Understanding the threats to the reliability of Engineering Field Services and their value to the viability of AngloGold Ashanti’s South African operations

A Research Dissertation
Presented to the Graduate School of Business
University of Cape Town
In partial fulfilment of the Executive MBA
EMBA10 – 2008/2009
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ABSTRACT

AngloGold Ashanti’s South African mines face a real threat to the viability of operations as a result of a threat to a maintenance service, referred to as engineering field services, these services are critical to safe and reliable operations. This research paper presents the research findings to this impending threat and its impact and proposes strategic options of structuring this service in order to deal with the threat. Field services generally includes inspection, monitoring and audit functions on major machinery and engineering infrastructure.

Maintenance and maintenance management over the decades has become more and more important to executives, it is after all one of the major consumers of cost, according to Campbell (1995) this cost can go as high as 50% of production cost in the mining environment. These figures are also comparable to those seen at AngloGold Ashanti (AGA). Maintenance is important for other key reasons as well, such as safety and reliability of operations. The mining environment in South Africa and around the world has seen failures and accidents as a result of poor upkeep of infrastructure and machinery. In fact in the UK’s Oil and Gas industry as a result of major disasters in that industry, the HSE went as far as legislating Asset Integrity Management to ensure that companies deal with the safety integrity of their assets. Recently as a result of poor shaft infrastructure AGA had to shut down one mine for more than three months, impacting badly on the bottom line.

Asset Integrity is really about maintenance management systems that seek to achieve both the availability and reliability of assets, both in terms of safety and production. In AGA’s South African Operations field services is one such maintenance system that falls under the asset integrity management concept, in AGA these services were developed over the past 15 years. Their importance lies in the support that they give to engineering maintenance and thus ensure safety and operational reliability for the mines, resting assured that the major and critical machinery that keep the mine running are doing just that, safely and reliable. The major equipment include winding plants that carry people and material up and down a mine shaft as far deep as 3 km’s and up to 160 people per single lift and 6000 people a day. Many in the mining industry would remember the Vaal Reefs 2 Shaft disaster, where 103 people died as a result of system failures. These field services help to prevent this type of failure.

These services were originally established within AGA, but in 2000 were moved under Anglo Technical Division (ATD), a technical services department for the Anglo Group of companies, while AGA was partly owned by Anglo American plc (AA plc). Established as Anglo Field Services (AFS), AGA had to buy these services from ATD at a special rate for an internal group company. The concern is that the supply of these services is now under threat from a number of fronts, indicated by the force field analysis graph below. In summary, among the key threats to the supply of these services was the disinvestment by AA plc in AGA, the restructuring and cost cutting exercise at ATD in late 2009, which actually resulted in a loss of some services, and other such concerns as a possible Xtrata buy-out of AA plc. Obviously a threat to the
reliability of these services threatens safety and production reliability – operational viability in other words.

**Force Field Analysis - Increasing Threat to the Reliability of Field Services**

![Force Field Analysis Diagram]

Given this concern my research goal was framed as follows: To **study the value, nature and management of the engineering field services** in order to **understand the threats to the reliability of these engineering field services and why they threaten the viability of AGA’s operations** in order to help the organisation **understand the underlying causes** of these threats and therefore **enable decision making** towards a sustainable strategic approach to the engineering field services.

The nature of this problem is about future viability concerns, dealing with things that have not yet happened and may or may not happen; it is about looking for sustainable strategic approaches to manage these threats. I have used the Viable Systems Model to understand and locate the problem in an organisational system functions context that seeks to ensure viability as espoused by Stafford Beer (1981). I have also used Scenario Planning to help develop the field services strategic options. But in order to gain understanding of the underlying causes of the problem I used a research framework that helped me dig deep, go past the opinions of participants into the actual events that drive the problem. The research methodology and paradigm I found suitable for this was the grounded theory from a critical realism paradigm.

Critical realism gives an understanding of the world that separates individual experiences from actual events and the underlying mechanism driving those events. The grounded theory methodology allows one to navigate through this critical realist view of the world, by going through individual experiences – data from interviews, developing concepts that give meaning to the actual events and finally surfacing the causal links to develop a theory that attempts to explain the underlying mechanisms causing the events. The research result is a theory that explains threats to both the reliability of field services and operational
viability. It is presented in a causal loop diagram (CLD) that shows causal links among the core variables of the problem situation arising from the data; this is called the Concern CLD, it is shown below.

Each of the arrows in the Concern CLD represents a claim of a driving relationship between the variables. A positive sign indicates a direct relationship, while a negative sign indicates an inverse relationship. The CLD represents a dynamic situation of reinforcing mechanisms among the variables presented. What this CLD shows is that there are three core variables that drive the suitability of the field services strategic approach, skills management, conducive market conditions and enabling organisational objectives. A suitable field services approach will result in efficient and effective asset integrity management and thus ensure reliability of safety and production outputs, referring to operational viability. But in the first place production and safety outputs drive the organisational objectives, and so this completes a reinforcing loop, because in turn organisational objectives drive skills management and the choice of the field services strategic approach and could even influence market conditions.

I used this research answer as input into the scenario planning, as the Rules of the Game. The scenarios and field services strategic options were develop through this process, both are presented below as Figure 1 and 2, together with a matrix that integrates the options and the scenarios as Figure 3. The options plotted in the scenarios provide a tool to make a decision on how to structure the field services depending on how the reality turns out among the key drivers of economic conditions, skills management and company objectives.

**Figure 1: Scenario Matrix**
The research presents a number of other actionable knowledge items in chapter 5, including review of the training schemes for artisan to deal with the low levels of skills at BU’s, passing on some of the field services duties to artisan once trained, consideration of online monitoring in line with Thin Operating Platforms (TOPs) idea and a number of others. The research did not develop these opportunities, each provides an opportunity to deal with the threats either under the options presented or separately depending on the scenario, and some need to be implemented regardless. The recommendation is that they at least be studied and/or developed and put into action.
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<th>Description</th>
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<td>AAC</td>
<td>Anglo American Corporation</td>
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<tr>
<td>AAplc</td>
<td>Anglo American plc</td>
</tr>
<tr>
<td>AFS</td>
<td>Anglo Field Services</td>
</tr>
<tr>
<td>AG</td>
<td>AngloGold</td>
</tr>
<tr>
<td>AGA</td>
<td>AngloGold Ashanti</td>
</tr>
<tr>
<td>ATD</td>
<td>Anglo Technical Division</td>
</tr>
<tr>
<td>BU</td>
<td>Business Unit</td>
</tr>
<tr>
<td>Concern</td>
<td>In the context of this paper it is a problem that requires attention in a problem situation</td>
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<tr>
<td>CBOT</td>
<td>Concern Behaviour over Time</td>
</tr>
<tr>
<td>CLD</td>
<td>Causal Loop Diagram, a diagram representing relationships between variable concepts</td>
</tr>
<tr>
<td>CCLD</td>
<td>Concern Casual Loop Diagram</td>
</tr>
<tr>
<td>Field Services</td>
<td>An engineering maintenance and audit system that includes inspections, condition monitoring and audit functions on major machinery and engineering infrastructure in AGA’s South African mines</td>
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<td>VSM</td>
<td>Viable Systems Methodology developed by Stafford Beer</td>
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ACKNOWLEDGEMENT

The Executive MBA has been a life changing experience. It was for me as much a personal growth experience as it was a social learning process. To Tom Ryan, in the EMBA programme you have developed what I believe is the best form of adult learning in institutions of higher learning, thank you for that.

Thank you to all the lecturers; you all have brought great value and a different experience of learning to this journey. To all the support staff in the EMBA, you were brilliant. Sherry Walklett, thank you for your great help and support through-out the process, in particular during inter-modular periods.

I thank all my EMBA 10 classmates for the wonderfully engaging journey. Ingo thank you for your friendship and the ‘return sanity’ walks during study schools; the selmon collar was great too! To the Elephant of the South - Mzimkhulu, I thank you for your constant support during the inter-modular work, the phone calls did the trick every time.

Much appreciation and gratitude goes to all the research participants, thank you for your time and insights. To Harry Calver, the conversation I had with you was rich in wisdom. Thank you for sharing your experiences with me.

To Iain Menzies, thank you for supporting me when I chose to do this program and insisting that I continue with it when I was in doubt.

Lastly, to my family, thank you for your understanding during the times of absence and at times even when I was home. I am grateful for the time you have allowed me to do this work. To my wife Monica, you have been a great support and encouragement when it was most tough in this process, without that I might not have seen this it to the end. To my kids, Thapelo, Sihle and Nandi – I have set the bar for you to surpass, reach for the stars.
1. INTRODUCTION AND OVERVIEW

AngloGold Ashanti’s South African mines face a real threat to the viability of operations as a result of a threat to a maintenance service, referred to as field services, these services are critical to safe and reliable operations. This research paper presents the research findings to this impending threat and proposes options of structuring this service in order to deal with this threat.

1.1. THE NATURE OF FIELD SERVICES IN THE ANGLOGOLD ASHANTI SOUTH AFRICAN MINES

Field Services generally include inspection, monitoring and audit functions on major machinery and engineering infrastructure. These services serve both as an assurance and maintenance function for major equipment in the mines. In this section the nature and value of the field services are discussed and then the research concern and question are described, and finally the research answer is summarized followed by an evaluation of the process to get to the answer and the implications of the answer.

1.1.1. THE VALUE OF MAINTENANCE IN ORGANISATIONS

In the past couple of decades' maintenance and maintenance management has become more and more an important part of the business processes and their success. Campbell (1995) in his Uptime book, suggests that many executives and senior managers are surprised at the cost of maintenance. He acknowledges that maintenance costs vary from industry to industry driven by how capital intensive an operation is; these costs can go as high as half the cost of production in the mining sector. The figures quoted are comparable to those seen within AngloGold Ashanti mining operations. Sundberg (2003) says the problem with maintenance is that 'its costs are easily measured while maintenance contribution to revenue is not', so this becomes an easy target for cost cutting instead of cost improvement.

Campbell agrees, saying as critical as maintenance is, unfortunately 'to managers concerned with the end result and how to sell products it may seem inconsequential, a matter of tweaking here, (and) tightening there'. This is very far from the truth, maintenance and maintenance management could become quite complex, particularly when taken with all the production demands. Maintenance is very important in a business, according to Campbell maintaining physical assets gives a business capacity to produce and provide goods and services and to produce and supply them consistently. Field services suffer these same problems, their contribution to revenue are not direct but are actually key to ensuring machinery upkeep thus assuring operational reliability and therefore consistent revenue.

The complexity of maintenance management lies in the following concerns that Campbell raises as questions:
How do we attract and keep capable people to maintain sophisticated equipment systems?
What is optimum level of maintenance parts, materials and consumables?
Do we need specialist maintenance engineering support?
What organisation arrangements are appropriate?
How much and what should we contract out?

The questions he raises are no different from the questions that this paper is dealing with about the engineering field services, even though field services is a much more focused area of maintenance and maintenance management, the questions and challenges remain the same.

The key point being made is that maintenance is important and needs the attention it is being given in this paper. Indeed for AGA some of the machinery we use in our mining operations is highly expensive, complex and need highly specialized skills to maintain. Most importantly, their failure could have major disastrous consequences, both in production and safety. In this context I can mention two examples to illustrate the point, in South African mining industry everyone would remember the 1995 Vaal Reefs No.2 Shaft disaster where 103 people died. More recently, one of AGA’s mines suffered a three month closure as a result of poor upkeep of shaft infrastructure which, following a fatal accident that resulted in major production losses. There have been many similar incidents in the South African mining industry that have had major safety and financial impact, so maintenance management is highly important to mining.

Lastly, I will address what are field services; I have included in the appendices the list of the various engineering field services. What I show on the list in appendix 1 details about these services, what they cost, how often they are performed and what skills are required, etc. Mostly the field services maintenance work falls under the banner of predictive maintenance. As such many of the services take the form of condition monitoring using specialized instruments, tools and methods. Many others take the form of performance testing of the actual machines and their safety protection equipment and systems, while others are simple observations using the five senses. These services can be split into two categories, maintenance processes and audit functions, ensuring both reliable production and safety. This is presented in a matrix below, Figure 1.1.1, showing some of the services to illustrate where they fall within the matrix.

In summary the importance of the field services lies in the support that it gives to engineering maintenance and thus ensure safety and operational reliability for the mine, resting assured that the major and critical machinery that keep the mine running are doing just that, safely and reliable.
1.1.2. **The Value of Field Services to the Underground Mines**

AGA’s South African operations are deep underground mines with many single drop mine shafts at 2km on average and the deepest at 3 km single lift. In these mine shafts, they transport people, equipment and production materials in and out of the mine and ore out of the mine. These shaft transportation systems are highly critical for the operation of the mine and must be highly dependable, firstly because they are the lifeblood of the mine operations—being the only access to the workings, secondly even more critical because people’s lives are dependent on them. A large mine shaft, for example, transports on a daily basis up to 6,000 people, with up to 160 people in a single lift. The risk involved in such operations cannot be underestimated. It is in this area that most of the field services are critical, from magnetic rope inspections, shaft guide alignment, to static and dynamic winder tests and other NDT condition monitoring services, all services are geared to ensuring firstly the safety of these winding plants and secondly reliability of operations.

Winding plants though aren’t the only critical engineering infrastructure in underground mining. Probable just as important as winders are main ventilation fans that supply air into the workings, refrigeration plants for cooling that air, at these deep levels at 3.5 km the virgin rock temperatures go above 50 degrees Celsius. There is also service water and compressed air required for mining operations, large air compressor plants supply compressed air, and large mine dewatering pumps in the region of 4MW of power consumption each, among the largest. There are field services to support all this major and critical equipment in the mines to keep them running safely and reliably. Field services also help to maintain the design capability and functional capacity of the equipment thus save on energy wastage and costs related to inefficiencies. They help extend life of equipment.

Furthermore the existence of the field services department has also been of great value because of the constantly declining levels of maintenance skills in the mining operations. This was confirmed by the
field services specialists, increasingly they find there is lack of experience and know-how among section engineers, foreman and artisans – where the frontline responsibility for equipment maintenance lies. These specialists are finding more and more that there are failures or areas of neglect that previously were unlikely to be found, such as obvious oil leaks after maintenance staff have done their inspections. To illustrate the point, recently at one of our plants, a mill sustained a crack that went around the mill end, as much 270°. This is incredible when you to think that this crack would have taken a long time to develop that far without anybody noticing it or paying any attention to it. Field services have been of great value by bringing knowledgeable people to look at the condition of machinery and be able to advise on appropriate action to ensure the upkeep of machinery in the operations.

1.1.3. THE CONTEXT OF THE PROBLEM – THE HISTORY OF FIELD SERVICES IN ANGLOGOLD ASHANTI

AngloGold, a South African based gold mining company, was established in 1998 before it later joined with Ashanti Goldfields of Ghana and became AngloGold Ashanti. AngloGold (AG) was formed when the former Anglo American Corporation (AAC) was unbundled into a number of subsidiaries and Business Units, among which was Be Beers Limited, Anglo Platinum, Anglo Coal and others. In this unbundling Anglo American still owned 50% plus one share on AG. Up until then, most of what became AngloGold was formerly known as the Gold Division. The Gold Division was made of three regions in South Africa, the Free State Mines, Vaal Reefs Mines and the Western Deep Levels Mines including Elandsrand.

Back in those days each mine used to have their own services within and most of the services that are now considered field services would either have been offered by the OEM’s (original equipment manufacturers) or by skilled technicians, artisans and specialists from within the mine. Over the years, with the improvement of technologies and maintenance methods such as condition monitoring, specialist equipment technicians and engineers were given opportunity to develop in these new fields. In particular this development occurred among large rotating machinery such as fridge plants, fans compressors and large multi-stage mine dewatering pumps and later on winding plants. It is in the formation of AngloGold in 1998 that these services were first pulled together under one umbrella that became known as field services.

Following the so called 'cooling off period' where AGA and De Beers in particular were not allowed to use Anglo Technical Division (ATD), a technical services department for the Anglo Group of companies, the field services were rationalized under ATD and called Anglo Field Services (AFS). AFS was made of skills from AngloGold's field services; from then on AGA would buy services from AFS on charge out basis, using special internal company rates. But, AGA did not let go of all the specialists, retaining a specialist for each critical area, e.g. winding plant’s electrical and mechanical specialist. Among the
duties of the internal field services specialists retained was to manage the services offered by AFS on behalf of the mines. They manage both the contract and the quality of the services, monitoring the reported conditions of equipment and giving advice to engineers at the mines on the actions to be taken. They were also required to be involved with technical audits of the equipment, as specialist.

There were also field services that were not moved over to the AFS possible at the time they were not considered critical as a service for AAC. This includes the major dewatering pumps and refrigeration plant performance monitoring. Having this service internally has proved over the years to be a competitive advantage, some of our pumps are among the best maintained and performing pumps in the deep level mining industry. This is confirmed by suppliers who do major overhauls of these pumps from all industry, in deep underground mining. This point about the nature of these services needs to be made; they are special because deep level mining is a 'niche' area of industry, certainly even more so with drastic shrinkage of the past fifteen years and South African deep level mining is known for its expertise, mainly in shaft infrastructure expertise, AGA has some of these key skills internally.

1.2. The Problem – Increasing Threat to the Reliability of Field Services

The past three years saw AA plc slowly disinvesting in AGA with the final shares being sold in the middle of 2009. With these changes all the services that AGA received from Anglo Technical Division almost doubled in price, AGA was now an external company and therefore had to be charged accordingly. But it was during the first sell-off of shares in 2008 that AGA began to have concerns of losing the service of AFS. It stands to reason that once AA plc owned nothing of AGA, they most likely would want nothing to do with AGA, it serves them no benefit, at least not readily obvious. Secondly, in time AGA is likely to become a competitor, and why would AA plc want to give services to their competition. At the time when all this was happening ATD management, under which AFS falls, made commitments that they will continue servicing AGA. The challenge for AGA is that even if these commitments were made, at what point is AA plc likely to want to server the relationship and no longer give the services. This question has no clear answer, and so a bit of apprehension about the services of AFS remained.

