

# **Towards an Antifragile South African SME**

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## ***DECLARATION***

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Date: December 2017

## **SUMMARY**

*“In all affairs it's a healthy thing now and then to hang a question mark on the things you have long taken for granted.” – **Bertrand Russell***

The contribution of small- to medium-sized enterprises (SMEs) to the employment, GDP and other factors that affect poverty and income inequality of South Africa is considerable. South African SMEs contribute to the economy despite the fact that 75% of SMEs fail within the first 42 months – worse than most other countries. If SMEs can be set up to survive and prosper in the experienced volatility, economies will prosper.

Enterprises are complex adaptive systems where the dynamic constructs of the enterprise cannot be determined to their finest detail. Enterprises can therefore be represented as a system with subsystems and components which should align functionally in pursuit of the purpose of the enterprise. These subsystems and components are usually formally defined in large corporations, but they often lack that level of definition in SMEs. SMEs require a way in which to master the complexity of the enterprise at effective levels.

Smaller enterprises respond to volatility in their external- or internal environment, and there is a need to understand the possible responses. These responses can be fragile (reduced in value/functionality), robust or resilient (maintain value/functionality) or seen to improve in value/functionality, also now known as 'antifragile'. Antifragile, on the opposite side of the spectrum of fragility, is the system response which improves under volatility. The field of antifragility is in its infancy and a part of this study sought to find characteristics that enabled antifragility in systems.

The objective of this study was to develop a framework that will assist South African SMEs to be more antifragile. The research was conducted through a constructivist perspective which sought to better understand phenomena whilst understanding that an absolute answer will most likely not be found. The research was exploratory in nature, with antifragility being approached by evaluating constructs and adapting these constructs to provide a more informed and sophisticated theory than those preceding its existence to allow for utilisation in the real world. The basic systems engineering process was utilised for the exploratory building study. This resulted in the creation of a set of requirements that needed to be met by the

framework, the design of the framework, and verification and validation that the framework had met the requirements.

Nine characteristics of antifragility were identified to provide guidelines for explicit antifragile SME design. In order to transform these guidelines to the design of the SME, the systems engineer is provided with the field of enterprise engineering. Enterprise engineering has evolved into three schools of thought of which the enterprise-in-environment adaptation school of thought, focussing on dynamic endo- and exogenous stressors, was chosen as the most representative of antifragile enterprise design.

Requirements were gathered from the fields of South African SMEs, antifragility and enterprise-in-environment adaptation and were grouped into five types of categories: 1) user requirements, 2) functional (essential and desirable) requirements, 3) design restrictions, 4) attention points and 5) boundary conditions. These were filtered into groups which play a role in: 1) understanding the current enterprise state, 2) providing an understanding of the future enterprise status, and/or 3) those that provide guidance for the transformation from the current to the future status. These provided the three distinct phases of the framework. These requirements were further distilled, per phase, into requirements which meet the same objective and resulted in nine stages.

The three phases with the nine supporting stages resulted in the output, as the objective of the study, the Epictetus framework, with each stage providing an objective, requirements, and antifragile considerations to guide the enterprise design decision-making for the SME.

The validation was done through 1) a per stage validation, 2) semi-structured interviews that were held both locally and internationally, and 3) through an illustrative case study.

The study provides explicit characteristics for antifragility, as well as a method in which antifragility in a system can be assessed. It also provides the clarity of practical steps which can make antifragility explicit in enterprises and more importantly in South African SMEs. It provides a stepping stone from which a better understanding of antifragility can be gained as well as how it can be used to design systems. It also provides a foundation from which SMEs can be designed to improve under volatility.

## **OPSOMMING**

*“Yster roes as dit nie gebruik word nie, water verloor sy skoonheid as dit stilstaan en vries in koue weer; net so laat onaktiwiteit die mens se gees sterf.” – Leonardo da Vinci*

Die bydrae van klein en medium sake-ondernemings (KMOs) om die indiensneming, die BBP en ander faktore wat 'n invloed op armoede en inkomste-ongelykheid is betekenisvol vir Suid-Afrika. Suid-Afrikaanse KMOs dra grootliks by tot die ekonomie ondanks die feit dat 75% nie langer as die eerste 42 maande oorleef nie. As die KMOs kan opgestel word om te oorleef en floreer in wisselvalligheid sal dit tot die voordeel wees van ekonomieë.

Ondernemings is kompleksaanpasbare stelsels waar die dinamiese konstrukte van die onderneming nie bepaal kan word tot in die fynste detail nie. Ondernemings kan dus voorgestel word as 'n stelsel met sub-stelsels en komponente wat funksioneel moet belyn in die doelwit nastrewing van die onderneming. Hierdie sub-stelsels en komponente is gewoonlik formeel gedefinieer in groot maatskappye, maar vir KMOs is daar dikwels 'n gebrek aan detail definisie. KMOs benodig 'n manier om die kompleksiteit van die onderneming op effektiewe vlakke te bemeester.

Kleiner ondernemings reageer op wisselvalligheid in sy eksterne- of interne omgewing, en daar is 'n behoefte om die moontlike terugvoere te verstaan. Hierdie terugvoere kan broos (verminder in waarde/funksie), of veerkragtig/robuust (Handhaaf waarde/funksie) of gesien word om toe te neem in waarde/funksie, nou ook bekend as antibroos. Antibroosheid, die teenoorgestelde kant van die spektrum van broosheid, is die stelsel reaksie wat verbeter onder wisselvalligheid.

Die doel van die studie is om 'n raamwerk te ontwikkel wat Suid-Afrikaanse KMOs sal help om meer antibroos te wees. Die navorsing is gedoen deur middel van 'n konstruktivistiese perspektief wat streef daarna om verskynsels beter te verstaan terwyl 'n verstandhouding bestaan dat 'n absolute antwoord heel waarskynlik nie gevind sal word nie. Die navorsing was verkennend van aard, met antibroosheid wat benader word deur die evaluering en aanpassing van konstrukte wat 'n meer gesofistikeerde teorie kan voorstel wat meer ingelig is as die konstrukte wat voor hom bestaan het en toegelaat word om betekenisvol te wees vir die

wêreld. Die basiese stelsel ingenieurswese proses is aangewend vir die verkennende studie. Dit het gelei tot die skepping van 'n stel behoeftes waaraan die ontwerp van die raamwerk moet voldoen, en waarteen die verifikasie en validasie gedoen moet word.

Nege eienskappe van antibroosheid is geïdentifiseer as riglyne vir die eksplisiete ontwerp van 'n antibrose klein en medium sake-ondernemings. Die stelsel ingenieur word in die dissipline van ondernemingsingenieurswese gelei deur 'n stelselbenadering vir die ontwerp van ondernemings. Ondernemingsingenieurswese het ontwikkel in drie denkrigtings waarvan die onderneming-in-omgewing aanpassing denkrigting, met die fokus op dinamiese endo- en eksogene stressors, gekies is as die mees verteenwoordigende vir 'n antibrose ondernemingsontwerp.

Die vereistes het bestaan waar die velde van Suid-Afrikaanse klein en medium sake-ondernemings, antibroosheid en onderneming-in-omgewing aanpassing oorvleuel het. Hierdie vereistes is gegroepeer in vyf tipes kategorieë; 1) vereistes van die gebruiker, 2) funksionele (noodsaaklik en wenslik) vereistes, 3) ontwerp beperkinge, 4) aandag punte, en 5) randvoorwaardes. Dit was verder gegroepeer volgens hulle rol in 1) die begrip van die huidige onderneming staat, 2) die begrip van die toekomstige status van die onderneming, en/of 3) diegene wat voorsiening leiding vir die transformasie van die huidige na die toekomstige status. Hierdie vereistes, vir elk van die drie fases, was verder opgebreek in vereistes wat na dieselfde doelwit gelei het om die nege stadiums te bereik.

Die drie fases met die nege stadiums het tot uitset van die studie gelei, en dit is die Epictetus raamwerk genoem. Elk van die nege stadiums het 'n doel, vereistes, en antibrose oorwegings wat die KMO sal lei om die onderneming se ontwerp te verbeter.

Die validasie is gedoen deur 1) 'n per stadium validasie, 2) semi-gestruktureerde plaaslike en internasionale onderhoude, en 3) deur 'n illustratiewe gevallestudie.

Die studie bied eksplisiete eienskappe vir antibroosheid, sowel as 'n wyse waarop antibroosheid in 'n stelsel geassesseer kan word. Dit bied ook duidelikheid oor die praktiese stappe wat antibroosheid eksplisiet in ondernemings maak. 'n Verbeterde begrip van wat antibroosheid is, sowel as hoe om stelsels daarvolgens te ontwerp word die fondasie waar dit vir KMOs gebruik kan word vir verbeterde ontwerp onder wisselvalligheid.

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*“For all that has been – thanks. For all that shall be – yes.” – Dag Hammarskjöld*

There is an African Proverb which states that if you want to go fast, go alone, but if you want to go far, go together. It has been a journey which we expected would be long and tough, and I would not have reached the end had it not been for the support and guidance of the following people:

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For all that shall be – YES!

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# 1. Introduction

*“A person who never made a mistake never tried anything new.” – Albert Einstein*

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This chapter provides the background to highlight the need for the research, definition of the problem and the research questions. The research domains are clarified through the investigation into the research methodology and the scope of the study which delivers on the document structure.

## 1.1 Background

The contribution of small- to medium-sized enterprises (SMEs) to the employment and GDP of South Africa differs depending on the source, but the numbers prove the scale of the contribution that SMEs have on the South African economy. The contribution to GDP ranges between 36% in 2002 (Fatoki & Odeyemi, 2010) to 57% in 2010 (Kongolo, 2010) and 45% in 2015 (Kelley, et al., 2015).

New SMEs are seen as a significant component to help solve the issues of poverty, income inequality and unemployment in South Africa (Ayyagari, et al., 2003) and (Maas & Herrington, 2006). The contribution from SMEs to salaries and wages in South Africa is approximately 43% (Nieman & Neuwenhuizen, 2009) and (Chimucheka, 2013) which makes them a powerful tool in alleviating the pressures of poverty on the economy.

SMEs are critical to South Africa’s economy, but they are so despite the fact that approximately 75% of new SMEs in South Africa do not become established. Compared with any country in the Global Entrepreneurship Monitor, a South African SME is less likely to

survive beyond 42 months (Von Broemsem, et al., 2005). Inadequate performances are attributable to how enterprises are arranged (Deming, 1986).

Enterprises are a design, consisting of a system with subsystems and components, to fulfil a function in pursuit of an enterprise's purpose. These subsystems and components, as functional parts, either play a core role in the goal of the enterprise or they fulfil a support function which ensures that the core capabilities are fulfilled (Jones, 2014). These functional units are, generally, formally defined, such as human resource management of human capital, but in smaller enterprises these are often not formally defined.

There has been a lack of theory that addresses the problem of organised complexity which was mentioned decades ago (by (Weaver, 1967) and (von Bertalanffy, 1969)) as a core problem that confronts modern science. Enterprises are complex adaptive systems where it is impossible to determine the reality of the enterprise down to the smallest detail. Some systems engineering approaches have suggested that there needs to be a specification to control it in every detail. Instead, appropriate approaches are needed to master the complexity of the enterprise at effective levels (Axelrod & Cohen, 2001).

The issue with building complex systems, and especially enterprises, is that the costs to properly design, test, deliver, operate and maintain these systems are high. The costs continue to add up when looking at the impact of time and the disruption of normal day-to-day operations. These systems continue to accelerate at unsustainable rates which leads to a system not delivering on its initial design (Jones, 2014). These systems, at the outset, will initially perform in line with their designs, but are difficult to maintain. The complexity included in these designs increases the probability of intermittent problems, which gives rise to the adage of 'fighting fires' instead of focussing on the enterprise and its future.

Smaller enterprises respond to the volatility in their external environment or internally in various ways, and to understand how a small- or medium enterprise can respond to these stressors, we need to understand the range of responses that are possible, given the resource constraints, that these smaller enterprises have. In system design, addressing risks is inherent to the activities of the designer. The risks are, in general, seen as a consequence of cause-effect relationships. There are some risks that are irreducible through the cause-effect

relationship, such as the financial crisis in 2008 or locally focussed, 'Nenegate'<sup>1</sup> in South Africa in December 2015, which do not form part of the normal distribution as consequence and/or frequency do not predict the future. These events are also known as 'black swans' (Taleb, 2007) and (Taleb, 2008). In terms of risks in enterprises, black swans are characterised by (Taleb, 2007):

1. them having an extremely low probability;
2. their impact being extreme; and
3. them being explicable in retrospect.

A change in how enterprises view chaos and complexity is required. This view needs to be supported by learning how to deal with an interdependent set of variables. These variables are caused due to the increased interdependence in the global economy. Enterprise engineering research has led to enterprise structures that are designed to resist change in order to improve control against external stressors (Gharajedaghi, 2011) and (Lapalme & de Guerre, 2014). This view is exacerbated by the system designer's fear of the failure of the system that has been designed.

The requirements that were normally used for the design of the enterprise concentrated on that which is known about the system, its environment and requirements. The system designer is often aware of the risk of encountering unknown events that would be beyond the scope of design of the system, but they do not have the resources or capabilities to structure the system in such a way as to address these unknown events.

These black swan events result in exposed systems/enterprises being more fragile. Fragile can be the unintended state of a system/enterprise which can be a known or previously unknown state. The progression from an intended to an unintended state is due to the application of an internal or external stressor. A fragile system is something that is known to fail under volatility. On the other side of the spectrum, antifragility has been denoted as that which prospers under

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<sup>1</sup> <https://www.businesslive.co.za/rdm/politics/2016-12-09-nenegate-12-months-that-rocked-the-nation/>

volatility (Taleb, 2012). The concept of antifragility gives the system engineer a spectrum to design a system beyond fragile, robust or resilient.

A research opportunity is identified where SMEs require a framework through which they can be constructed to prepare for increased volatility in the global economy by focussing on characteristics that make a system antifragile.

## **1.2 Problem statement**

In South Africa, approximately 75% of SMEs do not survive the first 42 months. A large number of these are due to poor products, services, markets and/or preparations. A large majority are left in the wake of increased global volatility. Black swans, such as the 2008 global financial market crash, resulted in the failure of SMEs which did not have the mechanisms to survive/prosper from these shocks. There is a lack of frameworks or tools that support SMEs to improve the way in which they prepare for these shocks. The field of antifragility, which can be used to combat the fragility of SMEs to shocks, is still in its infancy. The opportunity exists to provide a framework which would help SMEs in this regard.

## **1.3 Research question**

The key research questions are qualitative in nature. They focussed on theories and conceptual models, and are discussed below.

### **1.3.1 Main research question**

The main research question of the dissertation was:

*How can a South African SME be guided to improve its antifragility?*

### **1.3.2 Sub-research questions**

The research was broken down into specific areas which, through explorative research, have highlighted themselves to be of importance in reaching a product which will fulfil the research objective.

These research questions were developed as a result of the systems engineering approach to problem solving, and will be given in section 1.5.3 after the methodology section 1.5.2.

#### **1.4 Research objectives**

The research aimed to answer the research questions as highlighted in chapter 1.3 which supported the stated objective:

Develop a framework which would guide an SME to reduce its fragility.

#### **1.5 Research methodology**

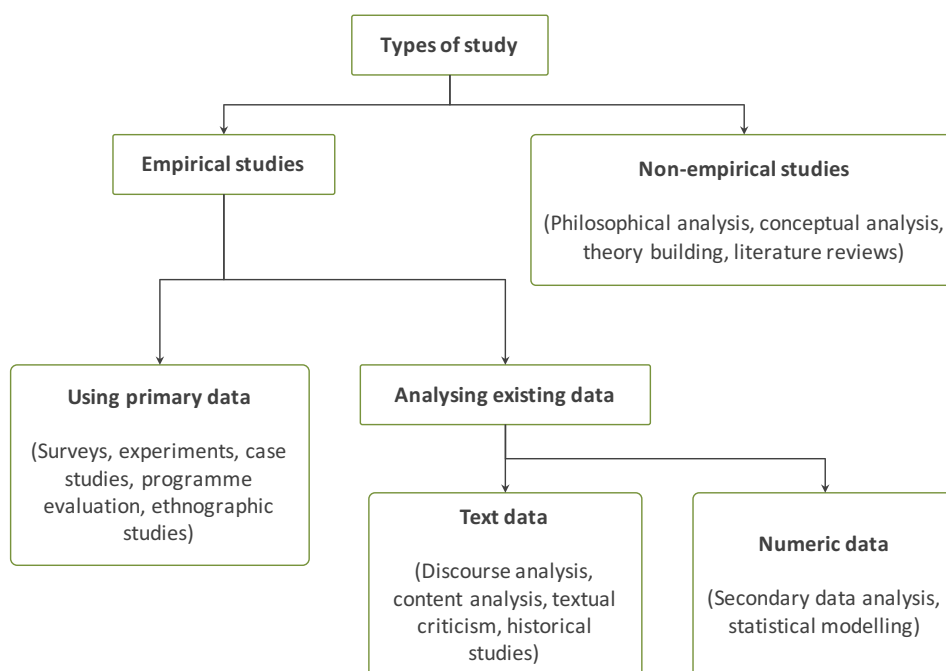
This section is based on the research design map development as proposed by Mouton (2013), in Figure 1-1 and Figure 1-2, to provide context for how the research was designed. The research design contextualised the study with the systems engineering approach to problem solving guiding the rationale for which research domains were investigated.

##### **1.5.1 The philosophical perspective**

SMEs find themselves in the context of a volatile and dynamic global and local business environment. The SME itself is a complex system which creates and operates in these uncertain and ambiguous environments. The constructivist perspective, as discussed and used by Ungerer (2015) and seminally unearthed by Guba & Lincoln (1994), sought to better understand phenomena with the understanding that an absolute answer would most likely not be found. The research was exploratory in nature and therefore the process of stating a hypothesis and hypothesis testing did not exist and need to be discovered. In approaching antifragility, a theory was proposed in a social setting, in which constructions were evaluated, and permutated to provide a more informed and sophisticated theory than that preceding its existence to allow for its utilisation in the real world.

##### **1.5.2 Research design types**

A broad classification of the design types to narrow and head the research in the appropriate direction, is shown in Figure 1-1.

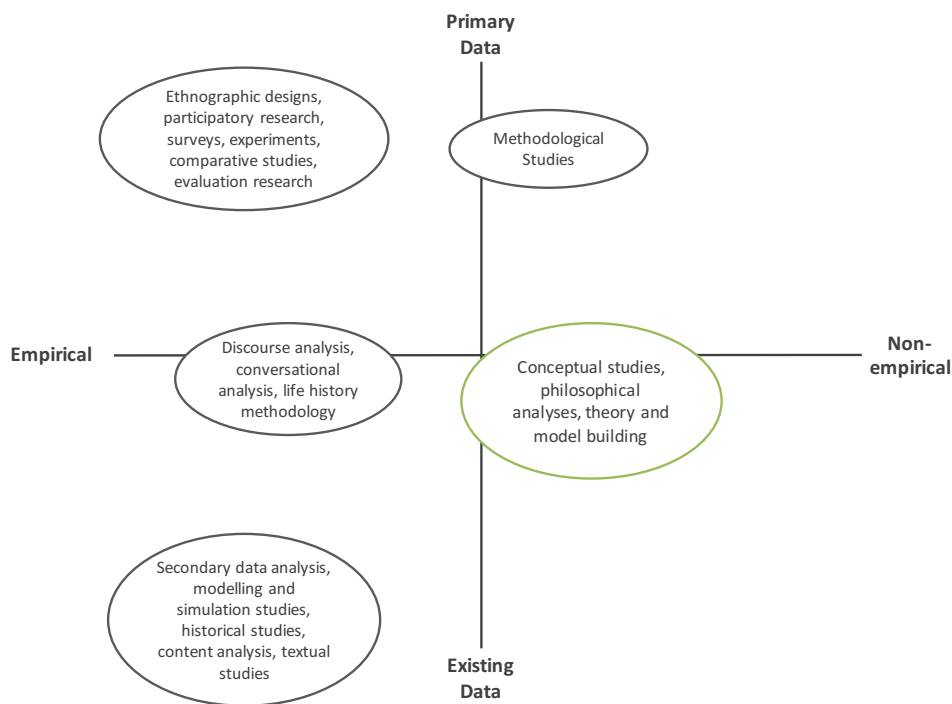


**Figure 1-1: The typology of research design types adapted (Mouton, 2013)**

The research was a non-empirical study with a focus on theory building which can be broken down into empirical studies in future research. The typology given above was used to map four dimensions in research design:

1. Empirical – compared to the non-empirical studies;
2. The use of primary – versus the use of existing or secondary data for analysis;
3. The nature of the data: numerical – versus textual data;
4. The degree of control: highly structured conditions – versus natural field settings.

The first two dimensions are mapped in Figure 1-2, by adapting the work of Mouton (2013). The research was exploratory in nature and used inductive reasoning to expand and refine the existing theories. The research was non-empirical through the use of existing data. This provided the field for theory building and conceptual studies.



**Figure 1-2: Mapping research designs (Mouton, 2013)**

The initial construction was done through a review of the literature in antifragility and expert discussions to test the initial construction's truths. This built on the constructivist approach (Ungerer, 2015) "knowledge consists of those constructions about which there is relative consensus ... among those competent ... to interpret the substance of the construction" (Gube & Lincoln, 1994). The expert discussions allowed for philosophical debate that mostly tested falsehoods in the constructions rather than proved a construction that had not been proven before. These discussions followed one which was semi-structured with control over the information presented to the experts with an open discussion allowing for idea generation and how these could improve the construction in its evolution. These experts were used to validate the framework, in part, where there was deemed to be an unknown gap between the theory proposed and the real world.

The second type of validation was an illustrative case study which was implemented at an SME in SA. The implementation of the framework was tested through the case study whilst the feedback from the participating members provided reasoning for the results obtained by using the framework.

The research investigation was done within the SME strategy research group at Stellenbosch University's Industrial Engineering department which is headed by Professor Corné Schutte (head of the department for the duration of the research). This was supplemented with close collaboration (as a co-author on publications) with Professor Eric Lutters, a professor in Design Engineering at the University of Twente (UoT). Professor Lutters is also an extraordinary Professor at Stellenbosch University. Further collaboration was done with Professor Reinhart, the chair of Industrial Management and Assembly Technologies, at the Technische Universität München (TUM) resulting in a final two-month visit to TUM and UoT.

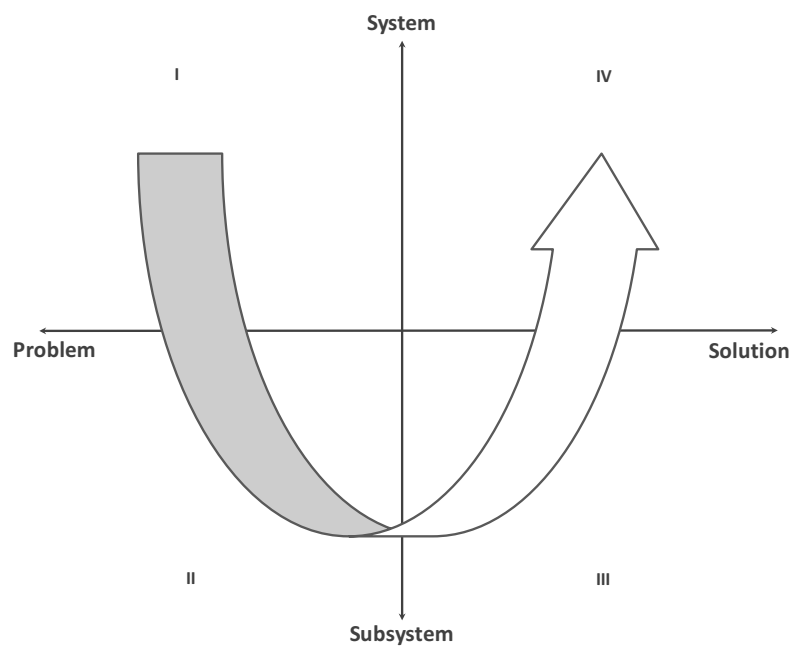
Enterprise engineering is part of the field of systems engineering with the aim of designing enterprises, which includes products, processes, and strategies. Its focus is on improving the effectiveness and efficiency of enterprises which ask for a practical approach to theory in the field. Enterprise engineering originated to structure an enterprise around its IT infrastructure, but that has evolved into the engineering of an enterprise as a socio-technical system in order to include the interaction of the enterprise, its other infrastructures, with what is currently being deemed as its most important asset, the human capital.

In order to apply antifragility to SMEs, the chasm needs to be bridged by marrying the term/concept of antifragility to the field of enterprise engineering. Given that the term antifragility and the research on the topic is in a developmental stage, it needs to be researched in the context of what it can bring to the field of enterprise engineering in order to provide improved and/or new tools which should support the role that systems engineers play in designing enterprises, and most importantly for this research, SMEs. It is for this reason that the research, together with theory/framework-building, followed conceptual analysis to clarify the conceptual linkages between antifragility and enterprise engineering through classification and categorisation. As a result of this, the implicit knowledge of antifragility will become more explicit when placed in the context of enterprise engineering. This new explicit knowledge will then be used, through a systems engineering approach, to build a framework in order to answer the research question and reach the stated research objective.

The knowledge of a problem, as introduced in this first chapter, will need to be understood. From a systems engineering perspective, the problem as a whole would be too complex to



approach as is, which is why it needs to be systematically broken down into smaller sub-problems without losing its understanding in the context of the whole. A greater understanding of the sub-problems will provide greater contextual knowledge of the greater whole. The sub-problems will be solved to find sub-solutions. These sub-solutions will be pieced together to find the solution as a whole and should be a solution to the problem initially stated.



**Figure 1-3: A systems engineering approach to problem solving**

It is in this context that the research problem is stated which takes up its position in the first quadrant. The research problem was given a research question (to be part of quadrant I) in order to test whether the objective could be met (which would be the test in the fourth quadrant). The sub-research questions, quadrant II, were broken down from the main research question to provide guidance into the fields to be researched in search of answers to these specific questions (the third quadrant). An understanding of the answers to these questions provided the framework requirements which were used to build the framework, answering the main research question and thus fulfilling the research objective.



**Figure 1-4: A simplified systems engineering approach for framework building**

Systems engineering provides a rigorous method for developing complex systems that act in alignment with a required function. The research focussed on the design of a framework with connecting research domains which did not exist. The methodology drew on a system engineering approach which involved identifying a set of requirements from state-of-the-art literature which needed to be satisfied by the conceptual framework. This conceptual framework would then provide the detail of steps in the framework which needed to be validated, as shown in Figure 1-4.

The constructivist paradigm required the principles of action research to provide extra meaning and understanding through iterative interactions between the researcher and the research problem (Checkland & Holwell, 1998). These were done continually through the interactions with the collaborations and the Enterprise Engineering research group. Furthermore, the research passed through three validation cycles, which initially focussed on validation by parts which was done at TUM. The considerations of the validation were taken into account when constructing a framework which was used in a case study. The result of the case study was then further presented to experts in the field for further consideration. Given the nature of antifragility, and as a proxy of the reflections of the interactions between the researcher and the research, the framework will be improved and updated in the future in response to newly gained insights from the interactions with practitioners and experts alike.

The systems engineering approach, in Figure 1-3, was aligned with the process in Figure 1-4. This provided the structure to 1) investigate for requirements analysis, 2) use the requirements to provide the conceptual framework, 3) build the framework phase models, and ultimately 4) verify and validate the built framework.


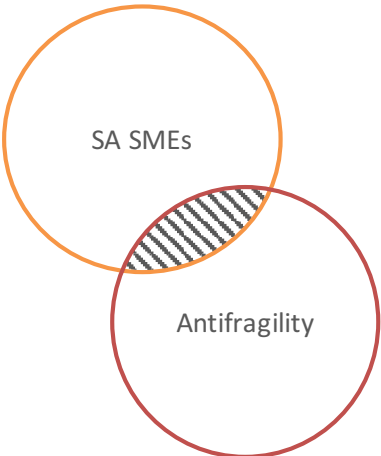
### **1.5.3 Sub-research questions**

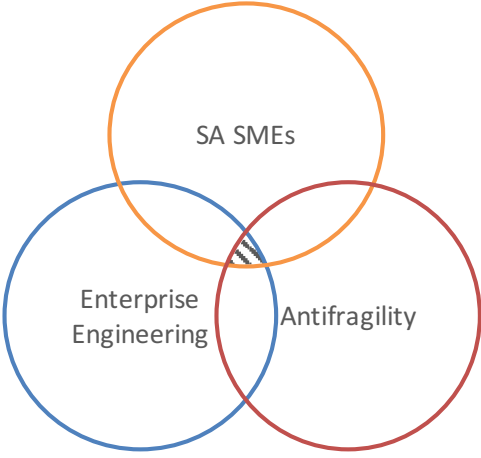
The first quadrant of the system engineering approach, Figure 1-3, allowed for the identification of the problem and as a result the research question. The main research question

was then broken up into sub-research questions (quadrant two), in order to identify the research domains that could provide answers to these questions (quadrant three).

The main research question, “How can a South African Small and Medium Enterprise be guided to improve its antifragility?” was broken down to provide the research domains and the sub-research questions shown in Table 1-1. These were found by deconstructing the main research question.

**Table 1-1: Research domain development through sub-research questions**

Main research question area of investigation	Research domain development	Sub-research question
<p>How can a <b>South African Small- and Medium Enterprise</b> be guided to improve its antifragility?</p>		<p>What are the characteristics of a South African SME?</p>
		<p>Why should South African SMEs be antifragile?</p>
		<p>What are the internal factors that influence an SME?</p>
		<p>What are the external factors that influence an SME?</p>
		<p>What are the user requirements for designing a framework for a South African SME?</p>
<p>How can a South African Small- and Medium Enterprise be guided to <b>improve its antifragility?</b></p>		<p>What is antifragility?</p>
		<p>What is a black swan?</p>
		<p>How do black swans affect SMEs?</p>
		<p>What is the antifragile SME response?</p>
		<p>How is an SME’s antifragility assessed?</p>
		<p>How can an SME become more antifragile?</p>

Main research question area of investigation	Research domain development	Sub-research question
		What are the requirements for designing an antifragile South African SME?
How can a South African Small- and Medium Enterprise be guided to improve its antifragility?		What is enterprise engineering?
		What is an enterprise architecture (EA)?
		What are the dominating schools of thought in EA?
		How is an enterprise constructed?
		What are the requirements for designing an enterprise engineering framework to design an antifragile South African SME?

The following questions need to be answered, as part of the solution space, in order to test whether the research objective, section 1.4, has been reached:

- How can the requirements be meaningfully synthesised into a framework?
- Is the framework addressing the requirements as set out by the research domains (verification)?
- Will the framework deliver on providing an improved antifragile South African SME (validation)?

The exploration into answering these questions led to the main research domains: SA SMEs, Antifragility and Enterprise Engineering which were the guiding criteria from which the framework was constructed.

#### 1.5.4 Research domains

The first stage of the systems engineering approach, requirements identification and analysis, was a view into South African SMEs. The context of South African SMEs created the lens<sup>2</sup> through which the other domains, and as a result the requirements, were investigated. The following domain focussed on Antifragility with a focus on Antifragility in the context of SMEs. Enterprise architecture was investigated through the lens of the prior knowledge and requirements created from South African SMEs and Antifragility. Enterprise engineering provides the backbone through which the enterprise is built with the specific focus on antifragility in South African SMEs. Supplementary fields were investigated under the helm of enterprise engineering to provide requirements or tools to deliver on a stated objective of the previously investigated domains. These include Design Structure Matrices, Enterprise Architecture and Enterprise in Environment Adaptation (which is a socio-technical view of enterprises).

The flow of the research is graphically depicted in Figure 1-5. The three domains were systematically investigated to show the flow (red arrow) of exploration to find the needed requirements to build the required framework.

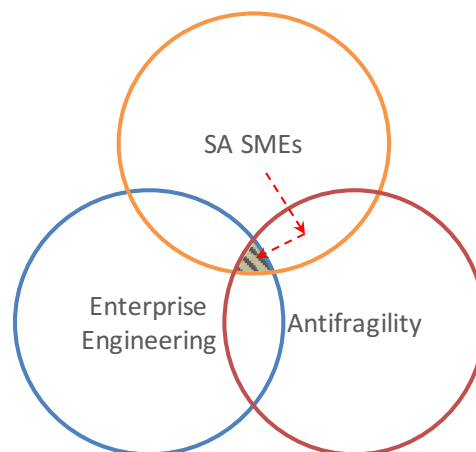


Figure 1-5: The research domains and their systematic progress to requirements gathering

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<sup>2</sup> The lens referred to throughout the document relates to lenses which are tinted in various colours which result in colours being seen in a different way as a result of certain frequencies being allowed to pass through the lens.

### **1.5.5 A model and the framework**

These two approaches, model and framework, are not mutually exclusive, but create a constructive tension with each other. Models ensure logical consistency and explore the subtle interactions involving a limited number of variables. The variables in frameworks and their assertion and links to outcomes are challenged through models. Frameworks, in turn, should challenge models by highlighting the omitted variables, the diversity of competitive situations, the range of actual strategy choices, and the extent to which important parameters are not fixed, but continually in flux. The need to inform practice has demanded that strategy researchers pursue the building of frameworks rather than restrict research only to theories that can be formally modelled (Porter, 1991).

Given the definitions and comparisons of models and frameworks as proposed by Porter (1991), a framework seems to be better suited to the main research question given the diversity of the competitive situations, the range of strategic choices and the extent to which parameters are not fixed.

### **1.5.6 Scope of the research**

Theories and models are ineffective if they make implausible claims on reality, if they make claims that are not testable and vague, or that are conceptually incoherent, inconsistent and confusing (Mouton, 2013). This section provides the definition about what the research is and what it is not.

The framework focussed on non-listed SMEs in South Africa. The sub-chapter aims to put forth the delimitations and limitations to set out the scope within which will be researched.

#### ***1.5.6.1 Delimitations***

The following delimitations created a playing field within which the research would explore:

- The framework would be administered to a South African SME by an enterprise architect;
- It would guide an enterprise to formulate and organise the enterprise to be better equipped for volatility;

- It would only focus on the formulation of the organisation of the enterprise and would not encroach on the implementation thereof;
- It would allow users to use their own creativity and resources in each of the phases;
- It would improve the learning within the enterprise; and
- It would provide a foundation for better understanding of the construct of the organisation of an enterprise for antifragility.

#### **1.5.6.2 Limitations**

The following limitations would look to control the research within a reasonable area to ensure focus on the task at hand was achieved.

- The execution and operations of the tactics that are part of the result of the framework would not be explored. The study focussed on the formulation of the organisation of an enterprise to improve its antifragility.
- The research would not focus on a full implementation and assessment of the implementation of the framework's outputs. The timeframe and the nature of the research would limit the practicality of this.
- The framework would be conceptual and generic. It would need to be applied and made more specific to derive greater value from it. Innovation and creativity would be required in the process. The framework could thus not guarantee business success or improvement as the developed strategy would be the responsibility of the enterprise. The framework does, however, provide a point of departure in pursuit of improved antifragility.
- The framework would not model the whole enterprise or complete strategy, but rather focusses on the organisation of the functional/business units within the enterprise.
- The framework would not facilitate the structural analysis of the industry and environment, and would assume the user had adequate knowledge regarding the competitive environment in which they want to compete.
- The framework would not relate to the success or failure of the enterprise as the organisation of the enterprise is both a process of formulation and execution.

## 1.6 Document structure

The outline proposed here in Figure 1-6 is in no way the final outcome of the research as a whole, but it does provide the guidelines through which the research progressed.

Chapter 1 provides the background, research problem, questions and objectives that needed to be delivered on by the research methodology and process. Chapters 2, 3 and 4 provide the theoretical background to extract the requirements needed to develop the framework, chapter 5. Chapter 6 explains the framework, its usage and key attention points. Chapter 7 focusses on the three stages of validation, or iterations, when looking at the pragmatic approach of the framework that will cement the framework in the current body of knowledge. Chapter 8 discusses the conclusions and the recommendations to further the body of knowledge. The appendices are used to provide the publications that are a result of the research (Appendix A - Publications), the antifragility literature publication list (Appendix B - Antifragility literature review), the documentation and transcribed interviews used in the verification and validation processes (Appendix C - Stages defined within the Epictetus phases to Appendix I - SME Case Study Epictetus Framework Facilitation Plan).

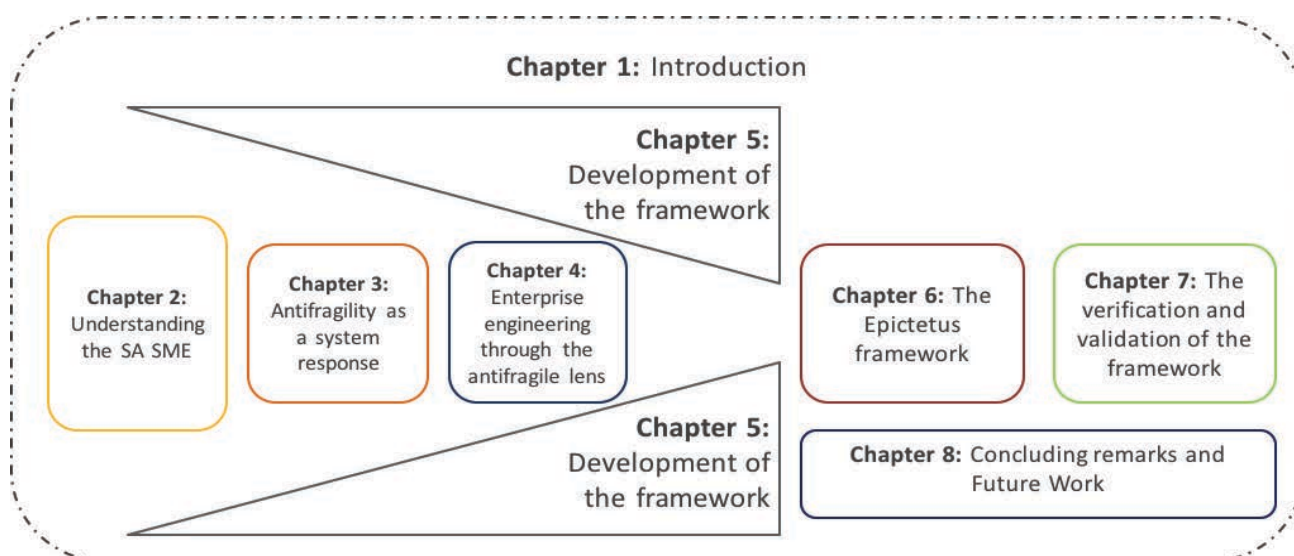


Figure 1-6: Chapter layout



### ***1.7 Chapter conclusion***

This chapter has provided the context for the dissertation, both in terms of reasoning and layout. It has set the objectives of the study, the approach taken to achieve these objectives and the roadmap for the structure of the dissertation itself.

## 2. Understanding the South African Small- and Medium Enterprise

*The New Economy is one where small business has the advantage. What is it about small business that is unique? Today's small businesses are lean, smart, complex – eternally entrepreneurial not just small versions of big business. These entrepreneurial models are the survivors in today's economy.” – Diane Helbig, “Thriving in the New Economy”*

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2.3	CHALLENGES THAT SMEs FACE .....	23
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The chapter's aim is to introduce the reader to Small- and Medium Enterprises (SMEs) in South Africa, their characteristics, their contribution to South Africa and their difficulties, and it provides the foundation from which the design requirements will be extracted to build the required framework.

### 2.1 The classification of SMEs

An SME is described by the National Small Business Act of South Africa of 1996, as amended in 2003, as “a separate distinct entity including cooperative enterprises and non-governmental organisations managed by one owner or more, including branches or subsidiaries if any is predominantly carried out in any sector or sub-sector of the economy mentioned in the schedule of size standards and can be classified as an SME by satisfying the criteria mentioned in the schedule of size standards” (South African Government, 2003). The schedule of size standards, as a quantitative definition, is presented in Table 2-1.

**Table 2-1: Definition of SMEs in South Africa (South African Government, 2003)\***

<b>Type</b>	<b>No. of Employees</b>	<b>Turnover</b>	<b>Balance Sheet Total</b>
Small	1-49	Maximum R13m	Maximum R5m
Medium*	50-200	Maximum R51m	Maximum R13m

\*Medium agricultural enterprises are defined as having less than 100 employees.

Krause & Schutte (2015) surveyed 531 people who were reached through various SME business groups on the professional online platform LinkedIn<sup>3</sup>, between March 2012 to May 2012. The qualified response rate was 16% to ensure that the results account only for SMEs in South Africa. They found that of these respondents; 77% were owners, 15% were managers and 8% classified themselves as specialists. This coincides with a survey done by Cant & Wiid (2013) who surveyed 81 respondents focussed in the Tshwane area (also known as the greater Pretoria region in the Gauteng province of South Africa). Their results showed that 18% of the respondents were owners, 32% were managers and 50% were both owners and managers. This confirms that the majority of SMEs in South Africa are owner-managed.

### **2.1.1 Education**

In their study, Cant & Wiid (2013) obtained the level of education of respondents, which is shown in Table 2-2. In their responses, approximately half (48%) were between the ages of 18 and 30, with 16% between 31 to 40, 23% between 41 – 50 and 12% between 51-60 with none older than 60.

**Table 2-2: The level of education of respondents (Cant & Wiid, 2013)**

<b>Education</b>	<b>Total (of 81)</b>
<b>Post-graduate degree</b>	12
<b>Undergraduate degree</b>	12
<b>Diploma</b>	6
<b>Certificate</b>	6
<b>Did not matriculate</b>	35

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<sup>3</sup> [www.linkedin.com](http://www.linkedin.com)

The findings of lack of education (41 of the 81 respondents having only a matric certificate or less) are further discussed as one of the current challenges to SMEs (see 2.3). It should be noted that this survey was done in urban- and peri-urban areas. The lack of education is expected to be worse in semi-rural and rural areas.

### 2.1.2 SME Size

The responses from the survey done by Krause & Schutte (2015) included 52.9% from Gauteng and 36.5% from the Western Cape which supports the economic distribution in South Africa with the distribution of employee size per SME given in Table 2-3.

Table 2-3: Number of employees in the sample (Krause & Schutte, 2015)

<b>Number of Employees</b>	<b>Percentage</b>
<b>1-10</b>	71.8%
<b>11-25</b>	12.9%
<b>26-50</b>	7.1%
<b>51-100</b>	3.5%
<b>More than 100</b>	4.7%

### 2.1.3 Sector representation

South African SMEs are diversified and operate in different industries, including retail, wholesale, tourism, mining, agriculture, manufacturing, construction and service (Chimucheka, 2013). The majority of the responses came from the sectors shown in Table 2-4.

Table 2-4: Major sector categories (Krause & Schutte, 2015)

<b>Categories of Industry</b>	<b>Percentage</b>
<b>Information Technology</b>	32.9%
<b>Educational Services</b>	11.8%
<b>Professional, Scientific and Technical Services</b>	10.6%
<b>Management of Companies and Enterprises</b>	10.6%
<b>Retail and Wholesale Trade</b>	5.9%
<b>Arts, Entertainment and Recreation</b>	5.9%

The distribution of industries in which SMEs operate show their contribution to the South African economy through various industries. As SMEs, they provide support to larger enterprises and to other SMEs, as well as to the economics, poverty alleviation and unemployment in their immediate communities.

## **2.2 The importance of SMEs**

SMEs play a large part in all economies, but particularly so in developing countries with difficulties regarding employment and income gaps. Since the 1990s, the spotlight has been on SMEs and their contribution to the GDP and employment of economies worldwide (Storey, 1994).

The evidence supports that SMEs are responsible for a considerable contribution to employment and the Gross Domestic Product (GDP) in South Africa (Ayyagari, et al., 2003). The research on the contribution by SMEs to the employment and GDP varies significantly. The believed contribution to GDP ranged between 36% in 2002 (Fatoki & Odeyemi, 2010), 45% (Kelley, et al., 2015), 46% (IISD, 2004) and 51-57% (Kongolo, 2010). These numbers may vary, but they provide us with a confirmation of the scale of their contribution to the South African economy.

The employment figures in SMEs also range significantly from 55% of private sector employment (Nieman & Neuwenhuizen, 2009), 56% (Fatoki & Odeyemi, 2010), 60% (Kongolo, 2010), 68% (Adcorp, 2012), 74% (The Business Place, 2009) to 84% (which is also an approximation of the informal employment) (IISD, 2004). The figures as of the second quarter in 2016 showed that unemployment in South Africa is at 26.6% (StatsSA, 2016).

According to Maas & Herrington (2006) new SMEs are seen as a significant component of the solution to South Africa's development issues which include poverty, income inequality and unemployment.

One of the best ways in which to address unemployment is to leverage the employment creation potential of small businesses and to promote small business development (Fatoki & Odeyemi, 2010) and (Abor & Quartey, 2010). This is due to the fact that SMEs are more labour

intensive than larger enterprises with more employment opportunities created per unit of invested capital (Cronje, et al., 2001) and (Chimucheka, 2013). SMEs employ a significant number of South Africans and contribute 43% of the total value of salaries and wages paid in South Africa (Nieman & Neuwenhuizen, 2009) and (Chimucheka, 2013). They also provide a platform on which talents and energy of entrepreneurship in individuals can be utilised and grown which is not possible in larger enterprises (Cronje, et al., 2001) and (Chimucheka, 2013).

Poverty is significantly higher in developing countries than in developed countries. The South African Government has identified that SMEs are the key to poverty alleviation by providing economic and employment participation in the economy to general members of their immediate communities (Chimucheka, 2013). SMEs combine society's resources to efficiently produce goods and services which are returned directly to the society within which they operate (Du Toit, et al., 2009) and (Chimucheka, 2013).

SMEs are essential in promoting and achieving economic growth and development, as well as the widespread creation of wealth and employment (Nieman & Neuwenhuizen, 2009) and (Chimucheka, 2013). SMEs create social stability, cause less damage to the physical environment than large factories and stimulate personal savings (Cronje, et al., 2001) and (Chimucheka, 2013).

