EFFECTIVE MANAGEMENT OF THE TRIPLE CONSTRAINT IN PROJECT MANAGEMENT THROUGH POLARITY MANAGEMENT TECHNIQUES - A REFRESHED PERSPECTIVE

by

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DECLARATION

I hereby declare that the work presented in this dissertation is to the best of my knowledge original, except where recognised otherwise in the text, and no part of this document has been previously submitted by me for a degree of any kind at this or any other academic institution.

C. Jurie Van Wyngaard

March, 2011

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ABSTRACT

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Projects are generally undertaken because they are part of the plans to advance organisations to new levels of performance and to operationalise business strategies. Projects are however constrained by conflicting demands and competing priorities within the project environment. Project success is a topic of much debate, but it is generally agreed that successful projects meet the strategic objectives and higher purpose of the endeavour. The processes and methods of project management provide the structure, focus, flexibility and control to help guide significant project investments to beneficial change.

The project management body of knowledge (PMBOK) endorses that every project is governed by the triple constraint, which reflects a framework for evaluating competing demands. The triple constraint is a critical project

management concept that originates from the project basis and provides direction for framing the project. The triple constraint comprises the three key elements of scope, time and cost. Quality is an inherent objective of the project specification that takes root in all three properties of the triple constraint.

The current literature in the project management domain suggests that there exists a lack of appropriate (and consistent) scholarship on the triple constraint and its dynamics. Project managers often create an illusion of tangible progress by relying heavily upon traditional on-time, on-budget and on-target measures – yet this tactic fails to address the strategy ambiguity or establish appropriate project goals. The triple constraint trade-offs are also often perceived as organisational problems that have a definitive solution – yet this tactic fails to effectively negotiate the triple constraint and leads to destructive conflict.

The principles and practices of polarity management introduce a refreshed perspective by supporting the 'either/or' problem solving approach with the 'both/and' rationale, which allows the mutually interdependent trade-offs to be held in respectful dialogue. Polarity management exploits the power of paradoxical considerations. Without the effective management of the triple constraint as an interrelated system, projects run the risk of becoming separated from purpose. Project managers must be able to appreciate and manage the trade-off relationships in order to gain and maintain control of the triple constraint. The premise is that if these constraints are properly managed, organisations will be successful in delivering projects and meeting organisational goals.

The primary objective of this study is to develop a framework and methodology that integrate the polarity management approach as part of the hierarchical rationale of the triple constraint. The desired outcome is to facilitate the management of flexibility within the triple constraint and optimise the delivery of project success. The research study extends the benefits of the polarity management rationale specifically to the management of the triple constraint in project management through an integrated framework, which is proposed as a new and unique approach in this area.

The research undertakes extensive literature studies of the triple constraint in project management as well as polarity management principles and practice, after which an analysis and synthesis process is conducted to determine appropriate theories and characteristics for an integrated framework. The implementation of the proposed framework is explored through case study analysis as a simplified mechanism to demonstrate that the derived model is valid and useful. The research study follows primarily a non-empirical approach, and focuses extensively on conceptual theory building with limited theory evaluation in terms of practical application. The findings of this research study should thus be considered as preliminary rather than conclusive, pending further research.

Chapter 1 presents relevant background information pertaining to the research, and provides justification for conducting the study. The chapter furthermore describes the problem statement, objectives, propositions, scope and approach of the research. Chapter 2 provides a literature review of project management nomenclature relevant to the research problem, and provides a study of the theories and concepts surrounding the project management triple constraint. The chapter concludes with a consolidated triple constraint model. Chapter 3 provides a study of the theory and literature surrounding the polarity management phenomenon, and considers the triple constraint elements as polarities to manage. The chapter concludes with a consolidated triple constraint polarity model. Chapter 4 develops the integrated framework (theoretical model and methodology) through conceptual analysis of the key aspects inherited from the literature studies and synthesis of the consolidated models. Chapter 5 explores the applicability and feasibility of the integrated framework against a simplified test case to indicate that the derived model and methodology are supported by the research. Chapter 6 summarises the main results and conclusions of the study, and discusses implications, limitations and areas for further research.