It was during this time that an exercise was conducted to see if any of the services that both ATD and AFS offered to AGA could be received externally. A number of the ATD and AFS services could be replaced by other suppliers. A number of smaller suppliers and OEM's who supplied a number of these AFS services existed, but the level of trust on these suppliers was and is a concern for AGA, a short report compiled in 2008 by Bill Pautz confirms this. Of concern were services in some of the safety critical items like the winder rope inspections and winding plant static and dynamic testing? The challenge here was that most of the field services that AGA is dependent on were supplied by AFS and that a number of the specialist technicians who have know-how in these specialist areas are
within AFS. For example, of the 14 certificated rope inspectors in South Africa, AFS has 8 of them. Therefore once again the concern about the field services remained.

There are also a number of other concern areas that compounded this problem, such as the skills shortages in the market and expected growth demands in platinum mines. I have already alluded to the challenge with the low maintenance skill levels in the operations, which is really the start of the problem, in my mind. The resources boom that preceded the recession exposed this very fact when every operator was expanding, technical skills became very hard to find and became highly expensive. With the recession many stopped training programs that had been established with the resources boom. Within AGA, we had the same experience.

In fact before the recession, there were a number of deep level shafts that were being sunk in the platinum mines and many more studies being conducted but put on hold as a result. This is another issue that has caused concerns for AGA; Anglo Platinum owned by AA plc has a number of shafts and sinking a couple more and as result the AFS work has increased more and more in Anglo Platinum. In fact over the years, when AFS was established, 80% of the work was from AGA, this was down to 40% in 2008, according to ATD board reports, not because the amount of work reduced at AGA, rather because of an increase in platinum deep level mines. The growth demand in that region is clearly a cause for concern given that there is little training and development happening in industry, how will it impact on the availability of the services to AGA in future. One of the immediate concerns is that during the cause of this research AFS moved their regional office from where it has been over the years, close to AGA operations, over to Rustenburg closer to Anglo Platinum mines. These clearly, are signs showing the prioritization of AA plc operations over AGA and possible the increasing demand of AFS services in the platinum mines. The prioritization of AA plc operations was in fact a statement made by one of the managers of ATD more than once while AA plc was undergoing the restructuring.

Even though ATD made new commitment to servicing AGA, the comment pointed out a reality, that ATD services and hence AFS services really exist for AA plc. Yes ATD will sell its services to external companies so long as there is benefit accruing to them in order to maintain a viable service to support AA plc operations, which is their mandate. And this is the reason that AGA’s concerns were heightened even more in the last 6 months when the ATD’s services were once again put under new threats such as the restructuring process, the change in technical management at AA plc and the possible Xtrata buy-out of AA plc. The possible buy-out by Xtrata of AA plc seemed, to us at AGA, to pose the biggest threat. This was a concern because of what we know about the way Xtrata operates or runs its businesses, with regard to lean corporate structures or services. When they buy other corporations, they have the reputation that they pull them apart and sell-off the bits that do not seem core mining business, such as the support services. A case in point is MIM, an Australian based mining company
that Xtrata bought a number of years ago; they did just that, pulled it all apart and sold off the technical support services.

The second threat was the change of the Technical Director and the Head of Engineering; the concern with this was implication to strategic change and the level of relationships that had been established with previous incumbents that would now not exist. So the changes necessarily had to bring about new levels of apprehension. Soon after this a cost cutting exercise was announced together with a restructuring, the extent of which meant a major cut in the corporate office in Johannesburg which included cuts within ATD. All of these three concerns were the reasons that gave rise to this research exercise.

In the cause of this research, the last two concerns were realized. In the initial exercise of cost cutting the cuts resulted in some of the AFS services being lost, specifically the electrical machinery inspectors, which AGA used extensively, AGA was not even consulted on this issue. But, a follow up restructuring did not come without changes that would impact on AGA, it resulted in a loss of some of the specialists skills to servicing AGA. AA plc separated what it calls technical services and an engineering core function; the technical services could be bought out but not the core engineering skills. Some of the specialist’s skills that were available through ATD, were now belonging to the engineering core function and therefore lost to AGA. This came about with the appointment of a new Head of Engineering who seems unwilling to share any of the core skills externally. So AGA concerns are real and with some realised in cause of this research, ATD can no longer be trusted to continue giving services to AGA, in spite of the promises.

I have presented in the paragraphs above what I would call the key drivers to a real and increasing concern about the dependability of the field services going forward. I have summarized these drivers in a graph below, Figure 1.2, called the force field analysis. I have super imposed on the same graph what I believe to represent the behaviour over time of this concern, the concern behaviour over time (C-BOT), an increasing threat to the reliability of field services.
In order to focus the research process, it is necessary to clearly define the research problem which is likely to be different from the practical problem and also define research question to focus the research process. This section seeks to show development of both the research problem and question.

1.3. Process followed to develop research problem and question

In defining the research question and problem I have followed the process defined in the book 'The Craft of Research' by Booth et al. Booth et al advise that in order to get to a good specific question that the research seeks to answer and more importantly to be able to express the problem that I want my readers to recognize and value, I need to be able to explain the following three questions:

1. What I am writing about – my topic: What am I studying?
2. What I don’t know about it – my question: What do I want to find out?
3. And why I want my reader to know about it – my rationale: What do I want my reader to understand better?

Booth et al also advise that the questions that ask who, what, when or where are important and should be asked in the research, but these questions may in most cases ask only about matters of settled fact. But that questions that ask how and why should be asked as they are more likely to invite deeper research and lead to more interesting answers. This approach is in line with my ontological approach.
of a critical realist, who is looking for deeper meaning. Booth et al also differentiates the research problem from a practical problem, they say:

- A practical problem is caused by some condition in the world that makes us unhappy because it costs us time, money, respect, security, pain, even our lives. And we solve practical problems by doing something that changes the world by eliminating the causes that lead to its costs, or by encouraging others to do so.
- A research problem on the other hand is motivated not by unhappiness, but an incomplete knowledge or flawed understanding. And we solve it not by changing the world but by understanding it better.

I have framed the resultant research problem and research question in Joseph Maxwell’s interactive model of research design.

1.3.2. **RESEARCH DESIGN**

I have used Joseph Maxwell’s Interactive Model of research design for the structure of my research design. Maxwell’s model is suitable for this research because it recognizes the systemic nature of particularly qualitative research. According to Maxwell, in qualitative study, “research design should be a reflexive process operating through every stage of a project”. This fits well with the research methodology chosen for this research, Grounded Theory, which is also reflexive in nature, going back and forth in the data, doing what is known as constant comparison. This method will be described later. Maxell’s research design model is presented below in Figure 1.3.2

**Figure 1.3.2 Interactive Model of Research Design by Joseph Maxwell**

![Interactive Model of Research Design by Joseph Maxwell](image)

The elements for the research design are described in a table below, Table 1.3.2.1, these components are not substantially different from the ones presented in many other discussions of research design, according to Maxwell, “what is innovative is the way the relationships among the components are
conceptualized, the different parts of the design form an integrated and interacting whole, with each component closely tied to several others”. My Research Design is also presented in a table below, Table 1.3.2.2

Table 1.3.2.1 Description of the Elements of the Interactive Model

<table>
<thead>
<tr>
<th>Element</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goals</td>
<td>Why is the study worth doing? What issues do you seek to clarify and what practices and policies do you want to influence? Why are you conducting this study, and why should we care about the results?</td>
</tr>
<tr>
<td>Conceptual Framework</td>
<td>What do you think is going on with the issues, settings or people you plan to study? What theories, beliefs, and prior studies will guide or inform your research and what literature, preliminary studies, and personal experiences will you draw on for understanding the issues you are studying?</td>
</tr>
<tr>
<td>Research Questions</td>
<td>What, specifically, do you want to understand by doing this study? What do you want to know about the phenomena you are studying that you want to learn? What questions will your research attempt to answer, and how are these questions related to one another.</td>
</tr>
<tr>
<td>Methods</td>
<td>What will you actually do in conducting the study? What approaches and techniques will you use to collect and analyze your data? This has four parts, 1) relationships you establish with participants, 2) selection of settings, participants, times and places of data collection and other data sources such as documents, 3) your data collection methods and 4) your data analysis strategies and techniques.</td>
</tr>
<tr>
<td>Validity</td>
<td>How might your results and conclusions be wrong? What are the plausible alternative interpretations and validity threats to these, and how will you deal with these? How can the data that you have, or that you could potentially collect, support or challenge your ideas about what’s going on? Why should anybody believe your results?</td>
</tr>
</tbody>
</table>
Table 1.3.2.2 My Research Design Framed in Maxwell' Interactive Model

| Goals | *I am studying the value, nature and management of field services because I want to understand the threats to the reliability of field services and why they threaten the viability of AGA’s operations in order to help my organisation understand the underlying causes of these threats and therefore enable decision making towards a sustainable strategic approach to field services.* |
| Conceptual Framework | Is it not time for AGA to re-establish its internal field service and do away with this dependence given that AA plc has disinvested in AGA early 2009? There is a new drive towards asset integrity and reliability engineering principles in the organisation – how can these be helpful in defining the nature and structure of our field services? The major concern with field services from experience is the lack of these specialized skills in the market found in AFS. I will use the systems thinking tools such as Viable Systems Model to look at how field services affect viability. Will use Scenario planning seeing that the nature of the problem is about future viability. |
| Research Questions | Why does the risk of losing AFS services pose a threat to the operational viability of AGA’s South African operations? What is the value of the field services to the viability of AGA? What is the sustainability of the AFS services to AGA? Is the risk of losing AFS services real? What services are offered by AFS? How dependent is AGA on these services? Can these services be obtained otherwise? What is the implication of buying these services elsewhere? What has been the impact of skills shortages been on field services dependability? These questions can be summarized to this all encompassing research question: *What threatens the reliability of field services and why does this pose a threat to the viability of AGA’s South African Operations?* |
| Methods | Critical realism as an ontology or philosophy that informs our understanding of the world would be followed in this research. A qualitative research methodology, the Grounded Theory process will be used to conduct the research. Conversational interviews will be the main data source, supported by applicable data from archives and suitable literature. The Ladder of Inference as a model for getting to the bottom of the issues in interviews will be used – the model asks what assumptions, beliefs, cultural meanings inform the opinions presented. The Viable Systems Methodology will be used to locate the problem concern to help focus the research in a key area of viability for operations. |
| Validity | Having had experience with the AFS and their services, I will have to be careful of my own opinions on the matter. Interviews held with AFS could have a lot of bias, given that AFS would prefer to keep going as long as possible in the current form. In all interviews there is a need to triangulate the sources it is crucial as all participants are likely to have biases. The ladder inference will be useful here. I need to get to the bottom of the issues – in other words, what informs the opinions, rather than the opinions themselves. I will need to follow grounded theory process and allow myself to be challenged by the data by keeping an open mind. I will also use the theory of values, critical system heuristics and the Velasquez to review the outcomes. |
1.4. RESEARCH OUTCOMES

1.4.1. THE RESEARCH ANSWER

The research answer is a theory represented by the causal loop diagram (CLD) below that explains the underlying mechanisms that drive the reliability of the field services and the value it brings to operational viability, I call this the concern causal loop diagram (CCLD). The concern is the core thesis of the problem situation.

Each of the arrows in the CCLD represents a claim of a driving relationship between the variables. A positive sign indicates a direct relationship while a negative sign represents an inverse one. The CLD shows a dynamic situation of reinforcing mechanisms among the variables presented. This concern CLD is broken down and discussed in detail in Chapter 4, arguments are made for each claim. Below I discuss a shortened version of the research answer represented in this CCLD.

The CCLD is made of what I call core variables that drive the concern of the reliability of field services and its value to operational viability. They are framed in a CLD, a theory that explains the concern's behaviour over time (CBOT), that is, why the threat has been increasing. The problem is not only with the changes in these variables, either positively or negatively, but also their relationships which creates the complexity in the problem, meaning a change in one variable always affects the other, either immediately or in a delayed fashion, and thus start a domino effect. This research answer explains the underlying causal mechanisms that have created and lead to the practical problem threat to viability of operations. It is the understanding it brings that allows for development of sustainable practical answers, what is called actionable knowledge presented in chapter 5.

I will explain the theory in a reverse fashion to the arrows of the causal loop diagram, starting from the Reliability of Production and Safety Outputs, the key driver of the concern. The Reliability of Production and Safety Outputs is driven by the Efficacy of Asset Integrity, asset integrity is about reliability and availability of machinery, which is achieved by field services and maintenance. The way to ensure reliability of field services and therefore enhance the Efficacy of Asset Integrity Management is by finding a Suitable Field Services Strategic Approach. But the suitability of field services strategy approach is driven by three core variables, externally Conducive Market Conditions, internally by Viable Skills Management and Enabling Organisational Objectives. And lastly, the king maker in this theory is the Enabling Organisational Objectives because they have impact on whether Skills
Management are viable or not and to some extent could influence the markets as well (dotted connection). Organisational objectives are about strategies, policies and organisational design. It is in turn driven by the performance of the company, Reliability of Production and Safety Outputs – which speaks to the practical concern of operational viability. This is because if for example the organisation was performing poorly, the organisation would review its strategy or may even fiddle with design and some policy directives that may be seen to be creating the problem of poor performance. But also important is the reliability of the outputs, investor and the markets do not take well to unreliable outputs; it would hurt the share price. AGA is currently putting systems to reduce variation in the organisations performances for that very reason.

1.5. The Rationale – Validity of the Research Answer

The research answer presented as the concern CLD is a grounded theory outcome, it was obtained through a rigorous grounded theory research process that produced the core variables and developed the relationships between these core variables. The answer comes out of the rigor of applying the research methodology presented in chapter 3. The research methodology sought to ensure a research answer that is grounded in the data obtained via interviews of key stakeholders involved with the field services. In chapter 4, the process as followed and its outcomes are presented to prove the veracity of the answer as an outcome of the research process. In Chapter 2 I present a literature review that locates this research answer in an existing body of knowledge, about maintenance management, maintenance contracting, labour market impact and the drivers of shortages of skills.

1.6. Reflection

In this introduction and overview I have developed and presented the problem this paper is seeking to deal with and why it deserves the attention it is given. First it showed how the field services are critical for the safety in mines and how machinery failures in the past have lead to disastrous consequences, beyond just financial losses. It was also shown how maintenance in particular in the mining environment can be such a large cash consumer and how failing to manage it can lead to both safety and financial losses. Lastly this chapter showed that there is indeed a threat building up on reliability of the field services; the threat comes from low level of skills at mines and skills shortages of the field services calibre. It also showed the rising demand of field services as a result of deep underground platinum mine development and lastly it showed how the changes within the AA plc have affected the dependability of the AFS services for AGA.

So, unless AGA finds a way to prepare for this threat, this could lead to serious failures in future when these services are finally lost or reduced in their effect. The usefulness of the answer in dealing with the research problem and therefore help resolve the practical problem I believe is proven in the actionable knowledge proposals given in Chapter 5. But here I deal with the usefulness of the research answer presented earlier. The theory (CCLD) shows the value of field services to reliability of
production and safety – through asset integrity management which is a key driver of reliable production and safety, reliable field services is what asset integrity is about. The answer also identifies the key threats/opportunities to the field services which are skills management, market conditions and organisational objectives. These three are key determinants of the suitability of a field services approach, because depending on their nature, any one option may be either appropriate or not. So the answer provides the key variables and their relationships, thus enabling whoever needs to deal with the problem understand where to focus. The answer obviously does not cover all details, but only focuses on the key major drivers for field services reliability.
2. LITERATURE REVIEW

This research seeks to understand the threats to the reliability of field services and why this threatens the viability of AGA’s operations in order to help AGA understand the underlying causes of these threats and thereby enable decision making towards a sustainable strategic approach to the field services. The purpose of this chapter is to review the body on knowledge that is relevant to this research and to locate the research answer, the emergent theory in this body of knowledge. I will seek to show how the emergent theory holds water in the literature and also seek to clarify its boundaries and test its generality against the literature and the relevant circumstances arising from the literature.

2.1. THE NATURE OF FIELD SERVICES

What is called field services in AGA South African operations – it is those engineering maintenance support services that tend to be specialized and therefore are not located within one business unit but rather are outside in a shared services type arrangement, some internal within the organisation and others external - outsourced. Many of the services take the form of condition monitoring using specialized instruments, tools and methods and many others take the form of performance testing of the actual machines and their safety protection equipment. These are the two major splits to the engineering field services in AGA South African operations. The services offered by field services fall within already established maintenance strategies, such as predictive maintenance and proactive maintenance in particular which consists mainly condition monitoring. In fact more and more organisations are moving towards condition monitoring and even going as far as online condition monitoring (Sundberg, 2003), where a technician no longer needs to go put probes and measure for example bearing vibration but instead have probes fitted on the machine as part of the design or retrofitted.

Condition monitoring is the process of monitoring a parameter of condition in machinery, such that a significant change is indicative of a developing failure (Wikipedia). It is a major component of predictive maintenance. Condition monitoring is a long established maintenance method mainly on rotating machinery, according to Sundberg (2003) it came about with the technical development of instrumentation and software and over the years the hand held instruments have become smaller and more powerful analytical tools. The first elements of condition monitoring in this form in AGA, came in 1991 at President Brand Mine in Welkom, Andrew Robbins one of the specialist engineers in field services today, wrote a paper about successful implementation of condition monitoring and its value on fridge plants. Some of the key condition monitoring techniques is the vibration analysis mainly on bearings of major rotating machinery, there is also oil analysis techniques such as spectrographic analysis, there is thermography where temperature differences are used to detect an impending
failure and ultrasound, all these are termed NDT (Non-Destructive Testing) techniques. According to Sundberg successful companies implement condition monitoring as part of maintenance strategy that supports the (maintenance) activity, and ‘condition monitoring is also used to identify the route-cause of the problem so that the right corrections or design changes are made’, this is called pro-active maintenance according to Sundalini (2003).

