the '*defence suppliers*', are all recognised as the groups and organisations within the public sector that are directly and indirectly involved in providing services and goods to defence forces (Government, 2019). Figure 2-5 is an illustration of the defence industry in South Africa (National Defence Industry Council, 2017).

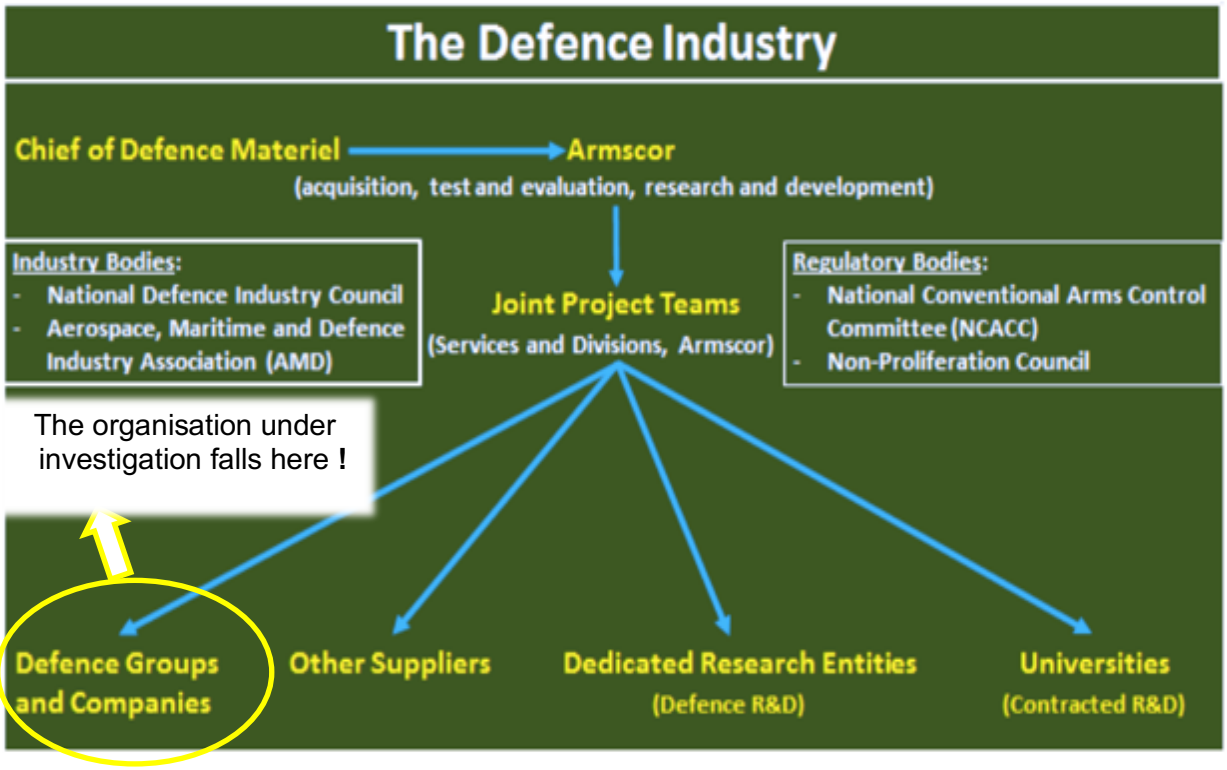

Figure 2-5: South Africa Defence industry- Adapted from NDIC (2017)

2.6.4 Chief of Defence Materiel

The Chief of Defence is the '*accounting officer'* of the MOD, responsible for policy and civilian oversight for all defence-related matters (National Defence Industry Council, 2017). It is also responsible for the acquisition of all armaments, supporting the industry's R&D and management of technology (National Defence Industry Council, 2017).

2.6.5 Armscor

Armscor was set up before the attainment of independence (Botha, 2003). The roles of Armscor were broad: promote and co-ordinate the development, manufacture, standardisation, maintenance, acquisition, or supply of armament (Rogerson, 1990). During this period, Armscor had the freedom to enter into contractual agreements with other stakeholders without any restrictions from the MOD (Rogerson, 1990). Armscor could make use of the services of individuals, or institutions or any state departments. This freedom created conflicts of interest, and there were complaints from other stakeholders about how they operate (Botha, 2003). Armscor's manufacturing responsibilities were then allocated to a government-owned corporation, and its role is now restricted to managing the acquisition of armament for the MOD (National Defence Industry Council, 2017).

2.6.6 Industry Bodies and Their Functions

This category includes associations which are responsible for the provision of a range of services to the MMI, including training and support along with lobbying on behalf of the MMI (Government, 2019).

2.6.7 National Defence Industry Council

The National Defence Industry Council (NDIC) was set up to create a working balance between the commercial elements and the state-owned defence industry to provide the best overall outcome for the defence forces (Government, 2019).

2.6.8 Aerospace, Maritime & Defence Industry Association (AMD)

The AMD is a group of private and public companies that supply defence materiel, products and services (Hartley & Belin, 2019). Its main objectives are to represent the MMI in matters of shared interest and to ensure that the industry remains profitable, sustainable and accountable (Hartley & Belin, 2019). AMD is also responsible for providing leadership in harnessing the combined effort of the MMI because these companies have an important role in the procurement supply chain (Botha, 2003). This responsibility ensures that all the companies involved have access to cost-effective and sustainable solutions that are compliant with strict technical requirements, matching global standards (Botha, 2003).