The goal of the research study is to show that the integrated framework is feasible for solving the generic problem, i.e. to improve the interpretation of the triple constraint trade-offs and dynamics in an effort to advance the effective and strategic management thereof – ultimately to promote the successful delivery of projects.

The integrated framework aspires to create an optimum synergy by capitalising on the positive results of the triple constraint trade-offs in order to sustain the drive to progressively fulfil the project higher purpose. The novelty of the integrated framework is evident in that two known concepts, namely polarity management and the triple constraint, are integrated and applied within a new framework and protocol.

It is theorised that the integrated framework may supplement triple constraint analysis and advance the effective and efficient management thereof. In practice, the framework is expected to overlap and interact dynamically with the project management process groups. The aspiration of this research study is that, in time, the principles presented in this dissertation will be incorporated into the project management ethos.

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AI	Appreciative Inquiry
BRUF	Big Requirements Up Front
C	Cost
CSF	Critical Success Factor
Dr.	Doctor
e.g.	for example
ICB	IPMA Competence Baseline
i.e.	that is
IEEE	Institute of Electrical and Electronics Engineers
IPMA	International Project Management Association
ISO	International Organisation for Standardisation
IT	Information Technology
KPI	Key Performance Indicator
Ltd.	Limited
MBA	Master of Business Administration
Med.	Medical
MoSCoW	Must-have Should-have Could-have Would-like-to-have
NASM	National Air and Space Museum
OBS	Organisation Breakdown Structure
ODN	Organisation Development Network
OGC	Office of Government Commerce
OPM3	Organisational Project Management Maturity Model
OST	Open Space Technology
PCTS	Performance Cost Time Scope
Perf.	Performance
Ph.D.	Doctor of Philosophy
PMA	Polarity Management Associates
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute

PMP	Project Management Professional
POLSTRAINT	POLarity management triple conSTRAINT
PRINCE	Projects In Controlled Environments
ProDEC	Problem Design Evidence Conclusions
Prof.	Professor
PSU	Pennsylvania State University
RFP	Request For Proposal
ROI	Return On Investment
S	Scope
T	Time
TM	Trademark
TPM	Technical Performance Measure
TRIJECT	TRIple constraint proJECT management
TRIPOLJECT	TRIple constraint POLarity management proJECT management
TWC	The World Café
USD	United States Dollar
vs.	versus
WBS	Work Breakdown Structure

CHAPTER 1 INTRODUCTION

1.1 Chapter overview

Chapter 1 presents the problem milieu and introduces the triple constraint and polarity management concepts as the setting for the study. The problem statement and research objectives are described and specific research questions are identified.

The reasons for selecting the particular problem and purpose of the study are also addressed. The chapter furthermore provides an outline of the proposed solution and key attributes, and describes the approach taken and methods used to conduct the research study.

1.2 Introduction to the problem milieu

Things need to be built faster, cheaper and better. Around the world mission-critical projects are being launched all the time involving significant capital investments and high-risk ventures. Projects are becoming the way of the working world – where things need to be created, collected ideas are organised as projects (Campbell & Baker, 2007: 4). These projects are carefully defined sets of activities that utilise limited resources to meet pre-defined objectives and operationalise strategy.

Projects are all about change. Generally projects are undertaken because they are part of the plans to take organisations to new levels of performance and to meet business needs. Projects are the vehicle by which business opportunities are turned into valued business assets (Lavingia, 2003: 22). An organisation or system has practically an infinite amount of useful, desirable work that needs to be done in terms of projects, but has only limited and finite resources available with which to do that work (Dobson, 2004: 7). In a perfect world scenario, according to Carlos (2007), once the project and baseline are established there should be no more change, there should be enough time and there should be sufficient funds and people to complete the project work. In the real world, however, there are changes (e.g. the customer is eager to add more features), the project is short of time for completion (e.g. the due date changed and less time is available), costs escalate

and resources become an issue. Choices must be made and priorities must be set.