SMEs act as training grounds by offering apprenticeships for the youth (Antonites, 2003) and (Chimucheka, 2013). Key to poverty alleviation is economic growth that is inclusive (includes both urban and rural areas) and reaches a majority of the people (Cronje, et al., 2001), (Chimucheka, 2013) and (IISD, 2004).

SMEs provide competition between businesses which improves the quality of products and services in the economy as well as holding larger firms to an improved product or service (Cronje, et al., 2001), (Du Toit, et al., 2009) and (Chimucheka, 2013). SMEs contribute to the success of large firms as they provide alternatives and supporting platforms for goods (raw materials), and services (as subcontractors) (Du Toit, et al., 2009) and (Chimucheka, 2013). They also provide services and take up a place in the economy which larger enterprises do not find attractive (Cronje, et al., 2001) and (Chimucheka, 2013).

The importance of SMEs to the South African economy is clear, albeit with sources finding differing values on the contribution to the GDP and employment. The contribution remains significant which calls for the support of SMEs in order to play a larger role in directly influencing their immediate communities as well as the economy of the greater South Africa. The support provided to SMEs needs to focus on the challenges that are often more attributable to SMEs than to larger enterprises.

### **2.3 Challenges that SMEs face**

*“Many small businesses would rather face an angry barbarian horde than tackle their cash flow statement or price a new product.” – Nicole Fende “How to be a Finance Rock Star”*

According to Fatoki & Odeyemi (2010), only 25% of new SMEs registered in South Africa will survive the first two years of operation (Fatoki & Odeyemi, 2010). Jacobs (2010) as head of Absa Small Business stated that the failure rates for small businesses that do not make it past the second year of trading is as high as 63% (Absa, 2010). Some figures suggest that 75% of new SMEs created in South Africa fail within the first two years of operation. The probability of a new SME surviving beyond the first 42 months is less likely in South Africa than in any other GEM participating country (Von Broemsem, et al., 2005).

Fatoki & Garwe (2010) questioned 361 SMEs in the Eastern Cape area to establish, out of 30 challenges, what they found were the largest challenges that SMEs face to survive in South Africa. They used principal component analysis to find these grouped into the following five main components:

1. Financial (internal);
2. Economic (external);
3. Market (external);
4. Management (internal); and
5. Infrastructure (external).

These are further explained below within the context of a wide body of research to show the convergence of challenges that SMEs in South Africa face.

### **2.3.1 Macro and market (external) environment**

SMEs in South Africa do not just experience problems in economic downturns but also during periods of strong economic progress (Kongolo, 2010). The major variables that impact South African SMEs on a macro and market level include interest and exchange rates, inflation, unemployment, crime, HIV/AIDS, technological advancements and government legislation (Brink, et al., 2003).

Economic variables include the fiscal and monetary policies of the government , inflation, interest rates and foreign exchange rates. SMEs, as with larger enterprises, face challenges due to the economic climate in a country as these have a direct impact on consumption patterns of consumers and, given the integrated nature of modern economies, affect most sectors (Ehlers & Lazenby, 2007) and (Fatoki & Garwe, 2010). Interest rates worldwide dropped significantly after the global financial crisis of 2008, dropping more than 18% in South Africa to reach as low as 7%. This affects the influences and demands for goods (Abor & Quartey, 2010) and (Fatoki & Garwe, 2010).

Competition impacts the market potential and growth opportunities for SMEs. To survive and achieve success, new firms need to understand the dynamics of competition in their industry and develop skills and competencies that give them a competitive advantage.

In South Africa, crime is a significant contributor to difficulties in the management of SMEs. SMEs incur huge losses due to high costs to safeguard not only goods but customers too. SMEs find themselves being part of the largest organised group suffering from crime and violence (Brown, 2001). Owners of SMEs are not aggressively pursuing avenues to grow their market and maintain their competitive advantage, they are rather focussing on operational matters because of high crime rates (Standard Bank & Fujitsu Siemens Computer, 2008). Crime also increases the investments required for security measure to eliminate or minimise the likelihood of crime. The corruption perception index published annually by Transparency



International (2015) ranked South Africa 61<sup>st</sup>, down from 43<sup>rd</sup> in 2008 (Transparency International, 2015).

SMEs do not believe that the South African Government provides enough support. It is due to the lack of information on available enterprises that are established and which are available to assist them. The majority of SMEs are not aware of the government incentives that have been put in place to assist them (Maas & Herrington, 2006). The costs attributable to register, licence and pay taxes for a business is a large inhibitor to success (Fatoki & Garwe, 2010). The time it takes to ensure that the enterprise is aligned with the legal requirements for the country is one that takes the focus of the owner away from a crucial time in the SME's development. Quality infrastructure is required to increase the success rate of SMEs. These include telecommunications, electricity and transportation (Fatoki & Garwe, 2010) and (Chimucheka, 2013).

### **2.3.2 Micro (internal) environment**

Fatoki & Odeyemi (2010) investigated the correlation between certain factors and the success an SME might have in sourcing finance in South Africa (Fatoki & Odeyemi, 2010). Their findings found that there was a high correlation between the SMEs that were managed by owners with high education and/or related business experience and the success in obtaining credit, which was consistent with previous findings by other researchers (Lyles, et al., 2004) and (Martin & Staines, 1994). Managerial competencies are defined as sets of knowledge, skills, behaviours, and attitudes that can contribute to personal effectiveness (Hellriegel, et al., 2008). Lack of education is one of the most significant barriers to entrepreneurial activity (Nieman & Neuwenhuizen, 2009) with a positive correlation shown between education and entrepreneurial activity (Fatoki & Odeyemi, 2010). Education and training support the development of management competencies which are necessary for success (Chimucheka, 2013). Lack of education and training is touted as one of the large reasons why there is a high failure rate of SMEs in South Africa (Abor & Quartey, 2010) and (Chimucheka, 2013). SMEs require a pool of qualified, skilled and motivated employees. SMEs face difficulties in accessing finance which increases the difficulty of hiring skilled labour (Abor & Quartey, 2010) and

(Chimucheka, 2013). Labour can only be hired at a cost and within the labour regulations in South Africa (Fatoki & Garwe, 2010).

Marketing is a fundamental concept which SMEs struggle to employ effectively (Brink, et al., 2003) and (Van Scheers, 2011). These factors include competition, low demand for products, not being able to meet customer needs, wrong pricing strategies, lack of knowledge, poor location, product variety and branding. SME owners' perception on marketing related challenges is that they lack time or funds to invest in research to establish their target market, customer trends and marketing in general (Van Scheers, 2011) and (Cant & Wiid, 2013).

Enterprises require finances to start trading and to fund growth. Access to finance is the second most reported contributor to failure of SMEs, after education and training (Fatoki & Odeyemi, 2010), (Abor & Quartey, 2010) and (Chimucheka, 2013). Research into financing through bank loans has found that 75% of the applications are rejected with only 2% of new SMEs having access to finances (Finmark Trust, 2010).

SMEs that could provide information on the business such as business plans were significantly more successful than their counterparts without the required business information (Fatoki & Odeyemi, 2010). The results were consistent with those found by previous researchers (Pretorius & Shaw, 2004) and (Kitindi, et al., 2007). Cant & Wiid (2013) found that the knowledge of their target market, industry business, wrong pricing strategies and competition played a large effect in the success of their enterprises (Cant & Wiid, 2013). Failure of SMEs to access markets can be attributed to industry competition (Abor & Quartey, 2010), (Du Toit, et al., 2009) and (Chimucheka, 2013).

SME owners who had previous relationships with banks were more likely to be successful in their credit applications (Fatoki & Odeyemi, 2010). Belonging to a network of companies, e.g. professional trade associations, did not have any significant impact on the success. The results were consistent with those found by previous researchers (Ngoc & Nguyen, 2009) and (Shane & Cable, 2002).

SMEs located in the city were more likely to be successful compared with those in rural areas (Dahl & Sorenson, 2007) and (Gilbert, et al., 2008). SMEs that were insured were also

significantly more likely to be successful. Demographic variables, such as gender, age of the owner of the business and the industry did not play a significant role. These were consistent with previous researchers (Blumberg & Letterie, 2008) and (Akkaro, 2009) as well as being confirmed by later research (Cant & Wiid, 2013).

The results showed that the size of the enterprise was a significant factor in success (Bollingtoft, et al., 2003). Medium sized firms were 3.97 times more likely to be successful compared to small firms (Fatoki & Odeyemi, 2010).

Technology plays a critical role in the development of an SME. Technological investments are often large, due to hard- and software requirements. It is beyond the capability of SMEs with no access to finance to access the advantages of modern technology (Abor & Quartey, 2010) and (Chimucheka, 2013).

This chapter discussed the difficulties that SMEs face in the South African environment as well as the micro environment within the enterprises themselves. These have been summarised in Table 2-5.

**Table 2-5: Macro and micro environment difficulties for SMEs**

<b>Difficulties</b>	<b>Description</b>	<b>Authors</b>
<b>Access to finance</b>	Finance is one of the largest contributors to SME failure. Finance gives the SME the capability to hire high quality employees, purchase the required equipment and technologies and absorb some volatility in the markets. Finance allows for SMEs to have sufficient cash flows, but requires managerial competency to effectively manage this finance.	(Fatoki & Odeyemi, 2010), (Chimucheka, 2013), (Fatoki & Garwe, 2010), (Van Aardt, et al., 2008), (Abor & Quartey, 2010)

<b>Difficulties</b>	<b>Description</b>	<b>Authors</b>
<b>Managerial competencies, education and training</b>	Managerial competencies, education and training play an important role in the way in which enterprises convert knowledge and materials into output which customers purchase. Firstly, management competencies are required, and secondly, the finance required to hire competent staff and educate and train them needs to be available to the managers in order to improve the possibilities of success.	(Fatoki & Odeyemi, 2010), (Cant & Wiid, 2013), (Lyles, et al., 2004) (Martin & Staines, 1994), (Chimucheka, 2013) and (Abor & Quartey, 2010)
<b>Business information</b>	Managerial competence contributes to the knowledge being held of the enterprise, its operations and its macro and market environment. The increased knowledge of the enterprise provides for the basis with which the enterprise interacts with funders, suppliers and customers.	(Fatoki & Odeyemi, 2010), (Kitindi, et al., 2007) (Pretorius & Shaw, 2004) (Cant & Wiid, 2013) and (Abor & Quartey, 2010)
<b>Access to markets</b>	Access to markets can be both access to suppliers and to customers. Marketing has been highlighted as one of the crucial skills that are required to access these markets. Marketing is an important skill in which clarity is required on who the market is, what the price point is for that market and how the produce/service should be sold to them.	(Chimucheka, 2013), (Brink, et al., 2003), (Abor & Quartey, 2010), (Cant & Wiid, 2013) and (Fatoki & Garwe, 2010)
<b>Government legislation and lack of support structures</b>	Government provides a large number of incentives to SMEs, but most SMEs are not aware of the government incentives available to assist them. The costs to register and operate a company in South Africa together with poor infrastructure, i.e. telecommunications, road and transport infrastructure and electricity pricing, act as inhibitors to success.	(Chimucheka, 2013), (Maas & Herrington, 2006), (Kelley, et al., 2015), (Brink, et al., 2003) (Cant & Wiid, 2013), (Fatoki & Garwe, 2010) and (Abor & Quartey, 2010)

<b>Difficulties</b>	<b>Description</b>	<b>Authors</b>
<b>Location</b>	The location of the enterprise plays a large role in access to financing. The reason for this is due to the differences in crime rates, the physical proximity to markets and access to technological advances (due to improved infrastructure).	(Fatoki & Odeyemi, 2010), (Akkaro, 2009) and (Blumberg & Letterie, 2008)
<b>Crime</b>	Crime and corruption play a considerable role in the minds of enterprises in poorer locations such as semi-rural and rural areas. The increased cost to address and manage crime reduces the time and finance that could be allocated to core operational services. Corruption plays a type of “competitive advantage” role in the South African economy. This reduces the ease of access to markets, locations, preferential treatment and incentives an ethical SME would have.	(Cant & Wiid, 2013), (Fatoki & Garwe, 2010) and (Chimucheka, 2013)
<b>Technological advances</b>	Technological advances play a dual role by improving efficiency in delivering services/products to a client as well as improving the type of services and products which were previously unattainable. Improved infrastructure, markets and finance allow SMEs to acquire the necessary technology to compete on a higher level than its actual size would normally allow for.	(Fatoki & Odeyemi, 2010) (Cant & Wiid, 2013), (Chimucheka, 2013) and (Abor & Quartey, 2010)
<b>Economic activity</b>	Interest rates, contracting or expanding economies, financial crises, exchange rates, etc. all play a role in suppliers, raw materials and customers' ability to purchase goods/services. Economic activity has been more sensitive to global economies through the increased interconnectedness.	(Cant & Wiid, 2013) (Fatoki & Odeyemi, 2010) and (Abor & Quartey, 2010)

#### **2.4 Resource requirements of SMEs**

SMEs require support if they are to grow and survive (Chimucheka, 2013), (Maas & Herrington, 2006) and (Kelley, et al., 2015). Resources include anything that an SME owner or operator

would need and use to pursue a business opportunity. These are defined as inputs that the business combines to create the outputs to customers (Du Toit, et al., 2009).

There are four broad categories of resources required for an SME (Nieman & Neuwenhuizen, 2009), (Du Toit, et al., 2009), (Van Aardt, et al., 2008), (Rwigema & Venter, 2004) and (Chimucheka, 2013):

1. Human resources;
2. Financial resources;
3. Physical resources; and
4. Information resources.

#### **2.4.1 Human resources**

Human resources include the human capital, their work ethic, skills, knowledge and insights which contribute to the performance of the SME. They can be either directly or indirectly involved in the core capability of an SME (Van Aardt, et al., 2008). SMEs need to provide training and education to staff to improve their human resources. Employees need to feel that they are motivated towards achieving the objective of the SME (Rwigema & Venter, 2004).

#### **2.4.2 Financial resources**

Financial resources can be any product, service, infrastructure and/or equipment that can easily be converted into a financial resource (Van Aardt, et al., 2008). They provide the capability for the SME to acquire other resources (Rwigema & Venter, 2004) and (Van Aardt, et al., 2008). SMEs need to determine the type of financial resource needed and investigate the appropriate means to obtain this. There are two main types of financial resources, debt and equity. These financial resources can be in the form of start-up capital, long-term or short-term loans, trade credit, start-up grants and investments by owners or shareholders (Van Aardt, et al., 2008).

#### **2.4.3 Physical resources**

Physical resources act as operating resources which include buildings and equipment as well as the raw materials that are required to create products and services as an output of the SME

(Van Aardt, et al., 2008). Physical resources can be classified as that which allows people to do their jobs (e.g. general supplies) (Van Aardt, et al., 2008).

#### **2.4.4 Information resources**

Information resources allow management and employees to make the appropriate decisions (Nieman & Neuwenhuizen, 2009). These can be internal or external resources which support decision-making on internal effectiveness and strategies to combat external competition to effectively obtain markets. The information resources also include technology, such as the internet, email and patents (Van Aardt, et al., 2008). Advanced information resources can provide an SME with a crucial competitive advantage over its competitors (Rwigema & Venter, 2004).

The characteristics, difficulties and required resources for SMEs provide a perspective through which the design of a framework would need to be built if it were to target SMEs.

#### **2.5 *Small- and Medium Enterprises in South Africa, a case for the future***

SMEs have challenges, but they do, however, have the advantage of more flexibility, and higher decision-making speeds coupled with business specialisation compared to their larger counterparts (Brunswicker, 2011) and (Bianchi, et al., 2010). They play a considerable role in the economic activity of South Africa which reaches far beyond just employment and GDP contribution, but also through community upliftment, large enterprise stability, etc.

#### **2.6 *Chapter conclusion***

This chapter has provided the background to the importance of SMEs to the South African economy, their characteristics and context for resources, and their challenges to succeed in the volatile South African and global economy. SMEs look to gain the most from being specifically prepared for volatility as they do not have the size with which to absorb the volatility imposed on them through the global business environment. These characteristics are referred to in chapter 5.2 and Table 5-1 to Table 5-5.

### 3. Antifragility as a system response

*“Just as a campfire feeds off random wind gusts, well-prepared people and organisations can benefit from volatility and chance events.” – N N Taleb (2012)*

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The chapter’s aim is to introduce the reader to 'Black Swans' and 'Antifragility', and the mechanisms for coping with black swans or volatility in order to become antifragile.

#### 3.1 The disciplines for antifragile research

The field of antifragility is in its infancy and has, only recently ventured into disciplines beyond philosophy and statistics. A systematic approach was followed to provide the full representation of the current body of knowledge in the field, the guiding principles can be seen in Table 3-1.

Table 3-1: Publication systematic approach to the literature

<b>Database</b>	EBSCO Information Services <sup>4</sup>
<b>Latest date of search</b>	15 May 2017
<b>Search terms</b>	“antifragility”, “antifragile”, “anti-fragile”, “anti-fragility”, “(anti)fragile” and “(anti)fragility”
<b>Publications types included</b>	Academic journals, journals and trade publications

<sup>4</sup> <https://www.ebsco.com>



<b>Publication types excluded</b>	Reviews, magazines and news
<b>Other excluding criteria</b>	Only publications in English were accepted.
<b>Final number of articles</b>	46
<b>Result</b>	See Appendix B - Antifragility literature review, Table B-.

The result of the expansion of the field of antifragility can be seen in Figure 3-1. Antifragility started as an answer to what Taleb (2007) labelled ‘black swans’, section 3.2. This created the foundation from which the field started to grow, with the expansion of the research field starting to grow the year after the publication of *Antifragile: How to live in a world we don’t understand*, (Taleb, 2012).

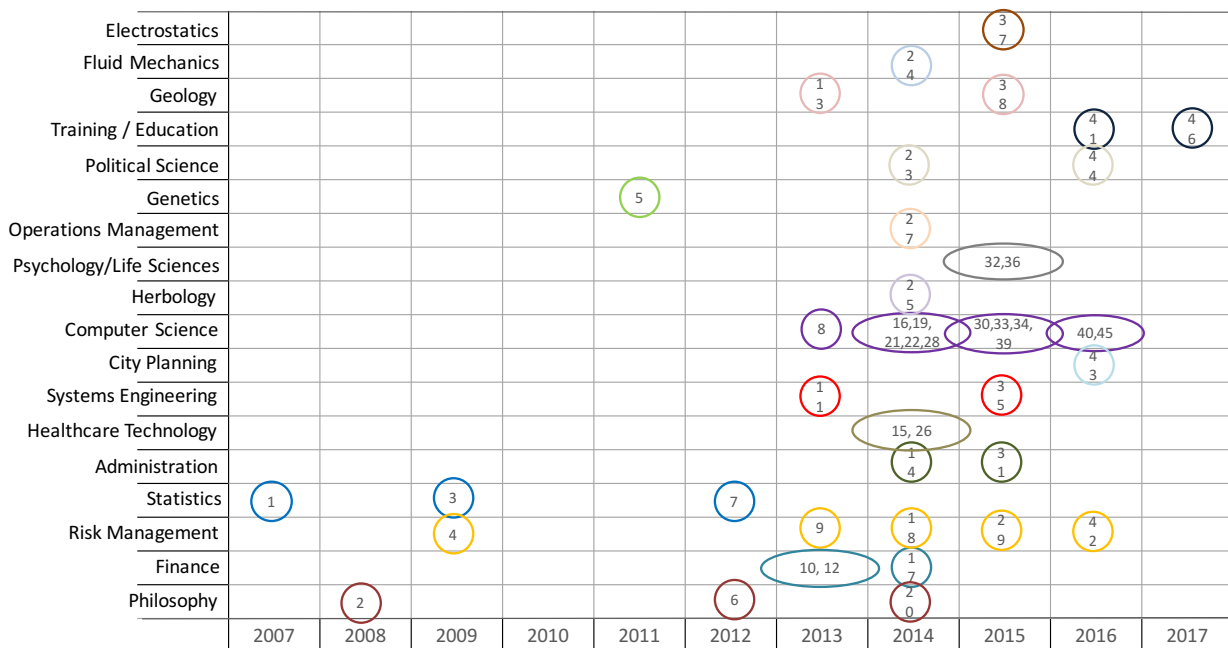


Figure 3-1: Antifragile increasing in publication diversity and outputs since 2012 (numbered reference to Table B-1)

The fields of Computer Science and Risk Management are shown to be the most prolific fields for the concept of antifragility. Computer Science tends to focus on the learning capabilities and the way in which software can be designed to learn from their shortcomings, such as

susceptibility to malware, user errors, etc. The majority of these publications are through the journal, *Procedia Computer Science*, but are not of the same author. This indicates that the expansion of the field is not through a small group of researchers, but through a collective.

A view of the literature has shown that even with the increased expansion of the field of antifragility, not one article was focussed on antifragility and SMEs and the constructs required to be advantageous to the SME.

### **3.2 Black swans: living in a highly improbable world**

*“Let’s face it, the universe is messy. It is nonlinear, turbulent and chaotic. It is dynamic. It spends its time in transient behaviour on its way to somewhere else, not in mathematically neat equilibria. It self-organises and evolves. It creates diversity, not uniformity. That’s what makes the world interesting, that’s what makes it beautiful, and that’s what makes it work.” – Donella Meadows, founder of the Sustainability Institute (1997)*

In 2008, Nicholas Nassim Taleb published a book *The Black Swan: The Impact of the Highly Improbable* (Taleb, 2008). In this publication, Taleb expanded on a principle which he introduced in a 2007 paper, *Black Swans and the Domains of Statistics*. The introduction of the black swan principle changed the way in which probabilities and their relation to their impact, or created opportunities, were thought of (Taleb, 2007).

The term was created out of the incorrect assumption that ‘all swans were white’, until black swans were discovered. The black swan was seen as an improbable event, and is now seen as the metaphor for something that could not exist (Taleb, 2008). These are seen as stressors that often have extreme outcomes and do not form part of the normal distribution nor can their frequency be used to predict the future.

The publication of Taleb’s book in 2008 coincided with one of the worst global financial crises in history. In this book, he explained that the black swan has three main characteristics (Taleb, 2008):

1. It lies beyond the realm of regular expectations, thus having an extremely low probability;
2. The consequences carry extreme impact, albeit positive or negative; and
3. It is retrospective in its predictability (as humans connect explanations after the fact).

An unpredictable event, such as a black swan, is dependent on the position and perspective of the observer. Taleb (2008) uses the example of a turkey at Thanksgiving. The turkey, as part of normal farming operations, is fed every day to ensure it is ready to be slaughtered for Thanksgiving. The turkey being slaughtered on Thanksgiving is a black swan event for the turkey as it could not believe that it would not be fed the day of its slaughter. The farmer finds this to be part of normal operations to slaughter the turkey for Thanksgiving. The metaphor highlights that an event being a black swan depends on perspective and position. As Aven (2014 & 2015) stated, there are unknown events that were not on the list of the known events from the perspective of those who carry out risk analysis, but known to others, and events on the list of known events in the risk analysis but judged to have negligible probability of occurrence and thus not believed to occur. The first is an explanation of the metaphor of the turkey, in others it is a common perception of risk management to dispel those events that have a low probability of occurring (Aven & Krohn, 2014) and (Aven, 2015).

The black swan represents the epistemic uncertainty or lack of fundamental knowledge with not just the distribution of the parameter being unknown, but the very existence of the phenomena itself (Taleb, 2007) and (Paté-Cornell, 2012).

Black swans do not always result in detrimental consequences: they can be extremely beneficial too. The internet was not initially built for people to connect and share knowledge, but it was developed and used as a military application which evolved (Taleb, 2007).

The reason why we are exposed to black swans, according to Taleb (2009), is due to confirmation bias. Confirmation bias explains how we state a theory or solution and collect information to strengthen the conviction that we are correct and we dispel other information refuting our view. We naïvely focus on historical observations as something definitive or

representative of the future and it is this that creates our inability to predict and expect black swans (Taleb & Makridakis, 2009).

Black swans are internal as well as external in nature. As an inherent consequence of their rarity, black swan events seem to be incompatible with Systems Engineering, as Systems Engineering approaches problems that would typically conform to a set of reasonably collected assumptions. These assumptions generally include requirements, an entity tasked with developing and configuring the solution, the solution itself and the external environment's relationship with the solution.

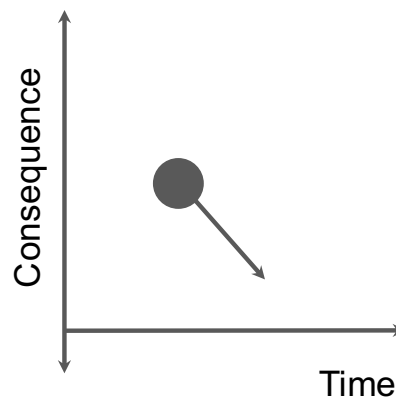
### ***3.3 A range of system responses***

Systems often face conditions where their function is not aligned to that which they were designed to do. These systems are seen to be in their unintended state, which can be known or previously unknown. Taleb (2012) placed system response states on a continuum in order to provide the context of the role that antifragility as a system response plays in relation to fragile or resilient/robust.

#### **3.3.1 Fragility**

Fragility is that which does not like volatility, something that loses operational/functional value after a shock is induced (Taleb & Goldstein, 2012).

The unintended and previously unknown states are known as failure states. Systems move from an intended to an unintended state through the application of stressors outside the constraints of operation (Johnson & Gheorghe, 2013). A fragile system is one that is limited on its upside, thus its functionality, but unlimited (or until ultimate failure) on its downside (Johnson & Gheorghe, 2013), (Taleb, 2008) and (Taleb, 2007). As the event size increases, the system approaches a failure state, a large negative consequence, as shown in Figure 3-2.



**Figure 3-2: A fragile system in response to a large event/stressor**

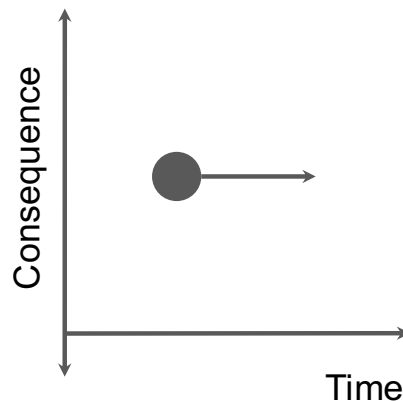
Fragile system responses can play an important role in the design of a system in order to limit the downside. An example is of a fuse in the control of an electrical circuit's exposure to large currents. The other example is of a shear bolt which can be used to have a specific outcome once a predetermined force is applied. It is designed to break to protect other parts of the system. The system will thus lose functionality as a whole instead of continuing to operate and causing a disastrous effect.

In enterprises, a fragile function could be built into a part of the system, i.e. finance's payments function. The payment system can be designed to fail (not pay a creditor) if the payment exceeds a certain amount or when a payment is to be made to an unqualified creditor. Providing a specific fragility to this function will allow for the protection of the enterprise as a whole.

### **3.3.2 Resilience/robust**

Resilience is a system response that gives a measure of effectively absorbing, adapting or rapidly recovering from undesired events/stressors. This approach emphasises the system's ability to develop an adaptive means to accommodate changes within or around the system and to establish behaviours in which it can respond by building capacity to withstand the disruption or recover as quickly as possible after an impact (Francis & Bekera, 2014). A resilient system is one which allows for a complex system to be flexible to accommodate stressors without irreversible or unacceptable declines in performance, structure and/or function (Francis & Bekera, 2014). This can be done through changes in current practices, policies and

rules in order to survive a large stressor. Preparing for events/stressors that may lead to failure as if they are inevitable requires regular evaluation of operational procedures, safety procedures, policy guidelines, risk assessment methods and counter measures (Francis & Bekera, 2014).



**Figure 3-3: A resilient system response to a large event/stressor**

Resilient/robust is the ability of the system to remain in a desired state while impacted by a range of stressors (Johnson & Gheorghe, 2013). A robust system will show no significant effect as a result of stressors and will continue to function and deliver on its designed capabilities. The broader the range and size of stressors than can be practised on the system without losing its designed functionality, the more resilient/robust it is considered.

An example of a resilient/robust component/subsystem is that of a flywheel. The flywheel allows for a fluctuating source of energy to be stored and transformed into continuous energy in order to protect the engine as a whole.

In an enterprise, the daily operations, i.e. manufacturing, should be resilient/robust to stressors internally or externally. It is for this reason that the use of buffers in raw materials and WIP is stockpiled around critical/bottleneck operations. This does not make the system robust/resilient under all stressors, but it aims to increase the system resilience/robustness through this strategy.

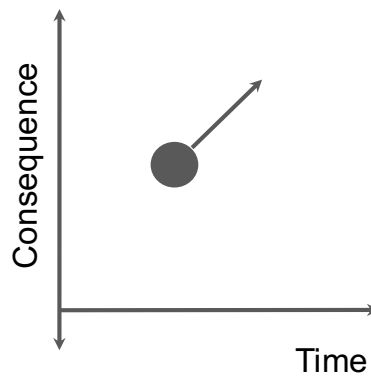
In systems engineering, systems have been designed to be more robust/resilient which was thought of as the opposite of fragile.

### 3.3.3 Antifragility

*"The future is uncertain, but this uncertainty is at the very heart of human creativity"*  
– **Ilya Prigogine**

In his book, *Antifragile: How to live in a world we don't understand*, Taleb (2012) introduced us to that which is the opposite of fragile. In the past, the opposite of fragility has been touted as something that is resilient or robust. Logical deduction dictates that the opposite of that which is negatively sensitive to volatility would be that which is positively sensitive to volatility (Taleb, 2012). Consequently, Taleb (2012) has labelled the term 'antifragile' to depict that which is positively sensitive to volatility. Antifragile systems are thus systems that thrive during or on volatility. The notion gives the systems engineer a wider spectrum than to address fragile systems and aim for resilient or robust systems, but to aim for antifragile systems.

Antifragility requires system strategies that, when faced with a stressor, limit the downside, but have increased exposure to the upside, as seen in Figure 3-4. The premise for an antifragile system is that the extreme consequences are positive compared to that of a fragile system which is negative. Strategies that limit the downside include the use of failure components (e.g. shear bolts), insurance (e.g. production line failure due to power failures), financial options on key elements that affect the system (e.g. metal prices for raw material), etc. In designing the limiting downside, antifragility supports a system that will fail early and cheaply. Through failing, a system should learn and adapt. A sustainable competitive advantage is supported by its ability to learn and adapt faster than the competition (Senge, 1994). Through this learning, a system should be able to action the repair of the system (Senge, 1994) and/or future design improvements (Taleb, 2012).



**Figure 3-4: An antifragile response to an increasing event/stressor**

The environments in which enterprises find themselves are dynamic with a host of stressors continually changing; constraints, opportunities, knowledge, technology, etc. Adaptability is being able to make internal adjustments in response to, or in anticipation of, external changes. In this context, being adaptive has two levels (Johnson & Gheorghe, 2013):

1. The ability to (autonomously) respond to or anticipate consequences of particular actions in a deterministic manner; and
2. By not just being responsive to environment dynamics, but self-organising, evolutionary or natural selection type behaviours like those of biological systems.

In enterprises, innovation is an example of an antifragile strategy. The cost to allow for the innovation function to operate is known, e.g. salaries, prototyping costs, etc. The downside is limited in its cost, but if a large stressor is experienced, then the role would be categorised as antifragile. Innovation is the successful generation, development and implementation of new and novel ideas, which introduce new products, processes and/or strategies to a company or enhance current products, processes and/or strategies leading to commercial success and possible market leadership and creating value for stakeholders, driving economic growth and improving standards of living (du Preez, et al., 2015), (Katz, 2006) and (Schumpeter, 1934). The reason for this is that the role of an innovation function is to generate ideas and turn them into commercially viable ideas. The exposure to new technologies will increase exposure to upside risks for the enterprise with a greater probability of engineering novel solutions/products.



'Kintsugi' is the Japanese art of repairing broken pottery with lacquer dusted or mixed with powdered gold, silver or platinum (Christy, et al., 2008). As a philosophy, it treats failure/breakage and repair as part of the history of an object, rather than something to disguise (Christy, et al., 2008). The piece becomes more valuable for having been broken, learned from and repaired. The large stressor induces a failure in the functional ability of the ceramic. The act of learning and repairing the piece results in a more valuable piece due to its failure. The act of repair has provided the antifragility to the piece with it becoming more valuable after suffering a large stressor.



Figure 3-5: An example of a Kintsugi repair on a 'wabi-sabi' teabowl<sup>5</sup>

Frank Tjepkema, a Dutch designer and the founder of Tjep (2006), a company based in Amsterdam that focusses on interior design, architecture, product design, virtual design and jewellery. Frank Tjepkema, together with Peter van der Jagt, created an antifragile vase with the principle of 'Do Break' behind it. The vase is functional as a vase, but if broken, the vase would only have the ceramic broken with lining which would still allow it to fulfil its function.

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<sup>5</sup> <http://www.lakesidepottery.com/Pages/Kintsugi-art-example-gallery.htm>



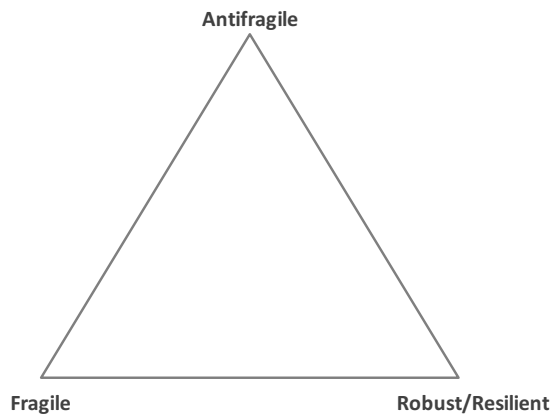
Figure 3-6: The 'Do Break' Vase by Frank Tjepkema and Peter van der Jagt (Tjep, 2006)

Fundamentally, antifragility is a system response that is incomparable to the other two system responses listed, as it improves the functional capabilities of the system in response to a volatile environment.

### **3.4 *The triangle of system responses***

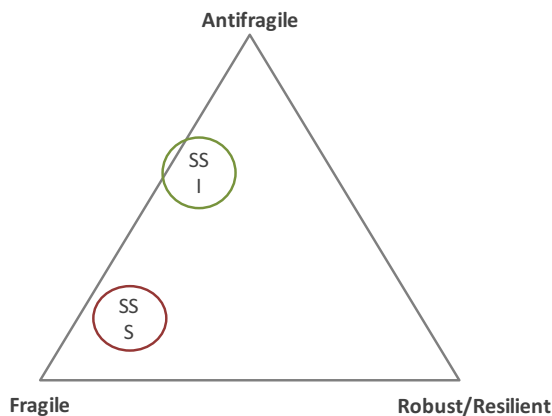
Taleb (2012) used a continuum to explain the system responses of fragility to robust/resilient and antifragile. The continuum was then also used in Johnson and Gheorghe's (2013) proposal of how to measure a system's antifragility. The use of the continuum provides a welcome foundation from which to explain the relationship between the type of responses, but does not allow for the construction of a system from subsystems/components.

It is for this reason that a triangle of system responses is presented which provides for the placement of a system's subsystems/components somewhere within the triangle in Figure 3-7. In the examples above, the function of innovation is not a pure antifragile component as there are certain conditions under which it will cease to function.



**Figure 3-7: The triangle of system responses**

The innovation function failing is limited on the downside with the known costs, but it is still a failure. The innovation function can then be placed somewhere close to the antifragile response, but also lean a bit towards fragility (green circle, SS I, in Figure 3-8). As with the role of shear bolts, by utilising and improving and learning from the shear bolt, it can be placed closer to the middle of the triangle, but leaning towards the fragile response (red circle, SS S, in Figure 3-8). The argument is that a learning component/subsystem has an antifragile characteristic, but this does not make the component antifragile.



**Figure 3-8: Example of subsystem placement within the triangle**

Take note that the positioning of a subsystem or component within the triangle is a matter of perspective. The important consideration at present is to understand that some components can be built to play a fragile role, but are antifragile in their construction/learning. The placement of these components/subsystems allows for a basis (a line in the sand) from which

we can evaluate the component and provide a solution which will improve its positioning in the triangle.

### **3.5 Coping with black swans, ways to improve antifragility**

In risk management, Taleb's work has received some criticism regarding his statement that the field of risk management should be turned on its head as they generally approach risk as though the size of the consequence is a product of the probability that the event will occur (Aven, 2016). Aven (2015) and (2016) explains that risk management and the concept of dealing with black swans can work together in a symbiotic manner. Cause and effect is a basis of risk management with antifragility supporting risk management practitioners by better understanding risk. Risk practitioners are now more concerned with identifying signals and warnings and they acknowledge the black swan uncertainties and the importance of knowledge (Aven, 2015) and (Aven, 2016). There is increased belief that antifragility provides something new which risk management practitioners could strive for. Risk management, as explained by Aven (2015) and Maslen & Hayes (2015), has gained the most value from the concept of antifragility as risk management now looks at the way stressors have occurred to support learning in the risk management process and from a position of learning has improved the way in which contingencies are compiled (Maslen & Hayes, 2015). The value here scratches the surface of the risk management process, but the value of antifragility has started to move from something that was known implicitly to an explicit explanation.

Taleb, et al. highlighted some guidelines to support his notion that enterprises can better prepare for the improbable circumstance (Taleb, et al., 2009). The main idea highlighted to address black swans is to be hyperconservative<sup>6</sup> when exposed to downside risk (Figure 3-9a) and hyperaggressive when presented with opportunities that cost you very little (Figure 3-9b).

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<sup>6</sup> For the remainder of this document only, 'conservative' and 'aggressive' replace 'hyperconservative' and 'hyperaggressive' will be referred to. Taleb (2012) used the prefix 'hyper' to denote that the enterprise should take an extreme stance on this.

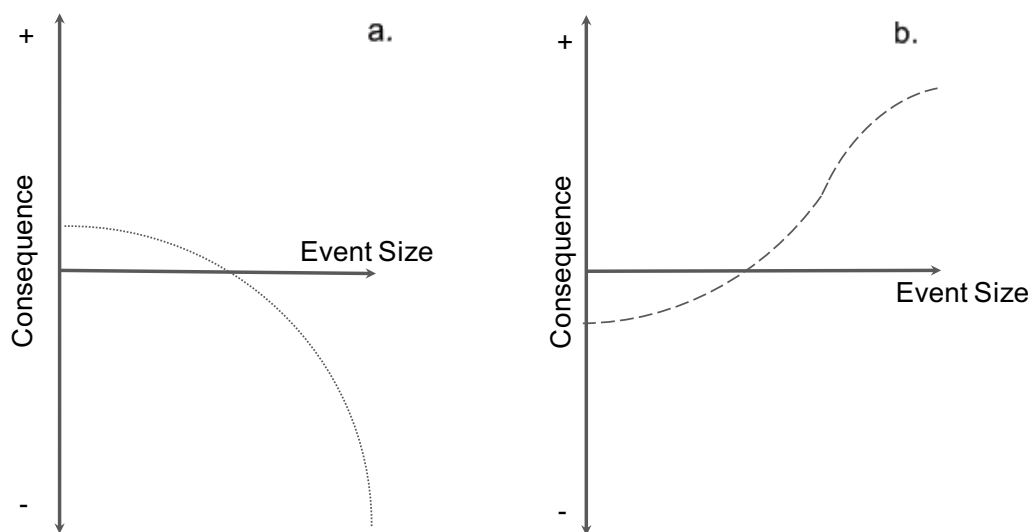


Figure 3-9: a) Illustration of 'unbound' downside risk with limited upside, and b) 'unbound' upside risk with a limited downside adapted from Taleb (2007)

Taleb (2007) found that most enterprises use dollars to create pennies, but the black swan coping philosophy is displayed through the return for risk b in Figure 3-9. Enterprises that are focussed on mitigating the shock of catastrophe do not perform as well as other enterprises on stock exchanges (i.e. NASDAQ, JSE, etc.) that do not have the added expenses which include, now known, coping mechanisms which include increased cash reserves, insurance and/or reduced leverage (Taleb, 2008). Enterprises that did enjoy the reduced expenses were those that were the most negatively affected during the crises (the 2008 financial crisis), those in comparison with the required mitigating expenses were in a better financial position after the crises (Taleb, 2008) and (Taleb, 2012).

The following do not stand as the only antifragile considerations, but they attempt to provide a starting point from which considerations can be constructed to design an antifragile system. Allowing for the field of antifragility to be antifragile in itself, space is provided for further research to enlighten the research community with further characteristics and considerations which would improve on the currently built models by adding to the considerations/characteristics or the frameworks themselves.

### 3.5.1 The entrepreneurial mindset

Taleb (2012) proposed two considerations for what he calls the 'entrepreneurial mindset'. The first refers to the capability of the human mind to respond to stressors in novel ways. It relates to the adaptive way in which humans can respond to various situations in the form of evolution. The second refers to the fact that those that make the decisions on short- and long-term futures of the enterprise should have 'skin in the game' (Taleb, 2012). This requires the decision-maker to be inextricably linked to the decisions they are making. This could be the loss of money, respect, position, share value, etc. if the wrong decision is made. This does not allow for the outcome of the enterprise and the decision-maker to be separated. Drucker called these individuals 'intrapreneurs' as the agents within an enterprise that are crucial to success as any enterprise will fail "unless they acquire entrepreneurial competence" (Drucker, 1985).

A part of the system is feedback to ensure that system stability is pursued, if this is not the case, then the system will restructure itself to compensate for the missing functions. These arrangements are generally put in place by the interventions of humans rather than the predetermined systems, governance/regulations or processes (Taleb, 2012), (Tseitlin, 2013) and (Bendell, 2014). Humans operate at a level of sophistication above that which can be achieved through the technical aspects of the systems and processes (Taleb, 2012) and (Bendell, 2014).

The human element plays a valuable role in providing robustness/resilience and antifragility in relation to inherent weaknesses in enterprises or ones created by unforeseen stresses. The ability to do this needs to be developed, taught and learned as well as the provision of support that should be provided to process longer-term solutions into systems and processes (Taleb, 2012) and (Bendell, 2014). There are negative aspects to allowing for human management which include the lack of consistency, processing power of information and emotional biases. It is thus the manner, and type of human intervention that it is critical to enable.

### **3.5.2 Decentralisation**

Centralisation has been used to increase the amount of control in a system to increase the efficiency and reduce costs through the use of a 'blueprint'. There are some requirements which are overlooked in centralisation which is addressed through decentralisation.

Decentralisation allows for functional/structural units of a system to create their unique features in relation to resources as well as required outputs. Centralised systems tend to be more fragile where one glitch in one of the overarching systems brings down the subsystem and in turn the larger system (Bendell, 2014). Through decentralisation, the coupling between subsystems can be reduced which will reduce the fragile nature of the system. Modular designs find ways to allow for coupling, but allow for risks to be addressed at the integration point. Historically, IT infrastructure has been the constraining factor regarding the design and decision-making within the enterprise, but technological breakthroughs have allowed for the investment into IT to be less resource intensive.

Decentralisation can be used to give functional units autonomy which can be used to make decisions which are unique to their function and immediate environment. This leads to more entrepreneurial functional units. Regulation is required in the system, especially through the alignment of decision-making with the strategic intent/purpose of the enterprise, but the aim of antifragility is more toward that of a decentralised entrepreneurial structure than a centralised one.

### **3.5.3 Diversification**

A range of products/services allows for increased upside when there is a shift in the market, as well as protection on the downside risk. The diversification of the value chain, incoming and outgoing, plays a role in the distribution of risk when markets shift.

The added benefit of diversification is through the exposure to more upside risk as more contact points within the market exist on a product and co-evolutionary level between stages in the value chain. The role of diversification is to first limit the downside risk, but second to allow for increased exposure to possible upside risks.

In 1957, Igor Ansoff stated diversification is made desirable through long-term trends (i.e. general economic trends, political and international trends, peculiar industry/sector trends, etc.), through a strategy of contingency and preparation for unforeseeable events (Ansoff, 1957). He stated that there are three types of diversification opportunities:

1. Vertical diversification;
2. Horizontal diversification; and
3. Lateral diversification.

Each of these can be used to fulfil a specific role, from vertical diversification to contribute to the inputs of the enterprise, horizontal diversification to improve market coverage or increase overall sales, to stabilise sales during economic downturns.

#### **3.5.4 Agility and flexibility**

Agility and flexibility are characteristics in the manner of the enterprise's form of adaptability to change and prioritise in a volatile environment. It allows for the response to changes endo- and exogenously to the enterprise, but only after determining whether the event/stressor warrants a response (Bendell, 2014).

A system that is designed to be able to adapt and be flexible to change in response to the changes in the environment can allow for the subsystems/components to improve the role it is required to play in the building of an antifragile system (Tseitlin, 2013).

Crisis management allows an enterprise to deal with major unpredictable events that threaten to harm the functionality/survival of the enterprise, its stakeholders or general public. A crisis is defined by 1) a threat to the enterprise, 2) the element of surprise, and 3) a short decision time (Seeger, et al., 1998). Aligning crisis management in the enterprise requires the preparation of resources and enterprise structures required to respond effectively in the face of a crisis and recover effectively in the aftermath. It supports the building of a capability that would identify threats to the enterprise and designing a plan to addressing those threats. In the role of black swans, the threat is not identified, but the understanding of the endogenous response to various threats is required to design a crisis management capability (Taleb, 2012).



Crisis management, as with agility and flexibility, is used as a tool through which the resilience of a subsystem can be improved. Taleb is critical of scenario planning, as this aims to whittle down events to four or five scenarios to the risk of excluding others. These tools should rather be used to take a view of how fragile an enterprise is to the environment (Taleb, 2007), (Taleb, 2008) and (Derbyshire & Wright, 2014). In the end, scenario planning should create scenarios to test the fragility rather than gambling on a forecast of events (Taleb, 2008) and (Sunter & Illbury, 2001). Taleb (2008) proposes an open mind to black swans by being aware of environments which encroach on extremes (i.e. in scenario planning, Clem Sunter highlights flags which indicate when a given event is becoming probable (Sunter & Illbury, 2001)) and (Taleb & Goldstein, 2012).