2.6.9 Regulatory Bodies and their Functions

Government regulatory bodies were created to implement a supervisory function, including selecting requirements, setting the standards, enforcing them and ensuring compliance (Government, 2019).

2.6.10 National Conventional Arms Control Committee (NCACC)

The National Conventional Arms Control Committee (NCACC) is a ministerial committee responsible for developing policies for the MMI, particularly in the transfer of weapons, and dispensing marketing and export permits to govern the flow of arms (Botha, 2003).

2.7 Conclusion

This chapter provided the state of knowledge about the military manufacturing industry and the innovative capability of research and development within this industry (MMI). It also gave an overview of the MMI in South Africa. The significance of the chapter was to provide the research context and demonstrate how the current study fits into the grand scheme of studies that investigate the key concepts of the study. The following chapter will discuss the research methodology that was applied to respond to the research objectives described in Chapter 1 systematically.

CHAPTER 3 RESEARCH METHODOLOGY

3.1 Introduction

This chapter describes the study design and methods used to fulfil the research objectives of the study. It also provides a brief description of the data collection tool, the data collection procedures, the statistical analyses performed and relevant ethical considerations.

3.2 Study Design

This study followed a quantitative, descriptive, cross-sectional design. The study is quantitative because the variables under investigation can be quantifiable (Bryman, 2018). It is descriptive because it describes the extent to which the entire MMI, as well as a specific group within the MMI, are aligned to the ideal status through the innovation phases. Furthermore, this research will be applied to the R&D sector of an internationally recognised company that produces armaments on a large scale for domestic and international markets. The research design entails thorough execution of pre-study evaluations, a systematic review of the literature, and proper research methodology in conjunction with data collection and data analysis to explore the relationship between employees with or without a military service history on the R&D innovation capability. The motivation was to understand the sample under investigation, instead of generalising results from the sample to the general military manufacturing industry. The research findings will be thoroughly discussed to pave the way for research output. Finally, this study will illustrate how the study findings align or differ with other studies on military innovation capabilities.

3.3 Research Method

This study was conducted in two phases. The first phase was a comprehensive review of literature on the innovation and creativity within the military context. Collection of quantitative data through an online survey instrument then followed this review. The survey instrument was used to establish a baseline measure of innovation capability in the investigated MMI, both as a diagnostic tool for this study, and as a standard for future interventions intended to improve innovation within the MMI.

3.3.1 Literature Review

To ensure a literature review covered a wide range of insights, a broad spectrum of sources was consulted. These sources include textbooks, peer-reviewed articles, scientific journals and several electronic references including websites and search engines. Keywords appropriate to the subject area were used to obtain relevant literature. These included keywords such as military, defence, industry, innovation, and creativity. The data mentioned above was obtained from peer-reviewed published articles from accredited journals such as the *South African Journal of International Affairs, Creativity and Innovation Management* and the *Journal of Strategic Studies,* among others.

3.3.2 Empirical Study

The innovative capability and creativity of employees within the MMI were explored and described using a descriptive cross-sectional survey. The study followed a positivism paradigm; this philosophy entails that objective knowledge is acquired through observing the phenomenon without any interference by the investigator (Rahi, 2017). This study applied the Innovation Phase Assessment Instrument (IPAI) developed in Cropley and Cropley (2012) and Cropley et al. (2013). The IPAI offers a statistically robust and reliable measure of an organisation's alignment the conditions that are ideal for innovation (Cropley D. , 2016).

3.4 Research Context

The MMI investigated does not fall within the Ministry of Defence (MOD) but under the Minister of Public Enterprises. It is one of the main MMI organisations in South Africa; it produces armaments on a large scale for both domestic and international markets. It is regulated by the regulatory bodies just like any other private MMI company in the country as it is a for-profit organisation (see Figure 2-5 in Chapter 2). The investigated MMI has an R&D unit from which the study participants were recruited for sampling.

3.4.1 Sampling

The researcher made use of purposive sampling to select participants that met the inclusion criteria. According to Etikan and Bala (2017), purposive sampling refers to the conscious selection of specific participants to take part in the study. Purposive sampling will be used

to recruit the participants from the investigated organisation to obtain the most suitable candidates to take part in the research.

3.4.1.1 Inclusion criteria

Both male and female participants in the listed groups below who were working in the R&D unit were selected to take part in the study. Participants were able to read and understand English and were willing to be included in the study. The following were the inclusion criteria:

- Employees working in the R&D unit
- Employment in the organisation for at least two years (those with at least two years of experience are more exposed to the organisational culture)
- Participation was voluntary – participants had to feel free to participate and not be forced or coerced to take part in the research.

3.4.1.2 Study Population

The population of the study refers to individuals who met the criteria for study inclusion (Etikan & Bala, 2017). This study was conducted in the MMI described in section 3.4. The study population consisted of employees working in the R&D unit of the investigated MMI. There was a total of approximately 100 employees.

3.4.1.3 Sample Size

In this study, the researcher made use of all the employees within the R&D unit of the military organisation who met the requirements of the inclusion criteria. The total number of participants in this unit were 18 employees. For total population samples, this number will be sufficient to conduct the statistical analyses (Thomas, 2021).

3.5 Recruitment Process

The researcher contacted the management of the investigated MMI via e-mail to ask for permission to conduct the study with the employees of this organisation (see Appendix A: permission request). The permission was granted via e-mail from the management of the investigated MMI (see Appendix B: study permission). The researcher complies with the permission's conditions that state the following:

- An instruction form must be submitted to the organisation management that illustrates the steps which the participants must follow to complete the survey for review and approval purposes (see Appendix C: instruction sheet for survey).