Lavingia (2003: 22) defines successful projects as the ones that are delivered on time, within budget and meet established business objectives. Throughout literature (Morris & Hough, 1987; Johnson et al., 2001; Dobson, 2004; Lewis, 2005; Kozak-Holland, 2007; Dobson & Feickert, 2007; Mathis, 2008) the performance criterion of the delivered product, service or result (scope of work) is also included as an important measurement of project success. What makes project delivery successful is a topic of much academic debate. It is generally agreed that to be considered successful, a project must be fit for purpose and it must have achieved its delivery targets (Brown et al., 2006: 77). It can therefore be generalised that the vision is to deliver project results that achieve the desired scope, with acceptable quality, on schedule and within budget. It is however not always considered practical in the real world to deliver all the targets exactly as planned. The delivery targets are interrelated and therefore normally no one target should be considered in isolation.

1.2.1 Introducing the triple constraint in project management

The processes and methods of project management provide the structure, focus, flexibility and control to help guide significant project investments to outstanding results, on time and within budget (Campbell & Baker, 2007: 1). Resources therefore need to be organised and managed in such a way that a project is performed and delivered within defined constraints. These constraints, or key project variables, are in general referred to as the triple constraint in project management or the project management triangle. Although variations and different interpretations of the dimensions exist, traditionally these constraints are listed as project scope, time and cost (Dawson, 2004; PMI, 2004; Chen, 2005; Schwalbe, 2005; Kosavinte, 2007; Wikipedia, 2007). Project quality is affected by balancing these three factors. The premise is that if these constraints are properly managed, organisations will be successful in delivering projects and meeting organisational goals. Figure 1.1 depicts the project management triangle where each side represents a constraint with quality at the centre. The triangle reflects the fact that the three constraints are interrelated and involves trade-offs – one side of the

triangle cannot be changed without impacting the others – and quality takes root in all three constraints.

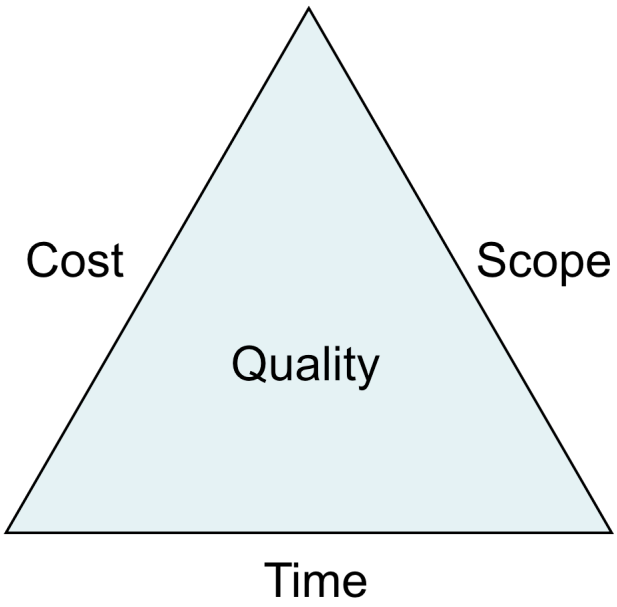

Figure 1.1: The project management triangle

Triple constraint issues are at the core of the most crucial decisions about a project. Failure to understand them, interpret them and exploit them correctly and effectively is enough to doom a project even if all other project management activities are done to a high standard of excellence (Dobson, 2004: xii). The triple constraint trade-offs are sometimes perceived as organisational problems that have a solution but because the constraints are intertwined, a solution cannot be implemented in isolation from each other. The relationship among these factors is such that if any one of the three factors changes, at least one other factor is likely to be affected (PMI 2004: 8). For example, adapted from Campbell & Baker (2007: 6), if the project time begins to slip (meaning a deadline may be missed) other elements of the project management triangle are affected. The project may be brought back on track by getting more people involved (increasing the costs) or by reducing the scope requirements that were originally designed into the project. The project manager must be able to appreciate and manage these interdependent relationships (trade-offs) in order to gain and maintain control of the project management triangle.