### **3.5.5 Learning**

Learning involves the detection and correction of an error. This description forms part of an adaptive system. The use of double-loop learning allows for the ability of a system to modify, or even reject, a goal in light of a stressor, compared to single-loop learning where the goal is unmovable. Double-loop learning breaks robust goals, but allows for insight to align goals in a different way (Bendell, 2014) and (Argyris & Schön, 1978).

Accelerated learning can be found in systems where small stressors are induced to see a small predictor of the type of output. The system learns to address the consequence, which can be unintended, which speeds up the process of learning (Tseitlin, 2013). The process through which subsystems are stressed to become stronger through a process of learning and improvement is called 'hormesis'. Applying stress beyond that which is manageable by the system will cause harm rather than good. Resilience is improved through being stressed, but it requires a mechanism where proportionality to the current state is identified and exercised and updated as the current state develops (Bendell, 2014), (Taleb, 2007), (Johnson & Gheorghe, 2013) and (Taleb, 2012).

The tinkering of events and stressors in a system allows for the learning capabilities which reduces employees' and management's attachment to preconceived ideas and beliefs. The open mind allows for the acknowledgement of a limitation of knowledge which is the

foundation from which decision-making can be done (Taleb, 2008) and (Taleb & Goldstein, 2012).

### **3.5.6 Environment of trust**

In an antifragile system, trust is required to allow for accountability and transparency for each subsystem/component to fulfil its role in alignment with the system's purpose. This allows for the decentralised, entrepreneurial units to be allowed autonomy with the belief that trust is bestowed to them to fulfil their role. Ostrom (1998) found that in periods of uncertainty, employees in a high-trust environment are more willing to step outside that which is expected of them in their regular roles and work with others to address the issue. Those in low-trust environments are more likely to apportion blame.

Trust creates other benefits such as an environment of less fear of judgement (Tseitlin, 2013) which allows employees to share ideas and test theories. The environment allows for one where ideas are tested, tinkered with and learnt from (Olstrom, 1998). This capability needs to be developed and supported as part of a longer-term solution into the design of systems.

### **3.5.7 Scenario planning closer to home**

Predictions of events in the future are sure to fail with forecasting in a time period looking at a single point in time. History has shown how incorrect forecasting has been (Taleb, 2008) and (Taleb & Goldstein, 2012). An enterprise should focus on the dimensions that work directly on its boundaries. The effect of a single activity in time, i.e. Nenegate, is thus catered for by focussing on the volatility of dimensions that work directly in on the boundaries of the enterprise, such as an increase in the Rand:USDollar exchange rate, or an increase/decrease in the amount of order of a product.

The focus on the dimension and what is possible for the enterprise to handle should be focussed on. The flags, as mentioned by Sunter and Illbury (2001) will thus be on the boundary conditions which would either result in the enterprise failing (see next section 3.5.8) or prospering (see section 3.5.9). These flags then allow for enterprises to prepare for the volatility, but focussed on the boundary conditions of the dimension.

### 3.5.8 Conservative on downside risk

In preparing for catastrophe, the enterprise is conservative when faced with downside risk.

Conservative approaches include tools and positions such as:

- derivatives for hedging (from the financial field);
- diversifying risk in various markets (from the field of strategic management);
- insurance; and
- liquid assets (both reduced exposure to leverage and thus volatility exposure to global markets as well as a way in which to prepare for the miraculous circumstance).

In uncertainty management, De Neufville (2004) listed three basic ways in which to address uncertainty (de Neufville, 2004):

1. Controlling uncertainty, i.e. demand management;
2. Protecting passively, such as building robustness or fragility into an enterprise; and/or
3. Protecting actively through the creation of flexibilities which managers can use to react to uncertainties.

These are consistent with the first step in making a system antifragile and that is to first and foremost protect it from failing.

High Reliability Organisations (HROs) have been used as an example by La Porte (1996), Weick & Sutcliffe (2000), Lapame & de Geurre (2014) and Bendell (2014) as a group of enterprises that exist which are known for a mindfulness approach to the management of complexity. They are the enterprises that have succeeded in avoiding catastrophe in environments where normally high impact incidents can be expected due to risk factors and complexity. These have shown that fragility of enterprise tenure can be addressed. They generally use complex processes to manage complex technologies and work to avoid failures (La Porte, 1996), (Weick & Sutcliffe, 2007), (Lapalme & de Guerre, 2014) & (Bendell, 2014).

HROs are diverse in various ways, but possess five key characteristics (La Porte, 1996), (Weick & Sutcliffe, 2007), (Lapalme & de Guerre, 2014)& (Bendell, 2014):

1. They are preoccupied with failure;
2. They are reluctant to simplify interpretations;
3. They are sensitive to operations;
4. They have a commitment to resilience; and
5. There is a deference to expertise.

Great destruction has always left opportunities behind. The adequate preparation during times of destruction paves the way to take advantage of the opportunities that exist when the dust settles. These enterprises find themselves operating where competitors are made immobile, just to loosen up assets to survive the aftershock. An enterprise looking to survive and grow would see it as a catastrophe to not pursue opportunities. An enterprise should ensure that it is in a position to create opportunities for itself, to take advantage of the miraculous event. These are precautions that are set in place in order to take advantage of miraculous events as well as a change in perspective in which a negative black swan is changed into a positive one.

### **3.5.9 Aggressive on upside risk**

*“Today’s new digital infrastructure in fact gives relatively small actions and investments an impact disproportionate to their size.” – Hagel III, et al. (2008)*

Enterprises in the midst of a catastrophe rarely have an idea of what the risks are; their main aim is to survive. Executives instinctively magnify apparent risks and discount exposure to potential rewards when confronted with rapid change (Hagel III, et al., 2008). In this mindset, displaying aggression towards opportunities that cost you little would have been lost.

The advantage of the times we are living in allows for enterprises to make a bigger impact than their size permits. Technology allows enterprises to make considerable consequential impacts through investment capital which are benign compared to the investments a decade or more ago.

As with the example of innovation given in section 3.4, the relentless pursuit of innovation and investment in ideas is antifragile in itself. The costs of investment are known, but the investment gives the enterprise access to focussed investigation into new products, processes, and strategies. The pace of technological developments at present results in enterprises becoming technologically obsolete. An innovation function turns this fragility around by investigating the use of these technologies in improving the enterprise. Innovation can turn technology from a fragile concept in an enterprise to a competitive advantage.

The list of concepts to improve the antifragility in the enterprise is not an exhaustive list, but acts as a starting point from which to develop a framework that allows for antifragile SMEs. In order to assess whether SMEs are, in fact, improving on their antifragility, they need to be measured to provide comparative analyses.

### ***3.6 Measuring antifragility, an alternative to current tools***

System Engineers increasingly aim to prepare systems better for extreme events, thus aiming to reduce the so-called fragility. The main difficulty here is to assess if the enterprise's ability to cope with black swans has indeed improved. The absence of a measurement approach for system (anti)fragility limits the effectiveness of governance in making systems less fragile and more robust, if not antifragile (Johnson & Gheorghe, 2013).

Initial steps to structure such assessment applied mathematical models, but appeared to be beyond the capabilities of the average enterprise's management (Taleb & Douady, 2013). In order to allow for the applicability to enterprises, a more framework-oriented approach was developed, aiming to measure an enterprise's antifragility (Johnson & Gheorghe, 2013). The framework was based on a system of systems criteria and sourcing quantitative values from stakeholders. It reduced a multidimensional concept of fragility into a two-dimensional continuous interval scale on which the quantitative average was plotted.

The framework provided by Johnson & Gheorghe (J&G) (2013) provided a solid foundation from which to elaborate on. The reason for elaborating on the framework for measurement given is that the ability to be able to adequately measure (anti)fragility is an imperative

precondition for purposefully improving the enterprise's strategic position to be less fragile or more antifragile.

### 3.6.1 The structure, logic and use of Johnson and Gheorghe

The evaluation system was built on the attributes that are of interest to system stakeholders: strategies, policies, governance, structure, components, subsystems and processes. The questions are then contextualised for a system in terms of how it would respond to the stressor based on the system criteria shown in Table 3-2.

Table 3-2: Analytical criteria of a system of systems adapted from (Johnson & Gheorghe, 2013) and (Jackson & Ferris, 2012)

Key	Criteria	Definition
F1	Emergence	Emergent outputs, there is little/no traceability between micro- and macro-level results of a system, has greater black swan event exposure compared to resultant due to an increase in the amount of unintended system states.
F2	Efficiency and Risk	Efficiencies are often gained at the expense of increased potential for harm due to stress. Less redundant systems designs are more efficient, but more fragile.
F3	Requisite Variety	Regulators in a system of systems attempt to control the outcome and behaviours in the system. Black swan events increase as a result of the number of regulators being insufficient relative to the number of agents (unpredictable behaviour).
F4	Stress Starvation	Protecting a system from stress or attempting to reduce uncertainty can cause weakness, fragility and expose them to hazardous black swan events.
F5	Redundancy	Duplication of components to meet the same objective create excess capacity in a system and are effective tools for extreme stressor defences. Redundancy tends to stabilise systems and improve robustness.

Key	Criteria	Definition
F6	Absorption	Absorption in systems can be used to improve robustness. Design margins that increase the magnitude and duration it can take during potential stresses to ensure it continues functioning as it should, increases the absorption ability of the system.
AF1	Induced small stressors	Some systems are found to improve with greater exposure to stress. Controlled stress to a system can increase its robustness and potentially lead to antifragility where the system 'learns' from these controlled responses.
AF2	Non-monotonicity	Learning from negative consequences induced by stressors can lead to new information. New information can result in improved practices and approaches. Stressors, when learned from, can thus cause a system to improve.

The system assessment criteria were mapped to a key (first column) to allow for ease of representation in tables, graphs and discussions.

Johnson & Gheorghe measured the system according to system criteria that assesses the system as a whole. They required quantitative responses to their questions on an interval scale. The main endogenous question in relation to this system criteria is (Johnson & Gheorghe, 2013):

- How will a system respond to a black swan stressor?

In application, they used the Delphi method to converge the stakeholder's interval responses per criterion. This allows for order, distance and the application of statistics and applied inferences (Johnson & Gheorghe, 2013).

The final result is an aggregate value over all criteria which is plotted on a curve in order to highlight its position on the fragile-antifragile continuum in Figure 3-10. The plot would allow for the system to assess its position on the continuum as well as create a reference to which future measurements can be compared.

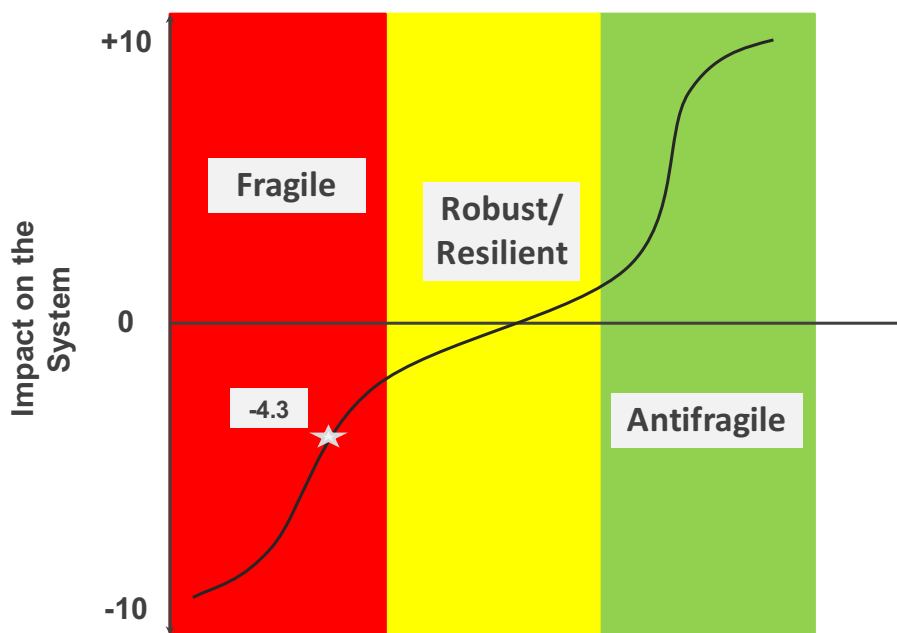


Figure 3-10: J&G framework result of the aggregated Delphi method responses (Johnson & Gheorghe, 2013)

The criteria are not mutually exclusive, but exclusion of one or another would reduce the probability of adequately assessing the system. The criteria given here were more focussed on the fragile-to-robust section of the continuum rather than the robust-antifragile continuum. The possible reasons for this could be that the fragile-robust continuum has received more research focus or that there are just not as many robust-antifragile criteria.

### 3.6.2 A critical review of the Johnson and Gheorghe framework

An inaccurate ruler will not measure the correct height of a child, but when used continuously, it will prove whether the child has grown (Taleb & Douady, 2013). The Johnson & Gheorghe framework is one which gives a specific value on a measured ruler, and it is thus useful to assess antifragility changes if the criteria remain the same.

The drawback to a specific measurement is that if future research proves that the criteria need to change, the ruler's previous values would have no comparable value. As noted, the current model can be improved by formally defining the standards for selection of the criteria and methods for aggregating evaluation results (Johnson & Gheorghe, 2013).

Another shortcoming which breeds from the point raised before is that the framework in itself is not adaptive. It does not depend on the type of criteria, but rather how the criteria can be



added and still be comparative to previous measurements. Given that the field of antifragility is in its infancy, other criteria could be identified to form part of an antifragility assessment (e.g. leadership is one avenue which can be elaborated on) (Gandz & Seijts, 2013).

### **3.6.3 An adapted approach to assessing (anti)fragility**

The question was not the criteria that were used by Johnson & Gheorghe (Table 3-2), but rather the way in which they were utilised.

#### ***3.6.3.1 Requirements specification of the adaptive assessment approach***

The first shortcoming related to the fragility/rigidity of the current tool was that it needed to be kept constant in order to ensure that the same ruler was consistently applied when measuring.

The second shortcoming was that the assessment tool was biased to the fragility-robust continuum. The result is that an assessment of fragile would be the specific value when it could be antifragile.

Given these two shortcomings, space is created to provide solutions to these shortcomings to build on the valuable first step taken by Johnson & Gheorghe. The two requirements arising out of this are:

1. It should be flexible to changing assessment criteria; and
2. The criteria that are used in the model should allow for comparisons between measurements once a change has been made to the assessment criteria.

#### ***3.6.3.2 The structure, logic and use of the adapted assessment approach, an explanation through a case study***

The adapted approach was developed and simultaneously applied in a case study that was done on an electro-vehicle assembly company based in the Western Cape, South Africa. The system that was assessed in the case study was the enterprise, which included the production/assembly as well as all the required support functions. The stakeholders that participated in the assessment had just been through a due diligence exercise to apply for further funding for expansion and strategic change of the enterprise.

The adapted approach divided each criterion up to have a quantitative value of -10 to 0 (fragile criteria) and 0 to 10 (antifragile criteria). These values are quantitative responses to questions. The questions asked were not the only interaction held with the stakeholders, but they were a starting point to move toward specific 'what-if' type of questions around extreme stressors. As an example, non-monotonicity had the following original questions:

- What is the system's ability to gather information on the consequence of a stressor?
- Are processes in place to assess the information gathered?
- Are processes in place to act and are they validated?

These provided the platform for the 'What-if' discussions, after which, the stakeholders' quantitative responses were submitted anonymously, which prevents anchoring. Anchoring follows when estimates are made starting from an initial value that is adjusted (as with the Delphi method). The adjustments are typically insufficient as different starting points yield different estimates, which are biased towards the initial values (Tversky & Kahneman, 1974).

The raw results (Table 3-3) were used to calculate each criterion's average and standard deviation. The average is not intended to determine the system response, but to assess whether the enterprise's (anti)fragility has improved in one of two ways:

- *Assessment per Criteria (C)*: Did the consensus improve on the impact of the criterion (indicated by reduced standard deviation)?
- *Assessment for Slope (S)*: Did changes in the overall assessed criteria improve the enterprise's (anti)fragility (strives to 0 for fragile criteria and to 10 for antifragile criteria)?

**Table 3-3: Criteria raw metric values per individual adapted from Johnson & Gheorghe (2013)**

		Criteria							
		F1	F2	F3	F4	F5	F6	AF1	AF2
Individual	Ind1	-10	-8	-7	-8	-9	-8	0	0
	Ind2	-7	-8	-8	-2	-8	-2	4	3
	Ind3	-6	-7	-5	-4	-7	-5	1	6
	Ind3	-7	-7	-7	-6	-6	-8	0	2

### 3.6.3.2.1 Assessment per Criteria, the power of the standard deviation

A standard deviation that is larger than the other criteria shows that the consensus on all the criteria is not the same. If a consensus does not exist between the stakeholders, a question arises as to the known states of the system. In this way, the value of the measurement is in comparing the spread per criterion to its previous measurements.

The adaptive approach does not aggregate values over different criteria as subsequent measurements are not comparable. If the values of all the criteria are aggregated without investigation, a learning opportunity is lost. Under the assumption that a new criterion might be added, an aggregate value as well as a standard deviation for the new criteria is calculated.

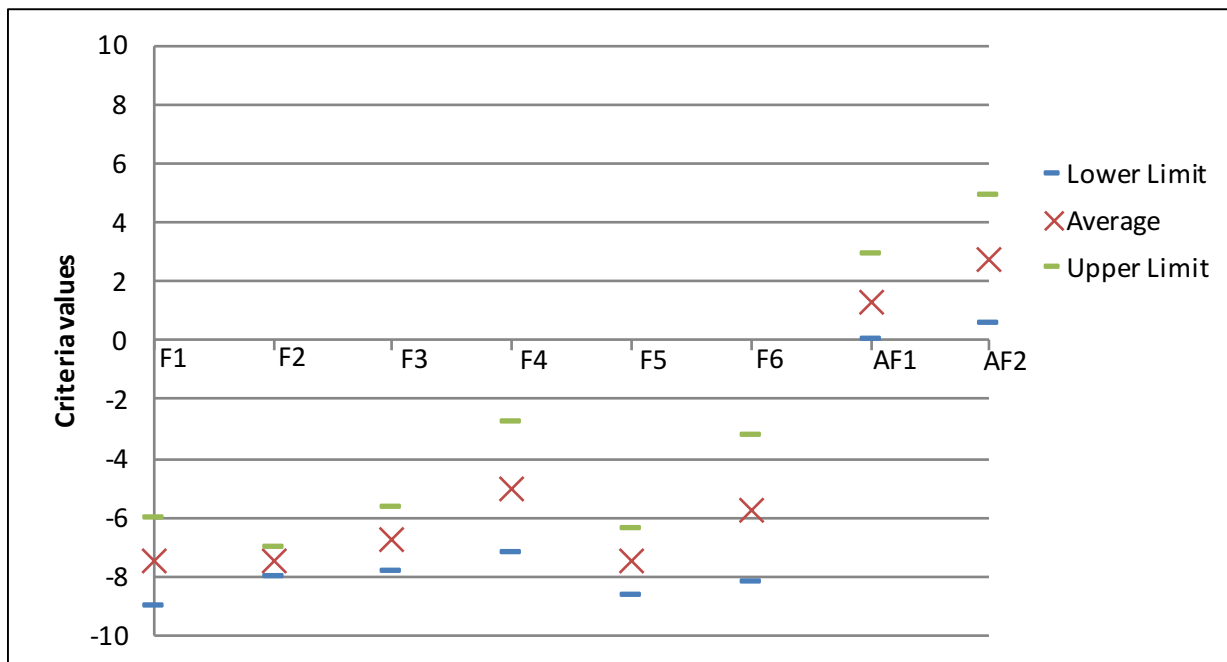


Figure 3-11: Assessment (C), the spread per criterion

F1, F2 and F5 have the worst averages, but F6 and F4 have the largest standard deviations, Figure 3-11. These criteria might not be mutually exclusive which increases the unknown probable system states if a large spread is encountered (stakeholder views do not converge). The view of senior management was that they view stressors (F4) as something to avoid at all costs as they were continually fighting the consequences of stressors they were experiencing every day. The result is that of time wasted away from their operational roles which results in a reduction of active regulators in the system (F3) which they believe resulted in more failures.

### 3.6.3.2.2 Assessment for Slope, complete system improvement

A view of the overall system improvement is required with the adaptive approach not using a singular value as a specific predictor of the categorisation of the system response, but it intends to show whether the system is improving, moving in the right direction. This can be achieved with linear regression. The absolutes of the fragile criteria are ordered from the highest to lowest values and are then followed by the average antifragile criteria (sorted from lowest to highest) seen in Figure 3-12.

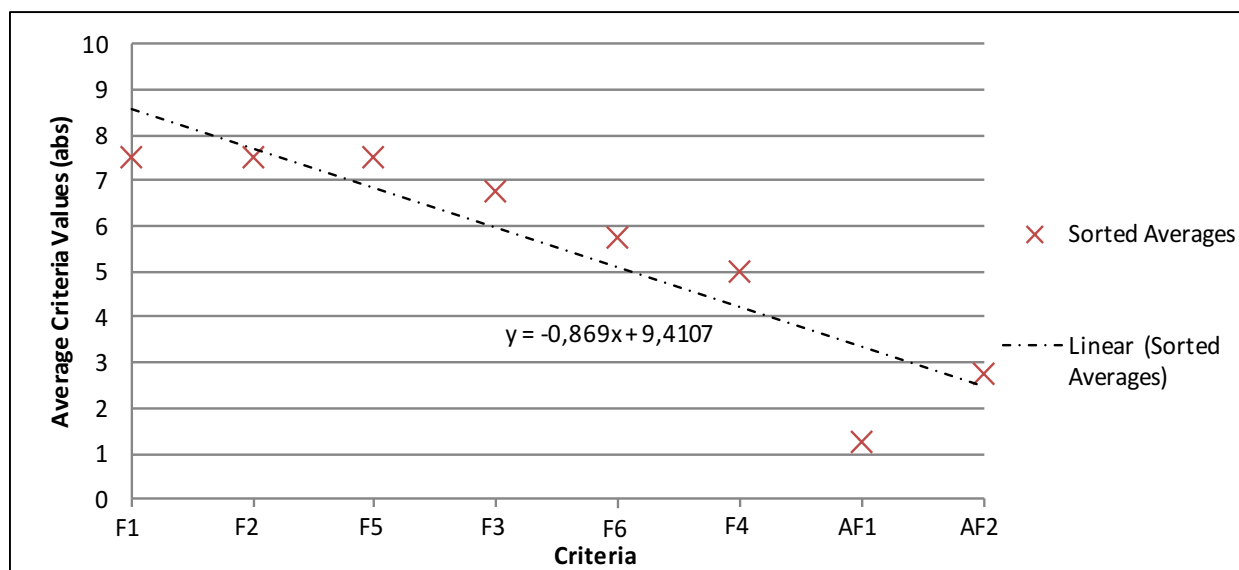


Figure 3-12: Assessment (S), assessed with linear regression

The slope obtained (-0,869) in this case provides the enterprise with a starting point for future assessments. The value is only significant in its relation to other assessments on the enterprise and should not be seen to categorise the system as being fragile or antifragile. The improvement of a system would then be presented by the improvements of the slope (as the slope increases or flattens).

### 3.6.3.3 Evaluation of the adaptive approach

In the workshop, the stakeholders agreed that it was difficult to understand the criteria at first, but allowed for clear constructive thinking to present quantitative values when supplemented by 'What-if' questions and further discussions. The stakeholders were surprised by the spreads given in *assessment (C)* as they had just gone through a thorough due diligence procedure.

In answering the requirements as they were provided in chapter 3.6.3.1:

- Two assessment phases allow for criteria to be changed. As criteria are changed, assessment (C) allows for the evaluation of the criterion and how the spread relates to other criteria. It highlights the criteria that need attention as well as providing an introduction into a new way of thinking about systems.
- Linear regression was used on the averages of the criteria for assessment (S). The objective is to provide feedback to stakeholders as to whether the system has improved, but not to place it on a specific point on the continuum.

The adaptive framework will improve in value to the enterprise as an increased understanding of criteria will allow for more accurate measurements/comparisons as well as increased understanding of the enterprise.

### ***3.7 Chapter conclusion***

This chapter provided background on black swans, antifragility, their characteristics and what constitutes an antifragile system. An antifragile system can be seen as a biological system where the underlying systems go through continuous improvements to strengthen the overall system. In an SME, the enterprise can be designed to improve the hormesis which these enterprise units go through to improve the antifragility of the enterprise. The role of the enterprise regulator is to align the enterprise units to fulfil the purpose of the enterprise. These enterprise units then need to contribute with specific functions in the enterprise. These functions need to be fragile, resilient, or in terms of the newly made explicit, antifragile. We also proposed a way in which antifragility can be measured to allow for subsequent measurements to be able to confirm whether an SME's antifragility has improved. These measurements do not provide the perfect measurement tool, but they provide the yardstick against which the enterprise can be measured to show improvement rather than an absolute value. The considerations for antifragile systems are used to design the framework through the building of requirements in chapter 5.2 and Table 5-1 to Table 5-5.

## 4. Enterprise engineering through an antifragile lens

*“... employee involvement and participation is essential for addressing enterprise dynamics, complexity and uncertainty. Enterprise change, hence redesign, is thus fuelled by enterprise learning. As Weick (2001) observes, redesign is a continuous activity whereby the responsibility for (re)design is dispersed and rests with enterprise members who are coping with the ‘unexpected’.” – Dietz, et al. (2013)*

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The industrial engineer approaches the construct of systems by following a systems approach. Through the lens of an industrial engineer, to ensure that a system is designed to be antifragile, a systems approach needs to be followed to include the antifragile considerations. In designing an enterprise, as with SMEs, the systems engineer utilises the field of enterprise engineering to approach the design of an SME and in so doing create the platform for this research to design an SME to be more antifragile.

The chapter introduces the reader to the field of enterprise engineering and how it has evolved to align with some considerations as highlighted in the previous chapter. The requirements for the design of an SME according to the antifragile considerations will be highlighted in order to provide the basis from which the framework construct will be built in order to create more antifragile South African SMEs.

### 4.1 Enterprise engineering

Enterprise engineering is a holistic approach to address enterprise changes of all sizes and in all kinds of enterprises. The holistic systemic approach was built on the principles of systems engineering (Sage, 1992) and (Stevens, et al., 1998). As Dietz (2013) stated, enterprise

engineering aims to do for enterprises (basically conceived as social systems) what systems engineering aims to do for technical systems.

The need for enterprises to operate as an integrated whole is becoming increasingly important. Trade barriers being removed, deregulation, globalisation through ICT, etc. have led to networks of enterprises entangled on a large scale. These enterprises operate in a more dynamic and global environment and this will continue to accelerate. They will need to become more adaptive, agile and transparent as they will be held more publicly accountable for every effect they produce. Enterprise engineering provides a way in which these enterprises can reach these objectives through the connection to generic goals, but achieved through the systematic redesign of an enterprise guided by design principles (Dietz, et al., 2013).

Design in this sense, is interpreted broadly and seen as devising “courses of action aimed at changing existing situations into preferred ones” (Simon, 1969). Design here is considered as an activity based on enterprise learning where the members of the enterprise cope with the ‘unexpected’ as opposed to the traditional architecture metaphor (Tsoukas, 1994). The notion of emergence is accommodated in this definition (Taylor & van Every, 2000). The responsibility for this redesign now lies with the enterprise members. The motive is to design through the understanding of the strategic intent that requires translation to operations and how this can be *arranged* to happen (Dietz, et al., 2013).

#### **4.2 Fundamentals in dealing with enterprise design**

Dietz, et al. (2013) formulated seven fundamentals in which an enterprise engineer can effectively deal with enterprise design, -governance and -management. These were derived from theories to provide guidelines that allow for increased adoption in practice. Fundamentals 1 to 4 are provided to ensure enterprise design is practically doable and manageable. They support concinnity in the enterprise. Fundamentals 5 to 7 are more ideological and convey the conviction that employees are the enterprise and that they must be empowered to perform optimally.

#### **4.2.1 Fundamental 1: distinction between function and construction**

A constructional model of an enterprise can always be validated from the actual construction (which is objective) of the enterprise. The functional model, however, is by nature very subjective and is not a system property, but it is a result of the relationship between the system and a stakeholder. It is seen that the system, at any moment, has one construction, but as least as many functions as it has stakeholders. These functions, however, are brought about by the construction. The system is thus constructed as a series of subsystems. Dietz, et al. (2013) used the example of an aircraft to explain this. The functional specifications for the aircraft's engines are derived from the constructional model of the aircraft, and not from the aircraft's functions. Further, the actual construction of the engines is immaterial for understanding the global construction of the aircraft.

Enterprise theory has logically followed that enterprise information systems are developed by starting with the goals of the enterprise or what the view of IT governance is rather than how the enterprise has been constructed. The consequence is that the construct of the enterprise is dictated by the IT governance or the goals of the enterprise. As with the view of antifragility, when the goals change (through double loop learning), the information system is redundant, needs to change or forces the goals to stay the same.

The enterprise can thus be constructed, or architected, through the understanding of the functional subsystems of the enterprise. These subsystems will from here onwards be referred to as enterprise units.

#### **4.2.2 Fundamental 2: focus on essential transactions and actors**

Enterprises are complex which creates a necessity for tasks to be divided. The key to enterprise success is the operation as a unified whole to a certain goal, which asks for task differentiation to be properly paired to the integration of distinct tasks. Lawrence and Lorsch (1967) and Daft (2001) have highlighted that differentiation and then integration of tasks is a non-trivial issue and have, as of yet, not found an effective approach to identify these tasks.

The notion of differentiation implies that employees are engaged in different activities where the notion of integration asks that these are coordinated such that the enterprise operates as



an integrated whole. Dietz (2006) called the coordination of these activities 'transactions', which can also be seen as the interface between two activities. These transactions are the building blocks of enterprises, with a large number of processes (multiple for production, recruitment, payments, logistics, accounting, etc.). These are different in their functional role, but appear to have the same pattern of a tree structure of transactions. This also holds true for support processes such as human resources and finance (Aveiro, et al., 2011).

#### **4.2.3 Fundamental 3: distinction between design and implementation**

A complete development process of a system consists of three phases, 1. Function, 2. Construction design and 3. Engineering/implementation design (Dietz, 2008). Implementation is the complete realisation of the system. This should follow a deterministic view with a precisely defined plan, detailed activities and a clear objective.

In contrast to the implementation or engineering of the development process, design is non-deterministic in its process. The design phase of function follows that the system is produced from given functional requirements and principles in applicable architecture. These are based on the essential model of the enterprise. Through the view of systems lifecycles, enterprise engineering is concerned with all activities right up to the implementation phase.

#### **4.2.4 Fundamental 4: application of design principles**

The challenge in an enterprise is to align the clear strategic goals to the operations and the other way around. The development of enterprises and their supporting systems needs to be controlled by constructional and functional design principles which guide the design of the enterprise. A coherent, consistent and hierarchically ordered set of principles for a particular class of systems is called an architecture.

The notion of architecture has a certain level of deliberate, normative restriction in the freedom of design which comes in addition to the specific functional and constructional requirements in designing a system.

#### **4.2.5 Fundamental 5: distributed operational responsibility**

The objective of empowering employees is to give as much responsibility to individual employees. These place an emphasis on effective control measures rather than strict control

measures. This is an expectation of employee support in pursuit of their responsibilities compared to that of employee control.

This expectation is coupled with the prerequisite that the employee understands their role in their enterprise and how it aligns to the ontological structure of the enterprise.

#### **4.2.6 Fundamental 6: distributed governance responsibility**

Governance is generally assigned to higher levels of management. The drawback of this is that the locus of knowledge and control rests with management. Dietz, et al. (2013) believe that governance should be extended to employees which will improve employee learning which in turn increases enterprise learning. Employees, however, should be enabled and competent to do so. Coherence in the development and implementation of ideas and projects requires a central governance capability which must be exercised at the holistic enterprise level.

#### **4.2.7 Fundamental 7: human-centred and knowledgeable management**

The seven fundamentals underpin a core ideological position of the role of the employee. Drucker (1985) confirmed that enterprise performance is based on the performance of its people. The consequence of the crucial role of employees is the human-centred nature of management (Katz & Kahn, 1978), (Likert, 1965) and (McGregor, 1960). Management needs to be concerned with the creation of conditions for employees to develop themselves and empower themselves (Miles, et al., 1995).

The provision of guidance is needed through shared purpose, goals and values to provide meaning within which individuals can orientate themselves to achievement in alignment with that of the enterprise (Smircich & Morgan, 1982).

### ***4.3 Enterprise architecture, the evolution of the ecological enterprise adaptation***

Deming (1986) showed that 94% of inadequate enterprise performances are attributable to how enterprises are arranged. This is high compared to the 6% that are due to erroneous actions of employees. Too often, the focus has been on limiting the 6% mentioned above, with the mindset of short-term financial gain (Dietz, et al., 2013).

Various definitions for Enterprise Architecture (EA) exist, but the systems focus as defined by Giachetti will be the definition used in this study (Giachetti, 2010):

*“An Enterprise Architecture describes the structure of an enterprise, its decomposition into sub-systems, the relationships between the sub-systems, the relationships with the external environment, the terminology to use, and the guiding principles for the design and evolution of an enterprise.”*

This definition resonates with the view of this study that an enterprise is a complex system that is required to be adaptable. It provides a shared language to communicate the important aspects of designing an enterprise with its relation to antifragility.

EA has evolved from a pure IT architecture and its relation to the enterprise into something that now, can also focus on the environment as well as the bi-directional relationship between the enterprise and its environment. To explain the origin of EA up to its development into one that allows for environment adaptation, Lapalme (2012) presents the three schools of thought:

1. Enterprise IT Architecting (EIT);
2. Enterprise Integrating (E); and
3. Enterprise Ecological Adaptation (the acronym EiE is used in literature as an acronym for enterprise-in-environment; this will be the used acronym from here on).

Table 4-1 provides a subset of qualifiers for the three schools of thought.

Table 4-1: The schools of thought in EA (Lapalme, 2012), (De Vries, 2012), (Lapalme & de Guerre, 2014) and (Gous, 2014)

	<b>Enterprise IT Architecting</b>	<b>Enterprise Integrating</b>	<b>Enterprise Ecological Adaptation</b>
<b>Scope</b>	Enterprise-wide IT platform (EIT). All components of the enterprise are IT assets.	Enterprise (E). The enterprise as a socio-cultural-techno-economic system; hence ALL facets of the enterprise are considered – the enterprise IT assets being one facet.	Enterprise-in-environment (EiE). Includes the previous scope but adds the environment of the enterprise as a key component as well as the bi-directional relationship and transactions between the enterprise and its environment.
<b>Purposes</b>	Enhance business strategy execution and operations. The primary means to this is the aligning of the business and IT strategies so that the proper IT capabilities are developed to support current and future business needs.	Effective enterprise strategy implementation. The primary means to this end is designing the various facets of the enterprise (e.g. governance structures, IT capabilities, remuneration policies and work design) to maximise coherency between them and minimise contradictions.	The purpose is enterprise innovation and adaptation to foster learning by designing the various facets of the enterprise (e.g. governance structures, IT capabilities, remuneration policies, and work design).
<b>Motto</b>	“EA as the glue between business and IT.”	“EA as the link between strategy and execution.”	“EA as the means for enterprise innovation and sustainability.”

	<b>Enterprise IT Architecting</b>	<b>Enterprise Integrating</b>	<b>Enterprise Ecological Adaptation</b>
<b>Principles and assumptions</b>	Reductionism. Business strategies and objectives are provided by the business and are correct. Independent design of enterprise dimensions. Disinterest in non-IT dimensions.	Holism. Business strategies and objectives are provided by the business and are correct. Environment as something to manage. Joint design of all enterprise dimensions.	Holism. System-in-environment co-evolution. Environment can be changed. Joint design of all enterprise dimensions.

Given the study and its focus on creating an enterprise as a living organism, the rest of the thesis will focus on the Enterprise-in-Environment (EiE) school of thought as this is synonymous with our focus on antifragility where endo- and exogenous responses of the enterprise to stressors are designed for.

#### **4.4 Enterprise-in-environment adaptation**

The term ‘management’ has traditionally been touted as Planning, Organising, Command, Coordinating and Controlling (POCCC). This was the role that management was expected to fulfil within the enterprise (Lapalme & de Guerre, 2014). In the face of complexity, however, this management approach needs to be adapted. In EiE, the enterprise is viewed as a complex adaptive system which (Lapalme & de Guerre, 2014):

- Cannot be perfectly understood through analysis;
- Has properties that emerge from interactions of the system’s sub-parts; and
- Is in a process of constant evolution over time.

There is a continuum which explains the extremes of complexity from determinism on the extreme left and indeterminism on the extreme right, shown in Figure 4-1. The traditional approach to the management of complexity, POCCC, focusses on determinism. On the other

extreme of the spectrum, the management of complexity is done through a mindfulness of its endo- and exogenous environments and their interactions.

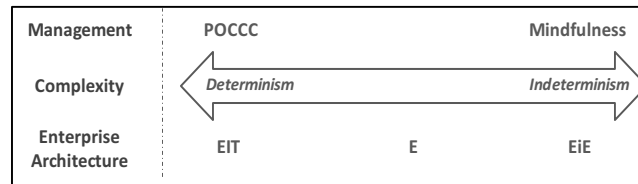


Figure 4-1: Continuum of complexity management (Lapalme & de Guerre, 2014)

The three schools of thought highlighted in Table 4-1 are found on parts of the complexity continuum, Figure 4-1. The enterprise IT Architecting promotes a more traditional POCCC approach to complexity management. The Enterprise Integrating school is based near the middle of the continuum due to its view that reductionism is not sufficient in the management of the system, but also promotes a traditional POCCC approach to complexity management.

The EiE approach to enterprises follows that, EA is about fostering enterprise learning, by designing all the facets of the enterprise and its relationship to its environment to enable innovation and enterprise-in-environment adaptation (EiEA) (Lapalme & de Guerre, 2014). It believes that a systematic approach alone is not sufficient, but it is required to achieve environment and enterprise co-evolution by purposefully changing the environment and designing both the enterprise and its relationship to its environment systematically. Co-evolution is achieved in three ways (Lapalme & de Guerre, 2014):

1. Making the environment friendlier for the desired goal of the enterprise;
2. Adapting the desired goals of the enterprise to ensure compatibility with the environment of the enterprise; and
3. Improving intra-enterprise coherency.

The first is supported by reinforcing pockets of desired futures within the environment and by reducing unwanted forces (Lapalme & de Guerre, 2014). The second is through environmental learning, which is supported by double loop learning to continuously adapt to the changing external forces (Bendell, 2014). EiEA does not filter any of the complexity, but promotes a considerate approach to complexity management, being rooted in mindfulness and thus on the right side of the complexity continuum, seen in Figure 4-1. The perspective of EiE allows for

EA to be concerned with the integration of open socio-technical systems or more simply open socio-technical systems design (Lapalme & de Guerre, 2014).

#### 4.4.1 Socio-technical system design

Emery (1972) defined an open socio-technical system as (Lapalme & de Guerre, 2014):

*“... a purposeful system composed of interrelated social (people, culture, norms, interactions, roles, etc.) and a technical component which is embedded in a broader context (the environment) that the system is both influenced by and influences.”*

In social systems, in order to express the ideals of contextualism, the following process needs to be managed well (Parsons, 1951) and (Lapalme & de Guerre, 2014):

1. Goal setting and attainment (e.g. the use of short-term goals linked to long-term strategic goals);
2. Adaptation to the external environment (e.g. changes demanded by new regulations or new customer requirements);
3. Integration of the activities of people within the system (e.g. how their differences are resolved); and
4. Long-term development to ensure the future survival and growth of the system (e.g. through recruitment, training and learning).

In socio-technical theory, each of these variables is assessed with respect to a particular key variance in the technical system and, in general, for each of the four most probable social system interactions (Lapalme & de Guerre, 2014):

1. Superior/subordinate or vertical relationships;
2. Intra-group relations or horizontal relationships within the work group involved in the control and coordination of work to control key variances in the technical system;
3. Inter-group relations or horizontal relationships between the work group and the groups they interact with to carry out their work tasks; and
4. Enterprise goals or relationships across the larger enterprise that contains the social system under study.

Socio-technical theory provides a set of nine principles that guide the design thereof, but it is not seen as a practical guiding approach (Parsons, 1951) and (Lapalme & de Guerre, 2014):

1. Compatibility: The process of design should complement its objectives.
2. Minimum Critical Specification: No more should be specified than is essential.
3. Socio-Technical Criterion: Variances that cannot be eliminated must be controlled as close to the point of origin as possible.
4. Redundancy of Function: The function of the part should have redundancies rather than the part itself. The same applies to the people as parts of the system, where a redundancy of skills is required.
5. Boundary location: The subsystem boundaries need to be established to group people and activities based on one or more of the three criteria: technology, territory and time.
6. Information flow: Information systems should focus on delivering information first to the point where action is dependent on the information.
7. Support congruence: The social support of the system should be designed to reinforce the behaviours that the enterprise is designed to elicit.
8. Design and Human Values: An objective of enterprise design should be to provide a high quality of work life.
9. Incompletion: Design is an iterative process.

#### **4.4.2 Viewing EiEA through the antifragile lens**

To understand the way in which EiEA design relates to antifragile considerations, we first look at the considerations of design for EiEA in a socio-technical system. The process should, according to (Lapalme & de Guerre, 2014):

1. Be participative and democratic;
2. Address, jointly, the social- and technical systems to achieve joint optimisation; and
3. Address the system-in-context of coherence and co-evolution.



**Table 4-2: The EiEA considerations of design related to socio-technical systems and the EA process adapted from (Lapalme & de Guerre, 2014)**

<b>EiEA design considerations in socio-technical systems</b>	<b>EiEA design considerations in EA process</b>	<b>Description</b>
Participative and democratic	EA outcome is owned by the enterprise under design.	The members will be full participants in the design process where they will determine (collectively) the outcome by making the design decisions
Addresses, jointly, the social- and technical systems to achieve joint optimisation	The architecture would be separated into three portions.	These portions are the social system, the technical system and the system in environment coherence (objectives, vision, purpose, competition, etc.)
	Current enterprise boundaries need to be redrawn.	To be coherent, all the enterprise entities that interact with the system must participate in the process in order to help new boundary relations.
Addresses the system in context of coherence and co-evolution.	Determining new boundaries of the system.	The participative nature of the design process allows for the sharing of knowledge and experiences which would lead to a greater system understanding of the interactions.
	Learning about the environment (stakeholder needs, competition, expectations, etc.)	
	Learning about the historical context of the system	
	Determining the vision and objectives of the system	The shared knowledge will lead to a greater understanding of the system capabilities and its environment.
	Influencing its environment to achieve co-evolution.	

A consequence of the EA outcome being owned by the enterprise under design is that the enterprise architect cannot be responsible for the outcome. The architect's responsibility lies in guiding the participants through the design process itself to maintain the socio-technical system's principles and open socio-technical system's design process characteristics. The enterprise architect must have a solid grounding in how machines/technology behave as well as how people and social groups behave. Since this is not always possible, an engineer-social scientist pairing is required.

## **4.5 Key execution guidelines**

Lapalme and de Guerre (2014) highlighted the following execution guidelines that are required to ground EA in open socio-technical systems theory. These guidelines aim to guide the enterprise architect in adjusting current ways of working and designing these workshops.

### **4.5.1 Facilitation and group dynamics**

The role of the enterprise architect is to develop and facilitate the design process, which must be a sound group process. Proper group process design and facilitation with group dynamics at the core is required. Support to the group on subject matters can be provided, but the design process, as an inclusive one, requires that members of the enterprise under design make a collaborative decision as they will champion the solutions.

The facilitation of the process needs to be constructed with an understanding of group behaviour. The poor performance of the group is not an indicator of the group, but could be more of an indication of poor group workshop design.

### **4.5.2 Participative and democratic**

The members in the enterprise are required to be the primary participants and decision-makers in the process in order to gain their commitment as well as ensure that the final design meets their psychological and social needs.

### **4.5.3 Holistic**

It might be required that a redesign of a number of domains is required in the iterative process. This cannot be done in an isolated fashion. Addressing any of the enterprise architecture subsystems separately and trying to adapt the other subsystems accordingly will probably produce an ineffective and unsustainable outcome.

### **4.5.4 Learning**

The most important outcome of the EA process is not a perfect design, but rather a system capable of continuous learning and adaptation. Enabling continuous learning is required as the future is unpredictable; a perfect design could easily become out of date due to the change in circumstances (Mintzberg, et al., 1998).

Learning to learn is important for participants. Enterprise members as part of the process not only understand and are ready to implement the design, they have implicitly participated in learning design thinking, and are therefore prepared to go on learning and changing the new design as necessary. This iterative process leads to elegant solutions (de Guerre, 2000) and (Lapalme & de Guerre, 2014).

#### **4.5.5 Shared Tools**

The tools used in the EA design process must be relevant for continuous management and improvement of the system. The design process should also allow the necessary time for the participants to learn, adapt, and create the necessary tools for the design.

#### **4.6 *The benefits and challenges of EiEA***

Through the grounding in open socio-technical systems design, EiEA is capable of managing a wide range of complexities, fostering enterprise innovation, adaptation and sustainability in the midst of constantly changing unknown and unavoidable unexpected factors. The participative process minimised resistance to change.

The challenges mean that a cultural transformation is required compared to traditional views. Three shifts are required from the traditional view, 1. Reductionism to holism, 2. closed system to enterprise-in-environment and 3. top-down to participative democracy.

The background and analysis of what antifragility and EiEA are provides guidelines, design criteria and attention points which can be used to design a framework which allows for a structured way in which antifragility can be incorporated in the design of the enterprise.

#### **4.7 *Chapter conclusion***

This chapter introduced the reader to enterprise engineering and more specifically enterprise-in-environment as the school of thought which aligns with being used as the guiding principles in designing an SME to be more antifragile. The enterprise-in-environment adaptation approach aligns with the considerations and characteristics provided by antifragility. These enterprise systems were shown to be designed in a socio-technical system manner which

provided design principles and requirements (to be shown in section 5.2 and Table 5-1 to Table 5-5). which will result in the realisation of a framework that will guide an SME to becoming more antifragile.