Maintenance management has developed over the years as its importance became more apparent and organisations follow different maintenance approaches, each approach is underpinned by some maintenance strategy. There are many forms and descriptions of maintenance strategy that are found in literature, I will only pick a few identified by Fitch (1992) and Sondalini (2003), which I found most applicable to AGA’s approaches to maintenances, they are:

- **Proactive Maintenance** – concerned with route cause condition monitoring;
- **Predictive Maintenance** – concerned with material degradation condition monitoring;
- **Preventive Maintenance** – based on natural sense and troubleshooting;
- **Breakdown** – which really is about post-mortem inspection after a failure has occurred.
- **Pre-emptive Detection and Elimination** – maintenance starts on the drawing board, during design;
- **Quality control and Assurance** – about ensuring that controls are in place during manufacture and assemble to ensure design criteria is met; and
- **Shut-down overhaul maintenance** – restoring design capacity.

The point about the list picked here is that all of the work that is done in the field services within AngloGold Ashanti (AGA) relates to all of these maintenance strategies. I have included in the appendices the list of AFS services and shown in that list where each has an element of one strategy.

### 2.2. Review of the Core Variables that Make up the Emergent Theory

The approach I have taken in the locating the emergent theory in a body of knowledge is to look at the body of knowledge around each of the core variables of the theory. This was done initially as part of the theory development in the Grounded Theory process, but is now done here with a larger scope, to look either supporting or deviating theories and arguments to the emerging social processes that inform each core variable and how it fits in the whole theory.

#### 2.2.1. Asset Integrity Management

Asset integrity management is the core variable that is made up of reliability and field services. Asset integrity management is about maintenance and inspection systems that ensure that equipment remain both available and reliable. A definition offered by one of the maintenance services providers refers to asset integrity management as ‘the management system that enables plant owners to maintain integrity of its assets in a fit for service condition for the desired life of the assets. According
To Oxy, Asset integrity systems include rotating equipment maintenance (e.g., pumps, compressors, motors) and mechanical integrity of stationery equipment (e.g., pipelines, pressure vessels, piping foundations, and structures). The list and types of equipment mentioned is same as the list that the field services inspection and maintenance processes look after in AGA.

Of interest when looking at literature about asset integrity is that in fact it is safety concerns that drove asset integrity management into the centre stage of critical installations. According to an Oil and Gas article on the history of asset integrity, asset integrity management was legislated in the UK in 1995 by the HSE (Health and Safety Executive) following a consultative process with the oil and gas industry as a result of a major disaster that killed 167 people in 1988 following a massive leak of gas condensate. According to this article asset integrity management was one of the three key elements that made up the 10 year strategy for improving safety in the oil and gas industry unveiled in 2000.

This is down the ally of the mining industry in South Africa in terms of safety improvement objectives. In AGA, the CEO’s ambition is to reduce fatalities drastically, the South African operations are still the main culprits in fatalities among the AGA operations. It comes as no surprise then when the new CEO introduced asset integrity audits during 2009 within AGA operations to deal with the safety and productivity of the physical assets among other things. Therefore asset integrity management is taking centre stage as well within AGA for similar reasons as in the UK oil and gas industry. This view is also supported by an article in Energy in Focus (issue 9, 2008), the article suggests that the energy industry is now turning its attention to reducing major incident risk through properly implemented asset integrity management systems. The article further suggests that among the primary reasons for improving the way asset integrity is managed is risk assessment and risk reduction.

In operationalising asset integrity, some integrity practitioners have developed what is known as Operational and Asset Integrity Management System (O-AIMS), the article claims that O-AIMS is a proven, lifecycle management system that delivers measurable risk reduction and cost benefits. And that its fundamental principle is ‘to ensure that critical elements remain fit-for-purpose throughout the lifecycle of the asset and at optimum cost’. Lastly, that O-AIMS is applied both in existing assets and new projects. For projects it ‘includes a process for developing integrity management budgets and schedules at project sanction stage’. And for existing assets, it ‘includes an authoritative review process that assesses and reports on the current condition of critical elements and compares the current asset integrity system with corporate and regulatory requirements as well as industry best practice. This is exactly what the field services work on the existing assets seeks to achieve as well in the South African operations. Some of the inspections and maintenance processes look to meet company objectives, regulatory requirements and industry best practices. While some of the field services are about maintenance systems of inspection and monitoring, others are for fulfilling an audit function – to achieve safety and operational trustworthiness.


2.2.2. **Skills Management**

Skills management is about how the organisation identify, hire, develop, performance manage, retain and finally deselect and dismiss talent/skills. Ultimately skills within an organisation can become a competitive advantage, from a resource based view of the organisation (Wernerfelt, 1984). The field services has highly specialized skills – unless there is a development of new skills now, when the resources boom again AGA will suffer. Therefore the skills driver in the skills management variable poses a serious threat on reliability of field services – an appropriate skills management response or strategy is necessary.

Sundberg (2003) makes a very useful claim referring to a shipping company that has oil tankers; he says by putting additional professional maintenance staff on board, this company saved millions of dollars per ship. This defines how an appropriate skills application in maintenance programs can bring successful asset management. I have shown how in many cases companies make a mistake in seeking profits by cutting costs and one of the first areas that gets a chop is maintenance, simple because as Sundberg (2003) puts it, ‘its costs are easily measured while maintenance contribution to revenue is not’. But it is not just any skills that need to be applied that gives the successes needed; they have to be appropriate for the situation. In other words, as this research shows, it is both about the level of internal skills and the type of skills that are available in the market. The application of skills in maintenance has to be suitable for that environment – there is no one size fits all in skills management.

For example, Durham (2007) when he discusses the shortfall of skills in the offshore industry suggests that there are arguments that say, among other reasons such as aging and lack of training and skills development, that the causes are that the industry is no longer ‘attractive’ enough for young people. He mentions problems like being far from home and the rise of the careers in IT and other spheres like the arts and others. As true as this may be in the developed world where the unemployment rate is quite low, in the single digits (before the recession of 2008), the same cannot be said for developing countries such as South Africa. Even in South Africa some have suggested that the mining industry and skills in engineering such as trade skills are not attractive to young people. This claim cannot hold water because there are masses of people who because of the high unemployment rate at 25%, with or without potential simple need an opportunities to be employed, trained and to gain a skill. Yes, the claim might be true for the young people who have opportunities, who within reason can ‘pick a choose’ any career they want to pursue, among this group mining, engineering and trade type careers may not necessarily be the first choice.

Durham also identifies ageing and a lack of new recruits as drivers for skills shortages, calling it a ‘pressing issue for industry today’. He concludes by saying that how well industry deals with these pressing issues could very well be a determinant of how productive the industry becomes in future.
The field services skills face the same challenges in South Africa. Unless there is an effective plan for dealing with the skills issues this could very well be a key factor to field services reliability, not just in terms of availability of services but also the quality of the services. But Durham proposes a tried method that is proving to be successful in closing the ‘gap in the middle’, meaning between the new recruits and the old hands which has become a norm, and that is what he calls cross skilling. Cross skilling means recruiting people who are already skilled in another engineering field or skills and taking them through a conversion programme to the new skills. The value of this is that you bring in mature skilled individuals who only need short intensive training courses to be competent in a new area, the individuals see the new training as ongoing development. This approach would work for field services because the nature of the job is such that recruits need to be individuals already highly skilled in maintenance work.

Williamson (1999) connects the skills shortages to reliability, asking the question, as the ageing skills disappear how will industries maintain high levels of equipment and process reliability that are demanded in today’s markets? He suggests that employers would be wise ‘to find ways to retain their high levels of experience and transfer their knowledge to younger workers’. He proposes another approach referred to by Fiscor (2001) as cross training, he suggests that focus should go to the current non-maintenance employees to be trained as maintenance mechanics and reliability technicians of the future, because they know the equipment and processes already. This approach has been quite successful in AGA, where operators have been accepted to train as artisans after obtaining a minimum trade qualification as acceptance criteria. These individuals have proved to be more successful because they are already familiar with our underground environment. But also importantly they performance is a known factor.

Williamson also points to critical success factors for a successful skills transfer; he suggests that top management must create a work environment that is conducive to senior employees sharing their skills and knowledge. The efficiency of any work environment is dependent on the work environment created by those responsible, top management. He further suggests that the future of a business most likely depends on how new employees are selected and hired, how they are trained and the rewards for a job well done. This point is an issue that came out in the research in relation to the level of skills of our maintenance staff, according to the research, there is number of jobs that could and should be performed by internal maintenance staff but ends up being a field services specialist duty. This is because somehow the level of training seems inadequate; lacking is some of the basic areas. The drivers for these conditions seem many and varied, possible an area of research on its own, but let me hazard to suggest that the problem lies both in the training content and quality at the training centres as well as during the on the job training. It is as Williamson suggests, that incentivized properly and assured of their jobs, experienced individuals may feel threatened and not see the value of transferring
2.2.3. **Market Conditions**

Market conditions covers all drivers in the market that lead to challenges for field services, from the availability of skills in the market to the availability of service providers, and from the demand of services or lack thereof because of economic status of the markets, to the structures of the economy such as the dictates of government policy e.g. employment equity, procurement practices, etc. All of these have some bearing to the best approach to field services. But the most critical of all conditions in the market currently besides the effects of the recession is the skills shortages as Kruger (2006) pointed, this could be a limiting factor to economic growth in a country, but could be just as limiting to a company based in that market. But it is also a good indicator of most of the other market condition issues.

Kruger (2006, 2 Nov Finweek) in his article Skills Spill recognizes that there is a shortage of skills in the South African market in general, he suggests that we experience this by its effects, such as bad service. He points to some of the widely accepted reasons within the South African context, which is emigration commonly referred to as brain drain and the impact of AIDS. He goes further to suggest that the shortage of skills is a result of a lack of willingness to work among many poor in South Africa, preferring to get government grants and unwillingness to earn little money while gaining practical experience by young people. In this first claim there is validity but on the grounds, as has been written about many a times in the South African press, of those who have become despondent about looking for jobs by virtue of them being in a the market for so long without getting employment. His claims would only if there was employment and skills development opportunity surplus and people chose not to look for employment or development.

I think Kruger fails to recognize an accepted fact that many large organisations in South Africa stopped training practical skills or reduced training programs drastically during financially difficult times, as do in many other countries. AGA has a shadow of the training numbers it used to have and so in Anglo American, Eskom, the Railways and Sasol and other mining houses which used to produce artisans and other skills aplenty. Among the drivers of large training programs, was the early 1980’s resources boom, when gold was at $800 an ounce level. During this time South Africa saw a great track of skills from the European countries, mainly the UK and the eastern block. There seems to be a natural cycle, when Markets boom, skills become scarce, large corporations start to train and develop skills, when the markets crash the opposite happens. Recently, the same has happened although not to the same effect, AGA experienced a shortage of draughting skills, it engaged a number of trainee draughtsmen,
as did a number of other companies, but this year it is stopping the training process and releasing the trainees due to cost pressures following the recession.

Fiscor (2001) supports this cyclic nature of the labour market, he suggests that all form of mining are cyclic, he speaks of the coal boom of the late 1970's and early 1980's. Speaking of the labour cycle about to hit the US in a few years from 2001, he suggests that the impact would have been huge on productivity and safety as new miners are being trained. The labour cycle seems to go against the market cycle, that is because the one lags the other. This a point supported by Williamson (2001), suggesting that the strongest economy in decades has seen the skills shortages reaching a critical point in every industrialized part of America. He points to the challenge of an ageing workforce and the low hiring of new staff as drivers of the concern with skills shortages that will create a challenge when the cycle turns. This point is also made by Durham (2007), suggesting that, besides demand, an aging workforce and lack of new recruits are the pressing issue for skills shortages. The problem is this creates what I call the ‘middle gap’ from one cycle to the next, it is created by this case of stopping a starting of skills development, because markets are never steady for long enough.

The lessons to be learned here is that, during difficult times, organisations should rather keep training knowing that the markets would turn. We have seen some companies do this in South Africa in the recent recession environment, 2008/2009. The South African government made a fund available for companies to put people under training instead of laying them off, as unavoidable as this may be at times. The point is skills shortages is a real challenge, the manner by which skills are managed in particular during difficult times will have an impact when the times are good again. This is an industry problem, but one that needs to be resolved by each market player internally first but also externally, industry bodies need to agree on strategic approaches to sustainable deal with the problem. The government through SETA’s tried to do this, unsuccessfully in many cases, but there have been a couple of successful cases. But, the key is industry players themselves dealing with a market issue.

2.2.4. Organisational Objectives

The variable termed here organisational objectives refers to all the facets about company goals that have impact on the choices made about maintenance, maintenance management, skills management, contracts management and issues of industry engagement. From the company mission statement to the business strategy, from company the vision to company directives, from policies to operating procedures and standards, from growth objectives to production targets and from organisational design to maintenance strategies, all of these are considered to constitute company objectives in this context. So for example company objectives dictate the nature of maintenance strategy and therefore field services approach. A number of the writers on reliability say that for reliability to be successful it needs to be supported by a policy, so that the entire organisation can focus on the correct thing to do (Sundberg, 2003).
Moubrey (1995) says that maintenance affects all aspects of the business effectiveness and risk – safety, environmental integrity, energy efficiency, product quality and customer service, not just plant availability and cost. Sundberg also suggests that sometime management takes a narrow view of maintenance, failing to see that it affects the whole businesses effectiveness. He further states that there are many other parts of the business that affect maintenance, such as procurement. The segregated approach does not help the cause of maintenance, alignment among departments is necessary. This is a case that only organisational objectives can resolve through organisational design and appropriate integrative strategies.

2.2.5. Field Services Strategic Approaches

At the heart of the strategic approaches to field services is the issue of whether you build an internal field services or you keep it external – outsourcing the service. The question really is which model would best deal with the challenges that lead to a threat of viability to these services. Now this is not a new argument in terms of maintenance approach, one thing is clear reading through literature, and that is there is no one size fits all, but every circumstance will be different. Depending on a number of drivers, the nature of maintenance that is complexity vs simplicity, availability of skills, amount of work at any one time in other words is the work seasonal or well spread over the year, etc. Bloch (1982) captures some of the key arguments in his comparison of the two approaches; calling them in-house maintenance and contract maintenance, see comparison tables below, Table 2.2.5.1 & 2.

Table 2.2.5.1 Comparing Advantages of In-House and Contract Maintenance

<table>
<thead>
<tr>
<th>Advantages of In-House Maintenance</th>
<th>Advantages of Contract Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under normal circumstances you have loyal employees with vested interest, who understand you maintenance objectives and can be trusted with proprietary features of your process.</td>
<td>Managers find that they can delegate details of work and leave the outside contract management to deal with it, thus giving them time to do what they need to do.</td>
</tr>
<tr>
<td>Generally aware of rules and procedures and recognize threat to termination of employment in case of proven incompetence.</td>
<td>Do not have to ‘create work’ just because there people employed needing to be kept busy. Easy to replace non-productive individuals. No responsibility for remuneration conditions, pension, medical aid, etc.</td>
</tr>
<tr>
<td>Internal staff must live with the results of their work, so likely to get job done properly.</td>
<td>It is generally expected that you get higher productivity from contracted staff.</td>
</tr>
<tr>
<td>In case of emergency, internal staff are right there, ready to work.</td>
<td>Are able to match size of maintenance workforce to given workload – therefore paying for what you need.</td>
</tr>
</tbody>
</table>
Table 2.2.5.2 Comparing Disadvantages of In-House and Contract Maintenance

<table>
<thead>
<tr>
<th>Disadvantages of In-House Maintenance</th>
<th>Disadvantages of contracted maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the right crew size? Putting more skills than the base-load work is clearly not cost efficient.</td>
<td>Risk of being stuck with an underperforming maintenance contractor on long term contracts.</td>
</tr>
<tr>
<td>Tends to encourage over staffing.</td>
<td>Cost generally tends to 'run away' over time, costing more and more over time.</td>
</tr>
<tr>
<td>More difficult to train and upgrade an existing maintenance force to keep up with technology. During shut down, it is not good time to do training.</td>
<td>Risk conflict with internal staff.</td>
</tr>
<tr>
<td>Tend to be short on depth knowledge because they encounter same equipment time and again. Tend not to have the same confidence like contract staff that have to deal with many different situations.</td>
<td>Risk of contractor not being immediately available when you need them for an emergency.</td>
</tr>
</tbody>
</table>

The issues raised by Bloch are similar issues that came up out of the research, even though in his work he was discussing actual maintenance work and overhauls, this is because these issue tend to be generic with all outsourced services. Hence you find that many organisations go through cycles of in-house services and then contracting and later in-house again, because the tendency is that each approach's costs and management gets out of control over time as the lessons learnt wane and the checks and balances disappear. One research participants put it this way, it is the contractor's goal to get you dependent on them for services, and once this is achieved it is easier to demand higher and higher prices for their services. The other driver is the market conditions, as indicated, in terms of work volume and skills availability. So clearly from these observations there is not one approach that is safe, what is required is some sort of a balancing act that considers all the conditions and permutations.

Bloch proposes a number of other variations and options such as: Peak Shaving Maintenance, use of OEM and independent contractors and lastly one called affiliations. I will discuss them in short. Peak shaving maintenance approach puts in-house maintenance crews adequate for the base-load work and contracting out the peak loads. Peak Shaving works in a market environment where skills and service providers are available, but would be very challenging and highly expensive in a market where there is a shortage of a certain type of skills, such as the deep level mining environment currently. OEM and or an independent contractor are options raised a number of occasions in my research. But OEM's are also affected by the situation of skills shortages, because as Bloch acknowledges as well, they tend to be thin on their satellite offices (due to global reach) having one specialist who pulls skills from the
market when he has major work. Talking to one OEM representative, he indicates that the issue of economic cycles is the reason they would not invest in developing a large number of skills and get into the field services environment, because they cannot be guaranteed workload in all ‘seasons’.