- The organisation management will distribute the instruction form to the participants, and they are only allowed to use their cell phone, home computer or internet cafe to complete the online survey questionnaire.

The questionnaire was completed online at a time convenient to the participants. The '*instruction sheet for survey*' directed participating employees in MMI to a website where the relevant survey was hosted. The website page opened with an informed consent form which the participants could sign by clicking a button before they could take part in the study. After clicking the informed consent form, the participants could complete the online survey within 10–15 minutes.

3.6 Data Collection

The study made use of an existing survey instrument, the Innovation Phase Assessment Instrument (IPAI), developed in Cropley and Cropley (2012) and Cropley et al. (2013). The researcher contacted Professor David H Cropley via e-mail to obtain permission to apply the IPAI in this study. The permission was obtained to make use of the IPAI only for this study purpose since it is owned by a third party (consultancy firm). Hence, to control the distribution of the instrument, the online survey (Survey Monkey) link was created by Professor Cropley (see Appendix D: survey questions or see link: https://www.surveymonkey.com/r/W8QL8HR). The collected data was sent to the researcher after completion in Excel file format (see Appendix E: collected data).

3.6.1 Data Collection Instrument

The IPAI survey contains a 95-item scale designed to evaluate the investigated organisation's alignment to six dimensions of human capital innovation inputs, to explore the innovation capacity within that organisation. The IPAI's 95-item scale are presented in random order and as a dichotomous choice (true/false) answers with both negative and positive keying to minimise response bias. The IPAI scores are given as percentage scores and represent the alignment of the investigated organisation to the ideal theoretical conditions for innovation, defined in the Innovation Phase Model (IPM) (Figure 2-3), on the given variable. The IPAI has been used in other similar studies and proved to be valid and reliable at Cronbach's alpha > 0.7 (Cropley D. , 2016).

3.6.2 Data Analysis

The Statistical Package for Social Sciences (SPSS) version 20 was used for data analysis. The researcher used descriptive analysis of the IPAI, i.e. means and standard deviations of the node, phase and dimension scores of innovation alignment to perform a SWOT (strengths, weaknesses, opportunities and threats) analysis of the MMI innovative capacity.

3.6.3 Validity and Reliability

Validity is the ability of the input data to conform to the data requirements of the system to avoid bias. Reliability is the ability of the survey to produce similar results in a similar context. The questionnaire adopted for this study has been used in other similar studies and proved to be valid and reliable at Cronbach's alpha > 0.7 (Cropley D. , 2016). Further discussion of the statistical properties of the IPAI can be found in Cropley and Cropley (2012) as well as Cropley et al. (2013). A comprehensive discussion of the formation of the theoretical foundation is given in Cropley and Cropley (2015).

3.6.4 Data Verification

Data verification is a process of ensuring that the data are well captured and ensures there is no missing data (Houston, Probst, & Martin, 2018). Data were checked for completeness through the online survey hosting platform services (Survey Monkey).

3.7 Ethical Considerations

3.7.1 Ethical Approval and Permission

Ethical approval was obtained from the ethics committee of North-West University, South Africa. Permission was obtained from the management of the investigated MMI.

3.7.2 Direct Benefits for Participants

There were no direct benefits associated with participating in this study. However, the benefits were indirect because participants provided data which will benefit the field of study.

3.7.3 Remuneration

Participants were not remunerated for taking part in the study because they did not incur any cost during data collection as the study was online and could be completed using the organisation's internet.

3.7.4 Dangers/risks and Precautions for Participants

The research did not pose more than minimal risk of harm to the participants. The participants were informed that their privacy and confidentiality would be maintained and that the information they provided will not be used for other purposes but only for this study.

3.7.5 Privacy/confidentiality

Participants completed the online questionnaire independently, where they felt safe during the process of data collection. No names were included in the data collection tools to ensure the confidentiality of the participants.

3.7.6 Storage of Electronic Data

All electronically captured data was saved on a password-protected computer. The external hard drive was used to back up all electronic data, which is locked in a cupboard in the researcher's office.

3.7.7 Dissemination of Study Findings

The study findings will be published as a research article and also be made available to the investigated organisation in the form of an information leaflet.

3.7.8 Destruction of Data

The electronic data has been backed up. After 5 years, the data will be destroyed according to North-West's University's rules and regulations for data/record management.

3.8 Summary

This chapter described the research methods applied to this study. Considering the topic is quite sensitive; the researcher described how he integrated the critical ethical issues within the entire research methodology, starting from obtaining legal authority to the dissemination of research results. The following chapter will provide a detailed description of the research results.

CHAPTER 4 RESEARCH RESULTS AND DISCUSSION

4.1 Introduction

The general objective of this research was to critically evaluate the R&D's innovation performance within an MMI, focusing specifically on a single company within this industry. The study also investigated the influence of personnel with a military service history on the R&D innovation capacity in the MMI. This chapter presents the research results and discussion. As a preface to the study results, the section below presents the demographic characteristics of the study sample. Results and discussion are presented based on the *Innovation Phase Assessment Instrument* (IPAI), which was used to gather data.

4.2 Overview of Study Participants

A total of 18 participants took part in this study, and the majority (16) were male. Ages of participants ranged from 18–64. Two units of the investigated organisation were represented in the sample, with an approximately equal distribution of participants in each group, i.e. SSW (10 participants) and BSK (8 participants). The group names SSW and BSK were used for confidentiality purposes. Participants were further divided into two groups, i.e. those with military background (4) and those with no military background (14). Table 4-1 is a summary of the demographic characteristics of this study population.