1.2.2 Introducing the Polarity Management™ philosophy

When it comes to intertwined organisational problems, Johnson (as cited in Kohn, 2007: 4-5) suggests that instead of viewing opposing concepts as being mutually exclusive (the 'either/or' approach) to rather manage the opposing concepts as a series of dilemmas[1] that are interdependent opposites (the 'both/and' approach). For example, within the project management triangle, instead of trying to solve the cheap-*or*-good (cost vs. quality) dilemma, rather aim in optimising the project to be both cheap-*and*-good. Johnson (1996) refers to these sets of opposing concepts as polarities, which are characterised as not functioning well independently and not possessing clear solutions. Other examples of organisational polarities include: centralisation vs. decentralisation; process engineering vs. product engineering; candor vs. diplomacy; individual vs. team; stability vs. change; and, directive decision making vs. participative decision making (Johnson, 1996; Maurer, 2002).

Polarity management[2] involves articulating the positive and negative aspects of the two extremes of a polarised issue as an aid in determining and deliberating where on the spectrum one can maximise the positives while minimising the negatives of the respective positions (Cantrell et al., 2005: 16). When this is done well, according to Johnson (1996), the inherent tension between the opposites will be converted into a creative synergy or synthesis. On the contrary, by only focussing on the upside of a particular pole, its downside will eventually be experienced. The objective of Johnson's polarity management perspective is to acquire the best of both opposites (polarities), while avoiding their limits (cited in McNaught, 2003: 76).

1.2.3 Introducing the problem within the environment and system goal

According to research by the Gartner Group, only 16% of information technology (IT) projects are completed within the desired time frame and budget and achieve the desired results. More than 30% of projects are cancelled and over 50% of projects will experience cost overruns. Less than 30% of the projects companies

[1] A word from the Greek expression 'double proposition'. A problem offering at least two possibilities, neither of which is practically acceptable (Stewart & Curry, 1996; Apple Inc. Dictionary Version 2.1.3, Copyright 2005-2009).

[2] The term 'polarity management' throughout this dissertation refers to the Polarity Management™ concept of Barry Johnson, Ph.D. (Johnson, 1996).

employ to change their businesses are successful (Campbell & Baker, 2007: 5). Across literature a range of criteria exist for declaring a project successful or failed. It is a slippery concept to measure and according to Morris & Hough (as cited in Pretorius, 2001: 5), it depends by whom and against which value system the project is being evaluated. Nonetheless, it is widely accepted that late completion, over budget and poor delivery of scope requirements (results) may be considered relative factors in terms of measuring project success against achievement of the business goals.

The author of this dissertation can confirm through experience that another contributing factor in terms of project success is the challenge to achieve consensus regarding which constraining elements are paramount in achieving the main project objectives.

The perceived system goal within the project management environment is to effectively and efficiently manage (and communicate) the relationships and trade-offs between the key triple constraint elements in order to consistently deliver projects that meet pre-defined objectives on time, on target (desired results) and within budget – at an acceptable level of quality, within an acceptable level of risk and in support of mission goals.

1.3 Rationale of the research

This dissertation considers the assorted formulations of the triple constraint across literature, and examines the rationale behind the project management triangle and power structure (hierarchy) of the constraints. The study furthermore undertakes to explore the dynamics of the triple constraint by considering their 'mutualities' as polarities to manage in order to bring a refreshed perspective to the time vs. cost vs. scope dilemma.

The importance of this research stems from the alarming statistics, which indicate that a large percentage of projects companies employ to meet business objectives fail by either exceeding the desired time frame or budget or not achieving the desired results. A further reason for addressing the particular research problem is that the study of the triple constraint is believed to be one of the most overlooked fundamentals of project management (Dobson & Feickert, 2007; Dobson, 2004).

This dissertation's literature study confirms that there is a general lack of consistent scholarship in this area, particularly surrounding the dynamic relationships between the key project variables. The author is in agreement with Dobson (2004: xii) that on a knowledgeable foundation of the triple constraint, project managers can build a substantial and powerful understanding of their projects that can empower them through a wide range of challenges. In addition to this knowledge foundation, understanding conflict dynamics, when it comes to managing trade-offs and negotiating the triple constraint in situations where stakeholders are tied to differing positions, is a vital ingredient for secure project management.