## **5. Development of an EiEA framework, towards an Antifragile SME**

*“When I say artist I mean the man who is building things - creating moulding the earth - whether it be the plains of the west - or the iron ore of Penn. It's all a big game of construction - some with a brush - some with a shovel - some choose a pen.”*

**– Jackson Pollock**

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In this chapter we present the requirements that were collected in order to develop a framework for SMEs to become more antifragile. These requirements were built from the preceding chapters and grouped according to how they would support the research objective.

### **5.1 Construct guidance for the development of the framework design**

The requirements need to be aligned to the purpose of the research, which is to guide the South African SME to become more antifragile. The implication of the research objective is 1) the transformation, 2) the objective of the transformation, and 3) the scope of the transformation.

Firstly, the transformation implies that the object needs a) a snapshot of its current state, b) to create a representation of what the future state should look like, and c) be able to create the steps required to move from the one to the other. Secondly, the objective is to ensure that the movement from the current to the next state is one which results in improved antifragility. Thirdly, the scope of the transformation is that of the user, which is the South African SME.



**Figure 5-1: Relational perspective of reaching the objective of the transformation within the scope of the study**

Following the implications of the breakdown mentioned above, Figure 5-1 explains how the requirements should be categorised so as to address the objective of taking the implicit concepts of antifragility by making them explicit in the context (scope) of the South African SME.

The categorisation of the requirements thus aims to fulfil one of three of these constructs: To confirm the role of understanding the current status of the SME (Current Construct), the role of providing a view of the future status of the SME (Future Construct), or the role of providing the transformative/progressive steps which will move the SME from the current to the future status (Progressive Construct). So, in addition to proving the requirements, they will, additionally, be grouped into one of these three constructs.

## **5.2 Requirements for the framework design**

In order for a framework to be designed, the requirements that the framework has to adhere to need to be known. The requirements that emerged out of the chapters on SMEs, Antifragility and EiEA to support the development of a framework to guide SMEs to become more antifragile will be categorised here. The design of the framework will take into account the considerations and characteristics of SMEs and antifragility to build the requirements according to the categorisations created by (Van Aken, et al., 2006) and used by (Brockmöller, 2008), (Weber, 2011) and (Krause & Schutte, 2015). These requirements will be used to align with the design considerations given by EiEAs which guide the phase creation for the framework.

Van Aken, et al. (2006) made the distinction between five type of requirements:

1. User requirements (U): Specific requirements from the view of the user which explain the constraints as well as how the framework will be used by the user;
2. Functional requirements (F): This forms the core of the requirement specification and is in the form of performance or result demands on the framework to be designed, that is, the functionality the framework is designed to perform;
3. Design restrictions (R): Requirements pertaining to the preferred solution space. The limits, exclusions, and elements of the design;
4. Attention points (A): The requirements that are relevant to the design and should be noted as desirable, but they are not requirements that have to be met, and are also not design restrictions; and
5. Boundary conditions (B): The requirements/rules that have to be met unconditionally and may not be altered, e.g. legislation, ethical habits and code of conduct.

The above categorisation of Van Aken, et al. (2006) was chosen as the requirements allow for the attention points, some requirements which are desirable but do not have to be adhered to strictly, in building a framework. This supports the development of a framework where the antifragile considerations are not a fixed requirement, i.e. the lack of an antifragile consideration does not mean that the enterprise is not antifragile or the presence of an antifragile consideration does not mean it is antifragile.

It should be noted that the assignment of the requirements to one of the categories is done by educated guess and is therefore subjective to some extent. Subjective categorisation of the requirements will imply that there is a weight given to the individual requirement. This can be explained by seeing how functional requirements have more impetus behind the design of the framework than the design restrictions and attention points. The subjectivity, however, does not imply that a requirement can be ignored. The consequence thereof is that the effect of the subjective categorisation is limited.

The requirements given in Table 5-1 to Table 5-5 were identified by following the literature investigation from the context created, the South African SME in Chapter 2, as a lens through

which the field of Antifragility is focussed, through Chapter 3. Enterprise engineering, and more specifically EiEA, Chapter 4, provided the systems engineering context that provides executable requirements and considerations through which a framework can be designed which would improve the antifragility of South African SMEs, as in Figure 6-1.

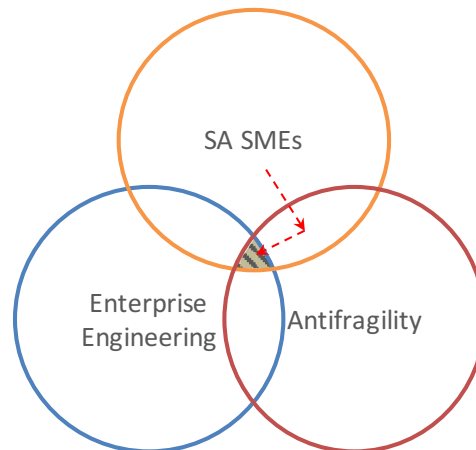


Figure 5-2: The research domains and the systematic progress to requirements gathering (as per Figure 1-5)

### 5.2.1 User requirements

The users that were taken into account needed to be split into two distinct groups, 1. The facilitator/architect/designer of the enterprise, and 2. the SME management and selected employees. It is important to note that in cases where the framework does not adhere to the requirements of the SME, the enterprise architect/designer will be the intermediary to provide the support to complete the framework process and is seen as the main user of the framework, where the second group of users are being guided through the process rather than being a primary user. The enterprise facilitator/architect/designer, as a primary user, is thus the bridge between the framework and the SME. The requirements given in Table 5-1 are conceptual in nature; they do not specifically provide requirements for steps or stages in the designed framework, but the framework needs to be verified against these to ensure they are fulfilled conceptually.



Table 5-1: Towards an antifragile South African SME - User Requirements

Requirement ID	Requirement	Motivation
U1	The framework should consider the context of the South African SME, specifically its constraints, such as number of employees, access to resources, education, etc.	SMEs differ in their size, ownership, ownership's level of education, etc. The framework should thus allow for the variations in these user characteristics given in sections 2.1 & 2.4.
U2	The user should be allowed to flexibly apply their own discretion when using the framework.	The framework should be prescriptive in nature. Adaptability and customisation should be allowed to suit the specific circumstances of the specific enterprise applying the framework (sections 2.1.2, 2.1.3 & 2.4). This is also confirmed by the requirement for an antifragile design where the framework is given the ability to learn and improve, section 3.5.
U3	The framework should be user-friendly.	The framework should be user-friendly and take resource constraints into account (sections 2.1.2 & 2.4).
U4	The framework should be considered as a management aid.	The majority of SMEs are owner-operated. The management team should be able to play dual roles of management and execution due to the low number of resources (sections 2.1 & 2.4). This is supported by the need for an entrepreneurial mindset in antifragility, section 3.5.1.
U5	The framework should provide clear definitions and explanations to cater for all levels of education found in an SME.	To simplify, while ensuring the correct application, and improving adoption, clear definitions and explanations on how to implement and use the approach (section 2.1.1).

<b>Requirement ID</b>	<b>Requirement</b>	<b>Motivation</b>
U6	The framework should allow for various sectors of industry for SMEs.	These SMEs operate in diverse industries. The framework should allow for the varied sectors in which SMEs function, section 2.1.
U7	The framework should allow for various sizes of SMEs.	SMEs are shown to be of varied sizes from 1 to 200 employees. The framework should allow for the varied sizes of SMEs, section 2.1.
U8	The enterprise architect must own the process of design.	The enterprise architect will own the process and the facilitation thereof to support the enterprise and its members to reach a design (section 4.4.2).
U9	The design should be owned by the enterprise and enterprise members	The enterprise and its members will be responsible for the implementation and operation of the design. The ownership over the design will allow for improved buy-in and increased employee ownership (Table 4-2 and section 4.4.2).

### 5.2.2 Functional requirements

The functional requirements provide the core of the performance and demands that are expected of the framework, thus more simply than that which the framework should do. The functional requirements have been separated into two groups, the essential functional requirements, and the desirable functional requirements. The essential functional requirements are required to be addressed by the framework, with the desirable functional requirements seen as a framework best practice, but they do not place strict controls on the functionality of the framework.

Table 5-2: Towards an antifragile South African SME - Functional Requirements

Requirement ID	Requirement	Motivation
<i>Essential functional requirements</i>		
F1	The framework should lead to improved antifragility in SMEs.	The main goal of the research is to design a framework to improve the antifragility in an enterprise, section 1.4. The improved antifragility should also be tracked and measured with an assessment tool, section 3.6.3.
F2	The framework should provide suggested tools in context of the process to assist and enable the process.	The users should be given applicable tools which support them in reaching the objectives of the approach to deliver on the antifragile characteristics and considerations, sections 3.5 & 4.5.5. It is not meant to be an exhaustive manual, but a proposed list of tools that can be considered. These would support the educational and competent management difficulties that SMEs face, Table 2-5.

Requirement ID	Requirement	Motivation
F3	The framework should support repeated and continued use.	<p>The intent of improving an SME is not a once-off approach but one that should allow for continuous learning (section 4.5.4) and improvement (section 4.4.1). It should allow for a repeatable practice within the enterprise. The global environment and internal environment changes continually which requires continuous improvements to align assess the enterprise's objective and its alignment with the internal and external environment (Table 2-5 &amp; sections 2.4 &amp; 4.5.3).</p> <p>The most important outcome of the process should not be a perfect design, but an enterprise capable of continuous learning and adaptation (section 4.5.4).</p>
F4	The framework must provide a way for the enterprise to understand the dimensions of stress that affect it and its units.	<p>Enterprises and their units need to be aware of the type of stressors that act on its boundaries, and how they affect the system. The focus of the enterprises and units should be on that which affects them directly (section 3.5.7).</p> <p>Learn about environment, competition, stakeholders, expectations, etc. as well as historical context of the system (Table 4-2 and section 4.4.2).</p>

<b>Requirement ID</b>	<b>Requirement</b>	<b>Motivation</b>
F5	The framework should promote a learning capability on enterprise and enterprise unit level.	<p>Learning is a critical step in evolutionary and biological systems. Double loop learning allows for the change in both the enterprise's goal and boundary to find a match between the two (sections 3.3.3, 3.5.5 &amp; 4.4).</p> <p>Exposure to small stressors allows for accelerated learning where the system sees a small predictor of the type of output in a safe environment. Enterprise units need to, as with the process of hormesis, promote stressing enterprise units to become stronger through learning to improve its role in the greater enterprise. Tinkering plays a role in which actions provide the learning experience and not just the theoretical study thereof. In this way, the enterprise members can reduce the gap between perceived responses in reality and actual responses (section 3.5.8). The power of resilient enterprises is that they are reluctant to accept simple explanations/interpretations of learning and a high respect for expertise.</p> <p>Failure is important to the strengthening of the system, (section 3.3.1). This happens through protection and learning (section 4.2.7). The total underpinning here is the knowledge-sharing and management throughout the enterprise.</p>

<b>Requirement ID</b>	<b>Requirement</b>	<b>Motivation</b>
F6	The framework should guide the enterprise to arrive at a vision and mission that is suited to its environment.	<p>The vision and objective of the enterprise and its influencing environment is required to achieve co-evolution (see double loop learning in requirement F5, sections 4.4.1, 4.4.2 and Table 4-2).</p> <p>The first solution will not be final and will require iterations, but a holistic view of a number of the enterprise units and how they relate to the purpose and environment of the enterprise is required (section 4.5.3).</p>
F7	The framework should allow for enterprise unit boundaries to be redrawn.	<p>Entities within the enterprise need to participate to help support co-evolution through new boundary relations (Table 4-2 and section 4.4.2). These boundaries can be based on function, technology, territory, time, etc. (section 4.4.1). See the use of double loop learning and holism in F5 and F6 and section 4.5.3).</p>

Requirement ID	Requirement	Motivation
<i>Desirable functional requirements</i>		
F8	The framework should allow for autonomy in decision-making in parts of the enterprise with an alignment between the decision-maker and the goal of the enterprise.	<p>The human mind is capable of novel responses to stressors as a good example of an adaptive, biological/evolutionary process (sections 3.3.3 &amp; 3.5.1).</p> <p>The decision-making within the enterprise should ensure that the decision-maker is directly aligned to the fortune of the decision (section 3.5.1). The responsibility and empowerment in this process can only be done if the support to understand the enterprise unit role within the structure of the enterprise is given. The enterprise units need to be enabled and competent (sections 4.2.5 &amp; 4.2.6).</p> <p>Human nature has negative elements, but these can be supported to limit the negative consequences.</p>
F9	The framework should guide decisions which will lead to decentralisation of enterprise units.	<p>Centralisation increases the amount of control in a system which increases efficiency and reduces costs, but it also takes away responsibility and accountability from the workforce.</p> <p>Decentralisation allows for the enterprise units to create their unique structure, organise their own work in alignment with intimate knowledge of its processes, and create moments for learning in alignment its specific needs (section 3.5.2).</p> <p>The decentralisation needs to be regulated, but this falls in alignment with requirement F8 in which the role of the unit needs to be understood for governance.</p>

Requirement ID	Requirement	Motivation
F10	The framework should guide the users which would lead to the diversification of enterprise units.	Diversification leads to increased exposure to markets in order to improve the upside consequences of volatility, but it also reduces the focus of the enterprise. There are certain risks which are mitigated through diversification, but with added costs of inefficiencies of processes. Diversification could also mean the diversification of exposure (increased/improved position in the market) to technologies which can be adopted through innovative practices to gain access to markets (sections 3.2 & 3.3.3). Diversification into the value chain also allows for the distribution of risk in the management of profit margins when the market shifts.
F11	The framework should guide the enterprise and its enterprise units to be agile and flexible.	Agility and flexibility enable the enterprise units with the power to change and prioritise in volatile environments. Responses occur endogenously to both endo- and exogenous stressors to the enterprise and/or enterprise units (section 3.5.4).  The use of crisis management provides the enterprise with a tool to deal with major unpredictable events that threaten the functionality of the enterprise. Enterprises need to align their units to respond to these events. The use of crisis management is a response characteristic.



Requirement ID	Requirement	Motivation
F12	The framework should promote an environment of trust.	<p>Trust allows for a unit to be decentralised, giving entrepreneurial units the autonomy to fulfil their role. Enterprise units require the freedom to organise their tasks in a way to fulfil their role in alignment with the enterprise's role. The regulator in the enterprise allows for guidance, but trust is required to allow the unit to organise best (sections 3.2 &amp; 3.5.6).</p> <p>Multiple views are only possible when employees feel empowered and trusted to share these views (section 3.2). As with the turkey example, perspective is important, and it is key to have multiple views to reduce the amount of unknowns. This will reduce the prevalence of confirmation bias as employees feel empowered to challenge others' views.</p> <p>Trust is also required to allow for governance in the enterprise to be distributed (section 4.2.6).</p> <p>The enterprise performance is based on the performance of its people. Conditions need to be created to develop and empower themselves through the guidance of the regulators in the system for alignment of the enterprise (section 4.2.7). The total underpinning here is the knowledge-sharing and management throughout the enterprise.</p>

Requirement ID	Requirement	Motivation
F13	The framework should guide the enterprise to be conservative on risks that carry dire consequences.	Enterprises, like high resilience enterprises, should aim to be conservative on downside risk. This is critical for survival in the case of an extreme stressor (sections 3.3.3, 3.5.8 and 3.3.2). Adaptation of the endogenous enterprise is required to reach appropriately (section 4.4.1).
F14	The framework should guide the enterprise to identify opportunities where it can take risks that limit enterprise loss and increase enterprise exposure to value.	In the event of an extreme event, enterprises should be aware of opportunities where the consequence can be extremely positive. Exposure to these positives often require a small risk to be taken (in the form of cash, options, etc.) with the possibility of gaining disproportionately (sections 3.3.3 & 3.5.9). Adaptation of the endogenous enterprise is required to reach appropriately (section 4.4.1).
F15	The framework should allow for the design process to be participative and democratic.	The result of the design process is the property of the enterprise and its members. The process should be participative and democratic to ensure buy-in, improved solutions for enterprise concinnity and co-evolution and provide the space from which employees can take ownership (sections 4.4.1, 4.4.2 & 4.5.2).

Requirement ID	Requirement	Motivation
F16	The framework should guide the enterprise to jointly address the social and technical system interactions for optimisation.	The enterprise that will be designed should be separated into three possible systems. Firstly, there is the enterprise in its environment, its purpose, vision, etc. (F13) and secondly the social and technical system. The social and technical system will be in the control of the enterprise units where the enterprise in its environment system is used and should be known by all to align the systems in the enterprise (Table 4-2 and section 4.4.2). Through the participative process, the technical and social part of the enterprise will be taken into account (section 4.4.2).

### 5.2.3 Design restrictions

The design restrictions focus on the preferred solution space of the framework to be designed.

Table 5-3: Towards an antifragile South African SME - Design Restrictions

Requirement ID	Restrictions	Motivation
R1	The framework is not meant to include an exhaustive set of tools and methods available to reach the objectives per phase, but should be comprehensive enough to provide sufficient options for SMEs.	No single method can be all things for all situations. The framework should be comprehensive, but it is not expected to contain every possible tool in existence. Having too broad a coverage could make the approach cumbersome and clumsy, reducing its effectiveness and increasing resistance to adopting it within the enterprise.

<b>Requirement ID</b>	<b>Restrictions</b>	<b>Motivation</b>
R2	The framework is intended for SMEs, but some principles, tools and methods may be applicable to larger enterprises.	The focus of the framework should be on being relevant to SMEs. Both large enterprises and SMEs can, for instance, use options pricing; but due to the nature of the enterprises, how they do this will be different.
R3	The framework is not a legal or legislative guide, and input required for such items (e.g. tax legislation) should be obtained from specialists within those fields.	Tax legislation plays a large part in the success of an SME. The legislative interpretation is known to be complex, and it is thus recommended to confirm any legal course of action with a specialist in the field.
R4	The framework does not guarantee antifragile success due to a multitude of factors that could influence such an outcome. However, it does provide principles based on theory and best practice to increase chances of success when applied.	The success of frameworks can never be guaranteed as it is highly dependent on the people that apply it, the circumstances and various other factors. The approach should provide a guide based on the best practice principles for implementing the framework to improve the chances of success.
R5	The framework should be designed as a design tool towards more antifragile SMEs in South Africa.	The framework will not go into the tactical requirements of projects and project selection, but stops at the end of the synthesis of a design (section 1.5.6.2).
R6	The framework is intended for SMEs in South Africa, but some principles, tools and methods may be applicable to SMEs in other countries.	The focus of the framework should be on being relevant to SMEs in South Africa. SMEs in other countries would also be able to use the framework to some extent, but it was not designed with the characteristics of SMEs in other countries in mind.

## 5.2.4 Attention points

Attention points allow for requirements that are relevant to the design and should be noted, but they are not hard requirements and do not constrain the design as with design restrictions, (section 5.2.3).

Table 5-4: Towards an antifragile South African SME - Attention Points

Requirement ID	Attention points	Motivation
A1	Some items to be included in the framework will be discretionary and dependent on factors inherent to the enterprise, such as its set-up, size, strategy and prior knowledge. Decisions about how or what to implement will therefore differ between enterprises.	There is variability between SMEs with different elements that affect decision-making such as enterprise strategy, available resources, and market dominance (sections 2.1 & 2.4). Examples of these include the use of insurance to limit the downside of losses due to crime such as inventory theft (Table 2-5). It therefore requires discretion on how the framework is implemented within the enterprise. Since the framework is descriptive in nature, it allows for flexibility in its application.
A2	The approach should be seen as a reflection of early best practice within an evolving field of knowledge.	Academic research on antifragility within SMEs, is still relatively undeveloped. The approach being designed needs, therefore, to draw upon a small pool of available expert content that will be based on emerging findings from the literature on antifragility and SMEs.
A3	The process of designing the enterprise should complement its objectives.	The framework should be used when the enterprise aims to improve on its antifragility (section 4.4.1). The framework might support the enterprise in reaching other objectives (See R6), but it is not what the framework was designed for.

<b>Requirement ID</b>	<b>Attention points</b>	<b>Motivation</b>
A4	The solution should not be more specific than is essential.	The minimal critical specification is required in the design as paperwork restricts the evolutionary perspective (section 4.4.1).
A5	Variances that cannot be eliminated should be controlled as close to the point of origin as possible	In the process of addressing variances, the source should be located and addressed (section 4.4.1). This will allow for quicker identification when the source is removed or solutions for the variance are found.
A6	The framework should support the solution of redundancies to be those of function and not of the unit parts.	In the case where redundancies for protection are required, the solutions thereof should focus on the function that is performed and not the part (sections 3.3.2 & 4.4.1).
A7	Group process design and facilitation with group dynamics at the core are required.	The facilitation of the design process needs to be constructed with a clear understanding of group behaviour to ensure there is a collaborative approach to the design of the enterprise (section 4.5.1).
A8	A clear handover to the project management function is required.	In order to continue with the implementation (which is outside of the scope of this study, R5 and section 1.5.6.2), the project management function in the enterprise requires information that will ensure that a successful implementation plan is possible.

### 5.2.5 Boundary conditions

Boundary conditions have to be met unconditionally for the design to work. These requirements were included as they dictate reasonably assumed boundaries of application for the framework, but they are not borne out of the literature review in chapters 2 to 4. They

were, however, adapted from work done by Van Aken, et al. (2006), Brockmüller (2008), Weber (2011) and Krause and Schutte (2015).

**Table 5-5: Towards an antifragile South African SME - Boundary Conditions**

<b>Requirement ID</b>	<b>Boundary conditions</b>	<b>Motivation</b>
B1	The framework should be used in a legal and ethical way by the SME.	The authors cannot control the use and possible exploitation of the framework in practice. It is therefore important to define the reasonably assumed boundaries of application (Weber, 2011). It is assumed that the framework will be applied in a legal and ethical way, adhering to corporate governance and other relevant restrictions.
B2	The framework should not be used to negatively exploit other parties involved in the framework.	Due to the nature of antifragility and knowledge-sharing for learning, parties involved in the sharing of ideas, knowledge, and technology can easily be exploited by interacting parties. Especially when there is a power imbalance, the smaller of the parties could be at a disadvantage (Weber, 2011).
B3	The framework should promote value for all parties involved and assist in establishing trust.	The intent of the framework should be to obtain mutual appropriate value for all parties involved.

### **5.3 Enterprise states guide requirements**

The designed framework would need to be based on the roles it plays in the states which dictate the transformation of an enterprise, i.e. Present, Future and the Progressive status. As stated in section 1.5.6.2, the framework will stop before the implementation phase of the systems design process, but the considerations for implementation are required for handover to continue the systems design process. Table 5-6 groups the user-, functional requirements and attention points per state of the enterprise. The reason for the exclusion of the boundary

conditions and the design restrictions is that they are conceptual in nature which envelops the framework as a whole. These will not escape the verification against the framework which will be done in section 7.1.

**Table 5-6: Grouping of U-, F requirements and A points into the enterprise states**

	<b>Present</b>	<b>Future</b>	<b>Progression</b>
<b>User requirements</b>			
U1 - The framework should consider the context of the South African SME, specifically its constraints, such as number of employees, access to resources, education, etc.	x	x	
U2 - The user should be allowed to flexibly apply their own discretion when using the framework.			x
U3 - The framework should be user-friendly.	x	x	x
U4 - The framework should be considered as a management aid.		x	x
U5 - The framework should provide clear definitions and explanations to cater for all levels of education found in an SME.	x	x	x
U6 - The framework should allow for various sectors of industry for SMEs.	x	x	x
U7 - The framework should allow for various sizes of SMEs.	x	x	x
U8 - The enterprise architect must own the process of design.	x	x	x
U9 - The design should be owned by the enterprise and enterprise members	x	x	x



	Present	Future	Progression
<b>Functional requirements</b>			
<i>Essential functional requirements</i>			
F1 - The framework should lead to improved antifragility in SMEs.		x	x
F2 - The framework should provide suggested tools in context of the process to assist and enable the process.	x	x	x
F3 - The framework should support repeated and continued use.	x	x	x
F4 - The framework must provide a way for the enterprise to understand the dimensions of stress that affect it and its units.	x		
F5 - The framework should promote a learning capability on enterprise and enterprise unit level.	x	x	x
F6 - The framework should guide the enterprise to arrive at a vision and mission that is suited to its environment.	x	x	
F7 - The framework should allow for enterprise unit boundaries to be redrawn.	x	x	
<i>Desirable functional requirements</i>			
F8 - The framework should allow for autonomy in decision-making in parts of the enterprise with an alignment between the decision-maker and the goal of the enterprise.		x	x
F9 - The framework should guide decisions which will lead to decentralisation of enterprise units.		x	x

	<b>Present</b>	<b>Future</b>	<b>Progression</b>
F10 - The framework should guide the users which would lead to the diversification of enterprise units.		x	x
F11 - The framework should guide the enterprise and its enterprise units to be agile and flexible.		x	x
F12 - The framework should promote an environment of trust.		x	x
F13 - The framework should guide the enterprise to be conservative on risks that carry dire consequences.		x	x
F14 - The framework should guide the enterprise to identify opportunities where it can take risks that limit enterprise loss and increase enterprise exposure to value.		x	x
F15 - The framework should allow for the design process to be participative and democratic.	x	x	x
F16 - The framework should guide the enterprise to jointly address the social and technical system interactions for optimisation.	x	x	x
<b>Attention points</b>			
A1 - Some items to be included in the framework will be discretionary and dependent on factors inherent to the enterprise, such as its set-up, size, strategy and prior knowledge. Decisions about how or what to implement will therefore differ between enterprises.	x	x	x
A2 - The approach should be seen as a reflection of early best practice within an evolving field of knowledge.	x	x	x

	<b>Present</b>	<b>Future</b>	<b>Progression</b>
A3 - The process of designing the enterprise should complement its objectives.		x	x
A4 - The solution should not be more specific than is essential.		x	x
A5 - Variances that cannot be eliminated should be controlled as close to the point of origin as possible.		x	x
A6 – The framework should support the solution of redundancies to be those of function and not of the unit parts.		x	x
A7 - Group process design and facilitation with group dynamics at the core is required.	x	x	x
A8 - A clear handover to the project management function is required.		x	x

The grouping of the above requirements allows for the requirements to speak to three overarching steps in the transformative process of the SME.

#### **5.4 Chapter conclusion**

The design and development of the framework can now be initiated. The literature was used to review the requirements for SMEs, the considerations to make them antifragile and how they can be made explicit and practical through enterprise-in-environment adaptation. Based on this work, the set of design requirements could be formulated.

## 6. The Epictetus Framework

*“The essence of philosophy is that a man should so live that his happiness shall depend as little as possible on external things.” – Epictetus (55 AD – 135 AD)*

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The research objective is to create a framework through which an SME can organise to be more antifragile. The requirements, as set out in chapter 5, were constructed under the guidance of the transformative steps of the SME to provide the framework which will make an SME more antifragile. This chapter will first explain the conceptual, high-level phases to provide an overall view of the framework before practical considerations are provided per stage (which underlies the phases).

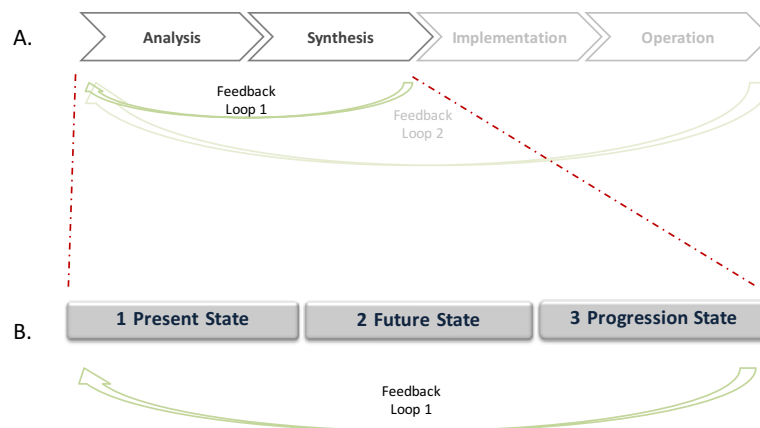
### 6.1 Behind the name

The framework has been named after Epictetus, who was an exponent of the philosophy of Stoicism. He believed philosophy needed to be a way of life rather than a theoretical exercise. Epictetus based his work on that of the early Stoic philosophers which dealt with three branches; logic, physics and ethics. The role of the Stoic teacher was to encourage his students to live a philosophic life, which ends in happiness, which is secured by living the life of reason, which for Stoics meant living virtuously and ‘living according to nature’ (Seddon, 2017).

The framework has been named after this philosopher for his role in Stoicism with the belief that all external events are beyond our control which we should accept calmly and dispassionately.

## 6.2 The conceptual phases of the Epictetus framework

The systems design process progresses from Analysis right through to Operation with the inclusion of feedback loops to ensure accuracy of design and accuracy of implementation compared to design and analysis (A in Figure 6-1).



**Figure 6-1: The scope and position of (B) the schematic Epictetus framework in relation to the (A) conceptual systems design process**

The scope of the framework identifies with the design of the static enterprise (structure and positioning) with the implementation thereof being handed over to a project management function.

The Epictetus framework consists of the following three phases (B in Figure 6-1):

1. Present State;
2. Future State; and
3. Progression State.

The requirements grouped per phase in Table 5-6 were used to prescribe stages that would ensure that the requirements successfully deliver on each phase. These requirements do need to be broken up further, per stage, to deliver on less general requirements per phase, but more specific needs that are required to be met. The requirements which dictated which stages would play a role in the framework fulfilling its objective were not defined by a general classification, but by the fact that they did not adhere to the grouping of the general classification.

### 6.3 Synthesis of construction of the stages within the conceptual phases

It is understood that the creation of the framework's phases and stages is subjective, but the construct given is one way in which the requirements can be systematically compiled to provide a framework to reach the research objective. In the Present State phase, the underlying stages created are defined by a single requirement which is not part of the general grouping under the Present State phase as a whole, but requires further granularity to reach a specific objective. This is shown in requirement F4 (Enterprise Unit Classification), F7 (Enterprise Unit Boundaries) and F16 (Enterprise Unit Influences). See Table 6-1.

Table 6-1: Present State phase stage creation

	Present State Phase		
	Enterprise Unit boundaries	Enterprise Unit Influences	Enterprise Unit Classification
<b>User requirements</b>			
U1 - The framework should consider the context of the South African SME, specifically its constraints, such as number of employees, access to resources, education, etc.	x	x	x
U3 - The framework should be user-friendly.	x	x	x
U5 - The framework should provide clear definitions and explanations to cater for all levels of education found in an SME.	x	x	x
U6 - The framework should allow for various sectors of industry for SMEs.	x	x	x
U7 - The framework should allow for various sizes of SMEs.	x	x	x
U8 - The enterprise architect must own the process of design.	x	x	x

	Present State Phase		
	Enterprise Unit boundaries	Enterprise Unit Influences	Enterprise Unit Classification
U9 - The design should be owned by the enterprise and enterprise members	x	x	x
<b>Functional requirements</b>			
<i>Essential functional requirements</i>			
F2 - The framework should provide suggested tools in context of the process to assist and enable the process.	x	x	x
F3 - The framework should support repeated and continued use.	x	x	x
F4 - The framework must provide a way for the enterprise to understand the dimensions of stress that affect it and its units.			x
F5 - The framework should promote a learning capability on enterprise and enterprise unit level.	x	x	x
F6 - The framework should guide the enterprise to arrive at a vision and mission that is suited to its environment.	x	x	x
F7 - The framework should allow for enterprise unit boundaries to be redrawn.	x		
F15 - The framework should allow for the design process to be participative and democratic.	x	x	x
F16 - The framework should guide the enterprise to jointly address the social and technical system interactions for optimisation.		x	

	Present State Phase		
	Enterprise Unit boundaries	Enterprise Unit Influences	Enterprise Unit Classification
<b>Attention points</b>			
A1 - Some items to be included in the framework will be discretionary and dependent on factors inherent to the enterprise, such as its set-up, size, strategy and prior knowledge. Decisions about how or what to implement will therefore differ between enterprises.	x	x	x
A2 - The approach should be seen as a reflection of early best practice within an evolving field of knowledge.	x	x	x
A7 - Group process design and facilitation with group dynamics at the core is required.	x	x	x

The table given for the Present State phase, Table 6-1, was also done for the Future State (Table C-1: Future State phase stage creation) and Progression State (Table C-2: Progression State phase stage creation) phases. See Appendix C - Stages defined within the Epictetus phases.

These tables resulted in the three phases of the Epictetus framework with nine stages to provide guidance for the SME to become more antifragile. These phases and stage categorisations are shown in Figure 6-2.

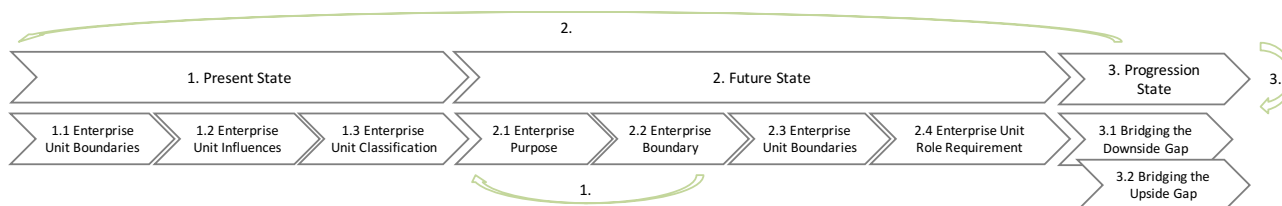


Figure 6-2: The Epictetus framework

Three feedback loops (the loops can be seen depicted schematically in Figure 6-3) provide; 1) the double loop learning iteration where the enterprise purpose and the definition of where the enterprise boundary should be compatible, 2) the loop where the end of the design phase



(after 3 Progressive State) compares the new design and how it informs the current reality and how it compares to the analysis done, and 3) a hierarchical loop where, if needed, each enterprise unit can apply the framework to its (re)design to align its enterprise subunits to the purpose of the enterprise unit. The framework can follow a linear progression, as in Figure 6-3, by starting at the first stage to progress right up to the last stage, but it is possible to move haphazardly through the framework.



**Figure 6-3: The schematic representation of the Epictetus framework**

The SME's improvement needs to be monitored to ensure that; 1) after the feedback loops 2 and 3 whether they would want to invest more time for the given improvements and/or 2) the SME is reaching the objective of the framework. The SME members thus decide when to move from a current stage in the framework to the next.

### 6.3.1 Monitoring SME progress

The use of a measurement tool to ensure that one can assess whether the enterprise has become more antifragile is required in any systems approach. The feedback loop 2 provides two ways in which the framework and the use thereof can be assessed. The first is to test whether the participants in the framework deemed the use of the framework as having value with the time spent being worth the output created. The second is to be able to reassess whether the enterprise's antifragility has improved and through this it could also highlight improvements that are possible given the dimensions being measured. This measurement will take place before the process and after the initial implementation.

The objective of the measurement allows for the comparison of the SME to its previous state and to ascertain if its perceived endogenous capabilities are seen to be more antifragile.

### 6.3.1.1 Requirements

The use of a tool which can allow for continuous assessments which can inform whether the SME has improved.

### 6.3.1.2 Tools

The use of the tool created by the author and explained in section 3.6 was used in the case study and is also, at present, the measuring tool which the author prefers. The measurement tool used by Johnson and Gheorghe (2013) is also a viable option, but there are some shortfalls in this tool which were addressed by the tool discussed in section 3.6.

## 6.3.2 Present State phase

The role of the Present State phase, Figure 6-4, is to provide the clarity as to the 1) Enterprise's current unit boundaries, 2) how they currently influence each other, and 3) how they would currently respond to volatility.



Figure 6-4: The Present State phase of the Epictetus framework

### 6.3.2.1 Enterprise unit boundaries

Through the definition of the enterprise unit boundaries it is possible to investigate the interactions, and types of interactions, between these enterprise units.

#### 6.3.2.1.1 Requirements

The type or categorisation of the boundaries is not important as they are required to investigate and provide a platform from which to assess the structure of the SME. It is important that the current enterprise units chosen are known to the enterprise to allow for investigation in the future. Through continued use the enterprise units will play an increasing role where the interactions provide guidance as to the inclusion or exclusion of parts of other enterprise units. The following iterations will allow for the change to improve the antifragility of the enterprise.

### **6.3.2.1.2 Tools**

The type of enterprise unit boundaries is initially not critical, as these would evolve as the framework is repeated. To gain an understanding of how the enterprise units are currently set up, they can be questioned according to:

- **Functionality:** Parts of the enterprise that perform the same functions are grouped together; and
- **Key man units:** Units can be designed around key individuals in the enterprise to ease autonomy of unit decision-making.

### **6.3.2.1.3 Key antifragile considerations**

The framework participants should take into account that enterprise units can be focussed on building them around individuals so as to act as entrepreneurial enterprise units and/or functional units. The setting up of units also allows for the understanding of hormesis where the enterprise units are stressed and set up to learn from this stress to result in a stronger enterprise. The decentralisation and diversification of units are antifragile considerations that can lead to improved antifragility. Through the understanding of the enterprise units, redundancy of function is also possible rather than redundancy of the unit itself.

### **6.3.2.2 Enterprise unit influences**

The enterprise unit needs to understand the influence they have through interactions on each other, as well as the interactions the external environment has directly on each of the enterprise units. It is only these and internal interactions that can affect the equilibrium/stress response of each enterprise unit.

#### **6.3.2.2.1 Requirements**

The enterprise units are required to understand what is required from other enterprise units (as well as external environment) to continue their functionality and what they provide to other enterprise units.

### **6.3.2.2.2 Tools**

Design Structure Matrices (DSMs) can provide the needed deliverables of this stage. They have been used as the basis for compiling these interactions as they provide a snapshot of the expected interactions in the dynamic system. DSMs, in this case, will be used in the following way.

Each enterprise unit has a member (enterprise unit i) that is asked to note which other enterprise units it provides information to and receives information from the enterprise unit i. The same could be done for responsibility, accountability, consultation and commitment. These interactions can be queried continuously. The interactions between enterprise unit i and enterprise unit j can be audited by comparing the outputs of enterprise unit i to enterprise unit j (compiled by enterprise unit i) with the inputs of enterprise unit j from enterprise unit i (compiled by enterprise unit j). Discrepancies are highlighted here which improves knowledge of enterprise unit interactions.

### **6.3.2.2.3 Antifragile considerations**

The auditing process will highlight interaction discrepancies. This allows for enterprise unit interaction unknowns to be reduced, thus improving learning within the enterprise. The auditing process will be continuous until all discrepancies have been removed. The DSM's snapshot of expected interactions places everyone closer to a point of joint understanding of the enterprise operation.

### **6.3.2.3 Enterprise unit classification**

The enterprise unit needs to be classified according to how it responds to extreme circumstances in its interactions. These will provide an indication of where resources should be allocated to improve the responses.

#### **6.3.2.3.1 Requirements**

The enterprise needs to understand the function of the enterprise unit in the enterprise and to what extent it functionally fulfils the role. The enterprise needs a clear view of the extent to which the enterprise unit will fulfil that role if extreme volatility were to be found in the

interactions with other enterprise units/external environment. Each enterprise unit needs to be placed somewhere in the triangle of system responses as shown in Figure 6-5. The placement will not be accurate as it is subjective to the collective view of the group. The triangle provides a visual representation of how the role of the enterprise unit is viewed (the AS-IS position).

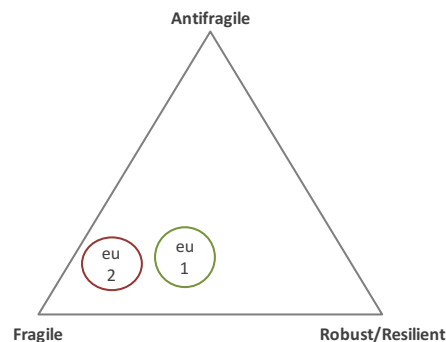


Figure 6-5: Triangle of system responses initial unit classification

### 6.3.2.3.2 Tools

Scenario planning uses scenarios as carefully crafted stories about the future embodying a variety of ideas and integrating them in a way that is communicable and useful. They link uncertainties about the future to the decisions that we must make today (Schwartz, 1991).

Each interaction that affects an enterprise unit needs to be assessed to see what the effect on the enterprise unit would be. Scenario planning creates 'what-if' questions to understand the extreme circumstances that could be met (Sunter & Illbury, 2001). Each interaction can be studied to see which boundary conditions of volatility on that interaction will result in a failure of function.

### 6.3.2.3.3 Antifragile considerations

It is crucial to focus on how the system will respond to an extreme external stressor, thus the endogenous responses. The inclusion of the enterprise unit leaders and senior management allows for a holistic view of the enterprise in these interactions to understand the regulatory provisions that can be provided in the future to improve the responses to these extreme

circumstances. The key objectives, requirements and antifragile considerations per stage in the Present State phase is shown in Figure 6-6.

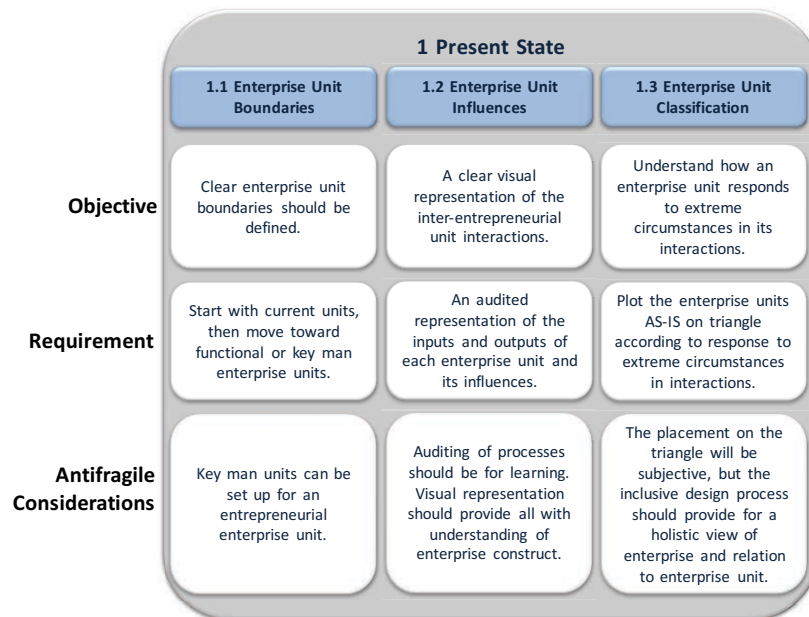


Figure 6-6: The Present State phase of the Epictetus framework with key stage objectives, requirements and antifragile considerations

### 6.3.3 Future State phase

The role of the Future State phase, Figure 6-7, provides the groundwork to understanding how the future state of the enterprise and its units would ideally be constructed with the support of the prior knowledge created in section 6.3.2.

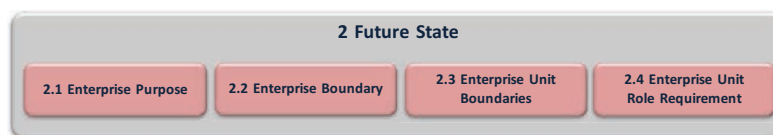


Figure 6-7: The Future State phase of the Epictetus framework

#### 6.3.3.1 Enterprise purpose

The Enterprise Purpose forms the first step in the Future State phase. As part of the feedback loop 1 in Figure 6-3, the enterprise purpose should be aligned with the enterprise boundary to enable the endogenous capabilities to effectively fulfil the enterprise purpose.

The objective of this stage is to reach an agreed purpose of the enterprise with which the enterprise units can align.

### **6.3.3.1.1 Requirements**

The purpose forms part of the mission statement. The purpose of the enterprise is the matching of the top-down and the bottom-up approach to strategic alignment. This is done through the shared culture and mission through the hierarchies of the enterprise.

### **6.3.3.1.2 Tools**

Tools which can be used in enterprise engineering which have been supported through continuous use in literature is the strategic intent as put forth by Hamel and Prahalad (1989) and again revisited in 2005<sup>7</sup>. Prahalad and Hamel provided three attributes to strategic intent (Prahalad & Hamel, 1989):

- 1) a sense of direction as a view of the future;
- 2) a sense of discovery which implies a unique view of the future; and
- 3) a sense of destiny to invoke an emotional side which employees perceive as inherently valuable.

The strategic intent that was included should be used through the inclusive approach where bottom-up strategic drive is met with the top-down strategic push from higher management.

### **6.3.3.1.3 Key antifragile considerations**

Antifragility asks for the adaptation of the environment (that which is endogenously controllable) and the desired goals/strategic intent of the enterprise to ensure there is a compatibility between the two. Double loop learning provides for the iteration of the compatibility of the goals and the environment.

### **6.3.3.2 Enterprise boundary**

The key to an antifragile enterprise is having a clear view of that which is endogenous and that which is exogenous. The enterprise boundary allows for the identification of the stressors that

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<sup>7</sup> As of 7 March 2017, the 2005 article had 3 656 citations on Google Scholar.

act in on the enterprise which can be studied to assess the volatility of these forces and decide on the allocation of resources to best respond to the stressors.

The objective of the stage is to create a system boundary from which it is clear to establish which interactions happen endogenously to the SME and which happen exogenously.

#### 6.3.3.2.1 Requirement

The enterprise boundary should be able to clearly define the interactions of individuals/entities that are not within the enterprise.

#### 6.3.3.2.2 Tools

Strategy consultants have used the checklist provided by the PEST (Political, Economic, Social and Technological factors) analysis framework to scan the external macro-environment in which the enterprise operates. Further research has highlighted the need to add Legal and Environmental factors. These will not be put forth in this example of a tool, but they can be used at the discretion of the enterprise and the enterprise architect.

A PEST analysis can give the enterprise and the design process a view of the environment within which it operates as well as highlight some key factors that would influence the enterprise directly. Under each acronym, a checklist can be used which the enterprise can go through to assess its relation to the enterprise and how it speaks to its environment. The analysis will highlight that which is outside of the control of the enterprise and that which can be included within the control of the enterprise.