Table 4-1: Demographic characteristics of the study participants

VARIABLE (N=18)							
Gender		**Age (years)**		**Workgroup**		**Military background**	
Male	16	18-24	2	BSK	10	Yes	4
Female	2	25-29	5	SSW	8	No	14
		30-34	5				
		35-39	2				
		40-44	-				
		45-49	1				
		50-54	1				
		55-60	-				
		60-64	2				

4.3 Overview of Study Results

The IPAI enabled the researcher to determine the extent to which the investigated MMI was aligned to the states of the antecedents that favour innovation in each phase for each dimension (see figure 3-1), and the key descriptive statistic used was the frequency count of aligned responses. The participants' responses as a percentage of the total responses for each node (*Phase/Dimension*) are presented in Table 4-2. The higher the frequency, the better the organisation aligns for that node with the favourable antecedent state.

Table 4-2: The MMI's R&D Overall innovation alignment

	Preparation	Activation	Generation	Illumination	Verification	Communication	Validation	
Process	88.89 **S**	80.56	55.56	91.67 **S**	72.22	70.37	55.56	73.55 **S**
Motivation	77.78	63.89	72.22	77.78	77.78	81.48 **S**	44.44 **W**	70.77
Personal Properties	72.22	80.56	46.30 **W**	70.37	66.67	75.93	69.44	68.78
Feelings	47.22 **W**	41.67 **W**	75.00	88.89 **S**	72.22	81.48 **S**	66.67	67.59
Product	57.41	70.37	72.22	80.56	63.89	88.89 **S**	48.15 **W**	68.78
Press	52.78 **W**	66.67	50.00 **W**	55.56	58.33	64.82	58.33	58.07 **W**
	66.05	67.28	61.88	77.47 **S**	68.52	77.16 **S**	57.10 **W**	**67.92**

(**S**) indicates a Strength (Value is >1SD above the mean); (**W**) indicates a Weakness (Value is <1SD below the mean)

The QQ plots were used to test the node, phase and dimension scores, and there was no indication of any major violation of normality. The descriptive statistics (mean, standard deviation and range) for individual alignment scores for nodes, phases and dimensions are presented in Table 4-3.

Table 4-3: Means and SDs for Node, Phase and Dimension Alignments

MEASURE	M (%)	SD (%)	Range (%)
Node alignment (%)	67.92	13.18	50.00
Phase alignment (%)	67.92	7.47	20.37
Dimension alignment (%)	67.92	5.26	15.48

The means and standard deviation of the node, phase and dimension scores of innovation alignment were used to perform a SWOT (strengths, weaknesses, opportunities and threats) analysis of the investigated the MMI's capacity for innovation. The categories of strength, weakness, opportunity and threat were defined by bands of standard deviation above and below the mean (see Table 4-4).

Table 4-4: Relative SWOT for MMI's R&D

	Weakness %	Threat %	Opportunity %	Strength %
Node SD (13.18)	< 54.74	54.74 67.92	81.10 67.92	>81.10
Phase SD (7,47)	< 60.45	60.45 67.92	75.39 67.92	>75.39
Dimension SD (5,26)	< 62.66	62.66 67.92	73.18 67.92	>73.18

As shown in Table 4-2, the investigated MMI's R&D indicated two outright strengths (M > 75.39%) for the phases of illumination and communication as well as a single weakness (M < 60.45%) in the validation phase. The overall result indicated one outright strength (M > 73.18 %) for the process dimension and a single weakness (M < 62.66%) for the dimension of press (organisational climate). Seven nodes presented as weaknesses (M < 54.74%), while six nodes presented as strengths (M > 81.10%) for the investigated MMI's R&D.

Table 4-5: SSW group overall innovation alignment

	Preparation	Activation	Generation	Illumination	Verification	Communication	Validation	
Process	90.00 **S**	85.00 **S**	55.00	95.00 **S**	70.00	73.34	63.33	75.95 **S**
Motivation	80.00	60.00	80.00	75.00	80.00	86.67 **S**	45.00 **W**	72.38
Personal Properties	75.00	85.00 **S**	50.00 **W**	76.67	65.00	86.67 **S**	75.00	73.33
Feelings	40.00 **W**	40.00 **W**	80.00	90.00 **S**	70.00	83.33	65.00	66.90
Product	46.67 **W**	73.34	70.00	75.00	45.00 **W**	90.00 **S**	46.67 **W**	63.81
Press	50.00 **W**	65.00	60.00	65.00	55.00	60.00	60.00	59.29 **W**
	63.61	68.06	65.83	79.44 **S**	64.17	80.00 **S**	59.17 **W**	**68.61**

(**S**) indicates a Strength (Value is >1SD above the mean); (**W**) indicates a Weakness (Value is <1SD below the mean)

Table 4-6: Means and SDs for the node, phase and dimension alignments for the SSW group

MEASURE	M (%)	SD (%)	Range (%)
Node alignment (%)	68.61	15.16	55.00
Phase alignment (%)	68.61	8.05	20.83
Dimension alignment (%)	68.61	6.38	16.67

Table 4-7: Relative SWOT for the SSW group

	Weakness %	Threat %	Opportunity %	Strength %
Node SD (15.16)	< 53.45	53.45 68.61	83.77 68.61	>83.77
Phase SD (8,05)	< 60.56	60.56 68.61	76.66 68.61	>76.66
Dimension SD (6.37)	< 62.23	62.23 68.61	74.98 68.61	>74.99

Table 4-5 illustrates that the SSW workgroup had two outright strengths (M > 76.66%) for the phases of illumination and communication as well as a single weakness (M < 60.56%) in the validation phase. The SSW workgroup indicated one outright strength (M > 74.99 %) for the process dimension and a single weakness (M < 62.23%) for the dimension of press (organisational climate). Eight nodes presented as weaknesses (M < 53.45%), while eight nodes presented as strengths (M > 83.77%) for the SSW group.