Accelerating trends within the project management industry are also a motivational factor to research new concepts. Business movements include (Mihalic, 2007: 11): global, multinational projects; importance of interpersonal skills; massive mergers and re-organisations; flatter organisations; drive for faster results; team environment; and dependence on technology. Basically the aim is to be doing more with less, and faster.

In the described real-world context this research study is necessary in order to promote the successful delivery of projects by indicating how to help analyse and weigh the factors contributing to the paradoxical interdependencies within the project management triangle through the application of polarity management techniques. The proportion of relevant studies on this subject is negligible. To the best of the author's knowledge, at the time of writing this dissertation, only one paper was published where polarity management has been applied to project management, but it is applied in a different context and on a higher level (refer to Hirschhorn, 2001).

Considering the changing industry, this research study extends the benefits of the polarity management principle specifically to the management of the triple constraint in project management, which is believed to be a new and unique approach in this area. The feasibility of the research study permeates a variety of branches in the profession of project management where the complexity and character of projects may range from space missions and social systems, to building museums. The outcome of this research study intends to contribute

towards the body of knowledge. The benefactors include, but are not limited to (adapted from PMI, 2004: 4):

- Senior executives, customers, sponsors and other stakeholders.
- Program managers and managers of project managers.
- Project managers and other project team members.
- Consultants and other specialists in project management.
- Educators and trainers developing and teaching project management programs.
- Researchers analysing project management and interrelated systems dynamics.

The aspiration of this research study is that, in time, the principles presented in this dissertation will be incorporated into the project management ethos.

1.4 Statement of the problem

The system goal within the project management environment introduced in Section 1.2.3 is to ensure that projects are delivered within the defined constraints of cost, time and scope, which are in line with the main project objectives and desired project outcome. Obtaining a balanced compromise between project schedule, budget and results (and often perceptions) is key to successful project management.

Without the effective and efficient management of the triple constraint as an interrelated system, projects run the risk of becoming separated from purpose, which often results in project failure. According to the 1994 Chaos Report study conducted by the Standish Group, a research firm that focuses on mission-critical project management applications, only 16% of information technology projects met the criteria for success – completed on time, on budget and with the required features and functions as originally specified (Johnson et al., 2001). The Chaos Report looks at thousands of projects big and small around the world in various business domains. The 2004 results of the Standish Group showed that 29% of all

projects succeeded; 53% were challenged (late, over budget and/or with less than the required features and functions) and 18% have failed (cancelled prior to completion or delivered and never used). A staggering 66% of information technology projects prove unsuccessful in some measure, whether they fail completely, exceed their allotted budget, are not completed according to schedule or are rolled out with fewer features and functions than promised (Kozak-Holland, 2007). These figures are problematic.

Project management executives and professionals more and more face the daunting dilemma of managing how scarce resources, people and time are allocated across projects. The problem is that opposing viewpoints and differing positions when negotiating the triple constraint under these circumstances can often lead to destructive conflict. Hirschhorn (2001) recommends that, as project lifecycles shorten, functional groups must build seamless relationships to prevent schedule slips and rework.

Another problem is that current literature in the triple constraint domain suggests that the relationships between the key project variables are poorly understood by project teams and not adequately managed. The term 'triple constraint' did not even appear in the PMBOK® Guide glossary or index until the third edition (PMI 2004). This knowledge gap results in project managers not being able to effectively prioritise and exploit the trade-offs between the scope of work to be done, the cost of resources assigned to perform that work and the schedule it will take to accomplish the work. Norrie & Walker (2004: 47) furthermore warn that project managers may try to create an illusion of tangible progress by relying more heavily upon traditional on-time, on-budget and on-quality measures – yet this tactic fails to address the strategy ambiguity or establish appropriate project goals.