Table 6-2: Examples of PEST factors

Political	Economic	Social	Technological
International trade regulations	Government spending	Income distribution	New inventions and technological effort
Employment laws	Taxation	Demographics	Mobile technology changes
Competition regulations	Exchange rates	Education	Energy use and costs



### **6.3.3.2.3 Key antifragile considerations**

The enterprise boundary allows for the separation of endogenous and exogenous interaction and responses. Antifragility focusses on endogenous reaction rather than the prediction of exogenous events/stressors. The stage should focus on understanding what it has control over and what it has no control over to provide information to future stages as to whether a focus is internal or external.

### **6.3.3.3 Enterprise unit boundaries**

The future enterprise unit boundaries provide the conceptualisation from which the interactions can be investigated between units.

#### **6.3.3.3.1 Requirement**

The current existing enterprise units should initially be used. The type or categorisation is not critical initially, as a point of departure is required to continue assessing the interactions. It is, however, important that the current enterprise units chosen are known to the enterprise to allow for investigation in the future. Through continued use, the enterprise units will play an increasing role where the interactions provide guidance as to the inclusion or exclusion of parts of other enterprise units. The following iterations will allow for the change to improve the antifragility of the enterprise.

#### **6.3.3.3.2 Tools**

As noted above, these enterprise unit boundaries are initially not critical, as they will evolve as the framework is repeated. The enterprise units can now be investigated to get an improved definition of what it should be by focussing, as in section 6.3.2.2.2, on:

- **Functionality:** Parts of the enterprise that perform the same functions are grouped together; and
- **Key man units:** Units can be designed around key individuals in the enterprise to ease autonomy of unit decision-making.

### 6.3.3.3.3 Key antifragile considerations

The same antifragile considerations as per section 6.3.2.1.3 apply.

### 6.3.3.4 Enterprise unit role requirement

The understanding created in previous stages provides the knowledge for the enterprise to understand how critical an enterprise unit's function is to the purpose of the enterprise and in what role it would be able to contribute to the continuous improvement of the enterprise.

#### 6.3.3.4.1 Requirements

The ideal position of the enterprise unit needs to be placed in the triangle (the TO-BE position), in Figure 6-8.

#### 6.3.3.4.2 Tools

The placement of the enterprise units is subjective to the enterprise. These should be placed in the triangle in Figure 6-8, to highlight the discrepancy between what it is at present and what it needs to be.

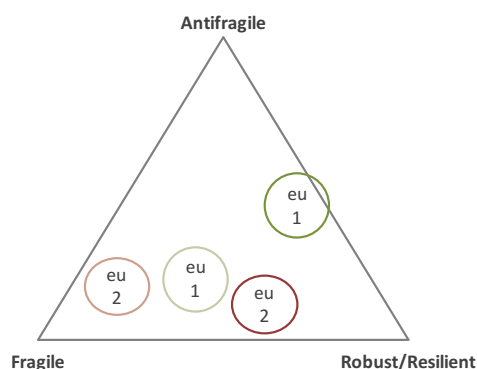


Figure 6-8: Triangle system of responses to the ideal enterprise unit classification

### 6.3.3.4.3 Antifragile considerations

It is crucial to be able to understand the role of the enterprise unit towards the purpose/antifragility of the enterprise. The inclusion of enterprise unit leaders as well as senior management is required to ensure the view is from a regulatory as well as an operational view. The regulatory view as part of a holistic solution is required in this process, whilst not excluding

the operational views. A misrepresentation would be that all units should be antifragile, but for an enterprise to be antifragile some enterprise units should be fragile or robust/resilient.

The key objectives, requirements and antifragile considerations per stage in the Enterprise Static Analysis phase are shown in Figure 6-9.

2 Future State				
	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundaries	2.4 Enterprise Unit Role Requirement
Objective	Reach an agreed purpose for the enterprise.	Define a clear boundary of what the enterprise should be.	Clear future enterprise unit boundaries should be defined.	Understand the ideal role a unit will play to align to the purpose and antifragility of the enterprise.
Requirement	Purpose should match the top-down and bottom-up approach to strategic alignment.	The boundary should clearly define that which is not part of the enterprise.	Start with current units, then move toward functional or key man enterprise units.	Plot the enterprise units TO-BE on triangle according to response to extreme circumstances in interactions.
Antifragile Considerations	Enterprise purpose, through double loop learning, should adapt to the environment.	The endogenous responses are controllable compared with exogenous interactions.	Key man units can be set up for an entrepreneurial enterprise unit.	Alignment of unit role to enterprise purpose through the inclusion of unit leaders in the process to align regulatory and operational view.

Figure 6-9: The Future State phase of the Epictetus framework with key stage objectives, requirements and antifragile considerations

### 6.3.4 The Progression State phase

In the previous phases an understanding was built up of how the enterprise operates through interactions between its enterprise units with each other as well as with the external environment. The previous stage highlighted the required role, as perceived by the enterprise, which was compared to the role the enterprise unit fulfils. This created gaps which can be addressed with strategies which look toward improving the antifragility of the enterprise.

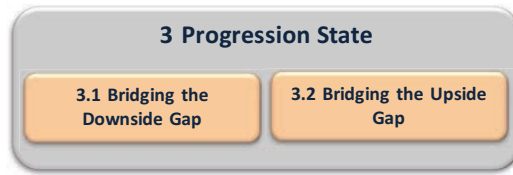


Figure 6-10: The Progression State phase in the Epictetus framework

### 6.3.4.1 Bridging the gap stage (3.1 and 3.2)

The identification of solutions to bridge the enterprise unit gap in stressor response roles is critical for ensuring the improvement of the enterprise's antifragility. These solutions require tinkering as knowledge of how the enterprise will respond to these needs to be developed. The strategies are, however, divided into two stages, 1) to bridge the downside risk gap, and 2) to bridge the upside risk gap. Actionable strategies are required at the end of this phase to ensure they are implementable by the project management function.

#### 6.3.4.1.1 Requirements

The requirements are to first, have fragile and robust/resilient enterprise units ensure that they are conservative on downside risk. Their respective role in the system is to ensure that the enterprise is protected from great losses (failure). Secondly, the antifragile enterprise units need to ensure that they are aggressive on upside risks, whilst ensuring that the investment risk is limited to a fixed downside to ensure sustainability of the enterprise function.

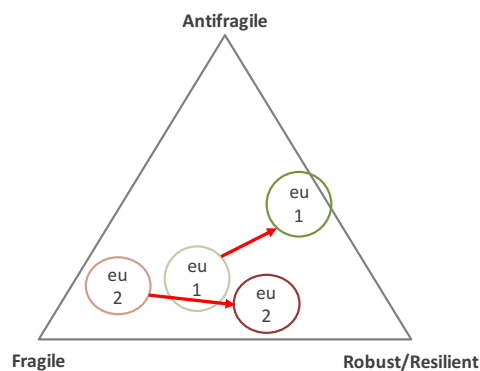


Figure 6-11: The design gaps that need to be bridged

### 6.3.4.1.2 Tools

There are strategies/tools which can be used to address the enterprise unit gaps (these are not all-inclusive, but they do provide a departure point for more strategies and tools to be included):

1. Internally (bridging the downside gap):
  - a. Redundancies: by focussing on redundancies of function the enterprise is protected on enterprise-critical functions,
  - b. Absorption: creating a buffer for an enterprise unit to be able to take a certain amount of stress improves the protection on downside risks,
  - c. Insurance: insurance plays a critical role in business-critical unfortunate circumstance events,
  - d. Options: i.e. the case of exchange rate risks could provide futures or options as financial instruments to protect against such things as the volatility in exchange rates; and/or
  - e. Learning: learning is crucial to ensuring that each event and the enterprise's (unit's) response is an opportunity to inform the future of the enterprise. This can be by introducing controlled stressors in the enterprise and ensuring these are well documented and shared.
2. Internally (bridging the upside gap):
  - a. Options: the options, such as the financial instruments mentioned above can play a role in taking advantage of the volatility of an interaction;
  - b. Innovation with R&D forming part of the process; and/or
  - c. Learning throughout the enterprise.
3. Relationally:
  - a. Reduction or severing influences: This can result in reduced exposure to volatility, or increased exposure to opportunities by being more agile/flexible; and/or
  - b. Redundancy of influences: Adding influences which could act as a redundant interaction on critical units.

### 6.3.4.1.3 Antifragile considerations

The first 'do no harm' principle needs to be understood by being conservative on downside risk by focussing on the enterprise units that are designed to play those roles, the second being to address the enterprise unit exposures required for the robust/resilient and antifragile roles.

The process is an iterative one, so what is not dealt with now will be aimed at being addressed in future iterations. The key is to first ensure the sustainability of the enterprise by addressing the downside risk, but also improving exposure to upside risk (if initially it is low cost on resources). The key objectives, requirements and antifragile considerations in the Progression State phase is shown in Figure 6-12.

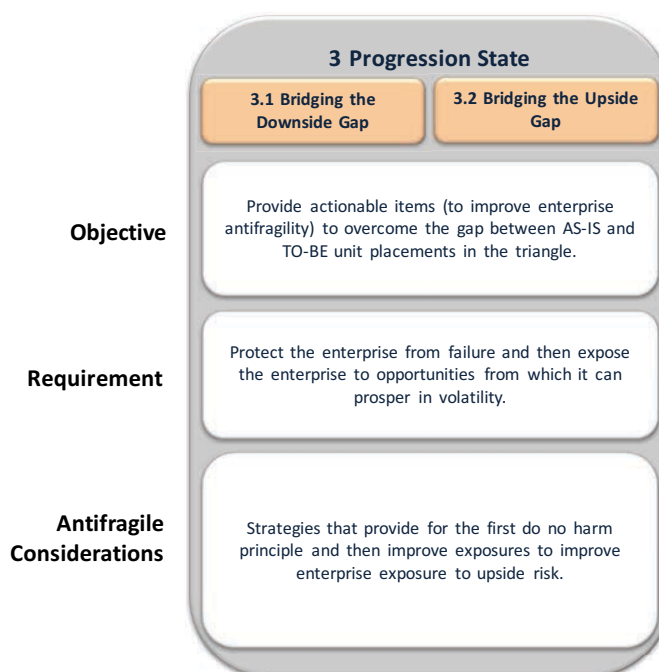


Figure 6-12: The Progression State phase of the Epictetus framework with key stage objectives, requirements and antifragile considerations

### 6.3.4.2 Feedback

To ensure an iterative framework, the previous assumptions and designs need to be retested to ensure there is learning from previous implementations, as shown in loop 2 in Figure 6-13. The second role of feedback loop 2 is to provide the participants in the design process with feedback and a choice as to whether the time, resources and effort are worth the value that

has been gained through the process. The loop thus gives feedback on the enterprise's maturity to continue with the improvement of the enterprise's design.

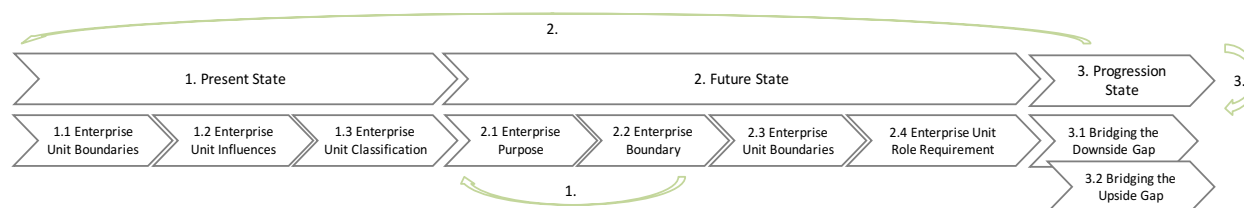


Figure 6-13: Feedback loop 2 in schematic representation of Epictetus framework

#### 6.3.4.2.1 Requirement

After the static solution phase, actionable items would have to be taken to implement the changes. These changes and the redesign can be retested by evaluating them according to the progression through the three phases (Present, Future, and Progression State), or these can be implemented before reassessing the enterprise to show iterative improvement.

#### 6.3.4.2.2 Tools

The measurement of framework as introduced in section 3.6 will be used to compare the results.

#### 6.3.4.2.3 Antifragile considerations

The feedback loop provides for a learning process. The outcome of the Epictetus framework is not a perfect design, but rather an enterprise capable of continuous learning and adaptation. Enabling continuous learning is required as the future is unpredictable; a perfect design could easily become out of date due to a change in circumstances.

Learning to learn is important for participants of the framework. Enterprise employees, as part of the process, not only understand and are ready to implement the design, they have implicitly participated in learning design thinking. They are therefore prepared to go on learning and changing the new design as may be required in future applications of the framework. This iterative process leads to elegant solutions.

The complete Epictetus framework is given in Figure 6-14.

#### **6.4 Chapter conclusion**

This chapter provided the framework as a designed result of the design requirements provided in chapter 5. The framework consists of three phases with eight stages providing the steps with recommended tools to provide the enterprise architect with the foundations to guide an SME to improved antifragility.



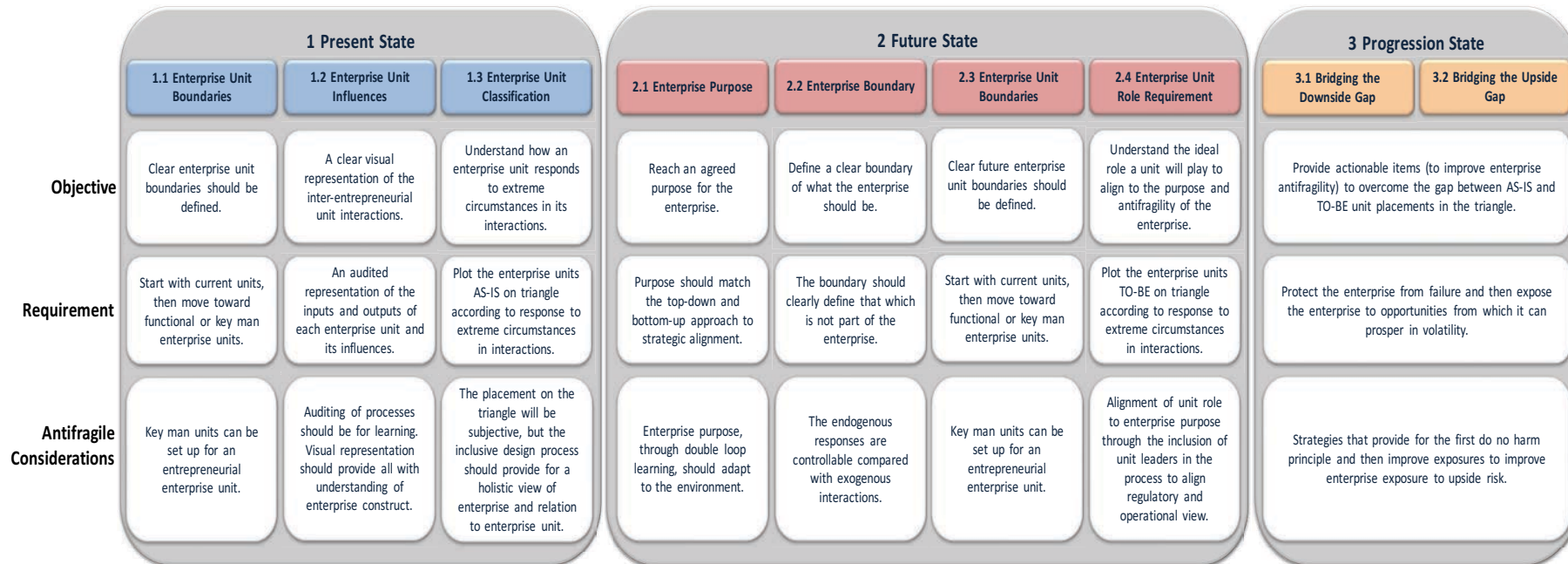


Figure 6-14: The Epictetus framework

## 7. Verification and validation of the Epictetus framework

*“A theory need not give us answers, but it should, perhaps, question the questions until they bleed a little.” – Anthony Boucher*

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This chapter deals with the verification and validation of the framework. The verification of the requirements and how they are satisfied by the framework provide the answer to whether the framework has adhered to the guidelines and restrictions provided by the literature research. The chapter then provides the validation process that was followed to provide the confidence that the framework will deliver on its stated objectives.

### 7.1 Verification of the framework

Verification relates to whether the framework has been developed according to its specifications. Boehm (1984) characterised that verification is building the system right and validation is whether the right system is built (Boehm, 1984). Forty-two requirements were categorised into five categories in chapter 5:

1. User requirements;
2. Functional requirements;
3. Design restrictions;
4. Attention points; and
5. Boundary conditions.

Each of the requirements in these categories was verified individually whether they are satisfied by the framework in a conceptual manner or whether they are satisfied by a specified stage or stages. The verification was done by comparing how the requirements (rows) were addressed by the stages of the framework (columns). This process was followed for all five requirement categories (Table 7-1 to Table 7-5).

### **7.1.1 User requirements verification**

The user requirements, as provided in section 5.2.1, Table 5-1, are attributable to the Epictetus framework as a whole. The user requirements are therefore not linked to specific phases or stages in the framework, but how they are addressed in the framework as a whole, as shown in Table 7-1.

**Table 7-1: The verification of the user requirements in the Epictetus framework**

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<b>U1</b>	The framework should consider the context of the South African SME, specifically its constraints, such as number of employees, access to resources, education, etc.	The framework allows the design participants to study the environment within which it operates as well as do their own analysis of where the enterprise boundary should be, how enterprise units are selected and how they interact with each other. The user is given the power to design solutions for these enterprise units.								
<b>U2</b>	The user should be allowed to flexibly apply their own discretion when using the framework.	The users will be in control of each stage of the framework with the guidance of the enterprise architect. Tools will be provided to them as examples in cases where they do not have their own tools to deliver on the requirements per stage.								
<b>U3</b>	The framework should be user-friendly.	The users are guided through the process by the enterprise architect who will guide or clarify when users struggle with the use of the framework.								
<b>U4</b>	The framework should be considered as a management aid.	Management forms part of the users of the framework, the result of which provides information on how employees see the enterprise as well as the future they see for solutions. Management will be able to identify talent as well as get information/knowledge that would otherwise not have been available.								
<b>U5</b>	The framework should provide clear definitions and explanations to cater for all levels of education found in an SME.	The framework will be facilitated by the enterprise architect who can, interactively, provide further explanations and examples of what is required per stage. These explanations will be required less as the enterprise iterates through the framework for improved designs.								
<b>U6</b>	The framework should allow for various sectors of industry for SMEs.	The framework allows the design participants to study the environment within which it operates. The framework is generic with guidelines to ensure that the users translate the stage requirements to their sector.								
<b>U7</b>	The framework should allow for various sizes of SMEs.	The framework allows for the users to decide on the size of the enterprise boundary as well as the construct of the enterprise units. An iteration of the framework hierarchically allows for larger SMEs to be designed to make the interactions between enterprise units manageable.								
<b>U8</b>	The enterprise architect must own the process of design.	The enterprise architect is responsible for facilitating the users throughout the process to ensure that the requirements and deliverables per stage are adhered to with the antifragile considerations in mind.								

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
U9	The design should be owned by the enterprise and enterprise members	The users are in control of making the decisions per stage. They, therefore, take control of the result of the design which is a result of the process of the design as owned by the enterprise architect.								

### 7.1.2 Functional requirements verification

The functional requirements, as provided in section 5.2.2, Table 5-2, are linked to specific stages where they have been satisfied in the design shown in Table 7-2. The functional requirements were divided into essential and desirable functional requirements. The desirable functional requirements will thus be selected in stages where they would be considered best practice. In the case where a tick mark is displayed in the merged cell across all stages, it denotes that the requirement addresses the framework in its use with feedback loops included.

**Table 7-2: The verification of the functional requirements in the Epictetus framework**

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<i>Essential Functional Requirements</i>										
F1	The framework should lead to improved antifragility in SMEs.							✓	✓	✓

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
F2	The framework should provide suggested tools in context of the process to assist and enable the process. <sup>8</sup>	✓	✓	✓	✓	✓	✓	✓	✓	✓
F3	The framework should support repeated and continued use.	The framework should provide a way in which the SME can continuously assess and improve on their current status. In the case where the SME feels that not enough value is being gained through iterations, there should be a loop that stops the process from repeating. This is done by all three feedback loops.								
F4	The framework must provide a way for the enterprise to understand the dimensions of stress that affect it and its units.		✓	✓			✓	✓		
F5	The framework should promote a learning capability on enterprise and enterprise unit level. <sup>9</sup>	✓	✓	✓	✓	✓	✓	✓	✓	✓
F6	The framework should guide the enterprise to arrive at a vision and mission that is suited to its environment.				✓	✓				
F7	The framework should allow for enterprise unit boundaries to be redrawn.	✓	✓				✓	✓		

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<sup>8</sup> Each cell being satisfied means that a tool is given per stage in the framework.

<sup>9</sup> Each stage in the framework focusses on learning to improve our current knowledge of the SME.

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<i>Desirable functional requirements</i>										
<b>F8</b>	The framework should allow for autonomy in decision-making in parts of the enterprise with an alignment between the decision-maker and the goal of the enterprise.				✓		✓	✓	✓	✓
<b>F9</b>	The framework should guide decisions which will lead to decentralisation of enterprise units.						✓	✓	✓	✓
<b>F10</b>	The framework should guide the users which would lead to the diversification of enterprise units.						✓	✓	✓	✓
<b>F11</b>	The framework should guide the enterprise and its enterprise units to be agile and flexible.								✓	✓
<b>F12</b>	The framework should promote an environment of trust.	The complete design process ensures that an open process is allowed through trust. The facilitation was designed in this way and will continue to be implemented in this way by the enterprise architect.								
<b>F13</b>	The framework should guide the enterprise to be conservative on risks that carry dire consequences.								✓	

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<b>F14</b>	The framework should guide the enterprise to identify opportunities where it can take risks that limit enterprise loss and increase enterprise exposure to value.									✓
<b>F15</b>	The framework should allow for the design process to be participative and democratic.	The framework's facilitation will ensure that all the participative members of the workshop will be included in the design construct. The role of the enterprise architect as a facilitator is important here.								
<b>F16</b>	The framework should guide the enterprise to jointly address the social and technical system interactions for optimisation.	✓	✓				✓	✓	✓	✓

The user requirements, as provided in section 5.2.1, Table 5-1, are attributable to the Epictetus framework as a whole. The user requirements are therefore not linked to specific phases or stages in the framework, but how they are addressed in the framework shown in Table 7-1.

### 7.1.3 Design restrictions verification

The design restrictions, as provided in section 5.2.3, Table 5-3, are attributable to the framework as a whole. The design restrictions are therefore not linked to specific phases or stages in the framework, but how they are addressed in the framework as a whole, shown in Table 7-3.



**Table 7-3: The verification of the design restrictions in the Epictetus framework**

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<b>R1</b>	The framework is not meant to include an exhaustive set of tools and methods available to reach the objectives per phase, but should be comprehensive enough to provide sufficient options for SMEs.	Each phase, as shown in F2's satisfaction of the requirements, provides tools and considerations which should be comprehensive enough to provide sufficient options for SMEs. It does, however, not provide an exhaustive list of possible tools which can be used to reach the objective and fulfil the requirements per stage.								
<b>R2</b>	The framework is intended for SMEs, but some principles, tools and methods may be applicable to larger enterprises.	There are tools that have been provided that can satisfy use in larger enterprises. Due consideration of who would need to be included in the design process will be required in larger organisations. The use of hierarchical breakdown of enterprise units will also require more depth of understanding per unit, but these can be tested in future research.								
<b>R3</b>	The framework is not a legal or legislative guide, and input required for such items (e.g. tax legislation) should be obtained from specialists within those fields.	There are certain agreements which can be made, which might not be within the legislative knowledge of the enterprise architect. The framework assumes that the enterprise senior management would know the legislative requirements for their decisions and where this is not the case, that they would know when to obtain an opinion from a legislative specialist in the field.								
<b>R4</b>	The framework does not guarantee antifragile success due to a multitude of factors that could influence such an outcome. However, it does provide principles based on theory and best practice to increase chances of success when applied.	The framework provides best practice guidelines of how it should be used, but poor implementation of the actionable items, extreme events not catered for yet, or other unforeseen events could result in the failure of an enterprise. The tools provided have been selected for their continued use in practice to reduce the gap between theory and reality of practice to improve validity of framework.								
<b>R5</b>	The framework should be designed as a design tool towards more antifragile SMEs in South Africa.	The framework follows a design process by developing it according to the first two phases of the systems design engineering process; the analysis and synthesis phases. The framework, through the facilitation of the enterprise architect, guides the users through the design process which will result in a static solution of how the enterprise should be constructed.								

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<b>R6</b>	The framework is intended for SMEs in South Africa, but some principles, tools and methods may be applicable to SMEs in other countries.	There are tools that have been provided that can satisfy use in other countries. Due consideration would need to be given to the environment in which the enterprise will operate will be taken in stage 1.1. The use of the framework in other countries will require an investigation into the characteristics and constraints of the specific country to ensure that the user requirements are addressed in the framework. Initial validation interviews in Germany have raised comments from the interviewees that the framework would be usable in Germany too, but this would require further research.								

#### 7.1.4 Attention points verification

The attention points, as provided in section 5.2.4, Table 5-4, are relevant to the design and were noted, but they were not hard requirements nor did they constrain the design. The attention points are not, in each case, linked to specific phases or stages, but could also be conceptually focussed on the framework as a whole, as shown in Table 7-4.

**Table 7-4: The verification of the attention points in the Epictetus framework**

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<b>A1</b>	Some items to be included in the framework will be discretionary and dependent on factors inherent to the enterprise, such as its set-up, size, strategy and prior knowledge. Decisions about how or what to implement will therefore differ between enterprises.								✓	✓
<b>A2</b>	The approach should be seen as a reflection of early best practice within an evolving field of knowledge.	Antifragility is a young field which has not been made to include practical steps through which enterprises can improve. As the field matures and research sheds more light on the characteristics, best practices and philosophy of antifragility, the research up until this point, which includes this framework, will improve to provide more value to enterprises looking to become more antifragile. This framework, however, has taken the systems design engineering approach through the requirements of EIEA, SA SMEs and antifragility best practices at present to provide actionable steps through which enterprises can strive to improve their antifragility.								
<b>A3</b>	The process of designing the enterprise should complement its objectives.	The enterprise should aim to become more antifragile, i.e. to improve under increased volatility before the framework is applied. Misalignment of the objectives of the enterprise and the objectives that this framework aims to deliver on will result in a high probability of ineffectual practices to support the enterprise in its future.								
<b>A4</b>	The solution should not be more specific than is essential.								✓	✓
<b>A5</b>	Variances that cannot be eliminated should be controlled as close to the point of origin as possible								✓	✓
<b>A6</b>	The framework should support the solution of redundancies to be those of function and not of the unit parts.								✓	

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
A7	Group process design and facilitation with group dynamics at the core is required.	The framework facilitation by the enterprise architect should be designed with a specialist/expert in the field of facilitation. Through this involvement the group dynamics to deliver on the objectives of the framework will be improved and the probability of a democratic and participatory decision-making process will improve.								
A8	A clear handover to the project management function is required.								✓	✓

### 7.1.5 Boundary conditions verification

The boundary conditions, as provided in section 5.2.5, Table 5-5, have to be unconditionally satisfied by the framework. They were included as they were reasonable assumed boundaries of application for the framework. These were not linked to specific stages in the framework, but they related to the framework in a conceptual manner, Table 7-5.

Table 7-5: The verification of the boundary conditions in the Epictetus framework

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
B1	The framework should be used in a legal and ethical way by the SME.	The framework should be used for the purpose, and aligned objective of the SME, to guide the SME to become more antifragile. Any use of the framework beyond this will be in the control of the enterprise architect, who controls the design process, to halt further design of the enterprise. Any encroachment on the legality of use will be subject to the requirement R3 where legal experts will provide opinions on any matter beyond the field of the enterprise architect or the management of the SME.								

		1 Present State Phase			2 Future State Phase				3 Progression State Phase	
		1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Classification	2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundary	2.4 Enterprise Unit Role Reqmt	3.1 Bridging the Downside Gap	3.2 Bridging the Upside Gap
<b>B2</b>	The framework should not be used to negatively exploit other parties involved in the framework.	The global business environment is a competitive one which will affect the competitors of the enterprise making use of the framework. The framework will, however, aim to do so in an ethical and legal way (requirements R3 and B1). This is in the control of the enterprise architect and the senior management of the SME.								
<b>B3</b>	The framework should promote value for all parties involved and assist in establishing trust.	As with requirement F12, the participative and democratic nature of the decision-making in the framework will provide a foundation from which trust can be built. The value created will be in the form of improved antifragility of the SME, if applied and implemented correctly.								

### **7.1.6 Verification conclusion**

Each requirement stated as a user-, functional (essential or desirable) requirement, design restriction, attention point or boundary condition has been addressed in the previous section. Each of these requirements was compared to, either a specific stage within the framework or the use of the framework conceptually. These were verified to have been satisfied by the framework, its use and its intention.

## **7.2 Validation**

The validation of the framework relates to evaluating whether the framework is suited for its intended purpose (the correct framework has been developed), in other words, “Was the right system built” (Boehm, 1984). The validation of a framework in a field of research in which very few experts exist makes validation through interviews difficult. The approach followed allowed for the questioning of experts in related fields to perform a validation of the framework by parts.

The validation of the framework was done in four parts:

1. The parts of the framework where theory has been proven to be representative of reality are validated through the tools used to empower the satisfaction of that part of the framework; for the remaining parts of the framework (refer section 7.2.1)
2. The use of a case study which will provide an illustrative example here (on an enterprise in South Africa, refer to section 7.2.2);
3. A round of interviews with experts (focussed on South African experts, refer to section 7.2.3.1); and
4. A round of interview with experts (four in Germany focussed at the Technische Universität München, refer to section 7.2.3.2).

### **7.2.1 Theoretical validation of stages**

Validation by parts is possible as each phase in the framework is a stand-alone stage which requires inputs with an internal process to deliver on the outputs which will be used as inputs by the following stage. In the cases of newly developed theories, the validation of a framework

would be required to state that what is stated in theory is representative of what would happen in reality.

In this section the stages that can be argued to be firmly rooted in theory and practice, before the commencement of this study, were validated and would not require further validation. We will, first, look at the Present State phase's three stages, 1) Enterprise Unit Boundaries, 2) Enterprise Unit Influences and 3) Enterprise Unit Classification stage.

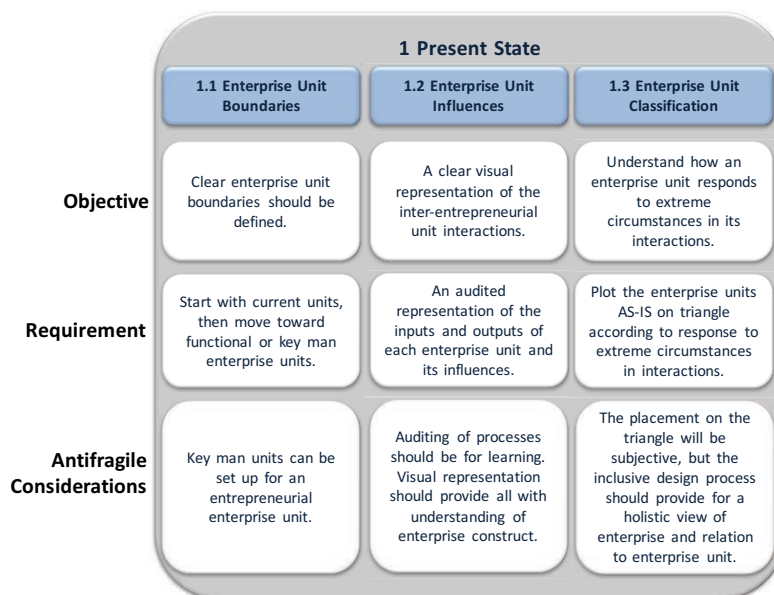


Figure 7-1: The Present State phase of the Epictetus framework, validation by parts of 1.1 & 1.2

### 7.2.1.1 Enterprise unit boundaries

The tools provided for this phase, section 6.3.2.1.2, functional enterprise units and/or entrepreneurially headed enterprise units are practically applicable. Generally, enterprises have been divided into functional units such as Human Resources, Purchasing, Manufacturing and Finance. The framework calls for enterprise units to be set up, given antifragile best practices, according to a function they fulfil with key leaders in the enterprise leading these units. The validation by parts done here is also valid for the enterprise unit boundaries stage in the Future State phase, Figure 7-2.

The next stage, the Enterprise Unit Influences stage in Figure 7-1, can be satisfied by tools which have gained maturity in literature and have reduced the theory to practicability gap.

### 7.2.1.2 Enterprise unit influences stage

Design Structure Matrices (DSMs) display the relationships between enterprise units in a compact, visual and analytically visible and advantageous format. DSMs have been used in analysing team interfaces (the interactions between teams/enterprise units). The value of the use of DSMs in enterprises has been confirmed by Browning (1998), (1999) and (2001), but more specifically in case studies done by Thomas and Worren (2000).

DSMs for enterprises require the following three steps:

1. Decomposing the enterprise into elements with specific functions, roles or assignments (this is also done in the enterprise unit boundaries of the Epictetus framework);
2. Documenting the interactions between the teams (through the use of the matrices and the subject of the validation of this stage); and
3. The analysis of the clustering of the 'teams' (to be seen as ways in which interactions can be addressed to improve).

		2 Future State			
		2.1 Enterprise Purpose	2.2 Enterprise Boundary	2.3 Enterprise Unit Boundaries	2.4 Enterprise Unit Role Requirement
Objective		Reach an agreed purpose for the enterprise.	Define a clear boundary of what the enterprise should be.	Clear future enterprise unit boundaries should be defined.	Understand the ideal role a unit will play to align to the purpose and antifragility of the enterprise.
Requirement		Purpose should match the top-down and bottom-up approach to strategic alignment.	The boundary should clearly define that which is not part of the enterprise.	Start with current units, then move toward functional or key man enterprise units.	Plot the enterprise units TO-BE on triangle according to response to extreme circumstances in interactions.
Antifragile Considerations		Enterprise purpose, through double loop learning, should adapt to the environment.	The endogenous responses are controllable compared with exogenous interactions.	Key man units can be set up for an entrepreneurial enterprise unit.	Alignment of unit role to enterprise purpose through the inclusion of unit leaders in the process to align regulatory and operational view.

Figure 7-2: The Future State phase of the Epictetus framework, validation by parts of 2.1, 2.2 & 2.3

### 7.2.1.3 Enterprise purpose and enterprise boundary stages

The framework requires employees from the SME to be facilitated through the process to (re)design the SME. It should be the aim that the facilitation be done by an enterprise architect. The enterprise purpose and enterprise boundary stages are brought into effect



through a double-loop learning feedback system where a compatibility between the environment and the stated purpose of the enterprise is found. The tool that is proposed, strategic intent together with the strategic intent architecture delivers on the requirements and objectives of this stage. These stages are similar to the enterprise engineering process which goes through the Initiation, Master Planning and Deployment Phases in Figure 7-3. The requirements for the Definition and Identification stage as well as the initial investigation into the strategic intent (Pralhad & Hamel, 1989) architecture's top-down approach deliver on the enterprise purpose and enterprise boundary stages.

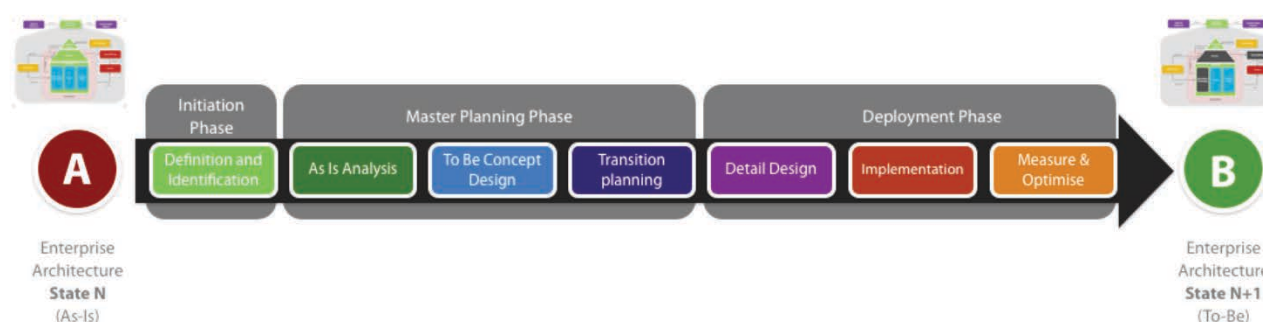


Figure 7-3: A typical enterprise engineering (re)design process (du Preez, et al., 2015)

These tools have supported the validation of five of the nine stages of the Epictetus framework. The remaining four stages will be validated through both an illustrative case study, section 7.2.2, but more directly through two rounds of interviews with experts, sections 7.2.3.1 and 7.2.3.2.

### 7.2.2 Illustrative case study

A case study was done on a small enterprise on the east coast of South Africa, in the KwaZulu-Natal province. The enterprise was originally registered as a close corporation in 2004, but has grown to three branches, with the additional two being added in the last two years in the Limpopo and KwaZulu-Natal provinces respectively. The enterprise has been run by the same owner since 2004. The enterprise owner's time has become increasingly constrained as she has attempted to continue operating all three branches in the same way she did the first one. This has led to increased mistakes made in the enterprise, with poor controls and oversight causing losses and a reduction in revenue due to the CEO's reduced time selling in the branches.

Table 7-6: Illustrative case study information

<b>Industry</b>	Retail
<b>Employees</b>	15 employees
<b>Turnover (pm)</b>	R650,000

**7.2.2.1 Measurement**

The antifragile measurement of the enterprise was done telephonically with the members that were earmarked for the facilitation of the Epictetus framework. These four members were phoned with 'what-if' questions to gain a measurement as set out in the tool given in section 3.6. The results of the two assessments are given in Figure 7-4.

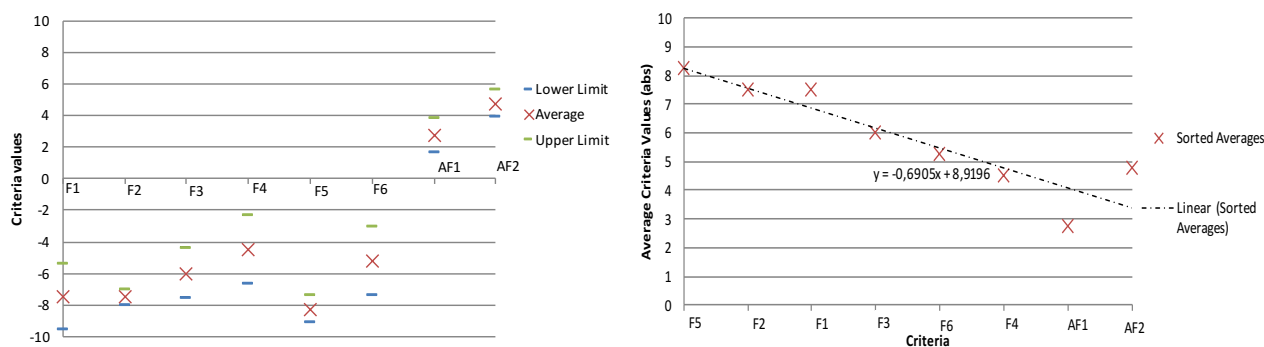


Figure 7-4: Initial Assessment (C) (left) and Assessment (S) (right) of the illustrative case study

The results show a large standard deviation for factors F1 (Emergence), F4 (Stress starvation) and F6 (Absorption) when looking at Assessment (C). These factors were used by the facilitator so as to highlight the differences that members might have around the enterprise as a whole. This created the foundation from which members shared knowledge around what is possible in the enterprise under these criteria. Assessment (S) relates to the improvement of the slope for relative measurements and will provide the feedback as to whether the enterprise is moving into the correct direction.

**7.2.2.2 Construction of the facilitation**

There were five stakeholders present at the facilitation. The stakeholders include four employees that initially fulfilled the functions of; 1) branch manager, 2) owner, 3) administrative assistant, 4) marketing head, and 5) finance and business development.

The timeline and plan for the facilitation session was created and presented to Van Der Spuy Brink of Corvus Dreammaker to confirm whether he would expect the plan to be successful. The facilitation plan was made available to him after he was presented with the framework. Van Der Spuy Brink is a specialist facilitator with more than 20 years' experience in strategic facilitation which ranged from large corporates to boutique wine farms. A curriculum vitae for Mr Brink is given in Appendix H - Van Der Spuy Brink Curriculum Vitae with a copy of the final plan given in Appendix I - SME Case Study Epictetus Framework Facilitation Plan. The author was taught by Mr Brink nine years ago, how to facilitate through an apprenticeship. Since then, the past five years have seen the author facilitate six strategic sessions as an outside consultant and stakeholder.

### **7.2.2.3 Present State phase**

The members decided that they did not want to focus on the Present state of the SME, but wanted to rather start addressing the Future state as their view was to build on a clean slate and not old information. Their rationale was that the structure of the SME would need to change drastically and time allocated to investigating the present state could be better used.

The nature of the framework allowed the SME to skip the Present state phase and move directly to stage 2.1, the Enterprise Purpose phase. This type of usage will be important with iterations where SMEs might want to reassess only parts of the framework stages in design and implementation. The framework allows for this type of use.

### **7.2.2.4 Future State phase**

The SME, in this phase, will start with the view of what the future for its enterprise will be constructed like.

#### **7.2.2.4.1 Enterprise purpose**

The purpose of the enterprise, notably, changed to one which was less specific around the sale of goods to one which created space for the enterprise boundaries to be expanded or contracted. The facilitator had to keep explaining and providing examples of what a purpose should look like.

The purpose was not settled upon until the enterprise understood what their current capabilities were in which to deliver on the proposed purpose. This led to a continuous loop between the Enterprise Purpose Stage, and the Enterprise Boundary stage.

#### **7.2.2.4.2 Enterprise boundary**

The enterprise focussed, initially, on the physical boundaries that comprised the enterprise such as the branch walls, but the thought of off-location administration changed this view. There were future endeavours which the workshop members thought were already included in the discussions about what the boundary should comprise, but they were continually brought back to the task at hand, to understand how their boundary aligned with the purpose.

The purpose, in the end, was finalised as:

*“Making the spaces we inhabit a constant reflection of ourselves.”*

This concluded that the branches and the administration function (both finance, marketing and customer and supplier relationships), as a first step would comprise the enterprise boundary.

#### **7.2.2.4.3 Enterprise unit boundaries**

The previous enterprise unit boundaries were immediately discarded as they focussed on the control of only one person and allowed for no contingency plan nor any further expansion of the enterprise.

The new enterprise units were selected as:

- Branch 1 (B1);
- Branch 2 (B2);
- Branch 3 (B3);
- Finance and business development (FBD);
- Marketing (M); and
- Administration (Supplier and customer relationships, and process management) (ADM).

These were selected focussed on key individuals, where, historically five of the functions above were fulfilled by one person, which created large bottlenecks and a reduction in enterprise

confidence from both suppliers and customers. The DSM was created as it will be populated when the enterprise moves into the active Present State phase where their current actions and influences will be investigated for further improvement.

	B1	B2	B3	FBD	M	ADM	ENV
B1							
B2							
B3							
FBD							
M							
ADM							
ENV							

Figure 7-5: Illustrative case study DSM template

The value of the current enterprise units is that they are set up to give transparency and accountability to single individuals. The success or failure of each of these units will be directly attributed to an individual which is one of the key antifragile considerations of the stage.

#### 7.2.2.4.4 Enterprise unit role requirement

The workshop members immediately wanted to place all the enterprise units in the antifragile corner of the triangle, which prompted the facilitator to explain the way in which a system is constructed to ensure that antifragility of the system is improved. Some parts require stability where others require innovation and exposure with the support of financial where fixed failures need to be in place for unexpected events.

The workshop members were, initially, apprehensive to place their business unit on the triangle, but once the facilitator placed it in the triangle they members were more inclined to move it around within the triangle. The three branches were selected as having to be robust/resilient to ensure that volatility is translated into continued operations, seen in Figure 7-6. The Marketing function needed to look to innovative solutions to taking advantage of new technologies in relation to markets and products. The Finance and Business Development function would need to be robust/resilient. The initial placement was due to the fragility which did exist in the function. The enterprise would like to pursue a more stable function within finance and will investigate the possibility of separating the finance and the business development functions to expand to other markets.

The limitation of the functions due to single person contact control resulted in the slant towards more stable functions to support the enterprise. The marketing function is a new function which can be seen by its placement where all agreed that it could be an antifragile function, but should have an element of fragility to ensure that the brand of the enterprise and costs are limited.

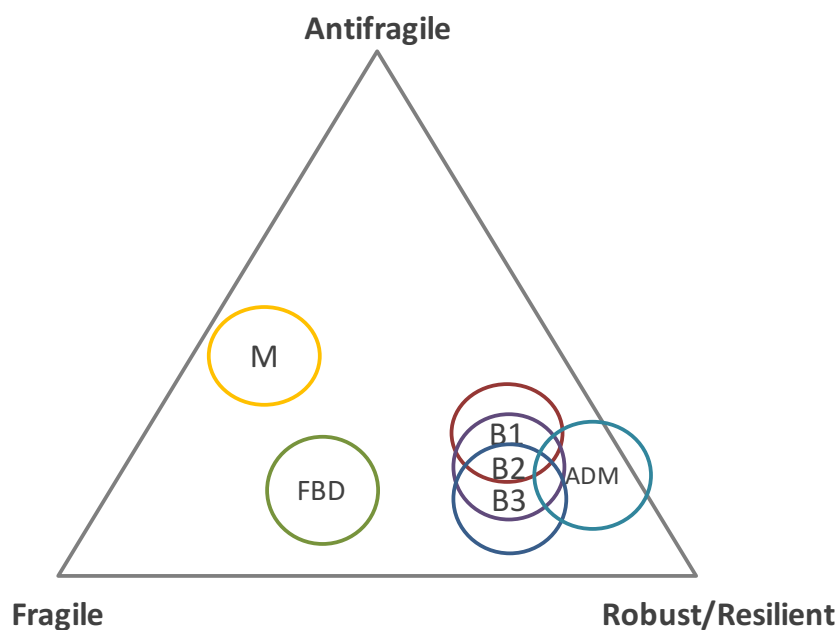


Figure 7-6: The role of the enterprise units

### 7.2.2.5 Progression State phase

The progression state phase looks to bridge the gap between the Current and the Present State by using certain internal or relational approaches. In this illustrative case study the enterprise did not follow through with a full investigation into the present state, but could address actions which could lead to their preferred/ideal role as portrayed in Figure 7-6.