Bloch’s option of affiliates suggests that affiliates share own skills with others during overhauls, in this way these teams are kept proficient, because of a variety of exposure and knowledge sharing. The specialists within AGA who manage the current outsourced services are similar to these affiliate groups in that they get to be involved with every major overhaul or service of all equipment and new technologies that come into company in all 7 BU’s or Shafts. The disadvantage with the affiliate teams is that the company loses its competitive advantage, because of exposing internal propriety features to external people. The nature of AGA operations is such that the same effect of the affiliation can be achieved without letting in others to your “secrets”, because you have enough owned BU’s within the same region. This approach opens many other opportunities for developing or strengthening maintenance skills with AGA, such as bringing key artisans to a central space when there is peak work, major overhauls and emergencies for purposes of exposure and knowledge share.

The only other point to raise on this core variable is that made by O’Connor (1989) in what he calls contracting for reliability. The common approach to reliability contracts is one which ties an incentive or a penalty to reliability demonstration. This goes without saying then that every warranty is a reliability contract according to O’Connor. This is a good way of managing contracts, one that ensures that you can expect the best quality output on work done by a contractor. In my research work I discovered that the contract we have with Anglo Field Services (AFS) did not have this type of reliability requirements, stands to reason, were one company. In fact the AFS manager had misgivings about giving services to AGA’s operations in the other parts of Africa, a new area for them, because these mines had an expectation that AFS as contractor gives guarantees once they have done the services/maintenance act on equipment or machinery.

His misgivings were understandable, as O’Connor puts it, penalty arrangements have negative connotations, they can result in arguments and/or litigation. O’Connor proposes a straight incentive approach, because it is positive, motivational, easy to negotiate and lastly more likely to be accepted as offered. This because even though “they represent a small percentage of the customer’s savings due to increased reliability, they provide a substantial increase in profit to the supplier” according to O’Connor, and this makes sense. The implication of O’Connor’s proposal is that there is a way to make outsourcing work for you, by taking the incentivized reliability contract approach.

What I have done in this section is to locate each of the core variables in the body of knowledge; I have showed that all these concepts and their basic social-psychological processes are present in other industries. In fact in some cases, some very useful approaches have been proposed such as cross skilling, reliability contracts and others. I have also disagreed with some of the notions, such as the
view about the skills shortages in SA by Kruger, suggesting that among its causes is that people do not actually want to work. I showed that the real challenge is lack of opportunities to the point that people become despondent. I also showed that companies do actually have the power to act on the labour market front as suggested in the emergent theory, by acting differently during a slowdown in the markets. Instead of laying off skills, considering retraining – because soon enough the markets turn, but now you are short of skills if you laid them off and chances are they have moved on.
3. RESEARCH METHODOLOGY

This research seeks to understand the threats to the reliability of field services and why this threatens the viability of AGA’s operations in order to help AGA understand the underlying causes of these threats and thereby enable decision making towards a sustainable strategic approach to the field services. The purpose of this chapter is to explain the research methodology that was followed, which is Grounded Theory from a critical realism paradigm. This chapter shows why this methodology was chosen, the design process of the methodology and how a critical realist view informs that research process.

3.1. RESEARCHING MANAGEMENT PRACTICE

3.1.1. SYSTEMIC NATURE OF MANAGEMENT PRACTICE

The management environment has been characterized by the rise of management fads that promise to offer solutions to managers but on implementation rarely deliver. The problem with most of these management fads is that they have a tendency to take a limited perspective to management or be very linear and one dimensional in their approach. Jackson (in his book Systems Thinking – Creative Holism for Managers) put it this way, "Unfortunately, as many managers have discovered to the cost of themselves and their organisations, these relatively simple solutions rarely work in the face of significant complexity, change and diversity". The truth is that the management environment is dynamic and ever changing. According to Ackoff (1999), "we are almost never confronted with separable problems but with situations that consist of complex systems of strongly interacting problems". The implication of this is that in most cases problems are systemic in nature, in fact the management practice environment is systemic in nature and dynamic.

It is no surprise than that the latest thinking in management practice is moving more towards systems thinking approaches. If we are to deal with problems that are systemic in nature we will need approaches that are systems based, including the way we research management problems and the way we develop solutions that deal with systemic problems. One of the great teachers of systems thinking and its application to management practice is Tom Ryan at UCT’s Graduate School in Cape Town. He has a model for management practice that I find useful for management research to help frame the nature of the problem and focus the research process, it connects three important aspects about what happens in management practice, theory, practice and context. Ryan calls this a model of sense making, decision taking and action taking, the model is presented below in figure 3.1.1.

What this model in figure 3.1.1 suggests is that a problem or opportunity happens within a context, as a manager needing to deal with a problem I first need to make sense of the problem and come up with or find a theory that explains the problem in its context, this is a research methodology. Secondly, having understood the problem – the theory, I need a process of decision making to turn it into
actionable knowledge – practice, as Shcoltes put it, “the proof of a theory is in its successful application”. Lastly, once I have actionable knowledge I need an action taking mechanism to successfully implement the actionable knowledge and deal with the problem in its context.

**Figure 3.1.1: Tom Ryan’s Model of Management Practice (Context-Theory-Practice)**

### 3.1.2. The nature of my research

My research falls within the realm of sense making and decision making. It is about first understanding the value of field services for the operational viability of AGA’s South African operations, but secondly it is about looking for the best model of structuring the field services to ensure operational viability. Having accepted that the nature of management practice is systemic and therefore accepting that the problems managers deal with is largely systemic in nature, it is necessary to locate this problem in a system methodology. I have chosen the Viable Systems Methodology to understand problem context, because the concern affects the viability of operations. And for solution considerations scenario planning would the problem is that of an impending nature which is depended on nature of things that some of which have not happened but can only be hypothesized.

### 3.1.3. Viable Systems Model (VSM)

**VSM:** The Viable Systems Model is way of seeing an organisation as a system, by describing the required systemic functions to make it a viable system. It is a skeleton by which we can frame the functions of any organisation to ensure it can be sustainable. These functions are grouped in 5 system functions that interact in a specific manner to ensure that an organisation is a viable system.

**Viability:** In the context of organisation sustainability, the term viability refers to an organisation’s ability to maintain its successful existence in changing times and environmental needs in which it operates.
**Five systems and their relationships:** The five systems are, S1 – Operations, S2 – Coordination, S3 – Control, S4 – Intelligence and S5 – Policy, see figure 3.1.3.1 below showing VSM and how the systems connect. At S1 function it is where the core activities of the organisation take place, these are activities that meet the purpose of the organisation. S2 functions are activities that add value to the S1 and S2 functions by coordinating activities of S1 and giving feedback to S3 about those activities, ensuring that S1 and S2 have all the inputs they require to appropriately fulfil their duties. S3 functions give direction to and resources for the activities of S1 ensuring that S1 operates within its mandate, setting the mandate for S1 on the basis of policy and intelligence inputs. Through audits (S3*), S3 monitors what happens in S1 and thereby keeping control on S1. S3 also controls and makes input into S1 through the coordination activities of S2. S4 functions provide foresight for S3 and S5, it continuously scanning what happens in the environment and provides input into S3 and S5 and thereby ensuring that both S3 and S5 are informed in their decisions concerning the sustainability of the organisation. S5 functions provide boundaries in which S3 can control the activities of the organisation.

**Figure 3.1.3. Viable Systems Model (De Beer)**

**Levels of Recursion and their limitation to S1:** Growth in an organisation leads to levels of recursion; it is a way for an organisation to expand by replicating its activities so that it does not compromise its service offering. The numbers of replicated services need to be controlled to achieve the singular purpose. They are limited to S1 because in S1 lie the functions that fulfil an organisations activities. The growth in the other system functions is dependent on S1 requirements. At each level of recursion though there are all the 5 functions in a particular S1, because it must be self organising.
3.2. Research Approach

I have followed a qualitative research approach, to explain why I need to go into the philosophical
paradigms of the nature of my research and research context.

3.2.1. Research Paradigm

According to Guba and Lincoln (as sited in Schoepp, 2003) "a paradigm is more than a simply
methodology, it is a set of basic beliefs that deals with ultimates or first principles. It represents a
worldview that defines, for its holder, the nature of the ‘world’, the individual’s place in it, and the
range of possible relationships to that world and its parts”. The research paradigm best suited for the
nature of my inquiry is critical realism and the research methodology is grounded theory, both will be
discussed in the following sections of this chapter to elaborate on their suitability.

I will start by giving the philosophical landscape of inquiry. Schoepp (2003) in his article 'The Tenets
of Good Qualitative Research' presents what he calls the paradigm continuum of four competing
research paradigms based on the work done by Guba and Lincoln, I have revised this model slightly, I
replaced post-positivism with realism, the model is presented below in figure 3.2.1. I find from the
literature that there are four key basic belief systems or world views that guide research, these are
Schoepp (2003)). Some hold that realism is the same as post-positivism (Guba and Lincoln 1994), I
will not delve into that discussion as it adds no value to this process.

According to Christie et al, at an ontological level in 'critical realism reality is ‘real’ but only imperfectly
and probabilistically apprehensible and so triangulation from many sources is required to know it'
where as in positivism reality is ‘real’ and apprehensible. At a methodological level positivism
approach is about verification of a hypothesis through experiments or surveys and chiefly follows a
quantitative approach. Realism on the other hand requires triangulation and theorizing through
mainly convergent interviews and case studies, using interpretation of research by qualitative and/or
quantitative methods.

Moving on to the other two paradigms, constructivism provides a methodology for investigating the
beliefs of individual respondents rather than investigating an external reality (Hunt, 1991), within the
constructivist paradigm 'perception is not reality for reality is a blend of perceptions with reality'
(Christie et al, 2000). Constructivists believe that knowledge is a social construct meaning humans
construct knowledge and that therefore there is no objective reality (Schoepp, 2003). And lastly,
critical theory covers those alternative approaches that value lived experience. Critical theory assumes
comprehensible social realities that incorporate structures over time and accepts that there are
multiple social realities, which are constructed by groups involved in research (Christie et al, 2000).
Ontology is part of our worldview that explains how we understand the ‘world” and epistemology is part of our worldview that explains how we create knowledge about the world. Lastly, Schoepp describes methodology as the study of practice and procedure, in this context; it is about understanding and following a method of inquiry. My ontology is critical realism which falls within the critical theory paradigm and the epistemology is grounded theory, both are discussed in detail in the preceding sections of this chapter and I have located them in the continuum in the model in figure 3.2.1. Grounded Theory is a qualitative research methodology, below I shall discuss the differences between quantitative and qualitative research in order to show why a qualitative research approach is more suited for my research problem.

3.2.2. QUALITATIVE AND QUANTITATIVE RESEARCH

To summarize what qualitative methodology is, a definition by Denzin and Lincoln (1994) is good overarching descriptor:

*Qualitative research is multi-method in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. Qualitative research involves the studied use and collection of variety of empirical materials – case study, personal experience, introspective, life story, interview, observational, historical, interactional, and visual texts – that describe routine and problematic moments and meanings in individuals’ lives.*

The best way to describe the two methodological approaches of research is by contrasting them against each other, in this way I ‘cut to the chase” as it were. The differences in qualitative research and quantitative research are summarized in the table below, Table 3.2.2. The list in the table is by no means exhaustive or precise it is only indicative or the differences.
Table 3.2.2 – Features of Qualitative and Quantitative Research

(Table taken from http://wilderdom.com/research/QualitativeVersusQuantitativeResearch.html)

<table>
<thead>
<tr>
<th>Qualitative</th>
<th>Quantitative</th>
</tr>
</thead>
<tbody>
<tr>
<td>The aim is a complete, detailed description.</td>
<td>The aim is to classify features, count them, and construct statistical models in an attempt to explain what is observed.</td>
</tr>
<tr>
<td>Researcher may only know roughly in advance what he/she is looking for.</td>
<td>Researcher knows clearly in advance what he/she is looking for.</td>
</tr>
<tr>
<td>The design emerges as the study unfolds.</td>
<td>All aspects of the study are carefully designed before data is collected.</td>
</tr>
<tr>
<td>Researcher is the data gathering instrument.</td>
<td>Researcher uses tools, such as questionnaires or equipment to collect numerical data.</td>
</tr>
<tr>
<td>Data is in the form of words, pictures or objects.</td>
<td>Data is in the form of numbers and statistics.</td>
</tr>
<tr>
<td>Subjective – individuals’ interpretation of events is important, e.g., uses participant observation, in-depth interviews etc.</td>
<td>Objective – seeks precise measurement &amp; analysis of target concepts, e.g., uses surveys, questionnaires etc.</td>
</tr>
<tr>
<td>Qualitative data is more ‘rich’, time consuming, and less able to be generalized.</td>
<td>Quantitative data is more efficient, able to test hypotheses, but may miss contextual detail.</td>
</tr>
<tr>
<td>Researcher tends to become subjectively immersed in the subject matter.</td>
<td>Researcher tends to remain objectively separated from the subject matter.</td>
</tr>
</tbody>
</table>

My research has taken a qualitative research approach because it is not about counting who wants what type of services and from which service providers, and thereby deciding on the basis of popularity, so to say, the way forward. Instead what is required is to understand what engineers and engineering managers see as value in the services and the service providers and why they believe these services are under threat. The research seeks to understand how the engineers want the field services structured and why; so that I can form a picture of the field services from the experiences of the engineers and the meaning they give to these services in the context of operational viability. This enquiry therefore needs to take the form of qualitative inquiry because I am seeking to understand the how and the why of field services value to operational viability.
3.3. THE ONTOLOGY – CRITICAL REALISM

Critical realism was developed by Roy Bhaskar who took a scientific realism approach to social sciences. Yeung (1997) summarizes critical realism as a philosophy that celebrates the existence of reality independent of human consciousness, ascribes causal powers to human reasons and social structures, rejects relativism in social and scientific discourses and re-orientates the social sciences towards its emancipatory goals. Nick Burnet describes realist theory as being based on three ontological premises about social reality: firstly that of intransitivity; secondly, the stratification of reality and; thirdly, the presence and role of causal relations operating in social reality.

3.3.1. CRITICAL REALISM ONTOLOGICAL PREMISES AND THEIR VALUE TO MY RESEARCH

According to Bhaskar, intransitive objects are those objects that exist independent of our knowledge of them, the real things, structures, mechanisms and processes, events and other possibilities. Transitive on the other hand consist of things known to us, that we already have descriptions for them. Another good way of looking at this is that ‘things exist and act independently of our descriptions’. But, we come to know them in society by the description we give them, but it is worth noting that those descriptions belong to society and individuals while the real structures and objects belong to the ‘real’ world. Burnett makes useful statement that describes the purpose of research, he says that ‘some things that exist in the intransitive dimension can become progressively known through the interaction between human theory and experience’ and that this is what research seeks to do, so that the veiled slowly becomes unveiled.

Bhaskar (1978) also spoke of stratification of reality into three domains of reality, namely the empirical, actual and the real domain, see table 3.3.1 below. In short the ‘empirical’ domain is made of our experiences through our senses, the things we can see, hear, feel, etc., it is really made of our perceptions of what we experience. The ‘actual’ domain is made of events that happen in the world outside regardless of our perception of them, it made of thing that actually happened. And, the ‘real’ domain is made of ‘underlying’ structures, powers, processes and causal mechanisms that cause the events and experiences in the actual and empirical domain. It is clear from this explanation that the intransitive is in the domain of the real and the transitive is in the domain of the actual and the empirical.

<table>
<thead>
<tr>
<th></th>
<th>Domain of Real (what caused )</th>
<th>Domain of Actual (what happened)</th>
<th>Domain of Empirical (what you perceive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanism</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Events</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Experiences</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>
The goal of my research is to get to the underlying structures, powers and mechanisms that drive the value of the field services and the threat to that value. It is in understanding these structures and defining them that I will be able to come up with proposals of structuring the field services in a manner that will ensure viability of the operations and if necessary the field services as well.

The third ontological premise of causal relations refers to the dual character of the world, that is, the mutual interactive nature of society and individuals. Burnett defines it this way, that ‘individuals both reproduce and transform social structures as well as are formed by them, while social structure both shape and place constraints on individuals but is also the result of continuous activity by individuals’. Within the research, it is important to keep in mind that the researcher and those participating in the research are as much formed by their social setting as they themselves influence it.

3.3.2. APPLICATION OF CRITICAL REALISM IN MY RESEARCH

Below in figure 3.3.2 I have represented the three domains of critical realism in a model; the model seeks to show the interaction between the three domains – thus explaining reality from a critical realist point of view for purposes of enquiry. In short what the model is saying is that people’s experiences and perceptions of an occurrence are in the domain of the empirical while observing a real occurrence that happen in the domain of the actual. A number of people may observe the same occurrence or event but may have a completely different experience of that event – hence the different perceptions of the same event. Important to note is that all of those perceptions are important to developing a richer picture of the events or occurrences or phenomena – this is called sweeping multiple perspectives. Whereas the event is observed in the domain of the actual, the mechanisms and structures and powers that give account of that event are intransitive, they are in the domain of the real, and are not seen or understood.

In the interviews I will need go past the perceptions of the interviewees and dig for the facts of the actual events and not their perceptions. One of the tools that can be used to move from perception to facts in an interview is called the Ladder of Inference, it is explained in the section on interviews further in this chapter. What this means is that I had to recognize that I am using the interviewees as instruments or tools to measure the events over time and therefore there is a need to know how to use the tool and how to interpret result of the tool.
3.4. THE EPISTEMOLOGY – GROUNDED THEORY

There is a number of research methods that may be suited for a critical realist philosophy, according to Yeung (1997), ‘probable the most practical methods in the practice of critical realism’ are: the use of iterative abstraction; the grounded theory and the use of ‘triangulation’. According to Yeung, the main difference in these methods from specific research instruments which refers to questionnaire survey, participant observations, personal interviews, etc. is that they ‘aim at the collection of empirical data’ in accordance with their set guidelines. Yeung evaluates each of these individually in his article; I will discuss the grounded theory as my best suited research method given my context.