Further to the problem definition, a concept that is often misused, or rather incorrectly used as an excuse to justify project failure, is the age-old argument within the project management culture that a maximum of two out of the three triple constraint elements can be achieved at any given time (also known as the 'good, fast or cheap - pick two' rationale). This is a manifestation of what Collins & Porras (1994: 43) have termed the 'Tyranny of the *Or*'. Collins & Porras discovered that instead of being oppressed by this tyranny, highly visionary

companies liberate themselves with the 'Genius of the *And*' – the ability to embrace both extremes of a number of dimensions at the same time, which is in line with Johnson's (1996) polarity management philosophy. These inspiring concepts need to be absorbed into the triple constraint management practices and a mechanism needs to be defined how to manage this seemingly contradictory task when it comes to constraint trade-offs.

What is generally sought after in the industry is an improved understanding of the triple constraint principles and a consistent project triangle model as well as an appropriate negotiation mechanism to facilitate and conceptualise optimum trade-offs between and exploitation of the key variables in an effort to ensure that the primary project objective is achieved. The generic problem to be addressed is thus how to improve the interpretation, exploitation and communication of the interdependent dynamics of the triple constraint in an effort to advance the effective and efficient management thereof. Ultimately the goal is to improve project success by delivering on time, on budget and on specification in accordance with the project mission statement.

Assuming that the problem to be addressed has been adequately described and defined under this section, it is important to establish specific sub-problems and research questions that the study will attempt to answer.

1.4.1 Sub-problem one

The key elements of the triple constraint are often confused due to the variety of interpretations throughout literature. The dynamics of the interdependent relationships between the constraints are also generally misunderstood and project managers are not familiar with the hierarchical theory of the triple constraint. In general there is a lack of appropriate (and consistent) scholarship on the triple constraint. It is also common that the constraints are incorrectly ranked in terms of their priority and impact on a project, which leads to mistaken trade-offs within the project management triangle that do not reflect the real goals and objectives of the project and ultimately result in project failure. Incorrect strategies are also often utilised to exploit the flexibilities within the constraining triangle of a particular project. This may lead to creative opportunities being overlooked which

could otherwise have prevented the violation of the higher hierarchical constraints placed on the project.

The first sub-problem is to establish the fundamentals of the triple constraint in project management and discover the benefits of controlling the power structure of the triple constraint. The research questions pertaining to sub-problem one include:

- What is project management and where does the triple constraint fit in?
- How do the project purpose and strategy affect the triple constraint?
- Why do projects fail or succeed and how is this related to the triple constraint?
- Why may some projects be perceived to be successful when they have failed to fully meet the traditional criteria of the triple constraint?
- What is the theory surrounding the triple constraint and what is the philosophy behind the project triangle?
- How and where can the triple constraint effectively be applied within the project life cycle?
- How do the concepts of quality, customer satisfaction, performance and risk play into the theory of the triple constraint?
- How does the interpretation of the triple constraint elements vary across literature?
- How can flexibility be utilised and managed within the power structure of the triple constraint?
- Is it possible to unify a feasible triple constraint model?

Sub-problem one negatively influences the system goal in that a hierarchy that does not reflect the mission statement of the project cannot effectively be managed to meet the strategic business goals. The full potential of hidden resources within the project management triangle is also not recognised and

unlocked, which may result in not achieving the core requirements of the project objectives and higher purpose. The negative outcome may include lack of added value, lack of beneficial change, and lack of customer satisfaction.

1.4.2 Sub-problem two

Triple constraint analysis is often approached as problems to solve and clear solutions are expected. This may lead to over focussing on the limitations of the opposing constraints, unresolved conflict and not recognising creative opportunity through their interdependencies.

The second sub-problem is to establish the feasibility of managing the 'mutualities' of the triple constraint as polarities. The research questions pertaining to sub-problem two are:

- What is polarity management and how can it provide an additional perspective on managing intertwined organisational dilemmas?
- How can the differentiation be made between problems to solve, and polarities to manage?
- How does polarity management contribute towards conflict resolution and change management?
- What are the benefits of polarity management and where can polarity management be applied?
- Can the triple constraint elements be considered as polarities to manage?
- How can polarity management principles be applied to the triple constraint?
- Is it possible to unify a feasible triple constraint polarity model?