#### 7.2.2.5.1 Bridging the downside gap

The workshop members agreed to investigate the downside gap of the future state units as a first iteration, with the exception of the role of the Marketing unit which will look at both the downside and the upside gap. The members agreed that Marketing is currently working effectively with a known cost (as per the budget) per month, they wanted to improve on the other units first. Each unit was discussed in the workshop with multiple ideas given per unit

and then plotted onto an Effort-Impact matrix. The workshop members decided to take one item per unit which needed to be actioned before the next iteration of the framework.

The key downside gap strategies were to reduce the key man dependencies within the enterprise to allow for a redundancy of functions within the enterprise units. These can be seen in the simple approach to their current construction action items in Table 7-7.

#### 7.2.2.5.2 Bridging the upside gap

The upside gap strategy was most prevalent for the Marketing unit. These would now allow for increased influential exposure in the local surrounds. Multiple ideas existed, but the reallocation of the print media budget to the marketing function was agreed to, as proposed by the key man now in charge of the marketing unit.

Table 7-7: Actionable items delivered from the Epictetus framework

Enterprise Unit	Actionable Item	Description
Branches 1, 2 & 3	Transfer of knowledge from single individual (business owner to the new branch unit heads.	Each Monday of the week will be spent to slowly hand-over the branch only tasks. These include daily, weekly, and monthly tasks to be completed by the branch head.
Finance and Business Development	Transfer of current accounting and inventory management by branches on Excel-based work to online accounting software.	An investigation into possible software required that could play the role of inventory management and online accounting software. This should align with the capabilities of the current auditors.
Administration	The role of administration will be reallocated from the current daily roles within the branches.	The administration will focus on the monitoring and decision-making of the enterprise as a whole after which tasks in branches will be reallocated. The management of client and customer relationships will, for this iteration, be part of the administration function.

Enterprise Unit	Actionable Item	Description
Marketing	Stopping the expansion of print media marketing and increasing the digital and community-based marketing.	The marketing unit manager will venture into the location-based business and tourism chambers. The budget of print marketing will be reallocated to the new strategy. The new strategy will be communicated to the acting branch heads and the SME manager.

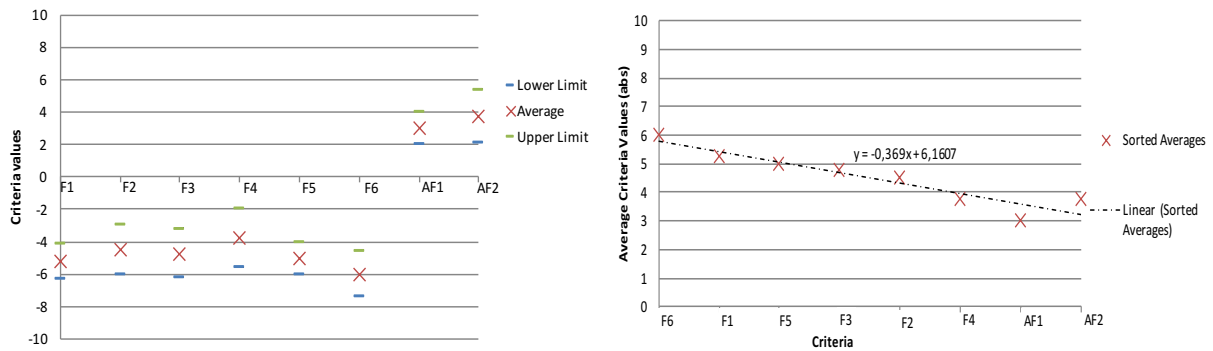
### **7.2.2.6 Case study concluding remarks**

The workshop produced the expected result of an improved construction for the SME's enterprise units. The initial stages of the workshop resulted in apprehension by younger employees to get involved, but once construction of their enterprise unit was allocated they increased in participation.

An increased understanding of antifragility resulted in the enterprise understanding how projects could be weighed up against one another together with the placement of projects on the Impact versus Effort matrix.

The follow up measurement, Figure 7-7, with the members of the enterprise showed improvement across the highlighted criteria as well as the slope given in section 7.2.2.1. The initial measurement with large standard deviation in factors F1 (Emergence), F4 (Stress starvation) and F6 (Absorption) where reduced which shows that a more convergent view of the members in the criteria when looking at the enterprise, according to Assessment (C). Assessment (S) relates to the slope and the overall system improvement. The decrease in a negative slope (from -0,691 to -0,369) shows that the direction of movement of the slope is flattening out which shows that the enterprise is moving towards a more antifragile response.





**Figure 7-7: Follow-up Assessment (C) (left) and Assessment (S) (right) of the illustrative case study**

A result of the changes in the enterprise was the reduction of someone who was initially believed to be a key man employee. The employee could not adapt to the change in structure and resulted in a restriction of function with some of the other enterprise units. The members of the enterprise, as a collective, decided that it would be best to remove the constraint to change in the enterprise. The functional role has been filled by dividing the function up between two of the branches. The result has been an improvement in efficiencies and more time released for the enterprise owner to focus on the interactions with customers and suppliers. The actionable items have been executed well, with only one branch struggling in the current economic climate. This could be due to the reduced access to the marketing function. Increased exposure for this branch is being investigated.

The enterprise owner holds a PhD in biological sciences, but none of the other employees has a tertiary education. Initial implementation of the actionable items was difficult, especially in the training of the new branch managers, but this was overcome by certain branch managers becoming the champion of the online account and inventory management software champions. This has created a key man dependency on this manager, but has spread the risk from the enterprise owner.

The enterprise will be looking to go through another iteration of the framework where current influences between units will be evaluated. This will be done once the implementation of the software has been done in all three of the branches.

The illustrative case study has proven to the author that the framework is implementable, and an iteration has been requested. The second step in the validation will focus on the perception of field experts on the framework through semi-structured interviews.

### **7.2.3 Semi-structured interviews for validation**

The format of the interviews followed that of one-on-one or one-to-many. The process of selecting experts followed that of finding people who were experts in the fields of at least one of the research fields studied in the research. Each interviewee attended a presentation by the author which was followed by a question and answer session. These sessions were both open to questions interrupting the process to increase the amount of value to be gained from the interviews. The questions were aimed at validating the framework and extracting the expert's views on the applicability of the framework together with their own opinions, apprehensions and recommendations.

Two rounds of interviews were held. The first, section 7.2.3.2, was held in Munich, Germany in September and October 2016. The second, section 7.2.3.1, was held in the Western Cape in South Africa during March and May 2017. The validation process here will place the South African interviews first as they focus the validation more securely on the research question and its focus on South African SMEs. The German interviews give light to the validation of the framework itself, but speaks less to the South African SME.

#### **7.2.3.1 Interviews held in the Western Cape, South Africa**

The second round of interviews was held in South Africa to focus more on the experts that understand the South African SME, its environment and the strategy required to support SMEs. A list of the interviewees is given in Table 7-8. Some of the interviewees requested anonymity which is why all six were granted anonymity.

**Table 7-8: Professionals interviewed in South Africa**

<b>Date</b>	<b>Interviewee</b>	<b>Position or summary</b>
16 March 2017	Mr V B	VB has more than 20 years' facilitation experience, and is a lecturer in strategy for an MBA class. VB has done strategic consulting for more than 20 years and is seen as an expert in the field of facilitation, strategy and SMEs.

<b>Date</b>	<b>Interviewee</b>	<b>Position or summary</b>
17 May 2017	Mr H S	HS has spent more than eight years in the private equity industry which includes a specialist knowledge of facilitation, enterprise engineering, strategy and SMEs.
19 May 2017	Dr S B	SB is a senior lecturer and programme manager at a university in the Western Cape. He was interviewed for his experience in systems and enterprise engineering, strategy, enterprise engineering and SMEs.
25 May 2017	Prof. M M	MM is a Vice-dean of Research at a large faculty at a university in the Western Cape. He was interviewed for his expertise in systems and enterprise engineering, facilitation, strategy and SMEs.
25 May 2017	Prof. R P	RP is part of institutional strategy at a university in the Western Cape. She holds a masters in Mathematical statistics, an MBA and holds a PhD in Systems Engineering. She was interviewed for her expertise in systems engineering, strategy and SMEs.
29 May 2017	Dr L L	LL is a senior lecturer at Stellenbosch University and was interviewed due to his expertise in the field of strategy and enterprise engineering.

The interviewee was given an overview of antifragility and an explanation of how the framework would work. The presentation used in the second round can be seen in Appendix D - Interview presentations March to May 2017.

The first step in the interview would be to establish whether the interviewee had prior knowledge of antifragility. This would allow the author to test whether there were differences between those who knew about antifragility and those who did not (question 1), in replies to the validation of the stages 1.3, 2.4, 3.1 and 3.2. Question 2 focussed on whether the interviewee believed that the framework delivered on the main research question. Question 3 focussed on whether there is an existing body of knowledge which the author missed in the approach to the literature study. Question 4 raised the question of, if the framework were to fail, where it would fail. Question 5 asked the interviewee to validate whether the tools given can validate the remaining parts left unvalidated previously.

Given the rationale above, the following questions were asked:

1. Do you have any prior knowledge of Antifragility?
2. Do you believe that this framework would guide an SME to be more Antifragile?
3. Are you aware of any other frameworks that would better improve the SME's Antifragility?
4. Where do you believe this framework could fail in its stated objective?
5. Given the following stages (1.3, 2.4, 3.1 and 3.2) do you think they are achievable? And do you believe they contribute to the objective of the framework?

There were some further discussions that continued with some of the interviewees which can be found in the transcripts, Appendix F - South African Interviewees, but the direct answers to the questions with some highlights are included below.

#### **7.2.3.1.1 Do you have any prior knowledge of antifragility?**

All six confirmed that they had some prior knowledge of antifragility. The degrees to which they have been exposed to it range from just being aware of it (LL, SB and RP) to well-read on the topic (VB, MM, HS).

#### **7.2.3.1.2 Do you believe that this framework would guide an SME to be more Antifragile?**

All the interviewees confirmed that they believe that the framework would improve the antifragility of the SME.

VB mentioned that, at worst, he believed that the SME would stay the same and nothing would happen, but his belief in the fact that the members of the enterprise were brought together to go through this process would result in improvement.

SB thinks that it would improve the antifragility of the SME and targeting the SME is a clever approach as it would be easier to organise them around this and it would contribute greatly to South Africa. He did, however, mention that the success of this would have to be linked to a certain cultural affinity for opening up the enterprise and allowing the total contribution process.

LL believes that the space given in a very high conceptual framework places the emphasis on the capabilities of the facilitator, but given this would result in the improved guidance to how an enterprise might become more antifragile.

RP enjoys that the framework is focussed and designed just for SMEs, and not in the way where frameworks are applied to SMEs which were initially designed for larger enterprises. She agreed that it will work, but first and foremost due to the fact that the design is a more formalised approach built on systems design principles.

MM believed that the framework would support the SME, but believes that as a first step in the field, it is a tentative approach which will improve vastly. The author believes that this comment is valuable with the framework increasing in its value as the field increases.

#### **7.2.3.1.3 Are you aware of any other frameworks that would better improve the SME's antifragility?**

None of the interviewees could think of a framework or guiding principle which they believed would better improve the antifragility of the enterprise. They all agreed that models and frameworks that were built for large corporates have been applied to SMEs for a long time, but they never account for the limitations that SMEs have. RP and MM especially praised the fact that a specific model for SMEs was built which they already believe would contribute to the future of SMEs in South Africa.

#### **7.2.3.1.4 Where do you believe this framework could fail in its stated objective?**

Two themes were raised during this answering of this question. The first was that the SME owner and its employees would need to be committed to following through with the framework, but they felt that this is true for most endeavours which look to change the SME. The second focussed on the way in which the framework would be translated through the workshop to be ensure that the workshop members would understand what was needed. The solution to this was that it would need to be as visual as possible to allow for the translation of theory to practical application for employees or owners who struggle with the application of abstract thought.

**7.2.3.1.5 Given the following stages (1.3, 2.4, 3.1 and 3.2) do you think they are achievable? And do you believe they contribute to the objective of the framework?**

All the interviewees agreed that these stages are achievable and are important to the success of the framework. The need for graphical representation was reiterated to make these stages achievable, especially in speaking to the concerns raised in section 7.2.3.1.4.

SB noted that it is valuable that stages 1.3 and 2.4 are not quantitative as it would result in the focus on small changes rather than the overall implication that the antifragility is being improved.

A view between stages 1.3 and 2.4 differed somewhat as the interviewees were interested as to the capability of all the members of the enterprise to be able to see, abstractly, into what the units' role should be. All felt they were possible and important to the success of the framework, but would require clear explanations of what the future for a unit would entail.

**7.2.3.2 Interviews held in Munich, Germany**

The interviews in Munich, Germany, included a representative from the Department of Industrial Engineering at TUM to bridge any language barriers which might exist as well as to corroborate the findings of the interviews. The interviewee was given an overview of antifragility and an explanation of how the framework would work, the presentation used in the first round can be seen in Appendix E - Interview presentations October 2016. It is important to note the stages to which the presentation in these interviews point. They focussed on the same stages as the South African interviews, only the numbering differed. The interviewee was open to question any information during the presentation to ensure that a common understanding of the framework was found.

The time allocated to each interview was 30 minutes, but three of the five interviews went well past the allocated time with one taking exactly 30 minutes and another being aborted after poor telephone connection. The first step in the interview would be to establish whether the interviewee had prior knowledge of antifragility. This would allow the author to test whether there are differences, between those who know about antifragility and those who did not (question 1), in replies to the validation of the stages 2.2 to 3.2. Question 2 focussed on stages 2.2 and 2.3 by testing how the interviewee perceived the success factors of these stages.

Question 3 provided the space for the interviewer to gather extra tools which the interviewees, from their experiences, could recommend to increase the probability of success in the implementation of the stage. Question 4 asked the interviewee to assess how the tools (as explained in section 6.3.4.1.2) would support the enterprise in reaching the objective of stages 3.1 and 3.2.

Given the rationale above, the following questions were asked:

1. Do you know what antifragility is?
2. What, to your mind, are key considerations to the success of stages 2.2 Enterprise unit classification and 2.3 enterprise unit influences?
3. Would these stages be adequately addressed by a specific tool?
4. In stages 3.1 bridging the downside gap and 3.2 bridging the upside gap, do you believe that the tools given would deliver solutions to deliver on the requirement, given the antifragile considerations?

There were some further discussions that continued with some of the interviewees which were summarised and highlighted. The interviews were not recorded, but they were summarised and sent to the interviewees to corroborate that these were their views. Three of the interviewees responded that these were in fact their findings. The other two interviewees did not reach a point where satisfactory answers were found. The first was due to the interview being cancelled, after which a telephone conference was attempted. The telephone connection did not allow for a coherent discussion to follow. The second interviewee believed that resilience, from a human psychological level, is what should be used as antifragile. This was believed for 27 minutes of the 30 minute interview after which the interviewee agreed on the concept of antifragility. No fruitful interview followed.

The three remaining interviewees that were valuable to the validation of the framework will be further discussed here. A list of the five interviewees and their positions is given in Table 7-9, but two will be excluded from further discussions from here on unless otherwise stated. These names were not listed according to importance, but according to the date of the interview.

Table 7-9: Professionals interviewed in Munich, Germany

Date	Interviewee	Position
16 September 2016	Prof. Dr.-Ing. Reinhart (GR)	Chair of Industrial Management and Assembly Technologies
18 October 2016	Univ.-Prof. Dr. Mohnen (AM)	Chair of Corporate Management
21 October 2016	Prof. Dr Alexy (OA)	Professor of Strategic Entrepreneurship

The following caveats to the interviews are given for disclosure:

- All the interviewees work at the Technische Universität München in Germany;
- All the interviews were set up by Prof. Reinhart and his colleague Andreas Hees (AH) (not included as an interviewee, but included as a moderator of the all interviews);
- The author was hosted by Prof. Reinhart and his colleague Andreas Hees; and
- Only Dr Andreas Hees was known to the author before the interviews.

### **7.2.3.3 Results and discussion**

The results of each of the questions together with the related answers and examples are given under the following subheadings.

#### **7.2.3.3.1 Do you know what antifragility is?**

None of the interviewees except OA knew what antifragility was or had heard of it before the interview. OA had not known before doing some background research on the author and his published articles which provided some perspective.

#### **7.2.3.3.2 What, to your mind, are key considerations to the success of stages 2.2 enterprise unit classification and 2.3 enterprise unit role requirement?**

GR initially noted that he does not believe there is a vast difference between the difficulties faced between German SMEs and South African SMEs. He believed that the use of DSMs should support the use of these interactions.

OA noted that he believes that there is no fixed direction as to how an enterprise is set up, but it allows for a continuous search for an equilibrium between the environment and the



enterprise. He believes that these stages are possible, and has not found any evidence to contradict stages 2.2 or 2.3. He did note that the facilitation session is critical as a language needs to be created which can be shared by all.

AM stated that she believed that transparency is critical in this framework. The peer pressure involved in having goals become visible for allows for self-direction and motivation. The trust here is critical and would need to be fostered by the process. She felt that the enterprise needs to feel comfortable to trust and that failure can lead to learning in the enterprise. She stated that the role of supporting functions would also be more clear, and seen as more valuable, to the harder science employee, e.g. engineers who would previously have brushed these functions off as non-critical or non-important. She believes the shared language will be formed through the workshops where the framework is implemented which gives the engineers and other functions a common language to improve communication. She believed that it will better equip engineers to share technical information and make it more translatable to other functions, as well as the other way around.

#### **7.2.3.3.3 Would these stages be adequately addressed by a specific tool?**

AH, in the interview with GR, noted that SIPOC (Suppliers, Inputs, Process, Outputs, Customers and Requirements) and DSMs would be tools to provide a basis from which the enterprise units could work. GR agreed that SIPOC would be able to support the requirements of these stages together with the support of interactions through DSMs.

If the interviewees did not have a specific tool, the author provided the use of SIPOC, as a possible tool to address this stage. The interviewee would then either have to confirm that they know the tool and confirm that it would work, or the question would be left unanswered.

OA did not have practical experience in SIPOC, but believed that it would be possible.

AM did not have experience with SIPOC, but believed that the open transparent process over a mutual tool would make this possible.

#### **7.2.3.3.4 In stages 3.1 bridging the downside gap and 3.2 bridging the upside gap, do you believe that the tools given would deliver solutions to deliver on the requirement given the antifragile considerations?**

GR believed that these would be possible, but did not have specific comments to this question.

OA did not have fixed views, but did mention that he thinks the difficulty here would be to limit the amount of new knowledge that is created at a time.

AM believes that each company will have different approaches, but clarifying how changes can occur internally or relationally is valuable. AM mentioned a view in organisational behaviour, incentive compatibility, which is a tool to look into when aligning the employee's decision in a company to that which might affect them. She stated that these tools would help, but the workshop members would need to be open and aligned to getting innovative ways in bridging these gaps.

#### **7.2.3.3.5 Other valuable comments**

GR stated that he would like to investigate the role of antifragility in a manufacturing context, especially in the way production lines can be organised to allow for more antifragile enterprises.

OA believed that the systematic approach allowed for a more concrete way in which the concept of antifragility can be made explicit in action in enterprises. He, together with HP, did, however, not believe that this should be implemented in entrepreneurial ventures as they have these characteristics at present.

OA believed that the field is interesting and he sees value in actively pursuing the implication of this for enterprises, especially the change in understanding of positive consequences due to shock. He closed the interview off with his view that the work is valuable and definitely executable within an enterprise, but thinks that the value and the idea is not obvious to all and that an individual would need to be open to accepting this.

AM believed that human resources would need to be aware of a specific culture in which to seek employees. She trusted that the process will improve through continued use of the framework. She believed that future research could look into certain functions in enterprises in

specific industries and how those functions' role would be best for that industry, e.g. finance in the manufacturing industry would need to be robust, but could be seen as one which should be antifragile in the financial sector.

AM immediately started thinking about ways in which to counter various stressors. The concept of antifragility was easy for her to understand through the way it is made explicit in the framework and she could understand how subsystems have various roles which aim to improve the antifragility of the system as a whole.

AM noted that the implementation of the solutions should be easy if a multidisciplinary and multifunctional (all enterprise units are present) workshop is used. She believes that this would in some way help to provide the perspective to the project management function, but also through their involvement in the implementation.

AM felt that the analysis of the interfaces from a regulator's (CEO's) point of view requires an unbiased view to an enterprise unit being on either end of the interaction. The CEO would often have a dual role, so she proposes that the facilitator play a role in being unbiased in conjunction with the CEO.

#### **7.2.3.3.6 Valuable recommendations and comments used for framework improvement**

It is important to note that none of the interviewees knew what antifragility was before the interview commenced (except for OA who did research on the author before the interview). The three interviewees who did not have difficulty in understanding the value of antifragility all believed that the stages 2.2 to 3.2 are implementable with some notable comments as to the facilitation process and tools. The most valuable recommendations that were considered in the improvement of the framework and the possible use of the implementation of the case study was:

- The contribution of DSMs and SIPOC as tools were added;
- In the case study, ideas for implementation should be limited;
- In the case study, incentive compatibility was added as a possible tool; and
- In the case study; the CEO/MD should play a non-biased role in interactions between enterprise units.

### **7.3 Chapter conclusion**

The validation approach followed looked to address the key parts of the framework

1. Whether it will improve the antifragility of an SME,
2. Whether it is implementable,
3. Whether the stages are valuable and contribute to the objective of the framework.

These questions were answered through the literature, the illustrative case study, and the two rounds of interviews.

The illustrative case study addressed whether the framework is implementable. The results of the case study have shown that the workshop provided the backbone on which the framework facilitation can be built. The key determinants that were a result of this case study showed that the facilitator would need an intimate knowledge of the framework and be skilled in managing varying hierarchies of employees.

The stages of the framework were supported by a large body of literature to support knowledge which is common place for use at present, with the stages that are new to the body of knowledge being validated through the interviews.

The framework was supported by the validation done through the interviews in whether it improved the antifragility of the SME. No critical elements were highlighted which would result in the framework failing in its stated objective.

## 8. Conclusion

*“There is nothing more difficult to take in and, more perilous to conduct, than to take a lead in the introduction of a new order of things, because the innovation has for enemies all those who have done well under the old conditions and lukewarm defenders in those who may do well under the new.” – Niccolo Machiavelli*

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The purpose of this chapter is to conclude the research and its findings and discuss future work as recommendations for the research.

### 8.1 Overview

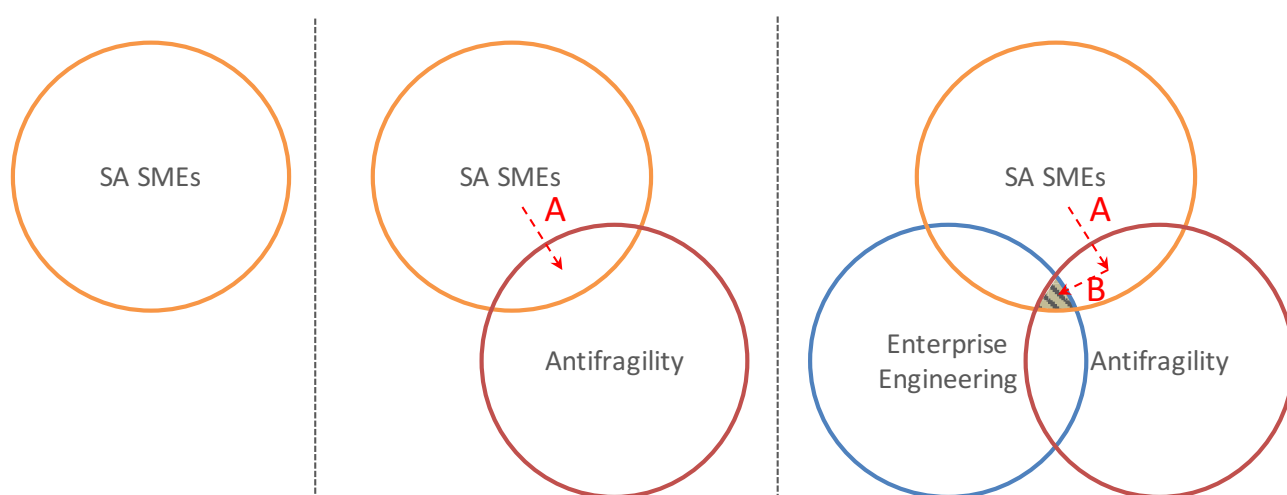
SMEs are increasingly being exposed to volatility through increased integration into the global business environment. The increased integration creates a complexity beyond what has been seen before. The increased volatility creates a threat to the sustainability of the SME, but this can also provide opportunities beyond that which was possible before.

The objective of the study was to develop a framework which would guide SMEs to improve the way in which they respond to this volatility, i.e. how they would be more antifragile. Antifragility is a system response in which a system response is positive compared to that of a fragile system which responds negatively to a stressor. The system thus becomes stronger by limiting the negative consequences to a stressor and increasing the exposure to having a positive outcome when faced with a stressor. Enterprises and especially SMEs have, up to now, not been provided with a way in which to prepare for the volatility to be antifragile. This research provides a framework to prepare an SME for antifragility.

This research followed the constructivist philosophical perspective approach where the result of the research had to be improved on the previous perspectives of the research fields whilst

providing practical utility in the real world. This was critical as a real contribution to the South African economy through SMEs would only be possible if SMEs practically benefited from the research. The systems engineering process was followed to reach the objective. The set of requirements that needed to be satisfied by the framework were categorised into five requirement types through which the framework was constructed to deliver a design of the enterprise. The research did not attempt to investigate the implementation phase of the systems engineering process as the research into project management is mature and has been proven. Finally, the framework and its objectives, requirements and antifragile considerations were verified and validated.

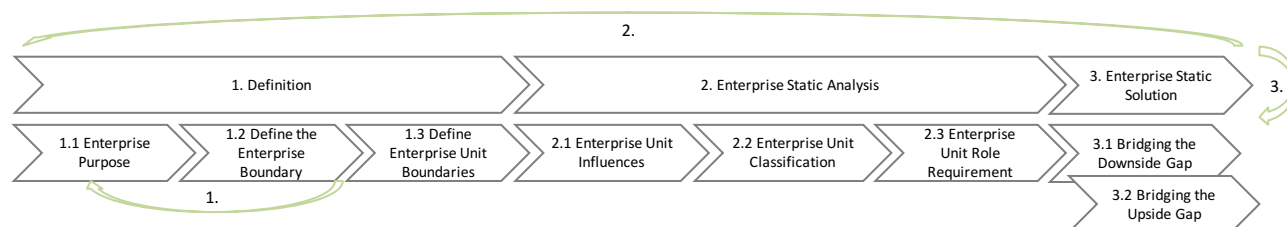
Three main research fields were investigated. The study was initiated within the South African SME landscape. The South African SME context provided a focussed lens (A) through which antifragility was brought into focus, thus focussing the literature review on what is relevant. Similarly, the final field, enterprise engineering, provided the structure (B) through which antifragility could be made explicit for the South African SME. Through this process, 42 requirements were found which included user requirements, functional requirements (both essential and desirable), design restrictions, attention points and boundary conditions.



**Figure 8-1: Development of the focus of the research fields**

The result of the construction is the Epictetus framework which has three phases with eight stages and three feedback loops of which one is hierarchical if needed. Each stage has objectives, with requirements that must be met with antifragile considerations to guide the decision-making. The intent of the framework is to provide a framework which can be

iteratively applied to continuously improve the antifragility of the enterprise through an enterprise-owned (re)design. The schematic representation of the Epictetus framework is given in Figure 8-2.



**Figure 8-2: Schematic representation of the Epictetus framework**

The framework aims to provide the design of the enterprise with their units in relation, but does not encroach on the implementation. The view of the static structure of the enterprise has been taken with the dynamics being left to the evolutionary growth within the structure. Iterative applications of the framework will test the construct of the enterprise and provides for the dynamic nature of the enterprise. This will guide the future constructs of the enterprise.

The use of the framework's process is in the control of the enterprise architect. The facilitation of this process will require a skilled facilitator. The final design of the enterprise will be owned by the enterprise and its enterprise members which reduces the risk of buy-in. To provide implementable stages, tools were given which would make these stages possible. These tools are not exhaustive nor do they intend to be a perfect fit for the stage's requirements, but they do provide a foundation from which the enterprise can continue their design.

## **8.2 Methodology execution**

The method followed was that of the constructivist approach by following the systems engineering process, the main research question, section 1.3.1, was broken down into sub-research questions, section 1.5.3. These questions were categorically broken down from the main research question to highlight the required fields of study, South African SMEs, Antifragility and Enterprise Engineering. These research domains followed a specific process to produce a focussed review of the literature to highlight the requirements to construct a

framework that will lead towards the research objective being achieved. Table 8-1 references the sections which answer the sub-research questions in section 1.5.3.

These requirements were categorised into five categories which were aligned to phases in the systems engineering process. This process guided the construction of the Epictetus framework.

**Table 8-1: Sub-research question verification**

<b>Sub-research Questions</b>	<b>Verification through Section(s)</b>	<b>Rationale</b>
What are the characteristics of a South African SME?	2.1, 2.3 & 2.4	The government's definition of the SME's size and turnover is provided. The advantages and challenges for SMEs were given.
Why should South African SMEs be antifragile?	1.1, 2.2 & 2.5	The contribution of SMEs to South Africa's GDP asks for SMEs that are successful so that an increased number as well as an increase in size of the SME can contribute to the advantages which it carries for the economy and social constructs.
What are the internal factors that influence an SME?	2.1 & 2.3	The internal constraints and capabilities of the SME were researched and summarised so as to provide guiding principles for the design of the framework for the subject.
What are the external factors that influence an SME?	2.1 & 2.3	The external environments and the challenges of the SME were researched and summarised so as to provide guiding principles for the design of the framework for the subject.
What are the user requirements for designing a framework for a South African SME?	2.1, 2.3, 2.4, 2.5 & 5.2.1	The SME's challenges and capabilities were distilled into the requirements from which the framework could be designed.
What is antifragility?	3.3.3	Antifragility was explained at the hand of a third possible system response compared to what system designers have utilised.



Sub-research Questions	Verification through Section(s)	Rationale
What is a black swan?	3.2	Black swan events, as an introduction through the work of N. N. Taleb, was given to provide the understanding of the events that result in failure when traditional methods of managing risk is used. The black swan's definition and characteristics were given.
How do black swans affect SMEs?	2.3 & 3.2	The outcome of black swan events show that they are devastating as a consequence. The fragility, through the challenges that SMEs face, make them susceptible to black swans which will lead to failure.
What is the antifragile SME response?	3.3.3	The SME is seen as a complex system which is susceptible to black swans in a way that is fragile given current constructs and the challenges they face. The antifragile response of a system to a stressor is that which improves under stressors.
How is an SME's antifragility assessed?	3.6.1 & 3.6.3	A measurement tool constructed by Johnson & Gheorghe (2013) was given, with the alternative proposed using Johnson & Gheorghe's measurement tool as the foundation.
How can an SME become more antifragile?	3.5	The characteristics of antifragile systems were given, but were required to be constructed in such a way to provide guidance to the SME to improve on its antifragility.
What are the requirements for designing an antifragile South African SME?	5.2.1, 5.2.2 & 5.2.4	The requirements were gathered through the investigation of the literature and compiled and categorised according to the five requirements as proposed by Aven, et al. (2006)
What is enterprise engineering?	4.1 & 4.2	The definition of enterprise engineering was given with the fundamental constructs which will support the development within the enterprise engineering process.

Sub-research Questions	Verification through Section(s)	Rationale
What is an enterprise architecture (EA)?	4.3	The definition of enterprise architecture was given.
What are the dominating schools of thought in EA?	4.3	The three schools of thought and their counter complexity and management approaches were given.
How is an enterprise constructed?	4.2 & 4.4.1	The fundamentals of the construct of enterprise engineering were given together with the lens through which enterprise engineering was looked at here with the result of enterprise-in-environment adaptation.
What are the requirements for designing an enterprise engineering framework to design an antifragile South African SME?	5.2.1, 5.2.2, 5.2.3, 5.2.4 & 5.2.5	The requirements were gathered through the investigation of the literature and compiled and categorised according to the five requirements as proposed by Aven, et al. (2006)
How can the requirements be meaningfully synthesised into a framework?	5.3 & 6	The full set of requirements were categorised to support the transition process of a system. These requirements were then subdivided into stages to provide for the constructive steps to support the stage depictions of the system.
Is the framework addressing the requirements as set out by the research domains (verification)?	7.1	The verification was done by addressing how each stage of the framework is addressing a requirement and/or a requirement is being addressed within the framework.
Will the framework deliver on providing an improved antifragile South African SME (validation)?	7.2	The result of the interviews for validation stated that all believed that the Epictetus framework will result in an improved antifragile South African SME (see the case of LL where further comments were to be given).

### **8.3 Results**

The validation of the framework was done through four approaches. These approaches were used to validate the framework, both as a whole and by parts, by validating the stages individually. The first validation focussed on stages, 1.1 Enterprise unit boundaries, 1.2 Enterprise unit influences, 2.1 Enterprise purpose, 2.2 Enterprise boundary and 2.3 Enterprise unit boundaries, which could be validated by providing tools which satisfy these stages' objectives and requirements. These tools have been proven in literature and has enjoyed widespread use.

The second validation was a first round of semi-structured interviews done by interviewing five experts (of which three were valuable to the construction or criticism of the framework) in Germany. These interviews were also used to validate the remaining stages of the framework as well as to gain additional information on possible tools that could be used to improve the successful implementation of the framework.

The third validation approach was through the form of an illustrative case study on a South African SME. The validation tested how practically usable the framework is, the enterprise's perception of the framework and it was used to gain insight into the difficulties that could be found by implementing it in SMEs.

The fourth, and final, form of validation focussed on semi-structured interviews with experts in South Africa. These experts were chosen for their experience in facilitations, SMEs, Enterprise Architecture, and were experts who are known to be interested by Antifragility. It is important to note that not one expert was experienced in all the fields, but all the fields were covered by the experts interviewed.

The validations proved that the framework itself was antifragile where contributions by the experts only strengthened the development of the framework and the case study confirming that the user structure provides for an implementable framework.

The framework will not be successful for all SMEs in South Africa as there are a myriad of factors that would contribute to this success, such as the facilitation session, the mood of the enterprise members and extreme circumstances. It is expected that the framework will help

both SMEs that have an enterprise structure in place or SMEs that have not formally defined these structures.

#### **8.4 Contribution**

The first contribution of the research is that of the contribution to the current field of antifragility. As at the 17<sup>th</sup> of March 2017, the most cited article only had 43 citations according to Google Scholar. This study increases the body of knowledge from which the field of antifragility can grow and become more mature and provide researchers with a greater body from which to improve on the current antifragility field. The publications which were borne out of the research can be seen in Appendix A - Publications.

The second contribution was to look at how South African SMEs can benefit from the view of antifragility. The constraints and requirements of SMEs were highlighted and provided the lens through which antifragility was viewed. This provided requirements and considerations which could be used by various approaches (such as the systems engineering approach through enterprise architecture here) to deliver on a concept which could improve the antifragility of SMEs.

The third contribution was the use of enterprise architecture to make the use of antifragility in South African SMEs explicit. To date, no practical steps have been given as to how SMEs can approach the question of how they can become more antifragile. The field of enterprise architecture has developed to a view of enterprise in environment adaptation which follows a socio-technical approach to designing an SME. The enterprise in environment adaptation school of thought provided the best fit of the three current schools of thought in enterprise engineering to antifragility. This is the first time that enterprise engineering, and especially enterprise in environment adaptation has been used through an antifragile lens.

A fourth contribution looked at the alternative way to assess the progress in antifragility in an enterprise. Previous tools were highly mathematical or used fuzzy logic which were either unusable by SMEs or the tools were antifragile themselves if alternative dimensions were used to measure the tool. The alternative assessment tool provided a tool which was more

antifragile than its predecessors and could be used on two dimensions (on the system as a whole or individual systems characteristics) which improved its repeated value.

The final contribution is that of a triangle of system responses in which each of the corners presents a negative functional result to a stressor, a neutral functional (no change or limited change in function) result or a positive response to a stressor. The triangle did not provide absolutes for each of these responses as a range of stressors provide different results, but the enterprise unit can be placed within the boundaries of the triangle to provide a subjective view of the current enterprise unit's role in the enterprise.

### **8.5 Conclusion**

The research was initiated after the understanding was gained as to the contributions that SMEs provide to the economy. This is beyond just the GDP of a country, but to improved employment, support to large organisations and poverty alleviation. SMEs, however, have high failure rates and these are due to difficulties in its environment and internally. The most are focussed outside of the control of the SME together with the statement from Deming (1986) that 94% of inadequate enterprise performances are attributable to how enterprises are arranged. The South African business environment is highly volatile and is becoming increasingly complex with the integration of global environments. This volatility results in SMEs failing due to inadequate preparation for events beyond the control of the enterprise. Taleb (2012) presented the idea of antifragility which provides an alternative way for enterprise designers to look at how the system can respond to stressors.

The framework designed will not be successful in all its implementations, but it is not expected to result in increased fragility. There are many factors which would dictate a successful implementation, but this framework provides a way through which SMEs can pursue antifragility for their enterprise. This was previously not possible. The practical steps to how this can now be done were given as well as a facilitation timeline that has proved to be successful in one implementation.

The research postulates that a better thought-through structure of the SME (enabled by the framework) with antifragile considerations to guide the design of this structure should lead to improved antifragility in enterprises.

The study is a first step to improve the antifragility in SMEs, but provides a large platform from which the field of antifragility can be expanded to benefit the use in SMEs.

## **8.6 Future work**

*“Develop a passion for learning. If you do, you will never cease to grow.”*

**– Anthony J. D’Angelo**

The nature of the field of antifragility makes possible a large body of possible future work. The research which is directly possible to the advancement of the framework are:

- The tools that were provided for stages 3.1 and 3.2 should be investigated to see how construct of a solution to bridging the gap can be more usable without the guidance of an enterprise architect;
- An investigation into the role that portfolio management theory can play in the selection of actionable items (from the 3. Progression State phase to the Implementation phase) to improve the antifragility of the enterprise;
- In the illustrative case study, the use of visuals supported the understanding of the organisation of the enterprise. These visuals were developed during the facilitation and may be specific to the enterprise in question. The next step in the development of the framework would be to create visuals, or guiding illustrations, to support the enterprise to become less dependent on the enterprise architect for implementation;
- The framework would benefit from an alignment of the field of antifragility to that of risk management. The use of an antifragile lens through which risk management is viewed will play a role in stage 3.1. Bridging the downside gap, initially, and later expand into the construction of how risk management will become an offensive tool in response to stressors;

- Further continued research into an assessment tool which could use SME or antifragile characteristics to assess an enterprise and provide a more informative view of the direction of the enterprise with regards to its system response; and
- An investigation can be done to provide a reference guide for the framework from which tools can be selected to deliver on the requirements and stated objective.

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## ***Appendix A - Publications***

The following publications were published, in peer reviewed journals and a conference, during the tenure of the study.

**Kennon, D.**, Schutte, CSL., Aug 2015. A strategic framework for improbable circumstances, South African Journal Industrial Engineering, Vol. 26, No. 2, pp.68-84.

**Kennon, D.**, Schutte, CSL., Lütters, EL., Apr 2015, An alternative view to assessing antifragility in an organisation: A case study in a manufacturing SME, CIRP Annals – Manufacturing Technology, Vol. 64, No. 1.

Snyman, HA., **Kennon, D.**, Schutte, CSL., von Leipzig, K., Aug 2014, A strategic framework to utilise venture capital funding to develop manufacturing SMEs in South Africa, South African Journal of Industrial Engineering, Vol. 25, No. 2, pp. 161-181.

Snyman, HA., **Kennon, D.**, Schutte, CSL., von Leipzig, K, Jul 2013. Formulating a strategic framework to promote SME development, SAIIE25 Conference Proceedings, 9–11 July 2013, Stellenbosch, South Africa, pp. 817: 1 – 20.

## Appendix B - Antifragility literature review

Antifragility was investigated by entering the permutations as per section 3.1 which resulted in the 46 publications below, Table B-1.

Table B-1: Result of the full antifragile paper search on EBSCO Information Services

Nr.	Author(s),	Title	Field of Research	Journal
1	(Taleb, 2007)	Black Swans and the Domains of Statistics	Statistics	The American Statistician
2	(Taleb, 2008)	The Black Swan: The Impact of the Highly Improbable	Philosophy	Penguin Books
3	(Taleb & Makridakis, 2009)	Living in a World with Low Levels of Predictability	Statistics	International Journal of Forecasting
4	(Taleb, et al., 2009)	The Six Mistakes Executives Make in Risk Management	Risk Management	Harvard Business Review
5	(Danchin, et al., 2011)	Antifragility and Tinkering in Biology (and in Business) Flexibility Provides an Efficient Epigenetic Way to Manage Risk.	Genetics/Biology	Genes
6	(Taleb, 2012)	Antifragile: How to live in a world we don't understand	Philosophy	Allan Lane Publishers
7	(Taleb & Goldstein, 2012)	The problem is beyond psychology: The real world is more random than Regression Analyses	Statistics	International Journal of Forecasting
8	(Tseitlin, 2013)	The Antifragile Organization.	Computer Science	Communications of the ACM
9	(De Martini, 2013)	Risky Business	Risk Management	Transmission & Distribution World
10	(White, 2013)	Antifragile Banking and Monetary Systems	Finance	CATO Journal
11	(Johnson & Gheorghe, 2013)	Antifragility analysis and measurement framework for systems of systems	Systems Engineering	International Journal of Disaster Risk Science
12	(Taleb & Douady, 2013)	Mathematical definition, mapping, and detection of (anti)fragility	Finance	Quantitative Finance
13	(Plag & Jules-Plag, 2013)	Disaster risks reduction for extreme natural hazards	Geology	American Geophysical Union Fall Meeting
14	(Clancy, 2014)	Handle with Care: The Fragile Nature of Complex Systems	Administration	Journal of Nursing Administration
15	(Fiorini & Santaroce, 2014)	A post-Bertalanffy Systemics Healthcare Competitive Framework Proposal	Healthcare Technology	Studies in Health Technology and Informatics

<b>Nr.</b>	<b>Author(s),</b>	<b>Title</b>	<b>Field of Research</b>	<b>Journal</b>
16	(Jones, 2014)	Engineering Antifragile Systems: A Change In Design Philosophy	Computer Science	Procedia Computer Science
17	(Van Der Burg, 2014)	Keep Your Options Open	Finance	Chartered Accountants Journal
18	(Derbyshire & Wright, 2014)	Preparing for the future: Development of an 'antifragile' methodology that complements scenario planning by omitting causation	Scenario Planning	Technological Forecasting and Social Change
19	(Bonsignorio, et al., 2014)	Fostering Progress in Performance Evaluation and Benchmarking of Robotic and Automation Systems	Computer Science	IEEE Robotics & Automation Magazine
20	(Reinertsen, 2014)	Welcome to my Brain	Philosophy	Qualitative Inquiry
21	(Verhulstra, 2014)	Applying Systems and Safety Engineering Principles for Antifragility	Computer Science	Procedia Computer Science
22	(De Florio, 2014)	Antifragility = Elasticity + Resilience + Machine Learning Models and Algorithms for Open System Fidelity	Computer Science	Procedia Computer Science
23	(Ifeanyi Ani, 2014)	A United States of Africa: Insights from Antifragility.	Political Science	Philosophia Africana
24	(Naji, et al., 2014)	Asymmetric Coulomb fluids at randomly charged dielectric interfaces: Anti-fragility, overcharging and charge inversion.	Fluid Mechanics	Journal of Chemical Physics
25	(Davis, 2014)	MATERIA MEDICA. Turkey Tail Mushrooms and the Antifragility of the Immune System	Herbology	Journal of the American Herbalists Guild
26	(Fiorini, et al., 2014)	Quality of Care as an Emergent Phenomenon out of a Small-World Network of Relational Actors	Healthcare Technology	Studies in Health Technology and Informatics
27	(Jaaron & Backhouse, 2014)	Building antifragility in service organisations: going beyond resilience	Operations Management	International Journal of Services and Operations Management
28	(Abid, et al., 2014)	Toward Antifragile Cloud Computing Infrastructures	Computer Science	Procedia Computer Science
29	(Aven, 2015)	The Concept of Antifragility and its Implications for the Practice of Risk Analysis.	Risk Management	Risk Analysis: An International Journal
30	(Verhulst, et al., 2015)	Antifragility: systems engineering at its best	Computer Science	Journal of Reliable Intelligent Environments
31	(Clancy, 2015)	Complexity, flow, and antifragile healthcare systems: implications for nurse executives	Administration	The Journal of Nursing Administration

<b>Nr.</b>	<b>Author(s),</b>	<b>Title</b>	<b>Field of Research</b>	<b>Journal</b>
32	(Fiorini, et al., 2015)	Resilient Systemics to Telehealth Support for Clinical Psychiatry and Psychology	Psychology	Studies in Technology and Informatics
33	(Asif, et al., 2015)	Flexible and efficient aggregation framework for antifragile wireless mesh networks	Computer Science	Journal of Reliable Intelligent Environments
34	(Primiero & Raimondi, 2015)	Software Theory Change for Resilient Near-Complete Specifications	Computer Science	Procedia Computer Science
35	(Kennon, et al., 2015)	An alternative view to assessing antifragility in an organisation: A case study in a manufacturing SME	Systems Engineering	CIRP Annals – Manufacturing Technology
36	(Liu, 2015)	A Developmentally Informed Perspective on the Relation Between Stress and Psychopathology: When the Problem With Stress Is That There Is Not Enough	Psychology	Journal of Abnormal Psychology
37	(Ghodrat, et al., 2015)	Strong coupling electrostatics for randomly charged surfaces: antifragility and effective interactions	Electrostatics	Soft Matter
38	(MacGill, 2015)	The Christchurch earthquakes' impact on the Convergence gathering	Geology	Kybernetes
39	(Hole, 2015)	Toward Anti-fragility: A Malware-Halting Technique	Computer Science	IEEE Security & Privacy
40	(Russo & Ciancarini, 2016)	A Proposal for an Antifragile Software Manifesto	Computer Science	Procedia Computer Science
41	(Cook, 2016)	Leading innovation, creativity and enterprise	Training	Industrial and Commercial Training
42	(Thekdi & Aven, 2016)	An enhanced data-analytic framework for integrating risk management and performance management.	Risk Management	Reliability Engineering & System Safety
43	(Platje, 2016)	Efficiency, fragility and unsustainable developmentT	City Planning	Research Papers of the Wroclaw University of Economics
44	(Saad, 2016)	Antifragilizing Public Procurement Systems: A Paradigm Shift	Political Science	Journal of Public Procurement
45	(Halder, et al., 2016)	Taxonomy and issues for antifragile-based multimedia cloud computing	Computer Science	Journal of Reliable Intelligent Environments
46	(Fortunato, 2017)	Advancing Educational Diversity: Antifragility, Standardization, Democracy, and a Multitude of Education Options	Education	Cultural Studies of Science Education



## Appendix C - Stages defined within the Epictetus phases

The Future State phase, Table C-1, and the Progression State phase, Table C-2: Progression State phase stage creation, were created as discussed in section 6.3, Table 6-1, for the Present state phase.