3.4.1. THE NATURE OF GROUNDED THEORY

The grounded theory in critical realism is based on data collection through observations, interviews, looking through journals, people’s comments and views. It is a form of field research, a qualitative research methodology, a careful and systematic study of relationships of individuals’ experiences of society and history, this means everyday social experiences and the sense they make of those experiences and what is recorded or told from history. This includes experiences of the researcher as well as those of participants within the research. It pays attention to how subjective experiences can be abstracted into theoretical statements about causal relationships between key concepts that describe processes of those experiences. It is a practical approach to help researchers understand complex social processes, according to Strauss and Glacier fathers of grounded theory, because the information pertinent to the emerging theory comes directly from the data, the generated theory remains connected to or grounded in the data.
3.4.2. THE GROUNDED THEORY PROCESS

The process begins with data generation by collection of empirical data, followed by concept formation, concept development and concept modification and integration which produces a grounded theory, each of these will be discussed below, see figure 3.4.3.1 below for a process flow.

**Data Collection** begins with a specific concern in mind that the research has, to which understanding is sought. Most importance in this is to have a powerful research question that will guide the research and provide ‘focus and clarity about what the phenomenon of interest is’, Strauss and Corbin (1990). Second, it is empirical data that is sort, and not so much the opinion, what informs the opinions. And lastly triangulation of the data collected, meaning the validity of the data needs to be confirmed by more than one source and/or technique and/or questioning.

For my research the data will come mainly from interviews and on smaller scale company documents (reports, meeting minutes and other records). I will use conversational interviews approach, which follows a semi-unstructured format; the interviewer would have an overarching theme, general themes, targeted issues and some specific questions and only guides the conversation along those themes, according to Lee (1999). The Ladder of Inference will be used as a tool to get to deeper meaning in the interviews, see figure 3.4.3.2 below.

**Figure 3.4.2.1 – Grounded Theory Processs – Modified from Struebert (1999)**

The Ladder of Inference says that people may experience the same event, but may have different perceptions of that event, when a person observes a phenomenon or event, they select data, add a cultural and personal meaning to it. They then make assumptions from the meanings they ascribe and from the meanings they adopt a belief and thereby create a map of what they observe. The challenge is...
that the individual is likely to believe that the map is the actual event – this is a case of map and territory. The map is never the territory, the case of the actual and the empirical. Using the critical realism’s ontological domains, the goal is to get from the empirical domain to the domain of the actual, by triangulating individual experiences in the empirical to get a better picture of the event in the actual domain.

**Figure 3.4.2.2 Ladder of inference** - taken from Tom Ryan EMBA 10 Presentation

The Concept formation process has three data coding levels, substantive coding, categorization and basic social-psychological processes. In substantive coding, the researcher goes through the data line by line looking for processes in the data and naming them either by using the words of the participant or meaning given by the researcher, using doing words. This is followed by categorization – here the substantive codes are categorized by comparing them with each other and clustering into categories according to obvious fit – mainly characteristic or meaning. The last step of categorization is comparing the categories with each other to ensure that they are mutually exclusive. The third coding level is to give titles to the basic social-psychological (BPS) processes that have been identified by that describe their central themes. Glaser and Strauss suggested some questions to be asked in order to identify the BSP’s processes such as, what is going on in the data, what processes are helping the participants cope with the problem, and such others?

Two key concepts during concept formation are worth discussing, first is constant comparison, through the process, from first level coding – the researcher needs to constantly compare data, the codes, the categories, with each other and with new data coming out of further investigations. The goal is to reach saturation of each of the categories identified; this is the second key concept. Saturation is reached when every new data brings up the same codes and categories, in other words there is no new information that gives rise to new categories or expansion of existing ones adding new meaning to the development of the theory.
Concept Development also has three levels, reduction sampling, selective sampling of literature and selective sampling of the data. The purpose of the reduction sampling is to cluster and connect the categories to combine into broader categories. Selective literature sampling is about becoming familiar with the works published in the broad categories of concepts that have emerged and help fill in the gaps in the emergent theory. Lastly, selective sampling with is about comparing the emerging concepts with the data selectively in order to determine under which conditions they occur. Additional data may be collected in a selective manner to develop the hypothesis and identify the properties of the main categories.

Concept modification and integration uses theoretical coding and memos to control the emerging theory. Theoretical coding is about maintaining a meaningful story line of the emerging theory that deals with the phenomenon being investigated. The memoing that was done all along the process, whereby the researcher jots down things that come up during the research process, hunches, emerging hypothesis and abstractions is now used to keep the researchers thoughts in the emerging theory and the report writing.

Figure 3.4.2.3 Shows how grounded theory integrates with critical realism

The grounded theory process up to the level of the core variables is about moving from the empirical to the actual. The final development of the theory, establishing the causal links between the core variables, is about moving from the actual to hypothesizing about the domain of the real. In this way the veil of the intransitive is lifted, exposing more of the ‘ice bag’ so to speak.

3.5. Value Judgements

Critical Systems Heuristic is a framework for reflective practice based on practical philosophy and systems thinking (Ulrich 2005). It recognizes that evaluation of any research can only be done on the basis of prior judgements made about the system in concern. Ulrich called these ‘boundary
judgements' as they define the 'boundaries of the reference system that is constitutive of the meaning of a proposition and for which it is valid'. They look at both the empirical observations (facts) and the value considerations or norms (value) of a study context. Ulrich framed this in what is know as the 'eternal triangle', see figure 3.5.1 below, the triangle represents the nature of boundary judgements in relation to the system, facts and norms and vice versa. As soon we modify our boundary judgements, relevant facts and norms are likely to change, similarly if new facts become relevant we have to review the system boundaries and modify our value judgements and the same is true for changes in the values or norms, it will have implication for the other two.

The boundary judgment process happens right through the research process from the start when defining the problem to the end when project is implemented. This also particularly useful and necessary in a qualitative research process where the process is reflexive, a constant evaluation of the processes, stakeholders, tools, facts and norms is necessary. In the process of my research I will use these boundary judgements to decide mainly the total system boundaries and therefore the stakeholders to interview and whatever other key questions needing to be understood about that system. But as the as the research goes on, I expect to constantly review the boundaries according to arising data.

Figure 3.5.1 The Eternal Triangle

But finally when it comes to action taking, the value judgements are about moral or ethical implications of the proposed action, for this I will use Valasquez' four ethical question of utility, justice, fairness and caring to test the ethical standing of the proposed solution.

3.6. Action Knowledge – Decision Making and Action Taking

Management research's purpose is really for making decisions and taking action about a concerning situation. Although this research will not get into the action taking part, I will be recommending some actions to be taken. Because of the nature of the problem context of this research being a concern about current activities that threaten what might happen in future, scenario planning would be used to
project what futures may be in order to propose methods of responding should any of the outcomes be realized. This is really a method to prepare for uncertain outcomes to be able to respond adequately.

### 3.6.1. What is Scenario Planning

The purpose of scenario planning is to inform decision makers and influence and enhance decision making, by helping managers see what possible futures might look like (end states); how these futures might come about (plots or stories); and why they might occur (logics). It forces new considerations to surface decisions that were not previously on the organisations agenda. It is useful for reframing and providing a new context for existing decisions. It helps managers formulate important contingent decisions. The matrix below in figure 3.6.1 shows the process for developing scenarios. The process starts at understanding the rules of the game, meaning what is your current business and its environment and what are the drivers in that environment, such as political, social etc. This is followed by the generation of scenarios, this done by taking each driver and looking at its two possible outcome, the outcomes are then plotted on the uncertainty/impact matrix.

The outcomes with the highest impact and lowest certainty are chosen to develop the scenario matrix. The two drivers and their outcomes are placed in two axis to create the scenario matrix. Each of the four quadrants is named as a specific scenario, a rich picture of each scenario and the current state are developed. At this point a story or plot gets developed using the outcomes of the other drivers for each of the scenarios, plotting a possible story that would develop from the current rich picture to that of the scenario identified. The goal of developing a plot is to raise awareness of what may happen so that managers can then put sensor or means of looking for the pointers that might indicate that one possible scenario might be realized. From then options are developed that would help your business deal with scenarios should it be realized. Lastly for decision making the options are ranked by pairwise comparison for fitness into some measures important to your business, such as financial fit, cultural fit, strategic fit and robustness.

**Figure 3.6.1 Scenario Planning Matrix**
3.7. INTEGRATED RESEARCH FRAMEWORK

I have summarized below in step by step process showing the research process in figure 3.7.1. The diagram shows that process starts with locating the problem in management research framework by Ryan of sense making, decision taking and action taking. Recognizing the systemic nature of the problem I used the Viable Systems Methodology to locate the organisation system to see where and how it affects viability of operations in the organisation’s system functions.

Third to draw the research boundaries of the system in question; fourth to follow the grounded theory process for researching the process from a critical realist perspective; fifth to propose actionable knowledge from new found understanding of the problem using scenario planning because of the futuristic nature of the concern and lastly to test the ethical implication of the proposed answer using Velasquez.

Figure 3.7.1 Integrated Research Process Framework
4. Research Results

This research seeks to understand the threats to the reliability of field services and why this threatens the viability of AGA’s operations in order to help AGA to understand the underlying causes of these threats and thereby enable decision making towards a sustainable strategic approach to the field services. In this chapter I present the research work and the outcomes of the research, a theory development following the grounded theory process.

The research was conducted over a period of 4 months through mainly an interview process, supported by documentary research. The scope of the interviews was extended from AGA operations Anglo Technical Division and Goldfields. The grounded theory process was followed rigorously and that had its challenges, this is discussed below.

4.1. Problem Definition

4.1.1. Locating Problem in Viable Systems Model (VSM)

My assessment is that the field services are services that exist both at S1 – operational functions, S2 – coordination functions and S3* - audit functions. But the nature of the problem is a problem that needs be managed both at the S4 adaptation function (which seeks to keep with changes to ensure sustainability) and S3 – cohesion (which is management control to achieve a coherent business) with direction from the S5 – policy (which is a system that set policies and company direction, both at CEO and board level). I show why this is on the table below, table 4.1.1

Table 4.1.1 VSM Analysis of the Field Services

| System 1: Operational | At an operational level, field services offer a maintenance support function for the maintenance staff, both in terms of giving information about condition of equipment and conducting actual specialist maintenance on equipment and advice maintenance staff during repair work. Weaknesses in this system would be felt through increased operational failure, thus threatening viability. |
| System 2: Coordination | The field services as currently structured also offers a coordination function by planning the audit and inspections of both the internal and external field services for the mines – meaning they plan and schedule theses activities according to equipment demands and in agreement with the operations. Weaknesses in this system would be felt when the schedules of inspections and audits are not carried through and when management do not receive reports about condition of equipment, thus threatening management ability to exercise control and achieve cohesion. |
| System 3*: Audit | Field services also offers the audit function on behalf of management, the audit is of both equipment condition and safety standards done when they do the regular inspections and condition monitoring and on specially arranged audit dates. |
### System 3: Cohesion
The cohesion system does not itself get involved with field services, but it is a key player in deciding what field services are necessary and how they need to be structured. It would do this on receiving information from S4 about what the future environment is like – S3 needs to then act on that information by changed or revising the nature of how things are done in operations, wherever the weaknesses in the system may be which threaten viability.

### System 4: Adaptation
It is system 4’s function that identified that the field services in particular the external ones are under threat, it is also this systems’ function to propose ways of adapting to this changing situation in the market. Therefore mainly this research is located in this system, the answer needs to propose ways of adapting should the threats be realized.

### System 5: Policy
System 5 is the system that gives boundaries within which the other systems need to operate, therefore the nature of the field services and at high level would be dictated by the policy directives or the rules of engagement with the market and/or other players stipulated by this function. For example, up until recently AGA was partly owned by AA plc, as such it was a policy directive that dictated that AGA South African operations had to use Anglo Technical Division services. This resulted partly in this sole dependence on Anglo Field Services. This has now changed – AA plc disinvested and no longer has policy influence.

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### 4.1.2. Research System Boundary Judgements
The boundary judgements were really mainly made on the selection of South Africa region of the company as an area of research, where initially it included the rest of the African continent operations. They were made on the selection of the participants, on the basis of the time frame for the research and also the pitching level of the research, having located the research problem at a strategic level. The participants chosen were from a level of engineer upwards to senior management as such. Lastly as it became obvious that time would not allow to interview other mining houses and other service providers, I had to abandon the option of considering the collaboration route and researching the possible answer, stopping at the level of the options without delving into their detail.

### 4.2. Data Collection
This data collection for this research was mainly based on interviews, with support from documentary research and general observations. A couple of group discussions were also held on some specifics of the research problem. Each of the data collection methods are discussed below, how they were applied, successes and challenges to extract useful data from them.

#### 4.2.1. Interviews
The process started with identification of some of the key stakeholders suitable for interviewing as indicated in the boundary judgements above. It is important to note that I have my own experiences of
the research problem area; having worked in the both the operations and had some exposure with Anglo Field Services and the work they do. The implication of this was that I was in a reasonable good position to gain access to most stakeholders for interviews in both areas. But this also did mean I needed to be more watchful of my own biases.

First set of interviews were held with engineering managers at operations, the input from these interviews soon reached saturation. My assessment was that this was due to either the fact that the issues are the same or it is a matter that has received attention in the past among this group, I concluded on the latter. The second set of interviews was held with the internal field services specialists who manage the outsourced work, their input revealed a deeper understanding of the level of skills issue in operations, but they also revealed new concerns about AFS capacity and possible moves away from AGA region. The third set of interviews was at the level senior management in engineering, this conversation gravitated towards more strategic intent issues and proved to where the concerns were mainly – this agreed with my VSM assessment.

The fourth set of interviews was held with the ATD and AFS, talking three levels of management, from AA plc Engineering Head, ATD Engineering Head and down to AFS Manager. The focus was on strategic intent with AFS services, intentions with supplying services to AGA, concerns with skills shortages; competition in the market; threats to AFS services from an AA plc buy-out by another major conglomerate and strategic issues about technical services. Interesting to observe is that because during this time AA plc was undergoing restructuring, every new meeting and interview seemed to offer a different take from the participants.

The fifth set of interviews was held with Gold Fields, mainly with senior engineering management staff, 2 other mining houses only telephone conversations were achieved and little came out of the discussion. The conversations with Goldfields focused more on the nature of technical services and where field services fit into the whole picture, also putting value to the field services.

I ensured that the number of interviews in each category was not less than three; this was to ensure a triangulated picture from each stakeholder group. I used the 'Ladder of Inference' in all the interviews reasonable well, particularly at being watchful of opinions being expressed and asking the probing questions to bring the participant down their ladder of inference in order to get to the empirical data by understanding the assumptions, beliefs and culture that informs the opinion and looking for the actual observations.

I recorded and transcribed one interview only, and this was the first interview, I found that the recording seemed to make the participant uncomfortable, even though he tried to assure me that it was OK. After this first session I stopped recording because I wanted the nature of the interviews to be conversational and to keep them as close reality as possible vs staging. And, I felt I would get a lot
more from speaking from the heart type thing. I found that in a couple of interviews participants shared things that they were unwilling to be quoted on - and it was on these very issues some key issue came up when I dug deeper. But transcribing during the interview proved difficult.

I sort to pay attention while the participant spoke and wrote afterwards, but this meant that in most cases I paraphrased. I tried to stick the key phases or words that the participant used as much as I could. I think that paraphrasing probable does increase the level of bias. I think it helped that it was subject matter I was familiar with so that I could pick up and hold the thoughts and at times be able to come back to them.

The outcomes from these interviews were analyzed and processed following the grounded theory. The process went along in parallel, the interviews and the processes of grounded theory, meaning the coding processes went along after every interview. The interviews were also not necessary staggered in the manner presented above – this was not the intention; it was merely the opportunities that the interviewees gave that dictated the line-up. The interviews with other mining houses were left for last because I saw their input as more towards the solution development – collaboration agenda.

4.2.2. Observations

Most of my observations would have been recorded as memos which I later in the grounded theory process went back to either code them or use in the BSP’s. I accepted that I am also an actor in the process and that the emerging theory would be influenced by my own experiences – in as much as I worked hard to get to the empirical data when interviewing people or when testing assumptions in meetings or when testing my assumptions with other people.

A number of meetings on this subject happened during this research, as this was case ‘live case’ problem context, including an engineering strategy session which included a discussion on field services. I have also used the meetings minutes as data. The value of the group discussions and meetings was evident in that they provided a very real setting in that they were official meetings or discussions. But also of importance is that they provided multiple perspectives, that could be tested and allow for some assumptions and beliefs to be laid open. Among the meetings held was two meetings with AFS – the first was held early on in the research at the height of the threat posed by cost cutting and restructuring at AA plc. The second was held later on in the research process after the restructuring had been finalized and some of our fears of losing AFS services had been realized. What worth noting was the change in attitude – the change in attitude was also as a result of a change in management?

4.2.3. Documentary Research

Some documentary research was done mainly as back-up to the interviews and also for purposes of triangulation. Records of issues about the problem context were reviewed with a particular view to
confirming some of the claims made by participants. Some records reviewed were about the problem context and expressed opinions and facts about the problem context – these were used and coded in the same manner as the interviews, as an example two documents, official notes, were written in the context of losing the field services because of disinvestment by AA plc and what can be done and how critical the services of AFS to AGA, about 18 months to 3 years old.

4.3. **Grounded Theory Process**

4.3.1. *Concept Formation, Level I Coding – Substantive Codes*

An example interview transcript and the Level I coding is given in the figure 4.3.1.1 below, this is an extract from one of the interviews on the left and the coding in indicated on the right.

**Figure 4.3.1 Interview Extract and Level I coding Example (Substantive Codes)**

A: A long term contract, say 10 years, with AFS could offer a solution because it gives them security of income, in this way they are able to make long term investments and the contract would also be binding giving AGA a security of service.