Table 4-8: BSK group overall innovation alignment

	Preparation	Activation	Generation	Illumination	Verification	Communication	Validation	
Process	87.50 **S**	75.00	56.25	87.50 **S**	75.00	66.67	45.83 **W**	70.54
Motivation	75.00	68.75	62.50	81.25 **S**	75.00	75.00	43.75 **W**	68.75
Personal Properties	68.75	75.00	41.67 **W**	62.50	68.75	62.50	62.50	63.10
Feelings	56.25	43.75 **W**	68.75	87.50 **S**	75.00	79.17	68.75	68.45
Product	70.83	66.67	75.00	87.50 **S**	87.50 **S**	87.50 **S**	50.00 **W**	75.00 **S**
Press	56.25	68.75	37.50 **W**	43.75 **W**	62.50	70.83	56.25	56.55 **W**
	69.10	66.32	56.94 **W**	75.00	73.96	73.61	54.51 **W**	**67.06**

(**S**) indicates a Strength (Value is >1SD above the mean); (**W**) indicates a Weakness (Value is <1SD below the mean)

Table 4-9: Means and SDs for the node, phase and dimension alignments for the BSK group

MEASURE	M (%)	SD (%)	Range (%)
Node alignment (%)	67.06	13.85	50.00
Phase alignment (%)	67.06	8.35	20.49
Dimension alignment (%)	67.06	6.42	18.45

Table 4-10: Relative SWOT for the BSK group

	Weakness %	Threat %	Opportunity %	Strength %
Node SD (13.85)	< 53.21	53.21 67.06	80.91 67.06	>80.91
Phase SD (8,35)	< 58.71	58.71 67.06	75.41 67.06	>75.41
Dimension SD (6.42)	< 60.64	60.64 67.06	73.48 67.06	>73.48

Table 4-8 shows the BSK workgroup indicated no outright strengths (M > 75.41%) for all the phases and two weaknesses (M < 58.71 %) in the generation and validation phases. This group also indicated one outright strength (M > 73.48 %) for the product dimension, and a single weakness (M < 60.64%) for the dimension of press (organisational climate). Seven nodes presented as weaknesses (M < 53.21%), and seven nodes presented as strengths (M > 80.91%) for the BSK workgroup.

Table 4-11: Innovation alignment for participants with a military background

	Preparation	Activation	Generation	Illumination	Verification	Communication	Validation	
Process	87.50 **S**	75.00	62.50	87.50 **S**	75.00	58.34	58.33	72.02
Motivation	75.00	62.50	62.50	75.00	87.50 **S**	75.00	37.50 **W**	67.86
Personal Properties	75.00	100.00 **S**	75.00	66.67	75.00	83.34	75.00	78.57 **S**
Feelings	37.50 **W**	37.50 **W**	87.50 **S**	87.50 **S**	75.00	75.00	50.00 **W**	64.29
Product	50.00 **W**	83.34	75.00	100.00 **S**	37.50 **W**	87.50 **S**	50.00 **W**	69.05
Press	75.00	62.50	87.50 **S**	37.50 **W**	62.50	66.67	62.50	64.88
	66.67	70.14	75.00	75.69	68.75	74.31	55.56	**69.44**

(**S**) indicates a Strength (Value is >1SD above the mean); (**W**) indicates a Weakness (Value is <1SD below the mean)

Table 4-12: Means and SDs for node, phase and dimension alignments for participants with a military background

MEASURE	M (%)	SD (%)	Range (%)
Node alignment (%)	69.44	16.91	62.50
Phase alignment (%)	69.44	7.01	20.14
Dimension alignment (%)	69.44	5.29	14.29

Table 4-13: Relative SWOT for participants with a military background

	Weakness %	Threat %	Opportunity %	Strength %
Node SD (13.85)	< 55.53	55.53 69.44	86.36 69.44	>86.36
Phase SD (8,35)	< 62.43	62.43 69.44	76.46 69.44	>76.46
Dimension SD (6.42)	< 64.15	64.15 69.44	74.74 69.44	>74.74

As seen in Table 4-11, the participants with a military background indicated neither outright strengths (M > 86.36%) nor weaknesses (M < 55.53 %) for all the innovation phases. This group of participants had one outright strength (M > 76.46 %) for the personal properties dimension, and no weaknesses (M < 64.15%) for all the dimensions. Eight nodes presented as weaknesses (M < 55.53%), while nine nodes presented as strengths (M > 86.36%) for the participants with a military background.