Table C-1: Future State phase stage creation

	Future State Phase			
	Enterprise Purpose	Enterprise Boundary	Enterprise Unit Boundaries	Enterprise Unit Influences
<b>User requirements</b>				
U1 - The framework should consider the context of the South African SME, specifically its constraints, such as number of employees, access to resources, education, etc.	x	x	x	x
U3 - The framework should be user-friendly.	x	x	x	x
U4 - The framework should be considered as a management aid.	x	x	x	x
U5 - The framework should provide clear definitions and explanations to cater for all levels of education found in an SME.	x	x	x	x
U6 - The framework should allow for various sectors of industry for SMEs.	x	x	x	x
U7 - The framework should allow for various sizes of SMEs.	x	x	x	x
U8 - The enterprise architect must own the process of design.	x	x	x	x

	Future State Phase			
	Enterprise Purpose	Enterprise Boundary	Enterprise Unit Boundaries	Enterprise Unit Influences
U9 - The design should be owned by the enterprise and enterprise members	x	x	x	x
<b>Functional requirements</b>				
<i>Essential functional requirements</i>				
F1 - The framework should lead to improved antifragility in SMEs.	x	x	x	x
F2 - The framework should provide suggested tools in context of the process to assist and enable the process.	x	x	x	x
F3 - The framework should support repeated and continued use.	x	x	x	X
F5 - The framework should promote a learning capability on enterprise and enterprise unit level.	x	x	x	x
F6 - The framework should guide the enterprise to arrive at a vision and mission that is suited to its environment.	x			
F7 - The framework should allow for enterprise unit boundaries to be redrawn.			x	
<i>Desirable functional requirements</i>				
F8 - The framework should allow for autonomy in decision making in parts of the enterprise with an alignment between the decision maker and the goal of the enterprise.	x	x	x	x

	Future State Phase			
	Enterprise Purpose	Enterprise Boundary	Enterprise Unit Boundaries	Enterprise Unit Influences
F9 - The framework should guide decisions which will lead to decentralisation of enterprise units.		x	x	x
F10 - The framework should guide the users which would lead to the diversification of enterprise units.	x	x	x	x
F11 - The framework should guide the enterprise and its enterprise units to be agile and flexible.			x	x
F12 - The framework should promote an environment of trust.	x	x	x	x
F13 - The framework should guide the enterprise to be conservative on risks that carry dire consequences.			x	x
F14 - The framework should guide the enterprise to identify opportunities where it can take risks that limit enterprise loss and increase enterprise exposure to value.			x	x
F15 - The framework should allow for the design process to be participative and democratic.	x	x	x	x
F16 - The framework should guide the enterprise to jointly address the social and technical system interactions for optimisation.			x	x

	Future State Phase			
	Enterprise Purpose	Enterprise Boundary	Enterprise Unit Boundaries	Enterprise Unit Influences
<b>Attention points</b>				
A1 - Some items to be included in the framework will be discretionary and dependent on factors inherent to the enterprise, such as its set-up, size, strategy and prior knowledge. Decisions about how or what to implement will therefore differ between enterprises.	x	x	x	x
A2 - The approach should be seen as a reflection of early best practice within an evolving field of knowledge.	x	x	x	x
A3 - The process of designing the enterprise should complement its objectives.	x	x	x	x
A4 - The solution should not be more specific than is essential.	x	x	x	x
A5 - Variances that cannot be eliminated should be controlled as close to the point of origin as possible.			x	x
A6 – The framework should support the solution of redundancies to be those of function and not of the unit parts.			x	x
A7 - Group process design and facilitation with group dynamics at the core is required.	x	x	x	x
A8 - A clear handover to the project management function is required.	x	x	x	x

Table C-2: Progression State phase stage creation

	Progression State Phase	
	Bridging the Downside Gap	Bridging the Upside Gap
<b>User requirements</b>		
U2 - The user should be allowed to flexibly apply their own discretion when using the framework.	x	x
U3 - The framework should be user-friendly.	x	x
U4 - The framework should be considered as a management aid.	x	x
U5 - The framework should provide clear definitions and explanations to cater for all levels of education found in an SME.	x	x
U6 - The framework should allow for various sectors of industry for SMEs.	x	x
U7 - The framework should allow for various sizes of SMEs.	x	x
U8 - The enterprise architect must own the process of design.	x	x
U9 - The design should be owned by the enterprise and enterprise members	x	x
<b>Functional requirements</b>		
<i>Essential functional requirements</i>		
F1 - The framework should lead to improved antifragility in SMEs.	x	x
F2 - The framework should provide suggested tools in context of the process to assist and enable the process.	x	x
F3 - The framework should support repeated and continued use.	x	x

	Progression State Phase	
	Bridging the Downside Gap	Bridging the Upside Gap
F5 - The framework should promote a learning capability on enterprise and enterprise unit level.	x	x
<i>Desirable functional requirements</i>		
F8 - The framework should allow for autonomy in decision making in parts of the enterprise with an alignment between the decision maker and the goal of the enterprise.	x	x
F9 - The framework should guide decisions which will lead to decentralisation of enterprise units.	x	x
F10 - The framework should guide the users which would lead to the diversification of enterprise units.	x	x
F11 - The framework should guide the enterprise and its enterprise units to be agile and flexible.	x	x
F12 - The framework should promote an environment of trust.	x	x
F13 - The framework should guide the enterprise to be conservative on risks that carry dire consequences.	x	
F14 - The framework should guide the enterprise to identify opportunities where it can take risks that limit enterprise loss and increase enterprise exposure to value.		x
F15 - The framework should allow for the design process to be participative and democratic.	x	x
F16 - The framework should guide the enterprise to jointly address the social and technical system interactions for optimisation.	x	x

	Progression State Phase	
	Bridging the Downside Gap	Bridging the Upside Gap
<b>Attention points</b>		
A1 - Some items to be included in the framework will be discretionary and dependent on factors inherent to the enterprise, such as its set-up, size, strategy and prior knowledge. Decisions about how or what to implement will therefore differ between enterprises.	x	x
A2 - The approach should be seen as a reflection of early best practice within an evolving field of knowledge.	x	x
A3 - The process of designing the enterprise should complement its objectives.	x	x
A4 - The solution should not be more specific than is essential.	x	x
A5 - Variances that cannot be eliminated should be controlled as close to the point of origin as possible.	x	x
A6 – The framework should support the solution of redundancies to be those of function and not of the unit parts.	x	x
A7 - Group process design and facilitation with group dynamics at the core is required.	x	x
A8 - A clear handover to the project management function is required.	x	x

## Appendix D - Interview presentations March to May 2017

The following slides were used in the second round of validation interviews, the South African interviewees, Table 7-8.

**Towards An Antifragile South African SME:**  
*Expert inputs & validation*



Presented by Darrell Gordon  
 Guided by Prof. C. S. L. Schultz  
 Department of Industrial Engineering  
 Stellenbosch University

**Summary of the future**


**Problem Statement**

In South Africa, approximately **75% of SMEs** do not survive the first **42 months**. A large amount of these are due to poor products, services, markets and/or preparations. A large majority are left in the wake of increased global **volatility**. Black swans, such as the 2008 global financial market crash, result in the failure of **SMEs** who **do not have the mechanisms** to survive/prosper from these shocks. There are a lack of frameworks or tools that support SMEs to improve the way in which they prepare for these shocks. The field of **antifragility** which can be used to combat the fragility of SMEs to shocks, is still in its infancy. The **opportunity** exists to provide a **framework** which would help SMEs in this regard.

**Main Research Question**

How does the framework work that can support an SME in South Africa to improve its **(anti)fragility**?

**We know fragility?**



**We know fragility!**

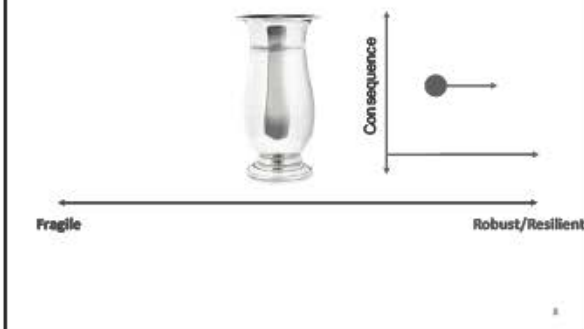




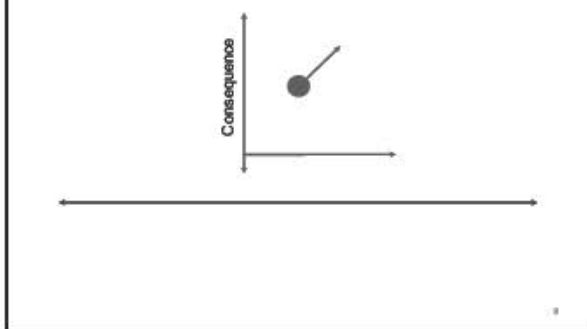
We know robust/resilient?



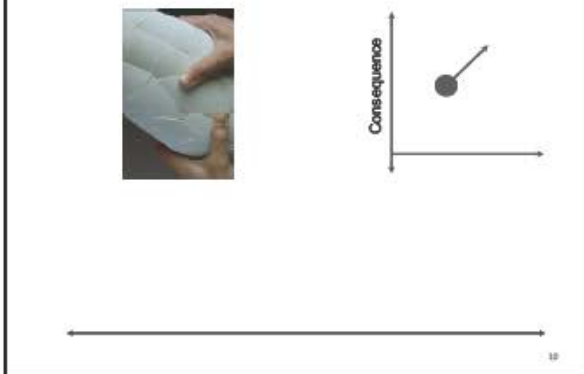
We know robust/resilient!



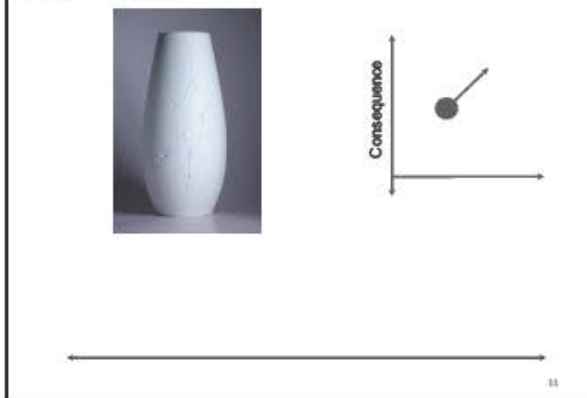
What is this?



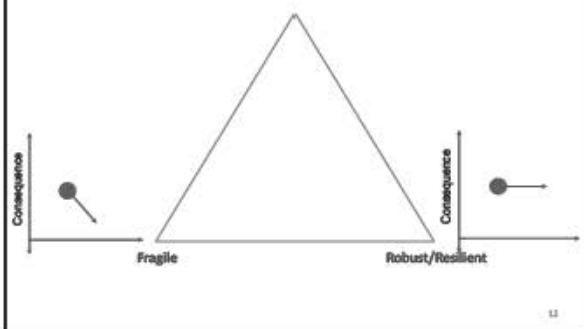
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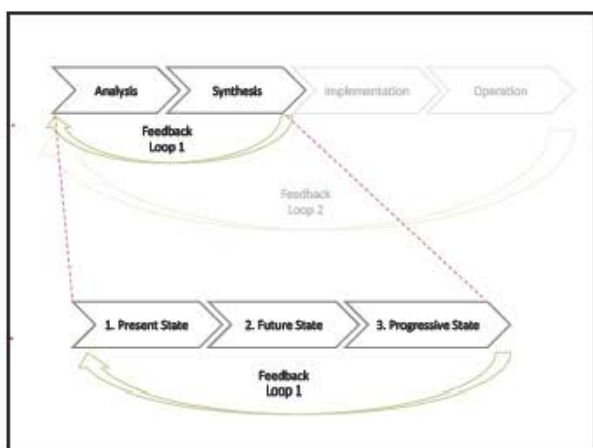
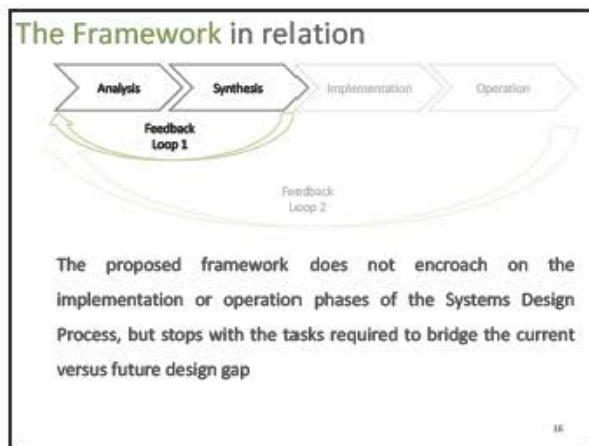
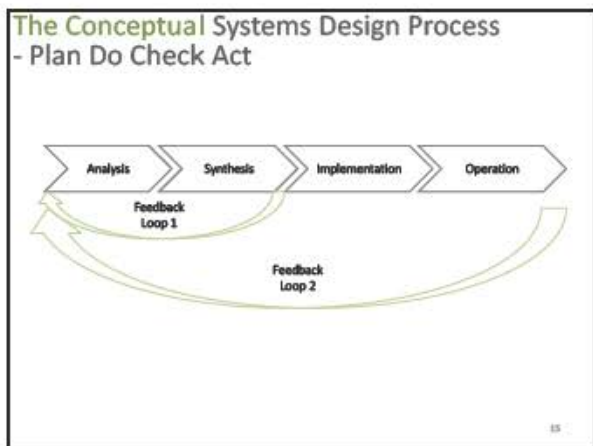
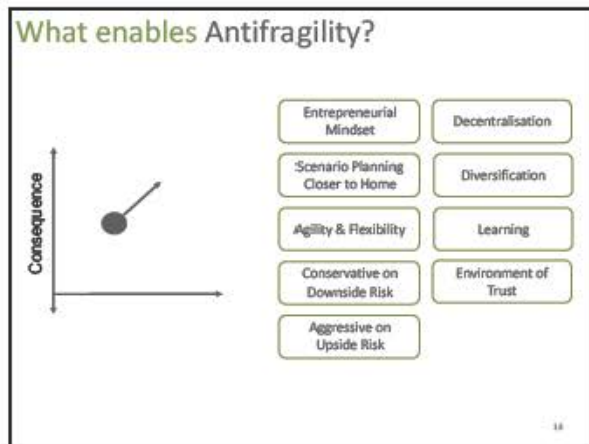
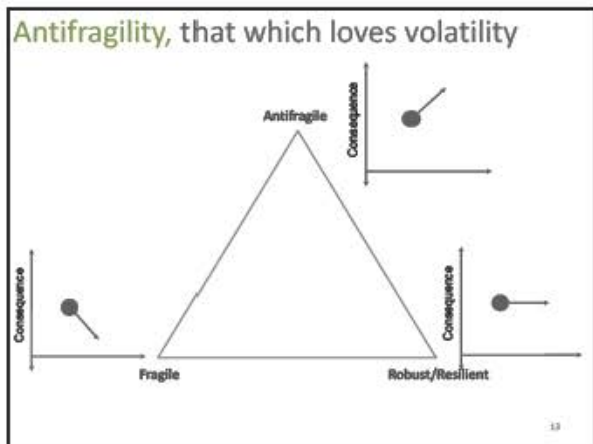


What is this?



Antifragility, that which loves volatility





### Main Research Question

How does the framework work that can support an SME in South Africa to improve its (anti)fragility?

18

### The Framework – A Workshop

- Framework is built to enable socio-technical enterprise building.
- The focus is on SMEs.
- Enterprise Architect is a facilitator.
- The solutions are designed by the participants, the Architect translates those ideas to structures in the workshop.
- Participants include senior management, mid-management and important shop-floor personnel.
- No limit on group size, but in reduction of the workshop size will allow for a more efficient workshop.
- But the size should not limit the inclusion of lower level employees.

### The Framework – A Workshop

EU	EU1	EU2	EU3	EU4	EU5	EU6
EU1						
EU2						
EU3						
EU4						
EU5						
EU6						

### The Framework – Present state

	1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Contributions
<b>Objective</b>	Clear enterprise unit boundaries should be defined.	A clear visual representation of the inter-relationships with stakeholders.	Understand how an enterprise unit contributes to enterprise objectives in its interactions.
<b>Requirement</b>	Start with current units, then show formal functions of the main enterprise units.	An initial representation of the inputs and outputs of each enterprise unit and its influences.	Fit the enterprise units within a single Enterprise Boundary according to requirements to ensure completeness in interactions.
<b>Artifrage Considerations</b>	Key user units can be set up for an enterprise unit.	Analysis of processes should be for learning about representation about process of understanding of enterprise context.	The placement on the diagram will be subjective, but the iterative design process should provide for a holistic view of enterprise and relation to enterprise unit.

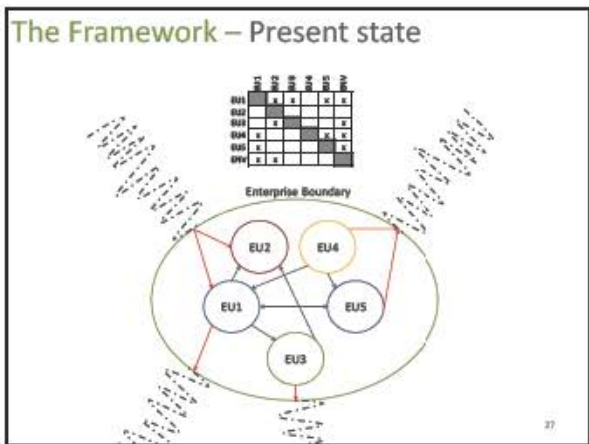
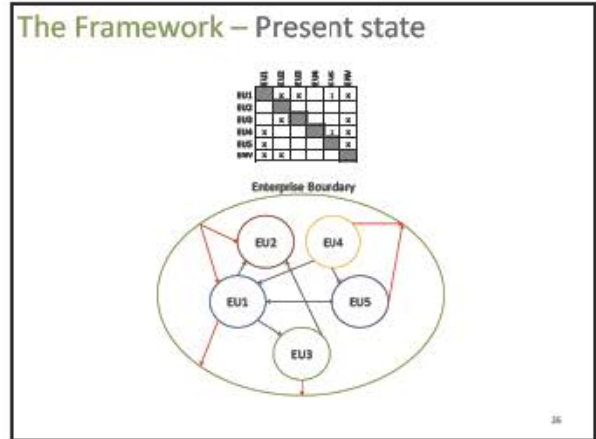
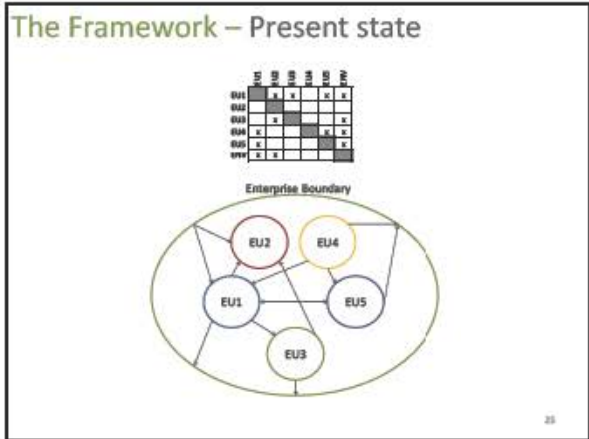
### The Framework – Present state

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### The Framework – Present state

	1.1 Enterprise Unit Boundaries	1.2 Enterprise Unit Influences	1.3 Enterprise Unit Contributions
<b>Objective</b>		A clear visual representation of the inter-relationships with stakeholders.	Understand how an enterprise unit contributes to enterprise objectives in its interactions.
<b>Requirement</b>		An initial representation of the inputs and outputs of each enterprise unit and its influences.	Fit the enterprise units within a single Enterprise Boundary according to requirements to ensure completeness in interactions.
<b>Artifrage Considerations</b>		Analysis of processes should be for learning about representation about process of understanding of enterprise context.	The placement on the diagram will be subjective, but the iterative design process should provide for a holistic view of enterprise and relation to enterprise unit.

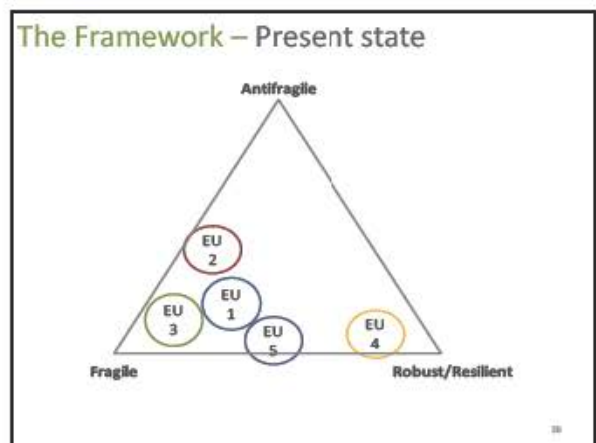
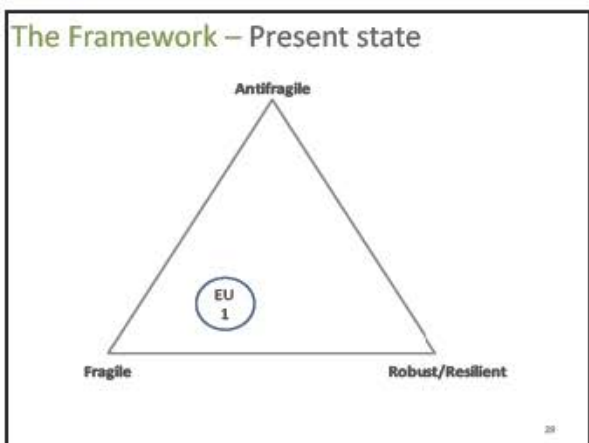
### The Framework – Present state



### The Framework – Present state

	1.2 Enterprise Unit Boundaries	1.3 Enterprise Unit Influences	1.4 Enterprise Unit Characteristics
<b>Objective</b>		A clear view of representation of the unit, interdependencies and dependencies.	Understand how an enterprise will respond to various circumstances in its interaction.
<b>Requirement</b>		An explicit representation of the inputs and outputs of each enterprise unit and its influence.	Fit the enterprise with its environment according to response to various circumstances in its interaction.
<b>Antifragile Considerations</b>		Building of processes should be for learning, shared representation should provide all with independence of enterprise activities.	The processes on the whole will be antifragile, but the iterative design process should provide for a holistic view of enterprise and relation to structure sets.

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### The Framework – Future State

	3 Future State			
	3.1 Enterprise Purpose	3.2 Enterprise Boundary	3.3 Enterprise Unit Boundaries	3.4 Enterprise Unit Role Requirements
<b>Objective</b>	Reach an agreed purpose for the enterprise.	Define a clear boundary of what the enterprise should be.	Clear future enterprise unit boundaries should be defined.	Understand the ideal role a unit will play to align to the purpose and sufficiency of the enterprise.
<b>Requirement</b>	Purpose should match the top-down and bottom-up approach to strategic alignment.	The boundary should clearly define that which is not part of the enterprise.	Unit will consist with clear roles (responsibilities) or key tasks and output units.	Fit the enterprise with TD to be an integral according to response to external circumstances in transition.
<b>Antifragile Considerations</b>	Enterprise purpose, through double loop learning, should adapt to the environment.	The enterprise response are consistently compared to strategic intention.	Key roles units can be set up for an entrepreneurial enterprise with.	Alignment of unit role to enterprise purpose through the inclusion of unit leaders in the process to align regulatory and operational view.

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### The Framework – Future State

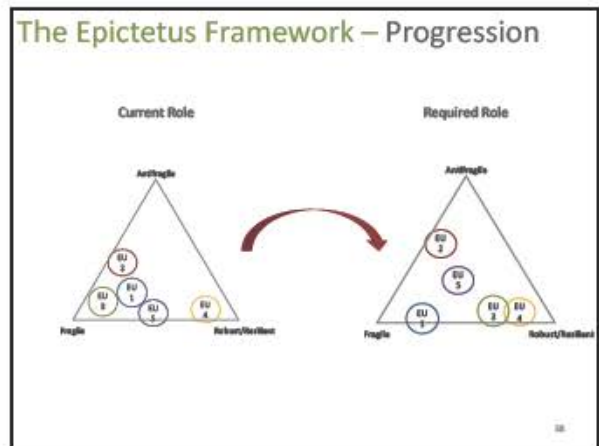
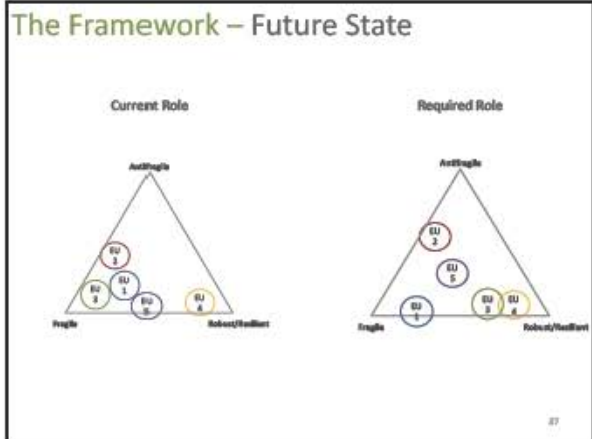
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### The Epictetus Framework – Progression

**3 Enterprise Static Solutions**

**1.1 Bridging the Downside Gap**      **1.2 Bridging the Upside Gap**

**Objective**      Provide economic tools to improve enterprise performance to overcome the gap between 2D-13 and 1D-11 unit placements in the triangle.

**Requirement**      Protect the enterprise from failure and then expose the enterprise to opportunities from which it can prosper in volatility.

**Artifragile Considerations**      Strategies that provide for the firm to learn, prosper, and then improve exposure to improve enterprise exposure to upside risk.

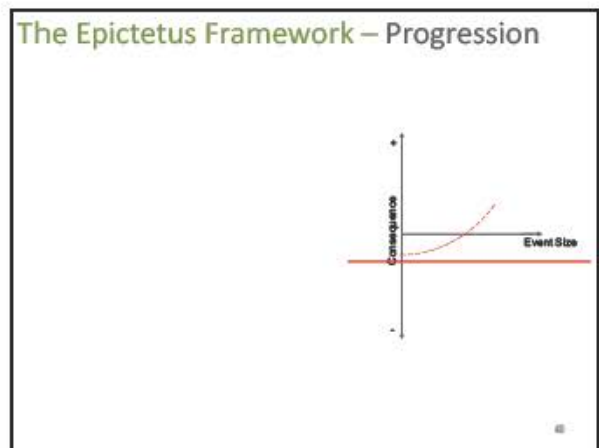
Artifragile

Fragile

Robust/Resilient

EU 1, EU 2

29



### The Epictetus Framework – Progression

**Internally**      **Bridging the downside gap**      **Redundancies of function**

- Absorption
- Insurance
- Options
- Learning

Consequence

Event Size

31

### The Epictetus Framework – Progression

**Internally**      **Bridging the downside gap**      **Redundancies of function**

- Absorption
- Insurance
- Options
- Learning

**Bridging the upside gap**

- Options
- Innovation
- Learning

Consequence

Event Size

32

## The Epictetus Framework – Progression

Internally	Bridging the downside gap	Redundancies of function Absorption Insurance Options Learning
	Bridging the upside gap	Options Innovation Learning
Relationally		Reduce Influences/Interactions Sever Influences/Interactions Redundancy of Influences/Interactions

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## The Epictetus Framework – Iterate



44

## Questions...

- Did you have any prior knowledge of Antifragility?
- Do you believe that this framework would guide an SME to be more Antifragile?
- Are you aware of any other frameworks that would better improve an SME's Antifragility?
- Where do you believe this framework could fall in its stated objective?
- Given the the following stages (1.3, 2.4, 3.1, 3.2) do you think they are achievable? And do you believe they contribute to the objective of the framework?

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## Appendix E - Interview presentations October 2016


The following slides were used in the first round of validation interviews, the German interviewees, Table 7-9

### Towards An Antifragile South African SME:

*Expert inputs & validation*

Presented by: Daniel Kozman  
loaded by: Prof. C. S. L. Schutte  
Department of Industrial Engineering  
Stellenbosch University

### Points of order

- Duration: 30 mins
- Input & validation by parts: Only slides with the red banner (  ) in the top right hand corner will be assessed
- These parts were selected due to perceived expertise
- Other slides provide the context of the work

### Problem Statement

In South Africa, 40-75% of SMEs do not survive the first 42 months. A large amount of these are due to poor products, services, markets and/or preparations. A large majority are left in the wake of increased global volatility. Black swans, such as the 2008 global financial market crash, result in the failure of SMEs who do not have the mechanisms to survive/prosper from these shocks. Antifragility, as the opposite of fragility, is a system response by which a system improves due to the volatility in the environment. System engineers have designed systems with predetermined requirements in mind, but when the conditions for them are exceeded, the system loses its functionality. SMEs need to be designed to be less fragile in a volatile world.

### Main Research Question

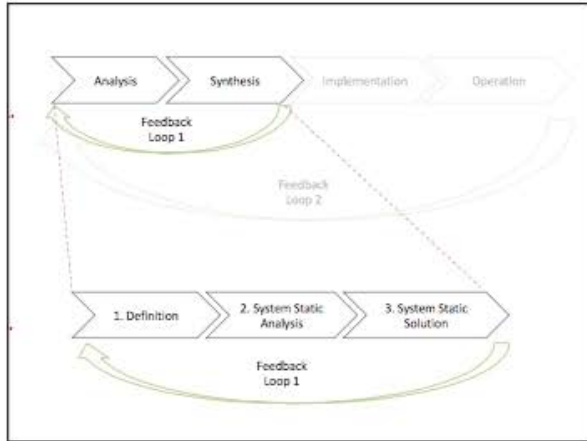
- How does the framework work that can support an SME in South Africa to improve its (anti)fragility?

### The Conceptual Systems Design Process - Plan Do Check Act

### The Framework in relation

The proposed framework does not encroach on the implementation or operation phases of the Systems Design Process, but stops with the tasks required to bridge the current versus future design gap.





### Main Research Question

- How does the framework work that can support an SME in South Africa to improve its (anti)fragility?

### We know fragility?

Fragile

### We know fragility!

Fragile

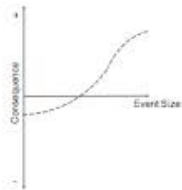
### We know robust/resilient?

Fragile Robust/Resilient

### We know robust/resilient!

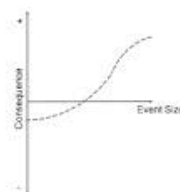
Fragile Robust/Resilient

### What is this?



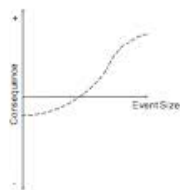
14

### What is this?



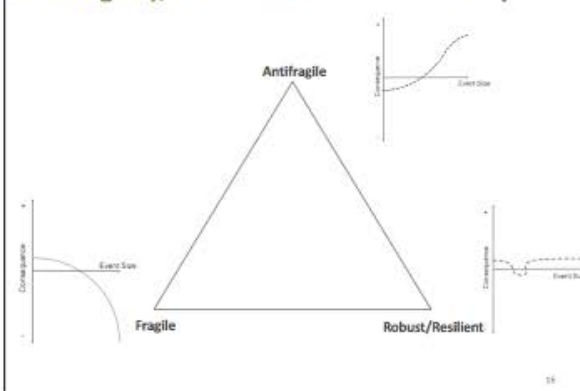
15

### What is this?



16

### Antifragility, that which loves volatility



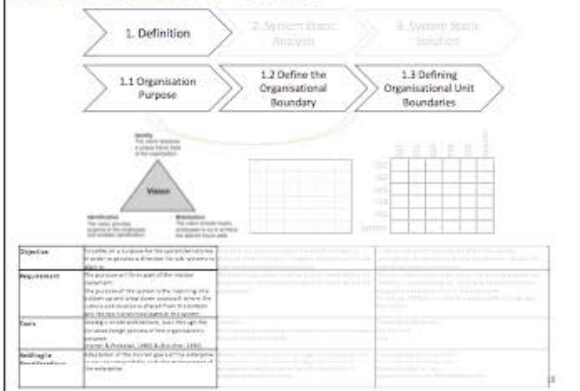
17

### The Framework – A Workshop

- Framework is built to enable socio-technical enterprise building.
- The focus is on SMEs.
- Enterprise Architect is a facilitator.
- The solutions are designed by the participants, the Architect translates those ideas to structures in the workshop.
- Participants include senior management, mid-management and important shop-floor personnel.
- No limit on group size, but in reduction of the workshop size will allow for a more efficient workshop.
- But the size should not limit the inclusion of lower level employees.

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### The Framework - Define



18

### The Framework - Define

Objective	1.1 Organisation Purpose	1.2 Define the Organisational Boundary	1.3 Defining Organisational Unit Boundaries
<b>Requirement</b>	Establish a purpose for the system to be defined in order to provide a direction for the system.	Establish a purpose for the system to be defined in order to provide a direction for the system.	Establish a purpose for the system to be defined in order to provide a direction for the system.
<b>Task</b>	Identify the purpose of the system to be defined in order to provide a direction for the system.	Identify the purpose of the system to be defined in order to provide a direction for the system.	Identify the purpose of the system to be defined in order to provide a direction for the system.
<b>Anticipated Considerations</b>	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.

### The Framework - Define

Objective	1.1 Organisation Purpose	1.2 Define the Organisational Boundary	1.3 Defining Organisational Unit Boundaries
<b>Requirement</b>	Establish a purpose for the system to be defined in order to provide a direction for the system.	Establish a purpose for the system to be defined in order to provide a direction for the system.	Establish a purpose for the system to be defined in order to provide a direction for the system.
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<b>Anticipated Considerations</b>	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.

### The Framework - Analyse

Objective	2.1 Organisational Unit Influences	2.2 Organisational Unit Classification	2.3 Organisational Unit Role Requirement
<b>Requirement</b>	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.
<b>Task</b>	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.
<b>Anticipated Considerations</b>	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.

### The Framework - Analyse

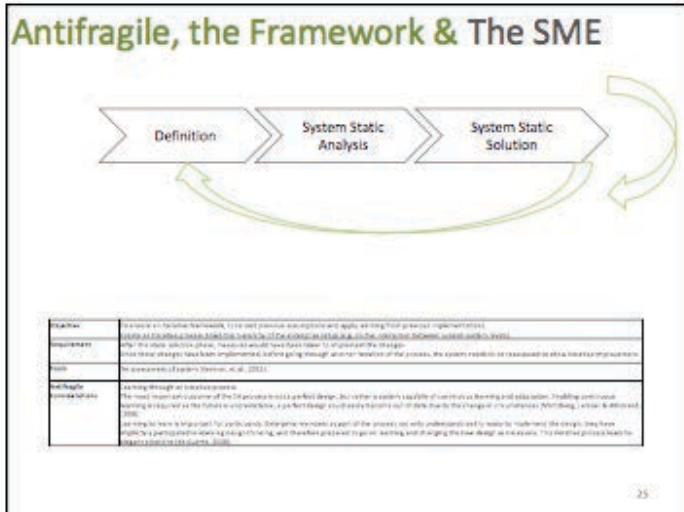
Objective	2.1 Organisational Unit Influences	2.2 Organisational Unit Classification	2.3 Organisational Unit Role Requirement
<b>Requirement</b>	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.
<b>Task</b>	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.
<b>Anticipated Considerations</b>	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.

### The Framework - Analyse

Objective	2.1 Organisational Unit Influences	2.2 Organisational Unit Classification	2.3 Organisational Unit Role Requirement
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<b>Task</b>	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.
<b>Anticipated Considerations</b>	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.

### The Framework - Synthesis

Objective	3.1 Bridging the Gap (Hyperconservative)	3.2 Bridging the Gap (Hyperaggressive)
<b>Requirement</b>	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.
<b>Task</b>	Identify the influence of the system on each other through dependencies.	Identify the influence of the system on each other through dependencies.
<b>Anticipated Considerations</b>	Ensure compliance with the relevant standards and regulations.	Ensure compliance with the relevant standards and regulations.



## **Appendix F - South African Interviewees**

The sections that follow are transcripts of the validation interviews as per Table 7-8.

### **F1 - V B Stellenbosch**

\*\*\*presented framework as per Appendix D - Interview presentations March to May 2017 \*\*\*

*VB: The old models of Michael Porter, the value chain, the supporting functions, HR, finance, strategy, somewhere they focus in the value chain. But in this something else is left in the shadows. Just yesterday I was in a session of an SME where the owner is an accountant, but the financial management was done poorly. It is that small focus on a part of the value chain where the balance of the business in small business falls short.*

DK: Yes, I feel that the balance is a thing where you have an owner-manager that is running the SME and they try and hold onto control for too long and somewhere a ball is dropped.

\*\*\*continue presentation of framework as per Appendix D - Interview presentations March to May 2017\*\*\*

*VB: This is great. Thanks.*

DK: Thank you. Do you think that stages 1.3, 2.4, 3.1 and 3.2 are achievable in the context of the framework?

*VB: Absolutely, I can see the images in my mind about how you would do it. Absolutely! It will be hard work, but I can see the images of how to do it practically. I just did the session at the plastic recycling company and I wish I could've walked in there with this. I think you can simplify it a bit, but absolutely. But you have to have them draw it out. One of my friend's students spoke about visual management. Just draw it out. Another one was how the Xhosa culture works for the uneducated person on the shop floor as they are the majority of the employees there. That fits into this. We have found that the biggest enemy for the uneducated on the shop floor are cellphones. And getting the total will show you how to identify this. So absolutely.*

DK: Fantastic.

*VB: But it is not easy.*

DK: No, but the facilitation opportunity is a very important part of this. And I think it is the next step of what could be a good piece of research and that is how this framework could be facilitated through exact design thinking methods.

*VB: Look, you and I have facilitated and it isn't always easy. It has a lot to do with the people and the culture in the walls and the fighting behind the scenes, but we know how to clear that up and get it done. The theory has shown to work. The importance is in getting the group prepared to get ready to go into depth is going to take a lot of work. A lot of information that has to be compiled and shared beforehand. A lot of preparation to do the session. You will have to draw a lot. The words need to be presented as images. But we can do it. Been there, done that.*

DK: The other question is, "Do you feel that the abovementioned phases contribute to the framework to help answer the research question? So, does it contribute to the objective of the framework as a whole?"

*VB: Yes, ok...so this is a subjective feeling that I have about this. But the subjective feeling is yes! Definitely.*

DK: The subjective feeling is something that we need. We called on certain experts due to their understanding of the various fields at play here. The next question is, "Did you have any prior knowledge of antifragility?"

*VB: yes, I read the book. And did a lot of reading on it as an article which I wrote for the Launchlab. The company there, Custos, they work on the antifragility concept in bitcoin and blockchain on how to evade antifragility by using their system. Because you don't want to take them on head-on, as cybercrime will come back at you head-on. So, with Custos I read a lot beyond the book. I am not an expert like you, but when you talk at least I know what you are talking about.*

DK: In your opinion, "Would this framework guide an SME to be more antifragile?"

*VB: Absolutely, but to get the SME needs to see more than one small thing. The psychological and sociological perspectives to take into account will not be easy. This restaurant is an SME, all of this applies here. If you sit in that tree and see what is happening here, then you see it.*

DK: That is it, and that is why I love the field for SMEs, as it makes a difference to people to whom it really is important. Large corporations will not easily look to do this.

*VB: They just don't want to listen, if we could just get them to listen.*

DK: "Are you aware of any other frameworks that would help SMEs to do something like this?"

*VB: A quick answer is no. If I drive off I might think of something.*

DK: Please let me know if you think of something.

*VB: yes.*

DK: "Where, in your opinion, beyond those already mentioned, do you think the framework could fail to reach its objective?"

*VB: Fail in the sense that you reach nothing? Or fail in the sense that it is totally destructive?*

DK: Lets say destructive.

*VB: I can't think. Here we are working as a group, Denzil, I have been given a lot of grace as I have worked with over 12,000 people. Some are just presentations, but the Sasol – almost 1,000, Kumba – 1,500 in groups of 20... see my grey hair... and hundreds others... some were successful, some were failures, but in the end. In Ian Mann's new book... he talks about the concept of creativity in the new world we live. It is not a "That person is so creative, look how nice they paint" type of thing. We are all creative, but collect a lot of information and work through it in a process. I use Edward de Bono's process and it works almost every time. And the two times it did not work, in the one case it worked beautifully, but due to a strange reason. The CEO carried a lot of baggage and the baggage had to come off and suddenly it went well with them. So, the planned strategy was a failure, but the CEO changed his view completely, and from there on the whole organisation took off. So it was an interesting one. The other one was the church. But for the rest, the process is not easy, you will have to draw, and draw and draw. A lot of them will not follow what you are saying, you know that, but you can simplify it. In Mann's book, and yesterday I had a long session, a lot of people are descending onto Stellenbosch from Switzerland which focusses on the digital age and a couple of people from government will be having a team build session. I am helping a friend there who is doing a presentation. So we took stuff out of her work and Mann's work and out of that combination*

*came one thing, Simplicity. Capitec Bank, they made fools out of everyone. I was at Capitec the other day, looking for a bank for our trust I walk around banks a lot. Capitec immediately invites me in, sits me down, "sir, how can we help you?" at a table. At other banks you look at them through glass. Capitec doesn't have money there, so you don't have to holler through a glass window, and they have you at a table, "Here, come get yourself a coffee." Uhm, "No, sir, we do not do trust accounts, we do this, this and this. That is all we do. Thank you." One app, simple products, simple and clear and done. Simplicity. So, this is kind of complex and in the practical application you can't scale it down, but just draw it.*

DK: Thank you.

\*\*\*End of Interview\*\*\*

## **F2 - H S Stellenbosch**

\*\*\*presented framework as per Appendix D - Interview presentations March to May 2017\*\*\*

*HS: This should become a core competency. Identifying and developing antifragile units should be as much a core competency as whatever product you are making. Or delivering whatever you are doing.*

DK: Exactly. I think it should be that the units should be built to form an antifragile enterprise. But for it being a core competency, yes.

*HS: One business which I think is very antifragile, is AVIS. When the economy is bad, people rent cars rather than buying them. And they can sell their vehicles on their books for a profit, because they can make their stock less. In economies that are going well, people have to rent more, because they are doing more stuff. If you needed an example.*

*Uhm, bridging the upside gap. Acquisitions, and having a warchest, knowing that if it gets tough, I need to have an option to buy that company. It is like the big short. So, I will pay you R1million to buy your company, with a valuation at the beginning of that year, pay it pay it pay it, company goes down, and then I buy it.*



DK: That could definitely be a tool, especially in the way it is applied. But that is what the framework should be, your contribution has made it stronger, allowed for it to become stronger.

So, into the questions. Did you have any prior knowledge of antifragility?

*HS: Yes.*

DK: Do you believe that this framework would guide an SME to be more antifragile?

*HS: If explained correctly, yes. The facilitator would be important. The facilitators knowledge of the framework and how it is explained to others is important.*

DK: Are you aware of any other framework that would improve an SME's antifragility?

*HS: No.*

DK: Where do you believe this framework could fail in its stated objective?

*HS: if it is presented like that. I would like to see pictures. You are going to explain it to all employees, they do not have this. You need to give them tangible examples, metaphors, analogy and gameplay to understand this and then you can go into the business environment. So, doing it like you explained it to me would not work for them.*

DK: That is a fair comment, and exactly what the previous interviewee said. This presentation was developed for experts though. The case study utilised more on the spot visuals.

So, I told you about the validation by parts. These are the four stages (1.3, 2.45, 3.1 and 3.2 that we need to validate, and whether they are achievable and whether they contribute to the objective of the framework as a whole.

\*\*\*shows stage 1.3\*\*\*

DK: Do you think it is achievable and does it contribute to the objective of the framework?

*HS: Yes, how are you going to understand what is or what needs to be antifragile if you do not know what it is currently. Yes, it is achievable.*

\*\*\*shows stage 2.4\*\*\*

*HS: Yeah, it is part of knowing what needs to be fragile, r/r and antifragile. Not all can be antifragile, you just need to understand how they should play their role. Some might need to be robust, you have a major asset base in one space. You need that part to be robust.*

DK: Lastly, “Understanding the contribution of the bridging of the downside gap and the upside gap.

\*\*\*shows stages 3.1 and 3.2\*\*\*

*HS: yeah, but you will have to explain and entice and get their juices flowing, and that comes down to how good the facilitator is. But it is definitely possible. If I can see it then somebody else should definitely be able to see it.*

DK: Thank you.