Sub-problem two negatively influences the system goal in that costly and unnecessary resistances are generated within the flow of the project management triangle, which complicates harmony. These resistances may inhibit the consideration of the hidden potential within the opposing constraints. The impact

of sub-problem two on the system goal consequently ties up with sub-problem one.

1.4.3 Sub-problem three

Considering the negative consequences of sub-problems one and two on the system goal, sub-problem three takes a look at how to flux the positive aspects of the preceding research questions into a generic methodology for effectively analysing and efficiently managing the triple constraint towards improving project success.

The third sub-problem is to establish how polarity management principles can be utilised within the power structure of the triple constraint through the development of an integrated framework to facilitate the optimum exploitation of flexibility in an effort to meet the absolute requirements of project success. The research questions pertaining to sub-problem three are:

- Which relevant theories and concepts can be derived from the project management and polarity management perspectives in support of the integrated framework?
- How does the proposed methodology improve the interpretation and management of the power structure and dynamics of the triple constraint?
- What value does the polarity management component of the integrated framework ad?
- What are the perceived benefits of the integrated framework and how can the proposed methodology be applied towards improving project success?

1.5 Research objectives

By addressing the research questions pertaining to sub-problems one and two, the supporting objectives of this study are to:

1. Uncover the knowledge foundation of the triple constraint.

2. Ascertain how flexibility within the triple constraint can be managed to ensure a beneficial outcome in terms of project success.

3. Introduce a consolidated triple constraint model.

4. Uncover the knowledge foundation of polarity management.

5. Establish the feasibility of applying polarity management principles to the triple constraint.

6. Introduce a consolidated triple constraint polarity model.

By addressing the research questions pertaining to sub-problem three, the primary objective of this study is to:

- Develop a framework and methodology that integrate the polarity management approach as part of the hierarchical rationale of the triple constraint, which facilitate the management of flexibility within the triple constraint and optimise the delivery of project success.

The goal of the research study is to show that the integrated framework (theoretical model and methodology) is valid and feasible for solving the generic problem addressed in Section 1.4, i.e. to improve the interpretation of the triple constraint trade-offs and dynamics in an effort to advance the effective and strategic management thereof.

1.6 Direction of the solution

The research propositions and hypothesis coupled to the problem statement are put forward in the following sections.

1.6.1 Proposition one

In order to address sub-problem one effectively, it is suggested that Dobson's theory on the hierarchy of constraints (Dobson, 2004; Dobson & Feickert, 2007) be considered as baseline in terms of triple constraint analysis. His theory suggests that every project is defined by listing the triple constraint elements in order of flexibility. They exist in a hierarchy of driver constraint (least flexible), middle

constraint (relatively flexible), and weak constraint (most flexible). The driver is the constraint that has to be met for the project to succeed. The flexibility within the weaker constraints furnishes opportunity that can be used creatively to ensure that the driver constraint does not fail.

It is proposed that, through a hierarchy of constraints that reflects the real goals and objectives of a project, incorrect trade-offs can be avoided and flexibility can be explored correctly and more creatively to uncover hidden resources, and drive the project to success.

1.6.2 Proposition two

In order to address sub-problem two effectively, it is suggested that Johnson's concept of polarity management (Johnson, 1996) can be applied to sets of opposing constraints within the project management triangle.

Within the context of this dissertation, it is proposed that opposing constraints is not a choice between alternatives ('either/or'), but require management with the support of their opposition ('both/and'). It is furthermore proposed that the following benefits will be attained through managing opposing constraints as polarities:

- A solid structure is provided for effectively addressing trade-offs between opposing constraints.
- Insight is provided into the dynamics of the opposing constraints and outcomes can be anticipated.
- The positive aspects of the trade-offs are obtained and maintained, while avoiding their downsides.

It is proposed that, through polarity management, unnecessary resistances between constraints can be avoided and the full potential of hidden opportunity can be recognised.

1.6.3 Research hypothesis

In order to address sub-problem three effectively, and accomplish the primary objective of this study, it is hypothesised that Johnson's polarity management

concept can be integrated into Dobson's hierarchy of constraints to facilitate and manage the exploitation of flexibility in the two more pliable constraints towards meeting the higher goal of the driver constraint.