Going outside, buying the service from smaller companies, poses a risk in that some these suppliers are not sustainable economically, reason being that they are run mostly by technical individuals who do not necessarily poses business skills. Example is the recent challenges of the economic down turn have seen a number smaller business that supply services to the mines go under. The other concern is that by taking this route, our destiny is no longer in our own hands, we will be at the mercy of these external suppliers.

| A: A long term contract, say 10 years, with AFS could offer a solution because it gives them security of income, in this way they are able to make long term investments and the contract would also be binding giving AGA a security of service. | contract nature can gives security; security of income gives ability to invest in development; Security of service; Lack of business acumen among small enterprises; economic viability; small enterprises not dependable; outsourcing takes away control or choice; |
| Going outside, buying the service from smaller companies, poses a risk in that some these suppliers are not sustainable economically, reason being that they are run mostly by technical individuals who do not necessarily poses business skills. Example is the recent challenges of the economic down turn have seen a number smaller business that supply services to the mines go under. The other concern is that by taking this route, our destiny is no longer in our own hands, we will be at the mercy of these external suppliers. | |

4.3.2. *Concept Formation, Level II Coding - Categorization*

As indicated as the interview process progressed, I started categorization – that is basically taking the substantives codes and grouping them according to their characterization of the problem context. For example, as can be seen below the, concepts ‘binding contract arrangement with AFS’ and ‘a shared service with other mining houses’ was categorized into the ‘Field Services Strategic Approach’ – because they both proposed a way to deal with the threat of losing AFS services. The initial categories were further refined as the interview processes further progressed and other documentary research input came in, through a process of constant comparison. Every new interview was coded into the concepts, these concepts would then either form part an existing category of form a new category.

During this process two things were happening, firstly there were new categories that would arise that tended to be on a higher level of abstraction than some initial categories – through a process of constant comparison, these were identified and subsumed in the higher abstraction level category. A developed category is one that is on the comparable level of abstraction within the problem context.
Regularly I found that there would be categories that would form but remained at a low level of abstraction with the problem context, for example 'Internal staff has an interest in the business to fix problems'. Although this came up from a number of interviews and therefore quickly reached saturation, it quickly became clear that it was low in abstraction level and together with a number of other categories is was subsumed into the category 'The value of internal field services'. Secondly, for some categories the same concepts would begin to come up in most interviews or documentary research, these were then considered as having reached saturation and needed no further development. See example in the table below, table 4.3.2

**Table 4.3.2 – From Concepts to Initial Categories and then Developed Categories**

<table>
<thead>
<tr>
<th>Developed Category</th>
<th>Initial Category</th>
<th>Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Internal field services</td>
<td>On-the-job knowledge transfer</td>
<td>An internal field service can benefit on-the-job training</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Internal specialists can do on-the-job-training</td>
</tr>
<tr>
<td></td>
<td>Internal staff have an interest in the business to fix problems</td>
<td>Internal field services can benefit resultant repair work following inspections</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fixing arising problems not priority for AFS services</td>
</tr>
</tbody>
</table>

**4.3.3. Concept Formation - Level III Coding – BSP’s**

The BSP's are the bridge to move us from just stand alone concepts to at least a descriptive theory; at this level we seek to connect the dots between the concepts, so the events in the ‘actual world’ that the concepts seek to describe ‘come to life’ as it were. These BSP’s came from the constant comparison processes and from nuances in interviews, through a process of ‘memoing' as they arose. I have used the BSP's in the Interrelationship Diagraph (ID) to help discover or confirm connections between the concepts, while new ones arose out of that process. The ID is presented figure 4.3.3. It is worth noting that some of the categories have been left out of the ID, those left out were deemed not to be critical or could fall under another category, the driver being to keep the ID variables to a manageable level, and here an 80/20 principle was used. This process of refining the emerging theory using the outcomes of learning from the ID is the next step in the grounded theory process – Reduction Sampling.
4.3.4. **CONCEPT DEVELOPMENT – REDUCTION SAMPLING**

Reduction Sampling is really about determining the core variable or the essential components for that make up the emerging theory, it is about finding broader categories defining the primary BSP’s in concern problem. The process of using BSP’s in the Interrelationship Diagraph (ID) and in turn using that ID in the process of reducing the categories into even fewer and broader categories is itself a reflexive process. The ID indicates to us what the key drivers and outcomes among the concepts are, in this way the core variables are identified. The key is to identify primary concepts or variables that give account to the phenomenon being observed. The core variables are only the framework or skeleton for the theory, the BSP’s are like the glue or the muscle that hold it together. The table below in table 4.3.4 presents the categories which have thus been reduced to five and then turned into variables to carry the meaning of the processes they represent.

**Table 4.3.4 – Reduced Categories and Core Variables**

<table>
<thead>
<tr>
<th>Core Variables</th>
<th>Reduced Categories</th>
<th>Developed and Saturated Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Conducive Market Conditions</strong></td>
<td>Market Conditions</td>
<td>External Influences; Availability and ability of alternative suppliers; Demand for field services; Cost of services; Lack of specialized skills in the market</td>
</tr>
<tr>
<td><strong>Enabling Organisational Objectives</strong></td>
<td>Company Objectives</td>
<td>Leading mining Company ambitions; Value of field service; Setting standards</td>
</tr>
<tr>
<td><strong>Capability of Systems for People</strong></td>
<td>Systems for People</td>
<td>Skills Management; Skills Development; Lack of maintenance expertise; Maintenance staff skill levels</td>
</tr>
<tr>
<td><strong>Efficacy of Asset Integrity Management</strong></td>
<td>Asset Integrity Management</td>
<td>Reliability engineering; Business Process Framework; Quality of Services; ‘Consuming of the assets’</td>
</tr>
<tr>
<td><strong>Viability of Field Services Strategic Approach</strong></td>
<td>Field services strategic approach</td>
<td>Maintenance approach and management; Importance of building relationships (with services providers); Economically viable services; Advantages of internal field services; Challenges of outsourcing FS; Challenges of building internal FS</td>
</tr>
</tbody>
</table>
4.3.5. **Concept Development – Theoretical Sampling of Literature**

A literature review was conducted on most of the core variables in order to strengthen them and to get a more complete definition of these variables and also to check if they are no theories that may stand in complete contradiction. The literature review is covered in chapter 2. I have done a concept analysis of each of these variables in the table below, Table 4.3.5.

<table>
<thead>
<tr>
<th>Table 4.3.5. Concept Analysis of Core Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Attributes</strong></td>
</tr>
<tr>
<td><strong>Antecedents</strong></td>
</tr>
<tr>
<td><strong>Consequences</strong></td>
</tr>
<tr>
<td><strong>Market Conditions</strong></td>
</tr>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Attributes</strong></td>
</tr>
<tr>
<td><strong>Antecedents</strong></td>
</tr>
<tr>
<td><strong>Consequences</strong></td>
</tr>
<tr>
<td><strong>Field services strategic approach</strong></td>
</tr>
<tr>
<td><strong>Definition</strong></td>
</tr>
<tr>
<td><strong>Attributes</strong></td>
</tr>
</tbody>
</table>
### 4.3.6. **Concept Modification and Integration – Developing A Theory of the Underlying Mechanisms of the Concern Problem**

In this section I wrestled with the data taking input from the memos, literature and the BSP’s in order to come up with a theory that best represents the problem context. This proved to be a difficult process. I had to add, as seen above, a joining concept called reliability of production and safety outputs to complete the connections of the causal loop diagram that gives an account of the underlying mechanisms and structures to the value of field services and the threats to viability of operations. Core Variables and their Basic Social-Psychological processes are discussed below along with the arguments for the causal links between the core variables. I show below the step by step development of the theory that is in the form of a causal loop diagram.

<table>
<thead>
<tr>
<th><strong>Antecedents</strong></th>
<th>Selection of maintenance strategies, maintenance plans, sound skills management, service sourcing arrangement.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consequences</strong></td>
<td>Efficient and reliable field services rendering, improved reliability of machinery and asset integrity.</td>
</tr>
<tr>
<td></td>
<td>Shareholder value creation, Satisfied shareholders and investors, increasing share prices, general positive outlook and company objectives.</td>
</tr>
</tbody>
</table>

Among the challenges that have faced AGA in 2009 was failure to meet its production targets and a number of serious safety incidents, this situation has in a number occasions hurt the AGA bottom-line. The CEO has consistently spoken about the need to produce consistently and to deliver on our promises – that is what the investor and shareholder wants. Reliability is about ensuring that variation is minimized – ensuring that performance requirements are consistently achieved as planned. The goal of Asset Integrity Management is to achieve this on the asset front, covering both safety and productivity concerns. Reliability of production and safety outputs is dependent largely on the efficacy of the asset integrity management. Asset Integrity is measured through audits, recently integrity audits conducted in the South African operations came our out poor in some operations (CEO report on Asset Integrity, Cutifani 2009), like TauTona mine where a serious failure occurred resulting in the shaft closure of more than three months thus affecting production. A decrease in the efficacy of asset integrity would result in decrease in reliability of production and safety outputs, and so will be in the case if it improves.
Among the elements of asset integrity is reliability, reliability is an ability of an item to perform a required function under stated conditions for a stated period of time, this includes systems and processes. The threat to the reliability field services is a threat to the efficacy of the asset integrity. The measure of suitability of a strategic approach lies in its ability to do away or reduce the threat to the reliability of field services and thus deal with the efficacy of the asset integrity management.

As an example, according to the internal field services specialists, in the current approach to field services there is an increasing dependence by mine maintenance personnel on the external field services to the extent that thorough daily or weekly or monthly inspections that should be conducted by internal maintenance staff is seemingly neglected waiting for the external field service specialist to give it attention. As a result very equipment is found by the external field service specialist in quite compromising conditions.

The first of the drivers of the suitability of a field services strategic approach is organisational objectives – this includes growth objectives, organisational mission and vision, organisational design and other such strategic objectives. The point that this claim makes is that these strategic drivers can either create an enabling or disabling environment for any type of field service approach. The changes in organisational objectives have a negative or positive influence to an approach of field services – an example was given that the current dependence on AFS is a result of policy decisions while AGA was part of AA plc, the current threat is partly as a result of disinvestment by AA plc, all these are policy or strategic decisions.

This relationship claim completes the first reinforcing loop, R1, among the four concepts, this loop is week without the other drivers of the other drivers of suitability if field services strategic approach. For example, poor performance may delay growth objectives while the company seeks to stabilize the operations, a phenomenon that has been observed within AGA. Similarly, improved reliability of outputs will lead to a full-out growth strategy, because the company would have a good standing among investors and therefore is more likely to get capital for investment operations as measured through
in growth.

The claim in this case is a second of those key drivers of suitability of the Fields Services Strategic Approach. The suitability of the field services strategic approach is determined on the grounds of market conditions. For example – in an environment of scarcity of skills in the market, the organisation is likely to develop these skills internally and use this as a competitive advantage. A poor gold price results in cost pressures which generally lead to cost cutting leading companies to go outsourcing, seeking to reduce overheads. But market conditions alone are not be the only bearing to the suitability of a chosen strategic approach.

I have included another link in dotted line between the market conditions and the organisational objectives. This strengthens the reinforcing loop, R1. As an example industry associations are set-up so that participants can influence each and therefore change market conditions – for example training of artisan skills when there is a shortage. Other examples are when organisations make representations to government, as in the case of the Eskom electricity hikes. So the company can set-out as its global objectives to influence some non-conducive market conditions for the better.

This claim is the third of the key drivers of a suitable field services strategic approach, that is the Viability of skills management, it finally completes the reinforcing loop, R1. Viability of Skills management is about the structures and processes within AGA that make help AGA ensure an adequate resource pool of skills for the chosen strategy of operation. Weak systems for people can weaken a chosen field service approach, for example if the company chooses an internal field services approach, but the systems for people fail to hire the right skills or develop or remunerate them appropriately, this would mean the chosen approach was not suitable for that condition. Another example, a number of the respondents in the research indicated that they would rather keep the services internally if the AFS services were lost, because they did not believe there are adequate skills
The other link viability of skills management has is with the Asset Integrity Management. Really the claim here is that for Asset Integrity Management to function efficiently and effectively, it needs a viable skills management. This is the same as the arguments above.

strategically the nature of the skills management is first and foremost defined by the organisational policies and secondly its direction on operational basis follows the global strategic objectives of the organisation. For example, growth objectives will determine the talent management approaches and the skills retention and recruitment strategies and decisions. So the organisational objectives are the enablers for viability in the skills management. This also completes two reinforcing loops, first in completes R1 through the suitability of fields services strategic approach and secondly it completes a second but weak reinforcing loop, R2, through the efficacy of the asset integrity management. As has happened within AGA, during 2001 to 2003, AGA released a large number of engineering trainees to join other companies, but only in 2004 was already in difficulty in finding suitable skills in the market.

4.3.7. THE GROUNDED THEORY – THEORY DISCUSSION

The concern causal loop diagram (CCLD) shown in the figure 4.3.7 below is a theory that explains the behaviour of the threat to the reliability of field services and thus the threat to the viability of operations. In summary what this emerging theory suggests is that it is conditions among the core variables that have created the threat posed by these field services. Firstly, the weaknesses in skills management both within AGA and externally in the market have crippled the quality of skills in mines to maintain the highly sophisticated and critical equipment. But they have also brought about a situation where AGA has become dependent on AFS because of a lack of credible suppliers in the market. Secondly, the market conditions generally affect everyone, but particularly commodities are cyclical in nature, as a result this creates conditions not conducive for skills development and the thriving small businesses to support the mining industry, leading to lack of development of both. But
also the failure of the government to respond adequately in developing successful programmes to counter this situation has lead to the current condition of lack of skills in the markets.

Thirdly, the theory also indicates that the organisational objectives have brought the company into this position, through decisions that were made in the past, firstly about field services being lost to AA plc, secondly by releasing skills when the market conditions were difficult. But also possible by failing to offer the kind of training and development of skills that will ensure sufficiently trained individuals to support the mine in good market conditions. Fourthly, lack of quality field services threatens the asset integrity programmes and thus the integrity of the assets and therefore operational viability in terms of impact on safety and productivity. This situation was seen in a number of plant equipment failures in 2008 in the Africa region where there was lack on support from field services, these have since been put in place.

**Figure 4.3.7 Concern CLD – A theory that explains the concern BOT.**

In conclusion, the research method as was intended was followed, not without difficulty and it produced a result grounded on data. The theory covers the key elements that came out of the data. From this some actionable knowledge can be developed because we now have the core variables and understand how they interact, as such we should be able to come up with an informed solution to the concern having understood the underlying causes of the threats.
5. Actionable Knowledge, Research Evaluation and Conclusions

This section covers two important areas of this paper that is actionable knowledge and the evaluation of the research and its results. I have indicated that management practice is about sense making, decision making and action taking. The first part in this chapter deals with turning the research answer and its outcomes – a sense making process, into practical actionable knowledge – decision taking, action taking, this is covered in sections 5.1 and 5.2. The second part of this section deals with the review of the research process and results and looks at the ethical implications of the research answer.

5.1. Enabling Decision Taking – Field Services Scenario Planning

Scenario planning is a process that requires involvement of groups responsible for the area of concern, preferable involving all key stakeholders. In this process of scenario planning I have not involved anybody else, except that I have presented the possible scenarios to Africa Regions Engineering Strategy Planning Session and the presentation was well received. The implication of developing this alone obviously does limit its scope. But, two things come to the rescue of that concern. Firstly I have spent the last 6 months researching the subject and talking to most key stakeholders, as such I should be fairly well appraised on the issue around this subject. Secondly, it is in the nature of scenario planning that you are not dealing with issues that are certain. The point about it is that the goal is to look at possible futures and respond effectively should they come to pass – this is threats or opportunities and also to identify indicators if conditions move towards a specific scenario and not be caught off-guard but respond accordingly.

The scenario planning matrix has four quadrants, indicating the steps that the process goes through, see Figure 3.6.1, starting from the ‘Rules of the Game’, to ‘Scenarios’, ‘Options” and lastly to ‘Decisions’.

5.1.1. Rules of the Game and Scenarios

As part of the scenario planning process I have taken my research work and its outcomes to make up the ‘Rules of the Game’ portion. I then picked up among the list of issues that drive uncertainty two that I found to have the most impact and the least uncertainty and they are the economic conditions in South Africa and the key issue of skills and thus resources in the field services available in the market. The economic conditions can either be conducive or poor for the economic success of gold mining, and in terms of skills resources the outcomes would either have high or low availability. Both these drivers form part of the research answer, the Concern CLD, this shows how critical they are to the approach to field services.
I developed the following scenario matrix made of the two drivers mentioned above in different axis, see Figure 5.1.1, to conditions under which AGA will find itself and thus dictate the approach to field services. The matrix shows for example that it is possible for AGA to experience good market conditions but its growth be curtailed by the lack of skilled field services resources in the market, this scenario is called ‘Curtailed Growth of AGA’. Three other scenarios are presented in the matrix, the ‘AGA grows in Africa and South Africa’ scenario, the ‘AGA on survival mode’ scenario and the ‘AGA Shrinking’ scenario.

**Figure 5.1.1 Scenarios Matrix – Market Impact Scenarios for AGA in the South African**

5.1.2. **Options and Decisions**

Looking at the scenarios I then considered how AGA could possibly respond today given the different scenarios. I picked only four options here, but there are obviously many approaches that could be followed. I picked these four because they are distinct approaches; there were a number of variations from these. Most of these options were proposed by participants in the research with all their variations.

**Option 1:** Keep the status quo and look for greater influence on AFS

- In this option AGA accepts the commitments that ATD is making of continuing to supply the field services to AGA, believing that ATD finds value in keeping the relationship with AGA. But AGA should try to have more say in the future of AFS, previously while AGA was partly owned by AA plc, AGA was part of the board that controlled AFS. This was lost when AA plc completely disinvested in AGA.