Table 4-14: Alignment of participants with no military background

	Preparation	Activation	Generation	Illumination	Verification	Communication	Validation	
Process	89.29 **S**	82.14 **S**	53.57	92.86 **S**	71.43	73.81	54.76	73.98 **S**
Motivation	78.57	64.29	75.00	78.57	75.00	83.33 **S**	46.43 **W**	71.60
Personal Properties	71.43	75.00	38.09 **W**	71.43	64.29	73.81	67.86	65.99
Feelings	50.00 **W**	42.86 **W**	71.43	89.29 **S**	71.43	83.33 **S**	71.43	68.54
Product	59.52	66.67	71.43	75.00	71.43	89.29 **S**	47.62 **W**	68.71
Press	46.43 **W**	67.86	39.29 **W**	60.71	57.14	64.29	57.14	56.12 **W**
	65.87	66.47	58.13 **W**	77.98 **S**	68.45	77.98 **S**	57.54 **W**	**67.49**

(**S**) indicates a Strength (Value is >1SD above the mean); (**W**) indicates a Weakness (Value is <1SD below the mean)

Table 4-15:Means and SDs for node, phase and dimension alignments for participants with no military background

MEASURE	M (%)	SD (%)	Range (%)
Node alignment (%)	67.49	13.99	54.77
Phase alignment (%)	67.49	8.28	20.44
Dimension alignment (%)	67.49	6.21	17.86

Table 4-16: Relative SWOT for participants with no military background

	Weakness %	Threat %	Opportunity %	Strength %
Node SD (13.85)	< 53.50	53.50 67.49	81.48 67.49	>81.48
Phase SD (8,35)	< 59.21	59.21 67.49	75.77 67.49	>75.77
Dimension SD (6.42)	< 61.27	61.27 67.49	73.70 67.49	>73.70

As seen in Table 4-14, the participants with no military background had two outright strengths (M > 75.77%) for the phases illumination and communication, as well as two weaknesses (M < 59.21%) in the generation and validation phases. This group of participants also had one outright strength (M > 73.70 %) for the process dimension, and a single weakness (M < 61.27%) for the dimension of press (organisational climate). Seven nodes presented as weaknesses (M < 53.50%), and also seven nodes presented as strengths (M > 81.48%) for the participants with no military background.

4.4 Intergroup Analyses

T-tests were done to compare phase, dimension and node scores for employees with a military background and those without a military background. Table 4-17 shows the *p*-values of the tests conducted; statistical significance was assigned at $p < 0.05$.

Table 4-17: Intergroup analyses for participants with military and non-military background

T-tests	t	Df	*P*-value
Nodes	0.58	79.22	0.57
Phases	0.58	11.68	0.64
Dimensions	0.59	9.75	0.57

No significant differences were found for the group comparison in either phase or dimension alignment scores for military experience.

4.5 Discussion

This critical evaluation using the IPAI aimed to characterise the innovation capability of R&D within the MMI. Likewise, the evaluation creates the foundation for innovation diffusion of significant importance to the MMIs. To improve an organisation's innovative capacity, there is a need to identify and understand where its strengths and weaknesses are located in relation to the innovation ideal. In this study, an internal evaluation of the MMI was conducted based on the strengths and weaknesses within the MMI.

The overall alignment for the investigated MMI (67.92%) demonstrated good alignment with the innovation ideal, as the range was 0% to 100%. This overall level of alignment is important as an organisational benchmark and can be used to track changes in interventions within the MMIs. However, this level of analysis is restricted to formulating intervention and improving the MMIs.

The entire organisation demonstrated weakness in the dimension press, indicating the organisational climate is not well aligned to the ideal for innovation in all phases of innovation in the investigated MMI. According to Cropley (2016), the innovative process is dynamic, and for organisations to be successful, they must be flexible and adaptable. The results shown in the dimension Press implies that the investigated MMI is not doing well in terms of organisational climate. Cropley (2016) indicated that when an organisation is struggling in this dimension, it could be attributed to the management's lack of understanding of active

innovation phases for a particular project. The reason for this could be a weakness in dealing with the organisational climate relative to these phases.

Examining individual nodes in Table 4-2 provides a deeper understanding of the determinants of strengths and weaknesses that were identified in phases and dimensions. Similarly, managers can develop specialised remedial actions for the investigated MMI. Strengths identified in the phases of illumination and communication are a product of strengths in a group of specific nodes that are linked to feelings and motivation. On the other hand, the weakness in validation is a result of a weakness in motivation and the quality of the product.

The results of the study were also interpreted for the two working groups, i.e. SSW and BSK. The overall alignment of the two groups were (68.61%) and (67.06%) respectively, which can be regarded as a good level of alignment. SSW and BSK showed weaknesses in the dimension press, emphasising the organisational climate misalignment to the innovation ideal. This idea is supported by Cropley (2016), who stated that for organisations to be successful, they must be flexible and adaptable. The results shown in the dimensions of the two groups (Tables 4-5 and 4-8) implies that the entire organisation is not performing well in terms of organisational climate. Again, this can be linked to the management's lack of understanding of active innovation phases for a particular project or a weakness in dealing with the organisational climate relative to these phases. The Dauber *et al.* (2012) model of organisational behaviours clearly explains how both the internal and external environment influences the impact of organisational behaviour on performance.

Similarly, examining individual nodes in Tables 4-5 and 4-8 provides a deeper understanding of the determinants of strengths and weaknesses that were identified in phases and dimensions. In the SSW group, strengths that were identified in the phases of illumination and communication are a product of strengths in a group of specific nodes linked to feelings, processes, personal properties and motivation. However, the weakness in validation is a result of a weakness in motivation and the quality of the product. In the BSK group, neither strengths nor weaknesses were identified in the phases of innovation.

This process of analysis and interpretation was repeated to compare differences between employees with a military background and those without a military background within the investigated MMI. The overall alignment of the two groups were (69.44%) and (67.47%) respectively, which can be regarded as a good level of alignment. The participants with no

military background showed weaknesses in the dimension press, meaning the organisational climate is not aligned in all phases of the innovation process for these participants. The results shown in the dimensions of participants with no military background (Table 4-14) imply that the organisation is not doing well in terms of organisational climate. Again, this can be linked to the lack of understanding of active innovation phases for a particular project or a weakness in dealing with the organisational climate relative to these phases.