\*\*\*End of Interview\*\*\*

### ***F3 - Dr. S B Cape Town***

DK: It has been so much easier to think about malleable SMEs. It is so much easier to contribute value for SMEs rather than corporates. If we can just create some context to add these nuances to help systems to prosper under volatility.

\*\*\*presented framework as per Appendix D - Interview presentations March to May 2017\*\*\*

*SB: it reminds me of that Japanese thing where it is more beautiful for having been broken.*

DK: It is actually in the document. Kintsukori is exactly it. When I pitched that to product design engineers, their view was that that product still failed. But the act of the maintenance plan with that as a system maintenance has made it more valuable.

Do you have any questions?

*SB: In fact, I do, but first, let's get through your questions.*

DK: Ok, well, the first question: Did you have any prior knowledge of Antifragility?

*SB: Sorry, Yes!*

DK: Do you believe that this framework would guide and SME to be more Antifragile?

*SB: I do think so and I like the fact that you focussed on the SME side of things. Because, as you indicated you can add more value. Larger enterprises are very difficult, but there are also frameworks that focus on that. It is something we can take up later, especially if you want to upscale it on the enterprise side of things.*

*SME is a great target environment, I think the challenge that you have. You mentioned the cultural issues, some people just don't get it. If you look at the SME, the leader or the people that engage with the SME can make a big difference. You need to have that personal cultural affinity to be able to make this happen. Even if they don't, sometimes people can change. Then the other question, the other I had was. So, I like this framework, it works together really nicely. But, as like with other frameworks, let's say you take it to the SME, facilitating it, it is something that becomes part of them, and it is nice and iterative which means they change over time. The challenge is, with an SME, if you think about your environment, but tomorrow when there is a problem with a customer order you chase that and chase your tail, you need to get money at the bank. You have no choice. How do you inculcate this, is it intended to be inculcated? SO, uhm, I always suspect that it is more valuable if it is. And, in which case, you do you make sure this is a sub-conscious approach to their business. You know, that implementation element of this on a sustainable basis. So, that is the question that I have got. You probably have addressed it, I just have not seen it in the preceding slides.*

DK: No, exactly. It is a big question for me. Because it is about fighting fires and ensuring we first do no harm, we need to survive, we need to get that order through, we need to get money in the bank. The first thing is that, the feedback was that antifragility is something that we think about and is now immediately a language that we share in this process. The people that are part of the framework itself, are the people that look to hold each other accountable now, saying "We need this thing sorted, etc." My hope is, firstly, yes, you need a company culture that says yes, let's see let's try this. The second thing is them saying, it is part of who we are now, let's keep developing. So, let's hope it is the conscience. Yes, we are fighting a fire, but let's take that step back. How do we take stock, what is the learning process behind. And those are the tools that I hope we get that. I am hoping after one or two facilitation sessions where they can sit there and say, "we can run through this framework, we can understand the

jargon, lets investigate some different tools that might help us, but the outcome needs to be the same. We focus and try to be more antifragile.

*SB: I think if organisations take that and they internalize it, it becomes a component of their competitiveness. Because they are able to think or outthink the market and that in itself is possibly a selling point. I'll draw an analogy, years ago I worked for a company called PSW and they ended up specialising in the telecoms market, IT and whatever the case is. Small organisation and I think that was ultimately part of the challenge, they remained small cause the guys that joined up first didn't want more managers anymore. What was interesting to me, and I think this was a 300 person organisation, every person that joined, there was an induction workshop and this induction workshop was focussed on was the company values. So, it is a bit ethereal but it was not about the strategy, the vision, it was about the values. And you got a list of values, and worked through them, and it was actually a 2 day workshop. But it was in essence, in a way, what you are trying to achieve here. Is it became subliminal. So that when you are out there, and things are tough, you think about innately what the response should be and how you deal with that, and so on. Sometimes those soft issues can be quite handy.*

DK: It is a difficult one, but I always ask the question. About, what comes first, thinking how I should act, and acting that way, or do I act that way and think afterwards, oh cool, I acted in the correct way. And I hope that in the organisation I think, oh, I should act like this, but I need to do this first. And that should change after a while.

*SB: But also, as you say, getting the guys together. So, people understand the constituents, they are more cognisant of the greater system in a way. Ok.*

DK: Are you aware of any other frameworks that would better improve an SME's antifragility?

*SB: Better improve...uhm... no, I like this model, because you brought a bunch of components together that I think are relevant. I think relevant in general, but obviously relevant to the target, the SME. Uhm, better...no, I do not think so. Are there any other, I mean, you have been through the lot anyway, so, yeah, there are various organisation designs, but they do not touch on antifragility that becomes, I like subconscious in an enterprise like this. I haven't come across anything like this.*

DK: Thanks. Where do you believe this framework could fail in its stated objective? If we cut out the earlier points of culture.

*SB: Yeah, I think there are a couple of hurdles. We have spoken of some of the early ones, but I think...as you go through this uhm, one other challenge and I was thinking as you were saying about defining the organisation and its objectives. Now, does the organisation's objective, in your mind and in this model remain fixed, or does it also evolve along with the dynamic in the organisation as well as those external components that come to play. Uhm, and if it tends to remain firm even though you are thinking about these other things then you are just off on a corner. The opposite challenge of that is, if you enable your objectives to be dynamic, at some stage you could also get quite confused. You know, when some of the guys are not as privy to your thinking, so the external market, your clients, customers, etc. That would actually need to be managed as well.*

DK: Yeah, I think the important part is that I keep hitting back at double loop learning. We are in such a volatile economic environment and within the tech space, obviously, uhm your strategic intents can stay the same, but the strategic objectives need to change compared to how the market responds. But yeah, that is also something that I found the case study struggled with to actually move out and say there is nothing else that we have. And I asked, think about rental art. And they responded saying, oh, that makes sense. Actually, getting the people to take account, where all businesses don't want to buy their art. So, there are different avenues, but sitting and thinking about what is the strategic intent and getting the objectives aligned to that. So ja, I do find that that is an issue.

*SB: I think the other thing is potentially is the level of thinking, and you touched on it earlier, to be able to get to think about this cause it really is beyond transactional, it is the abstract. Which I think is great. Some people just like to be told what to do. So, I think that is possibly a practical challenge. But there are ways of dealing with it. The other thing, also is, if the business is dynamic, greatly dynamic, depending on the kind of business, you have let's say IT systems, that enable the product or service, is that able to take into the account the business' ability to do what it needs to do.*

DK: That is a difficult Catch-22, in the type of technology if it has to keep up it is extremely expensive to keep that up. The second thing is if it doesn't keep up it is more expensive and you lose the market. So there is a sweet spot to address that. I do believe that technology now allows a lot more to keep up. And I think it will be more so in the future. In the case study we could integrate between current processes and the new online software, but integrating between current online providers would be easier. In this case study it was more beneficial for them to move from their archaic systems of multiple excel sheets to know exactly what is required to deliver on the core business.

*SB: That is a valid point, because I think that if you are dealing into this mindset and you design your support systems to be malleable from the word go then that will enable a lot.*

DK: The way in which I have gone about validation is there are four ways, where the first one is validation by parts (validation through literature), the second is an illustrative case study and the third and fourth are semi-structured interviews, locally and in Germany. Are the stages given, that are not part of the validated previous body of literature, valid for you? The first one is the plotting of them within the triangle?

*SB: yes, I think it is very valid. What I also think is sensible is that it is not quantitative.*

DK: And why do you say that?

*SB: Because, when you start trying...well...there is a place for numbers, but getting people to understand is much easier for them once you put it in the triangle...then they know it...they can feel it...they can sense it. And, just on that statement, that is valuable. I think that it would be great to see a space where it does become quantitative, but to be practical within the SME space I think it's a little bit of an overengineering.*

DK: No, the difficulty behind it was when the people asked, are we better now? And what we have is that on this ruler it shows you improve, but it does not give a fixed value which means anything. It just relates to the previous perspective.

*SB: Which I agree with, that level of thinking. The challenge is between this and the people that need the numbers.*

DK: We have done 2.3, just setting those boundaries and within the triangle. How easy would it be for the enterprise to actually think about their future required role within that triangle?

*SB: Well, I think it contributes greatly. And perhaps to jump into the first question, can it be done? SMEs, easier, because you would find that functional or roles would overlap. People will, certainly in a well-functioning SME, cover for each other. They are there as a team so it is a lot easier to achieve. If they don't necessarily see the benefit of antifragility, well, I think a way of dealing with that is through live examples of where things go wrong. And I assume your facilitation process takes them through what that could be and that picture. So, this matters how left or right brained you are. It is easier in SMEs, and yes it does add value to SMEs.*

DK: Then the last is the bridging phase, do these two stages make sense and how we try to do that?

*SB: Ja, I think you got the key elements. It makes sense. I mean, dealing with the downside and then the upside makes a lot of sense. You might not necessarily know at any one point whether you are going up or down, because you have such volatility. So, it is something where I think a bit of danger could be a good thing. But in terms of the way you suggest dealing with it, it certainly is there. And I mean on the next slide that you have where you have got some ways in which you treat it, it makes sense. As this goes on and is used, your knowledge will grow. Inherently it proves the value. So, yeah, it is good.*

DK: Any other comments?

*SB: Uh, no, I think it is good. It comes together well. But perhaps going back on what you said, introducing antifragility to someone who just wants to produce toothpaste, and you come up with this new word. It might require like the old lift/elevator test just breaking it down into simple concepts. But that being said, this is about a body of work and a PhD...so, I think you are hinting at the right level.*

\*\*\*End of Interview\*\*\*

**F4 - Prof. M M & Prof. R P Cape Town**

\*\*\*presented framework as per Appendix D - Interview presentations March to May 2017\*\*\*

DK: Firstly, did you have any prior knowledge of antifragility?

RP: Yes.

MM: Yes, I am not engaging with it academically, but I have moved from academia to academic management. I tried to stay abreast of topics of idols of mine, and Taleb is one of the idols. I understand the theory, and I understand, I have followed a lot of videos where Taleb provides good examples.

DK: Thank you, second question. Do you believe that this framework would guide an SME to be more antifragile?

MM: let me think about this... and I want to go way back. Firstly, I think that question looks to the importance of the research. And I believe we can say this, and I hope you addressed it somewhere in your work. The tremendous growth and proliferation of SMEs and the dependence of the economy increasingly being on SMEs and the fact that we are sitting with a country with 27% unemployment we have no other choice as to support and push it along. Given the challenges and the fact that they are too short on formalities that you might find in corporates. I would also like to answer the question one day as to what you are doing here and how it can help a university. I believe one of our biggest problems is that we sit with universities that are institutions of a colonial past and we have academics who have grown up in that system and do not have transformation based thoughts which is necessary for the country of today. Lets get back to the question. I think, in the absence of, even if your framework is just a tentative step, it is something that is valuable to have a look at as the normal SME is so unsophisticated in their approach to things. I think the proof of the pudding would lie in how you could unpack this in a simple way. All the theory and knowledge that you have in your mind translated to something simpler.

RP: A part of what you said now, I think, is beyond what he asks there. What he does not ask is the advantage of his framework on the SMEs. What he asks there is about antifragility. What he did not do is the link between antifragility and the success of the SME. It is logic, but it is not said there. So, you can only answer in terms of antifragility, nothing more. Otherwise you will first have to build the link between antifragility and the positive impact it would have on the success of the SME. What would be easy, because there is a large amount of work done on



*what are the success factors for SMEs or SMMEs for that matter. So, you can work that into some of the responses, but it is not there, that is just to antifragile.*

*MM: Last year, as an example, I had an M student who looked at the implementation of quality management in SMEs because one of the greatest problem that SMEs have is the lack of consistency in the product that is being developed and made. And to have ISO implemented is beyond their range of capabilities. So, he looked at what you can do to at least get certain basic stuff in place. So, basically to unpacking ISO for dummies so that you can do something for an SME so that they can be aware of the fact that you want variations to be smaller for quality, etc.*

*RP: But so, you have the impact of leadership, training. There is a big box full of this.*

*MM: Great corporate tools.*

*RP: But you can't just translate those to SMEs. Most research is done in corporate environment, very little is done is purely for the SME. And you can't just move that tool over. And that is the value of what this framework is.*

*MM: I would also guess that Denzil knows this better than I. Even corporates, are just a collection of SMEs... it is not the old traditional Jack Welsch type of corporate that we learnt of.*

*RP: But they do not come from small businesses that formed one large business. But they come from the large business that has to downsource to smaller structures. I think that is a different idea.*

*MM: But I think the model is also smaller groups.*

*RP: I say Resilience and he says antifragility and there is a strong relation. He says this is specific for SMEs and the motivation for that is easy to see, because this is a mark where so little has been studied or shared or knowledge lacks, they do not have this basic knowledge compared to the corporate environment.*

*MM: And what they get is a person that pops up with a small programme saying, How to start your business. How to write a business plan. That is basically what they get.*

*RP: What is the question that you have to ask so that the system that you create, whatever it is, will survive if something pushes against it. And the answer is, yes it will work, because anything*

*that is a more formal approach to creating it is better than nothing. And if it can have all the factors identified for systems thinking, then it has to be valuable.*

DK: Can I paraphrase that by saying that the worst that could happen is that nothing will happen?

*RP: I think the worst that could happen is that something happens, but you have put something in to improve.*

*MM: A case for change.*

*RP: Yes, and on top of this. Seeing that there is nothing in place, and you can, in a systems environment, identify what stuff influence each other. There is a bubble, and things will bump against it...and you just hope that something can't prick it. You want to allow the bumps. There you have value for the small business. A guy walks in with an idea, a product, not with the business, and if that is the problem. All he has now is a product, and he will have the basic elements of management. They are operated as silos, but what you present is the understanding of the interrelationships and create a synergy. Then the answer to my question is Yes.*

DK: I also made that link between success of SMEs and how antifragility relates to that. You can bring them together. You can have those pieces, but they are isolated pockets. Systems do not want that, they want synergy.

*MM: Just a remark, which might be trivial, but I recently listened to Clem Sunter on the radio and he had a long discourse on family owned businesses. These are based on things he learnt in Canada, which, apparently, has more than 50% of their businesses as family owned businesses.*

*RP: Oh yes, Ricardo Semler did that way back.*

DK: Yes, it was explained in his book Maverick. And I must say that his work there is the manifestation of my framework.

*RP: And that is a system almost like a family business.*

DK: And in Germany you see a lot of family owned businesses. And that is why I have heard the comment that this framework should work for Germany too.

*RP: But this to me is not structured, I still want to say resilient. A developed economy would have more structure, but also less entrepreneurship. We are almost the case study in which to make this work in the extreme SME environment, where the state doesn't support enough. It is up to the individual to start his own business. If it works in this environment, I believe it will work in another environment too. It is almost the case study for where it will work. This is the extreme. A lot of SMEs, little help, unstructured.*

*MM: Are you done in Germany? Because I know a director of SAP in Munich, in their top management team. He is tasked to have a look at new management models, because they, themselves, good large organisations have a team that look at alternatives if that product of theirs would fail. I actually met a guy at Marlboro who had the task of finding a product if cigarettes were totally banned the day.*

*RP: But hang on, that would be when he is done?*

*MM: Yes, but it this guy is an industrial engineer and if I had known I would've connected you.*

*RP: But this is about SMEs, SAP is not that.*

*MM: yes, but he sits separated from them in a unit which is type of an incubator.*

DK: Sort of like a skunkworks programme. Next question, are you aware of any other frameworks that would make SMEs more antifragile?

*RP: I can just say that I do not know of any.*

*MM: I can say that what exists is very simplified and I believe it speaks the basics. Like adult basic education.*

*RP: The question is quite one sided. I can say yes, and give you what I have or I can say I do not know, but I cannot say no.*

DK: I understand, I am happy with your knowledge, past experience. Thank you. Next question, where do you think the framework could fail in its stated objective?

*MM: Here is my view, and I believe it is probably the obvious answer. The ability to unpack this in a way in which an SME owner can understand this and operate with it because I think you need to understand. We take a problem, we transform it to a domain where a lot of intellectual*

*power has been applied to solve it and then the trick is to get it back to the root. The difficulty is in taking a real-world problem, applying it into the model or framework and then transplant it back to the start again.*

*RP: It is the translation of the real, into abstract, and then back into a language, methodologies, etc.*

*MM: Yes, in the end, this work has to be simple after you have applied your intellect. But the simple thing is trustworthy and it works. And it doesn't have to be built from simple thoughts....*

*RP: I am a good driver of a car, but I am definitely not the mechanic. So, I need that complex system to be translated into me just driving. They do not have time, it just needs to work. And if that can't be solved then the framework will fail. So, your failure is dependent on your ability to translate it to them.*

DK: And that is where I have gained a lot of help from the facilitation expert. We spoke about validation by parts. So, we want to focus on that which is not supported in literature.

*MM: Ok, so these stages are the stages for which you have no other form of validation.*

**\*\*\*showing stages 1.3 & 2.4\*\*\***

*RP: It is clear. It is easy to see.*

*MM: Yes. Ok, so in other words, an understanding of the current, and secondly an understanding of where we should be.*

*RP: Yes, it is not easy to see where you are, nor is it easy to say if it is right or wrong. But it is easier in relation to where you want to go. Where you are going is not clear, or experience-able. So, it is a vague picture which happens over time, so it is vague and indeterministic. Especially if you are not a futurist. It is easier to see and experience that something doesn't work today. So, when you compare the two with each other you can see the difference.*

DK: So it is valuable to first have that present state to make the future state more tangible. What is important here is that the SME manager is here, but to do it on a lower level is difficult with education being one of the challenges an SME faces.

*RP: Plus, I think you will only be able to create your picture of the future given where you currently are. So, if it goes badly, then your picture will speak to it to not go badly. If your picture is that it is ok, then you will look at a growth picture. So, the future state is determined by your current state and/or what it was. There will be two things, it is easier to see 1.3 than 2.4, because who are you to know. And secondly, dependent on who you are, you can try and differentiate between two cases the current is bad or ok, or great, because that can determine the future. So your framework should ask the person where you are now, and dependent on that they will think about their pathway of the future.*

**DK:** Thank you. The last question, is to look at stages 3.1 and 3.2 and confirm whether they are usable, possible and do they contribute to the framework.

*MM: Eventually, it is always possible.*

*RP: yes, I cannot say yes to that.*

*MM: My answer is philosophic, anything is possible, but it might take a long time to master.*

*RP: I can't say a no either.*

*MM: I can take someone from an informal settlement and make him a doctor in engineering, but it will take a lot of years and there will be a lot of rewriting. So, I think this is a law of nature. You spoke about equilibrium in the beginning and saying there is no such thing. There is only flux. And the flux is that if you ever reach steady state, it will oscillate. It will trend towards it, but never reach it. I think you should apply the same philosophy to that.*

*RP: You have to ask, what is the timeline. If you are reactive and it is going badly where you are now then your timeline is shorter. How much time do you have and how many resources do you have. So, there are certain mechanical questions that arise, what is your time.*

*MM: We have time and resources, it thus depends on how many constraints exists.*

*RP: And, again, where were you.*

**DK:** Is there anything you would like to add?

*RP: Me, personally, was not convinced at the beginning that all SMEs can be pulled together under the same umbrella. I think that this might pull you into a challenge of the size of the*

*company. These sizes of SMEs, I can imagine that the size of the company can have an influence on what happens here. So, it is almost a variable you should focus on. I am careful to pull them all together. The smaller the company, the more difficulty, or ease you might have.*

DK: Do you have a feeling of what might happen if the company is larger?

*MM: The Greiner Curve. The Greiner Curve starts at zero, and might speak to how a company sees this.*

DK: I think the value of this is that the volatility is important. So the we want some crises, but we do not want to shy away in a corner.

*RP: I think what you should do...is add these answers to the delimitations of your study. You can state that you accept that SMEs are homogenous. But that is not part of this study.*

*MM: Yes, that is a study on its own. Which says lets look at classes of SMEs by looking at their characteristics and group them on clusters.*

*RP: So do not say too much about this answer on this question, but rather take it and deal with it in the limitations. And the limitation is that you see SMEs as a homogenous group because this is the first of its study. But when you look at the next study, you will be able to classify according to size of business and not the government's view or definition of what an SME is. But a better classification. I have a PhD student that is working on a reclassification of that structure. And if it happens then you can match up with them. But that is not part of THIS study.*

*MM: That, to a certain level, defines your title. I like your title. You are laying a foundation to a movement. It is a reference point on which to build.*

\*\*\*End of Interview\*\*\*

#### **F5 - Dr. L L Stellenbosch**

\*\*\*presented framework as per Appendix D - Interview presentations March to May 2017\*\*\*

DK: The first question is, "Did you have any prior knowledge of antifragility?"

*LL: Yes, it is limited, but I do have some background on the topic. I understand the concept.*

DK: Thanks. The second question, “Do you believe that this framework would guide an SME to be more antifragile?”

*LL: At the moment I am not confident, I understand the theoretical concept of the framework, but I don't have a good understanding of the application of the framework for an SME from what you have explained now.*

DK: Well, perhaps I could explain the case study to you?

\*\*\*the case study was explained to the interviewee\*\*\*

*LL: Ok, so the framework, how does it support you in moving to antifragility and not just resilience or robustness?*

DK: The moment you go through the framework and start putting that learning process into place, you are already moving towards antifragility. It is already an improvement. As you might understand, I do not believe that there are absolutes at play here, but survival in the future is important. So, if we go through this framework with a company then we hope to move into the right direction and that is away from fragility as an organisation as a whole. It is the reason for the research question being masked as (anti)fragility. So we just want to move away from fragility and to do so by trying to improve under volatility...and that is not just absorption...throwing money at a problem, but thinking smartly about how the resources are allocated.

*LL: Can we go through the questions so that I could perhaps get more clarity? Can I send you the answer to this in the written form? Just so that I can apply my mind a bit more.*

DK: That is no problem. I will forward the slideshow and the questions.

*LL: Because, at the moment, I agree that addressing them all in the framework will help, but can it help to make you antifragile? Submitted to a stressor... will the framework support you to when you have this in place to become stronger.*

DK: Yes, we do not wait for the stressor and then apply the framework,

*LL: It is to prepare you for it?*

DK: Yes, it is not about reaction, but a construction that will be in place to improve when the stressor hits. As with the human body. The construction is there, how it moves is not dictated. So, I know which environment I operate in, how can I structure myself to be better under volatility?

*LL: Yes.*

DK: So, if we talk about the frequency of the framework. There is no right answer. Once a year, every six months, it depends on the enterprise and its needs and its maturity in this. The case study would now be in a good state to go through the framework again as the one business unit does not have the correct key man yet, and alternative solutions can be found for that shortcoming. And their old belief that a key man will cost you R30,000 is not part of the equation anymore. But this is definitely not a framework through which we quickly run to react to something, it is in place to set up a structure.

*LL: Yes.*

DK: Agility and flexibility is part of the structure, the design, which is timed based, but it is based in dynamics rather than structure, the static. But the structure, or sub-unit needs to be designed for that.

*LL: How do you think in terms of a system that is antifragile? Is it getting stronger in relation to its performance objectives or goals?*

DK: The framework will guide the SME to be better aligned to its purpose. Firstly, the purpose can change, which is important, together with the enterprise boundaries. But it is also that the failure of the enterprise is less evident. Learning being proposed is already valuable. We need to look at how we can make the organisation learn...and teach itself to learn to improve. If we look at the restaurant industry, the fact that a restaurant fails in an area is a good thing for the industry as a whole as the industry starts to learn from what it is that does not work there. That is what we would like to do for the organisation. Things that have and can fail, must be allowed to fail to teach us. So, failure in sub-units might bring the system down slightly, but the learning opportunity or the role that the unit played in protecting the system is antifragile in itself. We need to be able to identify these key units too. Even if we are moving, as an



enterprise, away from fragile to robust/resilient, we are moving in the right way, there is that improvement. The absolute does not exist.

We created a measurement tool which created an indication of what improvement would be, but the values within that does not look to give a number to antifragility. But rather create the perspective of improvement.

The system that improves is a purpose based improvement, but also increased survival in the future. EiEA allowed us to map the progression for improvement, in how we improve evolutionarily in response to stressors.

You can take your time to ponder the question a bit more.

*LL: Thanks.*

DK: The next question, “Are you aware of any frameworks that would better improve the antifragility of an SME?” The big issue being that frameworks and models are generally made for corporates, but SMEs have the same type of needs for constructivist approaches to building an enterprise.

*LL: I am not aware of any...there are things like risk management frameworks, which helps to manage risks, and might help you inherently to be more antifragile, but it is not focussed on doing that. But if you apply some of the concepts, they could definitely help.*

DK: yes, it would help. The big philosophical question about risk management is that of probability of occurrence versus consequence. That is the cornerstone, but it is attributed to a single risk because it is built on project management. You can still use it. The probability just doesn't play as big a role. The what if is a larger focus. But I do agree, Risk management will help, as anything that enables learning in an organisation is a good thing, but some views can be applied to enhance their improvement. With the research I wanted to focus on the need for SMEs, instead of larger corporations.

*LL: So, your framework is there to help an SME become more of a learning organisation, an innovative organisation, a more flexible and adaptable organisation and those capabilities give you the capability to be more antifragile.*

DK: Yes, but it is also to do those on the correct enterprise units. I would not want machine learning to be applicable to, e.g. finance, that is not where I want to spend a lot of resources on a need that is not critical to the antifragility of the enterprise. We want the employees and enterprise stakeholders to make those decisions, see that they do not work...and try something else, but to create the environment where that happens. I liked how you said it, the sandbox is created. I do not prescribe tools, but we need the sandbox, with toys applicable.

*LL: So, do you provide guidelines in those phases?*

DK: Yes, in the underlying stages. In those, you can look at more specific considerations with guidelines for requirements and objectives. This I had to make very tangible for the SME. And this framework has helped in that with the case study.

*LL: So, yeah, I am not aware of any other framework.*

DK: Where do you believe this framework could fail in its stated objective?

*LL: Yeah, I would say the understanding and interpretation of the framework. I also think it will depend greatly on the facilitator of the framework. If the SME just wants to take the framework and do it, I do not think it will work. You will have to use a facilitator.*

DK: Can I build on that answer and ask whether you think the SME would be capable to use it themselves after a couple of iterations with a facilitator?

*LL: Yeah, it is a capability which can be transferred. You will have to start with a facilitator that understands it though.*

DK: WE are doing validation by parts, so certain stages are new to literature, so I require a per stage validation, are they achievable and do they contribute to the stated objective of the framework.

\*\*\*shows stage 1.3\*\*\*

*LL: On the grounds of what would the placing take place?*

DK: on What if questions. So, we understand how they interact with each other, but what if questions test the fragility or robustness of an enterprise. They look at the lack of influences that are required, or other influences that are there that should not be there.

*LL: Yeah, different guys might have different perspectives. It is open which is good, you just need to have the right way in getting those perspectives. And, how would you get the consensus view of the group?*

DK: The power there lies with the person who would run the enterprise unit. But the facilitator plays a large role here. It is not only consensus that is important, but the learning process of all perspectives coming together in debate.

*LL: So, it specifically around the classification. Yes, it is important to know where you currently are. No constraints will not make you better, but you need to know where they are so that you can focus on them.*

DK: yes, and this helps a lot to talk about bridging theory. The low hanging fruits are shown, and this stage allows for that visual view of improvement per unit. A lot of the times improvement is not a physical change in a system, but merely a clearer understanding of what needs to be done.

*LL: The value does not lie in the classification as much as the process through which they go to do it. The thought processes will start to change, that is where learning comes in.*

DK: Thank you.

\*\*\*shows stage 2.3\*\*\*

*LL: Well, yes, it is absolutely critical to know where you should be. Understanding your current contributes to that too. In terms of whether it is required in the framework, it is definitely required. In terms of whether it can be done. Yes, it is difficult, but dependent on the role of the facilitator.*

DK: Thank you.

\*\*\*shows stages 3.1 and 3.2\*\*\*

*LL: Yeah, I agree. One advantage of an SME is generally that they are more adaptable than a larger organisation. It is an inherent thing in an SME, but a big part of that is to know what makes you flexible and adaptable and not doing something where we limit that. A lot of the times, the SME is too dependent on the owner and that makes it more fragile.*

DK: Thank you very much.

*LL: I will go think a bit more about the questions and look to supply you with more answers. But in general, I like the framework, I like the approach and elements. For me it is just about going through the process is valuable to an enterprise and to think about the organisation's areas and starting to think where I am susceptible to stressors and how to go with it. But yeah, you need that facilitator.*

**\*\*\*End of Interview\*\*\***

**\*\*\*The following is the e-mail response to the second question by the interviewee after the presentation\*\*\***

*"The framework seems to be on a high conceptual level. It will definitely require an experienced facilitator (experienced in the framework and anti fragility concepts) to guide a team through the process. I believe the process as described in the framework is the right approach. The framework appears to address more the "what" than the "how" – the "how" mostly sits with the experienced facilitator. The framework guidance therefore seems to be more regarding the "what" than the "how", and it should be a facilitated guidance. Since the framework does not cover the implementation phase but stops after the Future state design, the guidance is not towards being more anti-fragile (since a lot of actions are still required to make the organisation anti fragile), but more towards what is required to become more anti fragile (which is a bit of semantics J). In this regard I believe the framework will be helpful. However, I believe the guidance will come more from the facilitator than the framework (although he/she will follow the framework process, with which I agree)."*

## ***Appendix G - German Interviewees Curricula Vitae and Discussions***

The following sections provide the curricula vitae for the first round of validation interviews together with a summary of their responses.

### ***G1 - Prof. Dr.-Ing. Gunther Reinhart***

Chair of Industrial Management and Assembly Technologies at *Technische Universität München*

Prof. Dr.-Ing. Gunther Reinhart's Chair conducts research into assembly technology, automation and robotics as well as production management and logistics.

He studied mechanical engineering (specializing in design & development) at TUM until 1982. In 1987, he did his doctorate at TUM's Institute for Machine Tools and Industrial Management (iwb) under Prof. Dr.-Ing. J. Milberg. From 1988 to 1993, he worked at BMW AG, initially as head of the joining and handling development department and subsequently as director of the body paint shop in Munich. In 1993, Prof. Reinhart was appointed director of the iwb. From March 2002 to February 2007, he took a sabbatical to become the board member with responsibility for technology and marketing at IWKA AG in Karlsruhe. Since 2007, he and Prof. Dr.-Ing. Michael Zäh have served as co-directors of the iwb at Garching and Augsburg. Since January 1, 2009, he has been Head of the Fraunhofer Research Institution for Casting, Composite and Processing Technology (IGCV) in Augsburg.

#### **Rationale for interview:**

Prof. Reinhart is an expert in the organisation and management principles possible in the production management arena. His view on the work would allow for input from an expert who has played an active role on boards as part of strategic direction as well as current research into the production management environment and thus applicability to other fields.

#### **Areas of validation:**

The validation with him focussed on the work in the framework which sought to find applicable tools for stages 2.2 and 2.3 as well as the validity of the framework as a whole.

**Environment:**

**Date of Interview:** 16 September 2016

**Time of Interview:** 01:00 PM (Central European Summer Time)

**Total validation and discussion time:** 47 mins

**Present:** Prof. Dr. –Ing. Gunther Reinhart

Denzil Kennon

Andreas Fabian Hees

**Responses:**

1. Did the respondent have prior knowledge about Antifragility?

*No.*

2. Key considerations to the success of 2.2 and 2.3?

*The interviewee could not think of anything now, but agreed that this should not only be applicable in South Africa, but he can see this being used in Germany too.*

3. Would they be adequately addressed by a tool?

*Mr. Hees believed that SIPOC would be a valuable tool to support this translation. This was agreed on by Prof. Reinhart.*

4. In 3.1. & 3.2 do you believe that the tools would deliver solutions to deliver on the requirement given antifragile considerations?

*The expert agreed that he believed that he thinks that they could work, but reiterated that this should be expanded to other countries.*

**These responses were beyond the questioning of the interview, but were valuable and were noted for further investigation.**

*The expert believed that the field of antifragility is an interesting one and would be interested to see its application closer to the production management, and actual manufacturing environment.*

**G2 - Prof. Dr. Oliver Alexy**

Professor of Strategic Entrepreneurship at *Technische Universität München*

Prof. Alexy joined the TUM School of Management in July 2012 as Professor of Strategic Entrepreneurship. Previously, he held several roles in the Innovation & Entrepreneurship Group at Imperial College Business School in London, England. His teaching encompasses lectures and seminars on topics such as organizational design and renewal, strategy, business models, open innovation, and entrepreneurial growth.

In his research, he studies how to design organization that effectively deal with extremely high uncertainty, such as high-tech start-ups, R&D units, online communities, and social enterprises. In particular, he looks at how collaboration, knowledge disclosure, or framing may contribute to the strategic renewal of established companies and the establishment and growth of start-ups as well as entire industry ecosystems. As such, his work is of high interest and relevance to academics and practitioners alike. His research has been published or is forthcoming in leading international academic journals, such as the *Administrative Science Quarterly*, *Academy of Management Review*, *Research Policy*, *Strategic Management Journal* and *Entrepreneurship Theory & Practice*, as well as practitioner-oriented outlets such as *Harvard Business Review*, *California Management Review*, *Sloan Management Review*, and *McKinsey Quarterly*.

**Table G-1: Prof. Alexy professional timeline**

<b>Date</b>	<b>Event/Position</b>	<b>Institution</b>
2012 - Present	Professor of Strategic Entrepreneurship	Technische Universität München (Germany)
2011-2012	Temporary Lecturer	Imperial College Business School (London)
2010 - 2011	Research Fellow	
2008 - 2010	Research Associate	
2008	PhD	Technische Universität München (Germany)
2008	Visiting researcher	Massachusetts Institute of Technology & Harvard Business School

Date	Event/Position	Institution
2005	Diploma in Information Systems	University of Regensburg (Germany)

**Rationale for interview:**

Prof. Alexy is seen as an expert in the fields of organization design, growth and renewal of firms, ecosystems, innovation (open innovation) and strategy. His view on the work would allow for the input from an expert into the possibility of an organizing an organization to be better equipped for a volatile environment.

**Areas of validation:**

The validation with him focussed on the work in the framework which placed a tool, SIPOC diagrams, as an example of a tool that would help participating workshop members to deliver on the necessary outcomes of the phase in the framework.

He was also asked to provide his input on the phases 3.1 and 3.2 in developing solutions to the gap created in phase 2.2 and 2.3 (see slides).

**Slides for validation interview:**

See *Towards an Antifragile SA SME 14102016\_Experts.pdf*.

**Environment:**

**Date of Interview:** 21 October 2016

**Time of Interview:** 09:00 AM (Central European Summer Time)

**Total validation and discussion time:** 63 mins

**Present:** Prof. Dr. Alexy

Denzil Kennon

Andreas Fabian Hees (TUM Representative of  
Prof. Dr. –Ing. Gunther Reinhart)

**Responses:**

5. Did the respondent have prior knowledge about Antifragility?

*No. (But the respondent did do research on the author of this PhD and through his investigation came to know the field of antifragility.)*



6. Key considerations to the success of 2.2 and 2.3?

*The respondent noted that there is no fixed direction in how an organization is set up, but this develops the continuous search for an equilibrium between the environment and the organization.*

*He believes that these steps are possible, in his dealings as of yet, he has not found any evidence to contradict steps 2.2 and 2.3. The formation of the facilitation session is important as a language needs to be created which everyone can share.*

7. Would they be adequately addressed by SIPOC?

*The expert did not have experience in SIPOC, but believes this would be possible.*

8. In 3.1. & 3.2 do you believe that the tools would deliver solutions to deliver on the requirement given antifragile considerations?

*The expert did not have fixed views on these, but a discussion ensued as to the value of where this could be reached. The difficulty for him would be in limiting the amount of new knowledge that is created at a time.*

*He does believe that the systematic approach allows for a more concrete way in which the concept of antifragility can be made explicit in action in organisations.*

*He believes that this framework should not be implemented in entrepreneurial ventures.*

**These responses were beyond the questioning of the interview, but were valuable and were noted for further investigation.**

On Antifragility:

*He did note that it was an interesting field and that he sees value in actively pursuing the implication of this for organizations.*

*He mentioned that changes the current understanding of positive consequences due to shock.*

*His final comments in the interview is that the work is valuable and is definitely executable within an organization. He does believe that the value and the idea and concept is not obvious to all and that an individual would need to be open to accepting this rather than it being sold as a piece of work to everyone.*

**G3 - Univ.-Prof. Dr. Alwine Mohnen**

Chair of Corporate Management at the *Technische Universität München*

Professor Mohnen's research focus is on corporate management and personnel economics with a particular focus on incentive systems, performance measurement and remuneration forms. She is also the director of Experimentallabor of the Technische Universität München (TUM) which examines questions from the areas of behavioural economics and experimental economics.

**Table G-2: Prof. Mohnen professional timeline**

<b>Date</b>	<b>Event/Position</b>	<b>Institution</b>
2014 - Present	Chair of Corporate Management	Technische Universität München (Germany)
2011 - Present	Full Professor	
2008-2011	Full Professor	RWTH Aachen (Germany)
	Chair for HR & Corporate Management	
2006	Adjunct Professor	Business School at CEU Budapest (Hungary)
2005-2006	Visiting Scholar	Business School at Stanford University (USA)
2002	PhD	University of Cologne (Germany)
1998-2002	Research Assistant to Chair of Managerial Accounting	University of Vienna (Austria)
1997	Diploma Degree in Economics	University of Bonn (Germany)

**Rationale for interview:**

Prof. Mohnen is seen as an expert in the field of corporate management and personnel economics with a focus on incentive systems, performance measurement and remuneration forms.

### **Areas of validation:**

The validation with her focussed on the work in the framework which placed a tool, SIPOC diagrams, as an example of a tool that would help participating workshop members to deliver on the necessary outcomes of the phase in the framework.

She was also asked to provide her input on the phases 3.1 and 3.2 in developing solutions to the gap created in phase 2.2 and 2.3 (see slides).

### **Slides for validation interview:**

See *Towards an Antifragile SA SME 14102016\_Experts.pdf*.

### **Environment:**

**Date of Interview:** 18 October 2016

**Time of Interview:** 10:00 AM (Central European Summer Time)

**Total validation and discussion time:** 57mins

**Present:** Univ.-Prof. Dr. Mohnen

Denzil Kennon

Andreas Fabian Hees (TUM Representative of Prof. Dr. -Ing. Gunther Reinhart)

### **Responses:**

1. Did the respondent have prior knowledge about Antifragility?

No.

2. Key considerations to the success of 2.2 and 2.3?

*The respondent responded that transparency is important in the framework. The process needs to be transparent as well as how people respond to the framework. The peer pressure of having goals become visible for all allows for self-direction and motivation (intrinsically) is a valuable outcome of this process if done correct.*

*Trust is critical, which is needed or could be fostered by this process, within the organization. Everyone needs to feel comfortable with a culture of failure as a way to induce learning in the organization.*

*The role of supporting functions will also be more clear to the harder science employees, e.g. Engineers who would previously have brushed off these functions as non-critical or non-*

*important. This process will help improve the visibility of the supporting functions to the organisation's success and thus also the harder science functions, e.g. Manufacturing.*

*A shared language will need to be formed, which probably will in these workshops. This gives e.g. Engineers and financial supporting services the common language in order to communicate to each other on a more transparent and clear manner. Engineers will be better equipped to share technical information/documentation and make it translatable to finance, and the other way around.*

*The process allows for a contingency plan to handover within an organization as everyone gets a more clear picture of the whole.*

*It might be very important for HR to hire the right people to allow for this culture change, as it can sometimes not happen with current personnel.*

*People will need to start thinking like entrepreneurs in sharing their information with others, as well as how they act which is valuable within the organization. Communication will improve as a result of training... this could be through learning/training in the process or it will need to be introduced in another way.*

*This is quite a good point to start from as, e.g. Finance's position will need to be robust in one consideration, and very antifragile in another...this depends on the type of position of the company in the market and the market volatility. The flexibility here should for that.*

*Again, when in these workshops, HR will also be made aware of the type of people to be hired to align with the culture.*

### 3. Would they be adequately addressed by SIPOC?

*The expert did not have experience in SIPOC, but believes that the open transparent process over a mutual tool to deliver on this would be possible.*

### 4. In 3.1. & 3.2 do you believe that the tools would deliver solutions to deliver on the requirement given antifragile considerations?

*Well, there would be different approaches. One organization might have a big currency risk in its organization towards another. So, some tools or ways in dealing with the difference risks would need to be for a specific company, but the view of internal changes as well as focussing on what can be done with the relationships is valuable.*

*Incentive compatibility was also raised as a tool to look into when aligning the employee's decision in a company to that which might affect them... I do not make decisions that hurt the company because I am aligned to that company.*

*In Germany, SMEs have 90% of the employment power and are thus protected in some way by aligning towards a political power in the country.*

*Yes, these tools would help, but the workshop members need to be open and aligned to getting innovative ways in bridging these gaps.*

*It must be noted that Prof. Mohnen immediately could start thinking about ways in which to address ways to counter various stressors. She immediately understood that the concept of antifragility was immediately made explicit in the framework and could understand various sub-systems' roles varying to either improve antifragility on a subsystem level, but especially to the antifragility of the organization.*

**These responses were beyond the questioning of the interview, but were valuable and were noted for further investigation.**

On what is given to the implementation:

*Projects should be comprised of multi-disciplinary teams to include all perspective. That is dealt with in some way to find the solutions, but it would be beneficial to have various perspectives in the project teams too.*

Last notes:

*In some of the discussions, Prof. Mohnen felt that the analysis of the interfaces from a regulator's point of view requires an unbiased view to either subsystem being on either end of the influence. This could sometimes be the CEO, but often the CEO would have a dual role. She proposes that the facilitator play a role in being unbiased in conjunction with the CEO.*

## ***Appendix H - Van Der Spuy Brink Curriculum Vitae***

After fighting Russians in the Cold War as an air crew member VDS Brink studied to be a geologist at the University of Stellenbosch.

Studied ten years in the University of Life as a part-time constable in the South African Police Service. Obtained the highest speaking qualification from Toastmasters International majoring in Storytelling and Humour. A several times Toastmasters' Southern African semi-finalist in Prepared English, Humorous Speaking and Afrikaanse Skouspel.

Studied post graduate in group behaviour psychology at Unisa. Successfully completed a two year course on short story writing winning the 2012 award for the best Anglo Boer War stories. Recently obtained ALTx director accreditation after completion of the Institute of Directors process including King IV and financial management.

After unravelling the earthquake risk of the proposed Koeberg Power Station, a decade in mining IT development, several years in mining business development in Vietnam, Mozambique, Peru, USA, Kazakhstan and Australia. Managed Industrial Engineering, Technology and Innovation for Kumba Resources.

Since 2002 MBA lecturer on strategy and innovation for Unisa, Milpark and currently marketing strategy for IMM/Open University. Marked final year projects and guest lecturing at Stellenbosch Industrial Engineering. Guided many companies and academic institutions (CPUT North West University's Vaal Triangle Campus and Mafikeng Human Sciences) in strategy development including SABC Radio live transmission with the Truth and Reconciliation Commission.

As public speaker addressed many groups including several graduation ceremonies for Unisa, Damelin and Milpark. Session leader for the Governor General of Canada, Her Excellency Michaëlle Jean, during her visit to South Africa.

Cofounder of Personera.com, winning the 2009 Microsoft Enablis award in the media category and the minister of science and technology's award for systems design. Raised R20m venture capital in the process and sold successfully in the USA. Mentor for new ventures at Stellenbosch's Innovation Lab.

A Jack of all Trades being a lecturer, company director, mentor and innovator while writing science fiction, horror and steaming love stories.

## Appendix I - SME Case Study Epictetus Framework Facilitation Plan

Session Plan					
Time	Item	Responsible Person	Description	Objective	Stage
8:45	<i>Arrive and Mingle</i>				
9:00	Introduction	CEO/MD		Understanding why we are all here	
9:10	Explain the day	D Kennon		Set expectations and rules	
9:30	Cracking the shell (each person's personal story)	D Kennon	Give everyone sticky notes and markers and explain the guidelines around the notes, and stories about themselves. Take down that which grabs your attention at any time and whether it applies to Why, How or What? In life: Who am I? Why am I here? Where have I been? What do I want to do?	To break down the fear that people have that others might judge them. Providing a feeling of vulnerability improves the trust.	
10:00	Transpose these onto the Why, How or What?	D Kennon	The sticky notes which they wrote on would now be grouped according to: Why do we do what we do as Imbizo? How do we do it? And What do we do?	The group starts working together as their ideas are starting to build together.	1.1
10:40	Information Session	D Kennon	The art market, investment and who are our clients	A short explanation of the market factors that promote the need for art	1.2
11:00	<i>Tea</i>				
11:20	Ideating the environment	D Kennon	Video: Dominoes pizza turnaround	Understanding the client and other market needs	1.2
11:40	Filtering ideas	D Kennon	Does the Why and How which I created make sense given the market information we have and agree on?	Double loop learning where boundary of enterprise and goal of enterprise are compatible	
12:10	Information Session	D Kennon	How complex adaptive systems work?		
12:20	<i>Lunch</i>				
13:00	Selecting Enterprise Units	D Kennon			1.3
13:30	Enterprise Unit Influences	D Kennon	Each unit describes what information and/or physical product they provide/get from another unit	To get a DSM populated.	2.1
14:30	Information Session	D Kennon	What is the triangle of system responses?		
14:40	<i>Tea</i>				
15:00	Enterprise Unit Classification	D Kennon	Each key person places his/her unit in the triangle together with an explanation.		2.2
15:40	Enterprise Unit Role Requirements	D Kennon			2.3
16:10	Information Session	D Kennon	What can combat the downside risk? What can gain from the upside risk?		
16:20	<i>Tea</i>				
16:40	Bridging the downside gap	D Kennon	The enterprise members first investigate the internal ways in which volatile inputs can be addressed and then focus on the interactions.		3.1
17:10	Bridging the upside gap	D Kennon	The enterprise members first investigate the internal ways in which volatile inputs can be addressed and then focus on the interactions.		3.2
17:30	Actionable Plan	D Kennon	Call to Action	Use of Effort to Return Matrix to pick projects	
17:50	Debrief and Goodbye	D Kennon & Group			