- In this situation we have already seen ATD make changes on AFS that have affected services to AGA negatively. Some services were discontinued due to cost cutting retrenchments. This includes NDT on electrical equipment, electrical quality control services and the thermo-graph testing on electrical switchgear, motors and Eskom yards, see note in Appendix E.
Option 2: Set-up a standalone business with industry partners, a collaboration for a central service

- This consideration proved to be a slow starter because in talking to a number of industry players over the phone, a few of them sounded not so keen, believing that there are service suppliers externally and some OEM’s are starting to come to the party with field services.

Option 3: Build an internal field services to replace AFS

- This approach showed a lot of promise because most of AFS employees are former AGA employees and a number of them showed interest, should AGA want to go the route of an internal field services. AGA also has capacity to manage an internal structure, the only challenge posed is increasing corporate overheads, this currently is unlikely to gain support given the cost constrains in the company.

Option 4: Buy services from the market, help set-up and strengthen small suppliers

- The challenge with this approach really lies in the ability for AGA to trust the smaller suppliers. The concerns raised include that they are unsustainable, generally run by technical individuals with no succession planning, lacking business acumen and they generally do not have the right level of skills to add value. One of the ways to deal with this problem is for AGA to get involved and help these smaller players, with training and setting up viable structures.

- One other key driver for taking this route will be the need to create competition in the market so that the risk of depending on one supplier is reduced.

To help with making a decision on which of the options to take I have plotted each of the options on the scenario matrix – indicating which options would be suitable in each scenario, this is presented in Figure 5.1.2 below. For example in Scenario 1: AGA grows in Africa including SA, I said options 3 and 4 would be most suitable because firstly the skills are readily available in the market, so either option would work. The only difference is that Option 3 gives AGA more control and influence on the nature of field services whereas Option 4 gives no control.

Figure 5.1.2 Recommended Options plotted on Scenario Matrix
5.1.3. **Pros and Cons of the Field Services Strategies – Option 1-4.**

In the table below I have reviewed the options proposed in the scenario planning, looking at their pros and cons to help in decision making.

### Table 5.1.3 Field Services Options Pros and Cons

<table>
<thead>
<tr>
<th>Options</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
</table>
| **1: Keep status quo but seek greater influence on AFS e.g. member of the board** | ✷ Keeping same services and staff who already know our way of doing business  
✷ Have influence on any changes that happen, and always sighted of issues. Can also influence direction of business | ✷ Remain tied to AA plc. The threats that AA plc faces remain.  
✷ Unlikely for ATD to be willing to relinquish control over AFS. |
| **2: Set-up stand alone business to replace AFS (possible with other industry players)** | ✷ Greater control, will have influence on the future of services.  
✷ Able to grow with AGA, and to pursue direction that AGA takes as an organisation. | ✷ Cost of setting-up services  
✷ Responsibilities of managing a business and the skills thereof  
✷ Finding skills a challenge.  
✷ Create tensions with ATD, risk losing other services they offer. |
| **3: Build an internal field services to replace AFS** | ✷ Complete control of services and their future.  
✷ Can grow and shrink with AGA  
✷ Safe from market influences of these services. | ✷ Cost of setting up and operating the services  
✷ Finding skills in market a challenge. |
| **4: Buy services externally, strengthen other suppliers** | ✷ Have no responsibilities for managing services.  
✷ Have no responsibility when the business shrinks.  
✷ Create competition | ✷ Open to market influences of the services, costs, and availability due to demand.  
✷ No control over the services  
✷ Risk creating tension with ATD and lose their other services. |

The table above points to two other key issues about the choice of a field services approach, that is the outsourcing/in-sourcing and the level of influence. They are both important because outsourcing of services is generally the preferred way of getting services so that one can focus on the core business – so the argument goes, but it is not as simple as that. But the challenge about outsourcing is the loss of influence or control over that service and what becomes of it. The problem for AGA is the concern with the safety aspects of shafts and winding plants in particular and the reliability of field services as a result, the desire to have influence is born out of the need for dependability of the services. To aid
decision making I have plotted the options in another matrix of influence and sourcing of field services, see Figure 5.1.3 below. As an example, what this matrix shows is that if AGA values influence on field services highly but wants to avoid building a service department internally, then the best approach is Option 1 or 2.

**Figure 5.1.3 Matrix of Influence and Sourcing of Field Services**

<table>
<thead>
<tr>
<th>Out-source</th>
<th>No Influence</th>
<th>Influence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 3</strong> – Buy services externally, besides AFS, strengthen other service providers.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Option 4</strong> – Build an internal field services to replace AFS.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>In-source</th>
<th>Not Possible</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option 1</strong> – Look for greater influence on AFS (e.g. be part of the board)</td>
<td></td>
</tr>
<tr>
<td><strong>Option 2</strong> – Set-up a stand alone business and sell services to other players or join with them</td>
<td></td>
</tr>
</tbody>
</table>

5.2. **Other Actionable Insights**

A number of actionable insights were surfaced during the research and during the write of this paper. I have discussed the three key ones in detail and only mentioned in summary the rest.

5.2.1. **General Skills Development**

Among the issues arising from the research is that the level of skills of maintenance has dropped over the years in AGA. Indeed in some cases evidence was lead showing that the level of understanding of artisans or tradesman was below what it should be, e.g. ability to read a drawing and cases of failure to identify obvious conditions leading to equipment failure and general poor standard of upkeep of equipment. What was clear was that the lower than expected level of skills among maintenance staff was not only at artisan level, but also both at level of first line supervisor and section engineer level. The obvious question needing to be asked is why this is the case, given that AGA has arguably some of the best training programs for engineering skills, at least so we think. Have the training programs failed to deliver the right quality, it would seems so, or are there other mechanisms at play that need to be understood, very likely.

However it was not the purpose of this research to study this very concerning phenomenon, but this certainly emerged among the key drivers of the concern, it should therefore be studied further. Nevertheless, there are many possibilities that were given as causes of the problem, besides the obvious one needing to be understood – the training programs, these include skills erosion due to migration and ageing, low quality of education and the unattractiveness of the mining environment.
Lastly, another matter needing review in this context is whether the eroding of skills even though AGA is training artisans is not as a result of a change in technology, which our training content and methods may have failed to move along with. For example, should we still be training purely mechanical and electrical skills or should we be moving more towards technician skills given that equipment is increasingly becoming technologically advanced?

5.2.2. Online monitoring and the Thin Operating Platforms

Technology development has reached a level now whereby organisations can operate with skills that may not necessarily be on site. In fact in the geology and mine planning environment this is already happening, in particular with open pit mining, cases have been reported where expertise based in another country give their services via online, communicating with knowledgeable people on site, they are able to design the mine or respond to changes in the mine and give advice on how people on site need to respond to the problem. In fact AGA is already investigating this approach, termed TOPs for Thin Operating Platforms, it is seen as the way of the future for organisations, it will revolutionize the way organisations and skills working in these organisations are managed and organized. As it turns out the key to success for this approach lies in the communication bandwidth, stands to reasons given the amount of information needing to be exchanged in this approach.

The online monitoring is no different on some level. Online monitoring is also a phenomenon that is already in existence, many organisations have linked the performance of their machinery in the plants into the SCADA systems, and so did AGA even with equipment deep underground. This has been taken further to include condition monitoring instruments, such as bearing vibration and oil condition monitoring. In such cases the operators can track condition or state of an item of machinery, alarms are set to alert when equipment condition reach levels where attention needs to be given to the machinery. This can now be taken a step further, in line with TOPs thinking, so that the specialist field services experts no longer need to come on site, but receive information that comes directly from the machine’s probes and instruments. All they need to do is analysis and give feedback and recommendations to operating staff on site.

These approaches obviously have their downfall in that they take away the auditing functionality, a separate set of eyes that get to observe the machine physically, which is useful. In particular, experienced individuals are able to make judgements about the condition of equipment by virtue of seeing the machine and its environment. So an audit function now needs to be organized separately. But, the approach could on the one hand save costs and on the other address the issue of skills shortages. Lastly it also takes away the element of on the job knowledge sharing/training between the specialist and those maintaining and/or operating the equipment.
5.2.3. **Training of Maintenance Personnel to Take Some Responsibilities of What is Currently Field Services**

Field services specialists indicated that there are many of the things they do that they believe could and/or should be done by artisans (maintenance staff) at the operations. Notwithstanding the need for third party auditing, there is clearly a possibility to develop current internal staff at operations to carry-out some of the duties that are currently offered by external staff at a cost premium. This approach can extend the period by which specialists visit an operation, because specialist attention is still necessary, thereby saving cost and allowing them to service a larger pool of operations or machinery. This recommendation falls in line with and develops further the two points raised above, skills development and TOPs.

5.2.4. **Other Useful Actionable Items to Be Taken into Account or Be Studied Further**

a. There is a concern that there is shifting of responsibilities from internal engineering maintenance personnel within the BU in terms of accountability for equipment towards the specialist technicians and inspectors who conduct the field services inspections and audits. According to the specialists, increasingly they find some obvious maintenance items are neglected seemingly waiting for the specialists to attend to. Now this could also be that this is simple be an attitude issue that says “we have specialist who will do this work, why bother?”, or as indicated previously as a result of low skills levels, either way it needs some intervention. The pushing back of some of the specialist duties back to the mine personnel as suggested above might be a good antidote, but importantly this needs to be understood so an appropriate response can be initiated.

b. Creation of a centre of maintenance excellence is an idea that follows the affiliations approach by Fiscor (2001), whereby artisans from different BU’s can form teams to manage major overhaul work. The advantage with this approach is wider exposure and knowledge sharing. The idea will require a little more redundancy of artisans in each BU to be able to exploit this approach. The mines can achieve this by reducing the numbers of unskilled artisan assistants with skilled developing artisans, in this way the mine resolves the succession planning issues in artisan ranks, thus kill two birds with one stone.

c. Review and consider the use of OEM’s for some field services where there is grounds for it. They can bring good value because of their knowledge of the specific equipment.

d. The need to keep healthy competition in the market is an important element in ensuring sustainability of services. AGA should consider it seriously in its decision on field services strategic approaches.

e. The development of new tools and testing methods is an area that AFS was doing some work in, which AGA would be wise to sustain which ever option is chosen.
Lastly, AGA needs to review the contract with AFS to include guarantees or what O’Connor (1989) termed contracting for reliability, setting up incentives for achieved reliability levels (or even penalties if not achieved).

5.3. RESEARCH EVALUATION

The purpose of this section is to reflect critically on the research process followed in terms of its trustworthiness, relevance and evaluate the answer for its usefulness in dealing with the problem context. The criteria to be followed would look at firstly relevance of the research problem and the research process in dealing with the research problem. Secondly I will look at the research answer utility i.e. usefulness of the answer and the research process, asking the question how well does the answer deal with the research question and deal with the concern and how useful was the research process in dealing with the research context. Thirdly, I will look at the trustworthiness of the research process and in turn the research answer. And lastly, I will review the ethical implications of the research answer and recommended action.

5.3.1. RELEVANCE

I have showed in this paper that maintenance is a major cash consumer in a business and in the mining environment and goes as high as 50% of the production costs. I have also showed that failure to keep machinery in a fit-for-purpose condition could have disastrous consequences, in particular in our deep level mining environment, more than financial impact they can lead to fatalities. And finally, I showed how field services play a critical role in keeping the major critical machines in a fit-for-purpose condition in AGA’s mines and how the field services are key to achieve this. Therefore, the attention given to this topic of reliability of field services is highly necessary for AGA.

I showed that the nature of management environment in systemic, dynamic and complex – and as such is never clear cut. Thus, management research and in particular this context requires a research process that digs deeper to the meanings people give to their experiences asking the why and the how questions. I needed a research process that will enable one to cut through the opinions and get to the empirical data and therefore construct actual events in the phenomenon of threatened field services in order to be able to understand the underlying mechanisms driving that problem. The research process chosen to gain understanding of the research problem was a qualitative methodology, the grounded theory from a critical realist paradigm.

I showed how this approach allows me to achieve the objectives I stated – critical realism gives an understanding of the world that separates individual experiences from actual events and the underlying mechanism driving those events. The grounded theory methodology allows one to navigate through this critical realist view of the world, by going through individual experiences – data from interviews, developing concepts that give meaning to the actual events and finally surfacing the causal links to develop a theory that attempts to explain the underlying mechanisms causing the
events. In this way I believe this research process was relevant for this management practice problem and context.

Could other methods have been used? Possible yes, I reviewed and showed in chapter 3 that there are two other methods that could have been used from a critical realist view of the world, the iterative abstraction and the use of ‘triangulation’ in qualitative research. I found grounded theory useful because of a thorough and practical systematic process. I also reviewed the four key paradigms of research and showed that critical realist view was most suited for management practice because it takes both the critical and realist approaches, recognizing that things exist (realist) and act independent of our descriptions (critical). Management has proven this fact, management fads come and go, because they are incomplete descriptions of reality, they may work in one situation but not necessarily in all, so there is a need to take a critical approach about what is said to be real in management practice.

5.3.2. Utility

The research question that this paper seeks to deal with is: What threatens the reliability of field services and why does this pose a threat to the viability of AGA’s South African Operations? Its objectives were to focus the research to gain understanding of the underlying mechanisms that threaten reliability of field services and how this threatens the viability of operations. This is covered in the goals of the research in Chapter 1. The research obtained has achieved just this through a grounded theory process that produced key variables that drive the reliability of field services. The three core variables were identified skills management, market conditions and organisational objectives, suggesting that these are the actual threats to the field services. In Chapter 4 in section 4.3.6 I discuss how these pose this threat through the development of the concern CLD.

The research answer, the concern CLD, also discusses how field services forms part of asset integrity, and how asset integrity is key to ensuring consistent production and safety from infrastructure and equipment point of view, and therefore ensuring operational viability. The Concern CLD pulls these core variables together into a theory (of underlying mechanisms) that explains how they integrate to influence the reliability of field services and the viability of operations. This answer is useful because it allows AGA managers to know which key areas to focus on in order to deal with the threat of field services having understood how AGA finds itself in the current position, This like understanding what levers to pull in order to deal with the concern.

Out of the process actionable knowledge was identified which would help deal with the concern. Because the problem was futuristic scenario planning was utilized to look at possible futures, through it I was able to paint possible futures and therefore plot strategic options of structuring field services
to deal with those possible scenarios. I also presented the pros and cons of each strategic option. These two tools would help the decision maker at a particular time be able to choose the most appropriate approach.

5.3.3. VALIDITY/TRUSTWORTHINESS

I have reviewed the trustworthiness of this research using Lincoln and Guba’s (1985) four pillars of qualitative research trustworthiness, Credibility, Transferability, Dependability and Confirmability. Each is discussed below:

a. **Credibility**: is there compatibility between the constructed realities that exist in the minds of the inquiry’s respondents and those that are attributed to them?

Credibility is about whether the research outcomes are a true reflection of the reality – is my theory actually grounded in the data and how the data was obtained? The grounded theory methodology requires first that the data be triangulated in order for it to be credible by using different sources, methods and asking different questions. Secondly that in true fashion of qualitative research that through constant comparison, iteratively build and develop the key concepts of the theory. And thirdly, that the concepts reach saturation, that is saturating the data by bringing in new participants until new data replicates.

My research is mainly based on interviews with some documentary research to support some of the data arising out of the interviews. As such triangulation by methods of collecting data is limited. But I have made my research rich by using many different sources and reframing the questions as the research progressed. I sought to interview at least three levels of management in each of the key organisations of this context. So I think within reason and scope of the research, I reached a good level of triangulation.

The process of constant comparison was followed right through the research process, moving from one interview to the next, the interviews were coded and the codes categorized and with every new interview, the codes were compared with existing categories. New questions would also arise both with new categories and the arising themes from one interview to the next. Saturation was arrived at as more and more interviews did not bring new information and the new codes did not have any connecting leads with following interviews or were taking the research into a new direction.

b. **Transferability**: extent to which the findings can be applied in other contexts or with other respondents.

The findings in this research are quite specific to the AGA context, as I laid out a specific context under which the current situation was created. I did not manage to get enough of respondents outside of AGA and ATD, except for Gold Fields and a few others which I did not manage to get a complete
interview but only opinions and so could not use as part of the data. The Goldfields views were quite different in particular about their confidence in some external suppliers. So, yes within the current situation and different respondents in AGA and ATD, the findings I believe would be applicable. But outside of AGA, some things may come out different. I must add that I have done a similar exercise on design services in my previous EMBA work, albeit in a smaller scale, but the results were quite similar.

Lastly, I must hasten to say that I have abstracted the theory core variables higher than the problem context in order to increase the transferability of the theory with the help of a purposive literature sampling process. For example, instead of focusing on just field services – on the theory I have used asset integrity, field services is a key asset integrity process, but asset integrity is more encompassing of all the activities that ensure reliability and availability on assets in a business. And through the literature review, I found the theory had a lot of congruency with other situations elsewhere, such as in the oil and gas industry in the UK, Oil and Gas (2009).

c. **Dependability**: evidence that if it were replicated with the same or similar respondents in the same context, its findings would be repeated.

By virtue of the following the three key concepts in grounded theory of triangulation, constant comparison and saturation, I believe the findings should be repeatable except to recognize that if a different enquirer was involved, there is chance that the outcomes might be slightly different. The researcher is after all also an instrument within the research process, with own perspectives and experiences of the world, which in reality does impact on the research. So my own bias would certainly have had an impact on the nature and outcome of the research, it is not avoidable.

There are two counters to this situation, the first one is that the nature of conducting interviews was one that encouraged the participants to lead the conversation, in essence allow them to talk about what they find critical to the issue, with only some pointer questions from my side to constrain the discussion on the subject matter. It was for the same reason that the interviews were not recorded, in order to create an environment for a conversation, and I believe this was achieved. Yes this made capturing of the actual statements difficult, but in the notes I sought to write the actual words used by the participant for statements I found to be key to the arguments. Secondly, I believe the focused question and a clearly defined research problem and goal should at least create some boundaries for another to keep questions within the same boundaries and as such lead to a similar outcome.

d. **Confirmability**: the degree to which the findings are the product of the focus of the inquiry and not bias of the researcher.