There were no strengths identified in the phases of innovation for participants with a military background, as seen in individual nodes in Tables 4-11. For participants with no military background, the strength found in the communication phase was a result of the nature of the product, feelings and motivation. These alignment scores for phase, dimension and node for all the different groups that were discussed can provide an overview of workgroup capacity for innovation and allow the development of hypotheses aimed at improving weaknesses and sustaining the strengths in this organisation.

Independent t-tests were conducted to compare phase, dimension and node scores to examine the effect of employees with a military background on the innovative capacity of the entire organisation. No significant differences were found for this comparison in relation to either phase or dimension alignment scores for the military organisation. This result implies that having a military background had no significant effect on the innovative capacity for this military organisation.

CHAPTER 5 EVALUATION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter presents an overview of the research results and a critical evaluation of the R&D innovation performance within an MMI, focusing specifically on a single company within this industry. The chapter presents the relationship of the research results to previous studies that investigated the organisational innovation capability, especially in MMIs. The chapter also presents possible explanations for the results obtained, limitations of this research, the implication of the research results and recommendations for future research.

5.2 Purpose

The purpose of this study was to critically evaluate the R&D innovation performance within the MMI, focusing specifically on a single company within this industry. The study also investigated the influence of personnel with military service history on the R&D innovation capacity in the MMI. This is because there is a paucity of studies providing an outline of factors that can potentially hinder innovation in the military environment. Likewise, the study intends to bridge the gap in the literature regarding the understanding of innovation among employees with a military service history within the MMI. Moreover, this study will help existing MMIs aiming to promote innovation by determining the possible weaknesses and strength in the innovation process.

5.3 Study Objectives

The study managed to fulfil all the objective outlined in Chapter 1.

5.3.1 Summary of Findings in Relation to the Research Objectives

Objective 1 was *to determine the level of alignment of the examined MMI to the favoured criteria for innovativeness.* The overall alignment for the military organisation was 67.92% which is a good level of alignment to innovation. The entire organisation showed a weakness in the dimension press, indicating that the organisational climate is not aligned in all phases of the innovation process in the investigated organisation. Strengths that were identified in the phases of illumination and communication are a product of strengths in a group of specific nodes that are linked to feelings and motivation. In contrast, the weakness in the validation phase is a result of weaknesses in motivation and the quality of the product.

The results of the study were also interpreted for the two working groups, i.e. SSW and BSK. The overall alignment of the two groups was 68.61% and 67.06%, respectively, which can be regarded as a good level of alignment. The two groups showed weaknesses in the dimension press, meaning the organisational climate is not aligned in all phases of the innovation process in the two groups. In the SSW group, strengths identified in the phases of illumination and communication are a product of strengths in a group of specific nodes linked to feelings, processes, personal properties and motivation. In contrast, the weakness in validation is a result of weaknesses in motivation and the quality of the product. In the BSK group, there were neither strengths nor weaknesses that were identified in the phases of innovation.

Objective 2 was *to assess the influence of the 'military culture/environment' of the stakeholders on the MMI's innovativeness.* The entire organisation showed a weakness in the dimension press, and this means the organisational climate is not aligned in all phases of the innovation process in the investigated organisation. The two groups, SSW and BSK, showed weaknesses in the dimension press, meaning the organisational climate is not aligned in all phases of the innovation in the two groups.

Objective 3 was *to explore the relationship between employees with or without a military service history on the MMI's R&D innovation capability.* Having a military background had no significant effect on the innovative capacity of the entire organisation. The overall alignment of SSW and BSK was (69.44%) and (67.47%) respectively, which can be regarded as a good level of alignment. The participants with no military background showed weaknesses in the dimension press. On the other hand, examining individual nodes for participants with a military background, there were no strengths identified in the phases of innovation. For participants with no military background, the strength in the communication phase was a result of the nature of the product, feelings and motivation.

Table 5-1 shows how the study results compare with other studies on Military Manufacturing Industries innovative capabilities. Even though there are several similarities identified, the implementation of IPAI gives this study more depth. The results of the IPAI instrument provides organisational leadership with a deeper insight into the innovation strengths and weaknesses of their organisation, making it possible to provide specialised remedies effectively.

Table 5-1: How the study findings align or differ with other studies on military innovative capabilities

Author(s)	Study title	Focus or scope	Main findings	Similarity or differences with current study findings
Buys (2006)	Innovative Behaviour of the South African Defence Related Industries	The study was a comparative analysis between the innovative behaviours of the defence-related industries and other industrial sectors in South Africa focusing on financial perspective.	South African Defence Related Industries were the highest-scoring sector or close to the highest on all the innovation indicators measured.	The difference between the two studies was on the indicators used; the study by Buys (2006) incorporated financial expenditure as an indicator of innovation, whereas the current study does not.
Börjesson and Elmquist (2008)	Aiming at innovation in the Swedish defence industry-the difficulties of responding to disruptive market change in a technology-driven context.	The study aimed at contributing to a better understanding of how organisations respond to disruptive changes in their environment that are non-technological.	These results show that change is not easy, especially if it does not address the underlying organisational values and routines for knowledge generation that are vital for increasing innovative capabilities.	Both studies were focused on a single study in the defence industry, and the ultimate goal was to help the companies understand how to respond to change. The common theme in these studies is that military organisations are resistant to change.

García-Estévez and Trujillo-Baute (2014)	Drivers of R&D investment in the defence industry: evidence from Spain	This paper analysed the main drivers of R&D investment in Spanish defence. In particular, analysed the factors associated with the decision to innovate or not, and those that affect the number of resources dedicated to innovation process.	The intensity of the R&D investment accomplished by organisations is higher provided they devote a greater share of employees to innovative activities.	Both studies explored the external factors that lead or hinder the innovative process within the defence industry.
Koroglu and Eceral (2015)	Human Capital and Innovation Capacity of Firms in Defence and Aviation Industry in Ankara.	Explored the relationship between innovation and human capital.	The study offers ideas regarding the positive association between innovation activities and human resources in the defence industry.	The similarity between the two studies is mainly on exploring aspects with the individual employees that affect innovation.
Schmid (2018)	The determinants of military technology innovation and diffusion.	Explored the determinants of military technology innovation using the novel explanatory framework, the threat-capacity theory, to explain international variation in the capacity to develop and produce novel military technologies.	No difference was found in the rate of diffusion between civilian and military technologies. Military technologies allocated to government organisations do not diffuse at different rates compared to those allocated to civilian organisations.	Both studies explored whether having a military background affected the rate of innovation. The analyses were done based on specific frameworks for explaining innovation. Both studies found that having a military background did not affect the innovation process of the organisation.

Leske (2018)	A review on defence innovation: from spin-off to spin-in	Explored whether the Brazilian defence industry can generate overflows of the innovations developed in the military area for the civil area.	The decision of whether to invest in military or civil organisations to boost economic development is also dependent on historical and socio-economic contexts in which decisions are taken.	Both articles show that innovation cannot be observed by the linear perspective and social factors have to be considered for innovation to occur.
Ramalho et al. (2019)	Analysis of the innovation value chain in strategic projects of the Brazilian Army	This study described and compared seven case studies of strategic innovation projects of the Brazilian army; the projects exhibited high transformational potential and high investments and were supported by technology and science policies.	The results obtained suggest that the innovation process occurs in four stages: creation, selection, development and diffusion of ideas.	Both studies explored the effect of having a military background on the innovative capacity by different approach. However, they differ in terms of the outcome of this objective. The current study found that having a military background does not influence the innovative capacity with the MMI.

5.4 Limitations of the Study

The study made use of questionnaires that were developed and validated in a different context, which could have impacted the study findings. Another limitation of this study is the sample size (n = 18) relative to the total population of R&D employees (N = 100). The impact of sample size on the confidence interval is significant for smaller populations. Therefore, future studies of the MMIs must strive to maximise the sample sizes if meaningful to allow generalisation of the results to a broader population.

5.5 Conclusion

Based on the study results, the success of MMIs is tied to their alignment to the antecedents of innovation. The management of these organisations has to critically handle the identified set of innovation paradoxes, i.e. the conditions and characteristics that are ideal for the innovation process. Such conditions are dynamic and could change depending on the stage of the innovation process. Therefore, the MMIs have to be proactive in managing the characteristics of the person, the process, the product and the press, to guarantee that the appropriate actions are taken at the right time. The instrument applied to this study (IPAI) provides the R&D in the MMI with a deeper insight into the innovation strengths and weaknesses of the MMI, making it possible to improve effectively.

5.6 Implications of the study findings

The results of this study will guide the management within the investigated organisation in applying suitable measures and designating appropriate policies. This study offers the investigated MMI managers indicators of differences across a range of factors that stimulate innovation capacity, and these indicators then serve as a framework to guide organisational change and improve innovation. Innovation requires management to be dynamic as the conditions are also dynamic, and could change any time during the innovation process. Apart from providing an overview of the organisational capacity for innovation, the alignment scores for phase, dimension and node also allow for the development of hypotheses aimed at improving weaknesses and sustaining strengths. Thus, the successful innovation managers proactively maintain the characteristics of the process, the person, the product and the press, to ensure that the right things are done at the right time.

5.7 Summary

Since the end of World War II, most countries have accepted the fact that a vital feature of the nation's security policy is the MMI. Findings from the literature show that innovating both organizationally and technologically is historically the most promising approach in terms of increasing military power and effectiveness. In this quest, MMIs around the world are striving to become more innovative to satisfy their military needs.

The literature has described various inhibitors to innovation that exist in the military organisations and the military culture. There is a close interaction between the military entities and the MMIs, and the involvement of the military veterans in the MMIs' R&D processes leads to the hypothesis that the innovation capability within the MMIs might be negatively affected. Nevertheless, there is a gap in the literature examining the innovative capability of organisations within the MMI. Therefore, this study critically evaluated the innovation capability of R&D within the MMI sector. The aims of this study were to a) experimentally examine the MMI's R&D innovation capability to contribute to the formulation of the diagnostic baseline for performance improvement, b) contribute to filling the gap in the literature regarding the influence of the 'military culture/environment' of the stakeholders on the MMI innovativeness and c) conceptualise factors that could potentially hinder innovation in the MMIs.

Results of the study show that the overall alignment for the investigated organisation (MMI) was 67.92% which is a good level of alignment to the ideal status for innovation. The results of the study also highlight a weakness in the press dimension, indicating the organisational environment is not aligned in all phases of the innovation. Finally, the employees having a military background had no significant effect on the innovative capacity for the investigated organisation.

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APPENDIX A: PERMISSION REQUEST

APPENDIX B: STUDY PERMISSION

APPENDIX C: INSTRUCTION SHEET FOR SURVEY

APPENDIX D: SURVEY QUESTIONS

APPENDIX E: COLLECTED DATA