As I have already indicated bias is not completely avoidable, but I have followed the grounded theory process as indicated in my research methodology – from the interview using the ladder of inference to move away from assumptions and ascribed meanings of what is said to get to the empirical and
transcriptions, coding, categorization, theoretical sampling of literature and finally theory
development through to memos and BSP’s. It is following this set process that I believe gives
confirmability of the research answer. I have presented in Chapter 4 a step by step write up giving
proof of following the process right up to the research answer.

5.3.4. ETHICS

Velasquez’s (2006) four ethical question have been used to evaluate the ethical implications of the
research answer. I present both the questions and the answers below:

a. **Utility**: Does the answer, as far as possible maximize social benefits and minimize social
injuries?

Skills development improves social benefits. In particular in the South African context, economic
development is necessary for many to come out of poverty, the key to this is a viable skills
development—one of the restrictions to South Africa’s economic growth is shortage of skills. The skills
challenge is both at the level of demand and supply and at the level of impact in failure to deliver
services, as Kruger (2006) put it – ‘we experience skills shortage through bad service’. This answer
seeks to address this within the context of the organisation but also suggests that AGA leadership
could possible influence industry towards an integrated development of skills, at least within the
mining industry.

b. **Justice**: Will the proposed answer lead to a just distribution of benefits and burdens?

Once again this answer does not look to a just distribution of benefits and burdens but neither do its
effects lead to an unjust distribution of burdens and benefits. It is inward looking for the organisation,
looking at the company to deal with and manage its challenges without looking at another as
responsible. But there is an unstated expectation that the government of South Africa needs to play its
part in creating market conditions that encourage both economic growth and skills development.

c. **Fairness**: Is the proposed answer consistent with the moral rights of those whom it will affect?

The answer does not have implications of unfairness, it does though give recognition in the
management of skills by implication that the remuneration needs to be fair and compatible; otherwise
the company stands to lose key skills.

d. **Caring**: Does the proposed answer exhibit appropriate care for the well being of those who are
closely related to or dependent on oneself?

This is the same as in the case of fairness, caring is covered in the area of skills management in that the
company needs processes and structures that will ensure caring is exercised to those closely affected
by its operations – there is no value in overworking employees who are specialists because of the lack
of skills and in the process affect their families for example. But rather a caring approach to
management of skills and conditions of employment need to take this into consideration and it would
go a long way in increasing the organisations status as an employer of choice and thus attract skills.
REFERENCES

Christie, M; Rowe, P; Perry, C; Chamard, J. (2000). Implementation of Realism in Case Study Research. International Council of Small Business, Annual Conference, Brisbane
Kruger, A. (2006). Skills Spill, FinWeek of November 2,
Maxwell, J. (2005), Qualitative Research Design. Sage
Oil and Gas. (2009). The History of Asset Integrity Management in the UK. Oil and Gas.
Pautz, WG. (2008), ATD Field Services. AGA internal reports.


Williamson, RM. (2000), Facing a Famine in the Workforce – How Manufacturing Leaders can Overcome the Shortage of Skilled Maintenance Employees. Strategic Work Systems, Columbus


## APPENDIX A – LIST OF INTERVIEWS

<table>
<thead>
<tr>
<th>Name</th>
<th>Occupation</th>
<th>Company</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rudi Giessenburg</td>
<td>Engineering Manager</td>
<td>AGA - Business Unit</td>
<td>20-10-2009</td>
</tr>
<tr>
<td>At Greyling</td>
<td>Engineering Manager</td>
<td>AGA - Field Services</td>
<td>20-10-2009</td>
</tr>
<tr>
<td>Mario Mendes</td>
<td>Winder Specialist</td>
<td>AGA - Field Services</td>
<td>20-10-2009</td>
</tr>
<tr>
<td>Richard Mack</td>
<td>Head of Engineering</td>
<td>AGA - SA Division</td>
<td>29-10-2009</td>
</tr>
<tr>
<td>Iain Menzies</td>
<td>VP Engineering</td>
<td>AGA - Africa Region</td>
<td>2-11-2009</td>
</tr>
<tr>
<td>Meshal Ruplal</td>
<td>AFS Manager</td>
<td>ATD - AFS</td>
<td>2-11-2009</td>
</tr>
<tr>
<td>Harry Calver</td>
<td>Former Head of Engineering</td>
<td>AA plc</td>
<td>4-11-2009</td>
</tr>
<tr>
<td>Keith Wainwright</td>
<td>Head of Engineering</td>
<td>ATD</td>
<td>6-11-2009</td>
</tr>
<tr>
<td>Peter Geyser</td>
<td>Engineering Manager</td>
<td>AGA - Business Unit</td>
<td>17-11-2009</td>
</tr>
<tr>
<td>Gerry Brophy</td>
<td>Head of Engineering</td>
<td>AA plc</td>
<td>20-11-2009</td>
</tr>
<tr>
<td>Johan Jansen van Rensburg</td>
<td>Engineering Manager</td>
<td>AGA - Business Unit</td>
<td>4-12-2009</td>
</tr>
<tr>
<td>Martin Dohm</td>
<td>Head of ATD</td>
<td>AA plc</td>
<td>9-12-2009</td>
</tr>
<tr>
<td>Andrew Robbins</td>
<td>Pumps and Refrigeration Specialist</td>
<td>AGA - Field Services</td>
<td>14-12-2009</td>
</tr>
<tr>
<td>Larry DeBry</td>
<td>Senior VP Reliability</td>
<td>AGA</td>
<td>17-12-2009</td>
</tr>
<tr>
<td>Piet du Toit</td>
<td>Rotating Machinery Specialist</td>
<td>AGA - Field Services</td>
<td>26-02-2010</td>
</tr>
</tbody>
</table>
Conversational Interviews for a research on Sustainable model of Field Services to Support AGA operations

Interview No. 4
Conversational Interviewer: Moses Madondo

Conversational Interviewee: Richard Mack, Head of Engineer – Southern Africa Division, AGA

Date: 29 October 2009, 10h00
Place: AGA Potchefstroom Office
Duration: 1hr15 minutes

I gave a brief explanation of what the interview was about and.

A: 10 years back AFS was part of AngloGold (former Gold Division). The current AFS service is a consultancy service, our internal field services department has a specialist to support the services offered by AFS.

Q: Should we re-establish the field services internally?
A: To take back AFS services would require playing all the scenarios and consider the best approach. Most of the AFS services are mainly underground. If we take over AFS, it will have to be a global service, because our SAD mines alone will not be adequate to support that structure because of cost implications.

Q: What other risk factors or challenges do you foresee?
A: Supplying global services will mean changing the conditions of employment - in particular issues that relate to the risk factor of travelling and travelling to some of the more risky places. The will definitely be a need to compensate for this. There is currently a discrepancy in the salary scales between our field services staff and those of AFS – AFS salaries are higher in comparison. There are also the issues of poaching staff between each other, there sensitivities around that to contend with.

Q: What about setting-up and external body to service the industry at large in comparison to an internal department?
A: Internal is preferred, we will have better control, we can determine our own destiny and develop the resources according to our needs.

Q: Are there any services that we could get directly from the market that you are aware of?
A: Mainly in the condition monitoring field, there a host of smaller companies that offer an number of services, such as vibration analysis, and others. But the specialist skills are not available, such winder tests – statics and dynamics, rope tests (NDT). But, yes we need to have some contingency plans should we loose AFS services. If we were to do the field services ourselves, we will in particular have to do the services with legal implications ourselves such as the winder ropes and static and dynamics loads on winders, whereas the other condition monitoring services can be bought in.

Q: are you happy with current AFS service?
A: Yes, they generally still give us a good service, but there is a concern that we may not be the priority anymore. Yes, the lack of correspondence from the Senior Management of AFS is concerning, we are still after all a major client, we not asking for special treatment, but to be given the due recognition and a major customer.

Q: Do you get the sense of how the other mining houses approach this subject, is it something you discuss in the industry meeting such as the CM&EE forums?

A: Yes the issue has been discusses but not in this detail and focus. The only companies represented in the CM&EE are those in the Chamber of Mines, this excludes the likes of Harmony and Simmer and Jack. AA plc, Anglo Plats, Impala Plats, Goldfields, Xtrata and BHP are represented. But Both Simmer and Jack and Harmony are serviced by AFS in some shafts.

Q: Would you be happy to continue with AFS services in its current form?

A: We would be happy to continue with AFS, but certainly if the risk of losing their services persist, we will have to pull out. Again we will need to play out a couple of scenarios to decide on the best approach. One of the concerns that remains is where does our internal services belong, SAD or Africa Region, more and more these services are being used for their operations outside of SAD, there is a desire again to take it away from the SAD. The service can be shared or centralized and remain under SAD but will need to be resourced properly and offer services on a charge out basis.

Q: What do you make of Reliability Engineering and Asset Integrity?

A: It is about capacity – our engineers tend to be more ‘managers’ and ‘fire fighter’ and not maintenance engineers, our engineers do not focus on maintenance and the reliability of equipment. Other Anglo operations are employing more and more reliability engineers – there is a reason they are going this route, it is about time for us as well to take this approach.

Asset integrity is about the set service strategy which is part of Business Process Framework, this should be part of ongoing business, not a once-off activity like we have done recently – currently we are doing a risk ranking process – we are not going deep enough for the purposes of asset integrity. But we are beginning to do so – some work has began at Mponeng. It is about going to a low enough level to set a service strategy. Some of the current condition monitoring forms part of asset integrity, but we miss a number of other areas and the reports are not integrated into as single process to help set the service strategy. Field service audits and inspections actually form part of the asset integrity process. The focus at Mponeng now is to say what do we already do and what are we missing?

The outcomes of audits and inspections must be consolidated and integrated into asset integrity to reflect the true condition of the equipment. Asset Integrity process is simple a better organised
### APPENDIX C – EXAMPLE OF SUBSTANTIVE CODING OF AN INTERVIEW

<table>
<thead>
<tr>
<th>No. 4 – Richard Mack</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>10 years back AFS was part of AngloGold (former Gold Division). The current AFS service is a consultancy service, our internal field services department has a specialist to support the services offered by AFS.</strong></td>
<td>Consultancy type service; internal field services ensures internal specialist support service;</td>
</tr>
<tr>
<td><strong>To take back AFS services would require playing all the scenarios and consider the best approach. Most of the AFS services are mainly underground. If we take over AFS, it will have to be a global service, because our SAD mines alone will not be adequate to support that structure because of cost implications.</strong></td>
<td>AFS services mainly for U/G mine services; need to make field services a global service to be economically viable;</td>
</tr>
<tr>
<td><strong>Supplying global services will mean changing the conditions of employment - in particular issues that relate to the risk factor of travelling and travelling to some of the more riskier places. The will definitely be a need to compensate for this. There is currently a discrepancy in the salary scales between our field services staff and those of AFS – AFS salaries are higher in comparison. There is also the issues of poaching staff between each other, there sensitivities around that to contend with.</strong></td>
<td>Global service will require change in employment conditions for internal staff; global service has travel risk implications; internal field service staff currently paid unequally against their AFS counterparts; staff poaching arrangements between companies could be a hindrance to creating internal service;</td>
</tr>
<tr>
<td><strong>Internal is preferred, we will have better control, we can determine our own destiny and develop the resources according to our needs</strong></td>
<td>Internal field service would lead to better control of these services; internal service also means control on the future of the field services.</td>
</tr>
<tr>
<td><strong>Mainly in the condition monitoring field, there a host of smaller companies that offer an number of services, such as vibration analysis, and others. But the specialist skills are not available, such winder tests – statics and dynamics, rope tests (NDT). But, yes we need to have some contingency plans should we loose AFS services. If we were to do the field services ourselves, we will in particular have to do the services with legal implications ourselves such as the winder ropes and static and dynamics loads on winders, whereas the other condition monitoring services can be bought in.</strong></td>
<td>No lack of service providers in the condition monitoring field; lack of the specialist skills for some of the critical services; if we were to buy services externally we would rather keep the services with legal implication internally.</td>
</tr>
<tr>
<td><strong>Yes, they generally still give us a good service, but there is a concern that we may not be the priority anymore. Yes, the lack of correspondence from the Senior Management of AFS is concerning, we are still after all a major client, we not asking for special treatment, but to be given the due recognition and a major customer.</strong></td>
<td>Concern that AGA no longer priority to AFS; not getting due recognition as a major client.</td>
</tr>
</tbody>
</table>
Yes the issue has been discussed but not in this detail and focus. The only companies represented in the CM&EE are those in the Chamber of Mines, this excludes the likes of Harmony and Simmer and Jack. AApLc, Anglo Plats, Impala Plats, Goldfields, Extrata and BHP are represented. But Both Simmer and Jack and Harmony are serviced by AFS in some shafts.

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The outcomes of audits and inspections must be consolidated and integrated into asset integrity to reflect the true condition of the equipment. Asset Integrity process is simple a better organised
## List of Field Services

<table>
<thead>
<tr>
<th>Service</th>
<th>Details of Services</th>
<th>Time it takes</th>
<th>Number of AFS Staff Required</th>
<th>Number of Internal Staff Required</th>
<th>Frequency</th>
<th>Estimate cost of instruments if done by AFS</th>
<th>Is 3rd party audit required?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winder Dynamic</td>
<td>Test the Integrity of the Brakes operation and Speed supervision settings</td>
<td>Around 3 hours</td>
<td>1 Inspector, 1 Eng., 1 Fitter</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>Around R50,000</td>
<td>No, This is an Eng. Test</td>
</tr>
<tr>
<td>Winder Electrical</td>
<td>Test the Winder A.C.Es, Safety Circuits and Power Circuits</td>
<td>Around 4 hours</td>
<td>1 Inspector, 2 Eng., 1 Fitter</td>
<td>2 Eng., 1 Fitter, 2 Fitter, 1 Other</td>
<td>Yearly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Gravity Winding</td>
<td>Should be conducted with Dynamic test</td>
<td>1 hour</td>
<td>1 Inspector, 1 Eng., 1 Fitter</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Post NDT</td>
<td>Should be conducted after NDT of the Brakes</td>
<td>1 hour</td>
<td>1 Inspector, 1 Fitter</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Post Wires</td>
<td>Should be conducted at end of shaft</td>
<td>1 hour</td>
<td>1 Inspector, 1 Eng., 1 Fitter</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Scale Alignment</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Inspector, 1 Fitter</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Jack Sels</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Station Stop Devices</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Major Electrical</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Major Mechanical</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Escalator Efficiency Testing</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Environment Audits</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NDT Repe Attentions</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NDT Business</td>
<td>Should be checked at regular intervals</td>
<td>1 hour</td>
<td>1 Eng., 1 Fitter, 1 Other</td>
<td>1 Eng., 1 Fitter</td>
<td>Monthly</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>
APPENDIX E – NOTE FOR THE RECORD: SUPPLY OF FIELD SERVICES TO ANGLOGOLD ASHANTI BY ANGLO FIELD SERVICES

NOTE FOR THE RECORD

SUPPLY OF FIELD SERVICES TO ANGLOGOLD ASHANTI BY ANGLO FIELD SERVICES

This note is record of matters discussed in a consultative meeting on the supply of services by Anglo Technical Services (which includes Anglo Field Services) to Anglogold Ashanti, the meeting was held on the 10 of February, 2010 at AGA Offices.

Preamble
Following the disinvestment from Anglogold Ashanti (AGA) by Anglo American plc (AAplc) and a subsequent restructuring in Anglo American plc, AGA raised concerns about the continued supply of technical services from Anglo Technical Services (ATS) formerly Anglo Technical Division and in particular Anglo Field Services (AFS). Notwithstanding the increases in rates that ensued during 2009 following the disinvestment in AGA by AAplc, AGA sort assurances from ATS that the said services will not be lost and the rates will not change outside of the competitive market rates.

Present at the meeting

Mr Martin Dohm          Anglo Technical Services
Mr Meshal Rupal          Anglo Technical Services
Mr Iain Menzies          Anglogold Ashanti
Mr At Greyling           Anglogold Ashanti
Mr Moses Madondo         Anglogold Ashanti

The parties involved came to an understanding on the following issues:

1. ATS will continue its services to Anglogold Ashanti. The current rates regime will remain. ATS is reviewing long term contractual rates but will seek to come in line with the rates in the market.
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2. AFS seeks to keep the relationship with AngloGold Ashanti with a view to keeping up best practice and sharing developments. AFS will maintain services and there will be no rates increases except for the current annual rates review which is inflation related.

3. Where services have already been lost as a result of the restructuring process at AAplc late 2009, AFS has set-up a vendor arrangement with the individuals who were offering the services with the proviso that the said individuals will be able to use some of the expensive tools for an agreed period until they can establish themselves. During this period – AGA will buy these services through AFS. This includes NDT, electrical quality control services and the thermo-graph testing on electrical switchgear, motors and Eskom yards.

4. AFS recognises and endeavours to support the growth objectives of AGA within the Africa Region and the American Region. Particularly noting the synergies within these regions where AAplc also has operations. Both parties will look at optimising service provision to these regions by possible setting up strategic service offices. Other methods may be pursued, such as online monitoring and/or training and skilling up local technical staff to conduct inspections, e.g. vibration analysis.

5. ATS and AFS also commit to continue doing Research and Development work and to involve AGA where matters are of dual interest.

6. AGA will review the matrix of inspections and audits required for Obuasi mine and the Open pit mines in the Africa Region to schedule with AFS to possibly supply some of these services.

7. AFS needs to keep record of inspection in particular where rope manufacturing inspections are concerned should issues of dispute arise.

8. The possible loss of Geoff Krige’s services should be revisited with Keith Wainwright, Head of Engineering.

9. The arrangement on the Group Specification should also be reviewed with Keith Wainwright.

Moses Madondo
12 February, 2010