It is therefore suggested that the absolute requirement of the driver constraint can be achieved through creative synthesis, by considering the mutual flexibilities in the middle and weak constraints as polarities to exploit and manage. It is believed that the integrated framework will improve the interpretation and exploitation of the power structure and dynamics of the triple constraint.

Key attributes of the conceptual methodology and model include:

- Determination of the triple constraint and its power structure within a project.
- Construction of the conceptual model and description of the project triangle polarity map.
- Diagnosis of the triple constraint critical elements and anticipation of complications.
- Conversion of the inherent tension and hidden opportunities between the two flexible constraints into a creative synergy that will ensure the higher goal of the driver constraint does not fail.
- Prescription of the guidelines to effectively manage the exploitation trade-offs and primarily maintain the positive results of both constraining poles.

It is theorised that the proposed model and methodology (integrated framework) will supplement triple constraint analysis and advance the effective and efficient management thereof. The prediction within the described real-world context of this research study is that the integrated framework will improve project success by ensuring that the delivered results reflect the desired project goal.

The integrated framework is supported by the research study and assessed through case study exploration.

1.7 Scope of the research

Project management is a broad and complex subject and the tools and the body of knowledge that support project management are extensive. The focus of this dissertation specifically surrounds the triple constraint in project management and the approach is mainly conceptual.

Of the nine knowledge areas of project management, the research study will briefly touch the following: project scope management, project time management, project cost management and project quality management. Instead of considering traditional strategies for managing these areas, this dissertation explores a refreshed perspective within the scope of selected polarity management principles and practices.

In particular, the scope of the research study encompasses the management of exploiting flexibility within the triple constraint hierarchy and optimising the trade-offs between the delivery targets.

1.7.1 Limitations

The project management body of knowledge is thoroughly documented and continuously researched. This dissertation limits the study to selected aspects pertaining to the triple constraint in project management. The key elements of the triple constraint are limited to the traditional constraining variables of time, cost and scope and exclude other environmental constraints pertaining to the project.

The research study does not cover other essential management elements, such as developing the skills the project manager needs to interpret the triple constraint, nor does it cover details of essential project management processes such as initiation, planning, execution, monitoring and controlling, and project closure. The various methods and activities to manage deliverables, as well as several other key elements in the project life that the project manager needs to consider, are beyond the scope of this dissertation.

The outcome of the study is limited to the conceptual exploration of the feasibility of consolidating polarity management principles as a model to facilitate triple

constraint analysis. Hypothesis testing is limited to exploratory case study analysis.

An anticipated limitation of the proposed framework is that it may not effectively be applied to the triple constraint in cases where trade-offs are not considered an option, for example when exploitation flexibility is minimal and a definitive decision is required in terms of prioritisation.

1.7.2 Assumptions

The literature study only provides a concise review of selected project management fundamentals in support of the theory surrounding the triple constraint. It is assumed that the readers of this dissertation have established knowledge of, or will further investigate into, the detailed project management principles and practices, as required. Previous knowledge of polarity management principles is not required since a comprehensive theoretical review is provided.

The following suppositions are associated with this research study:

- Time, cost and scope are considered the key elements of the triple constraint.
- A degree of flexibility is always possible in at least one of the triple constraint elements.
- Changing one of the key elements will impact at least one of the remaining elements.
- Only one of the triple constraint elements can be the driver constraint for the project at any given time.
- Accomplishment of the higher purpose of the project is dependent on the success of the driver constraint.
- The exploitation trade-off between the middle constraint and the weak constraint is interdependent and ongoing.

- The implied value of polarity management can effectively be applied in practice.

1.8 Research approach

The basic structure of the research process follows Mouton's ProDEC framework of social scientific reasoning (Mouton, 2008: 46). ProDEC refers to the four standard research elements: a research problem (Pro), research design (D), evidence (E) and conclusions (C).

The basic structure of the research process for this study is presented in Figure 1.2 (integrated and adapted from Brent, 2006: 5; Mouton, 2008: 47).

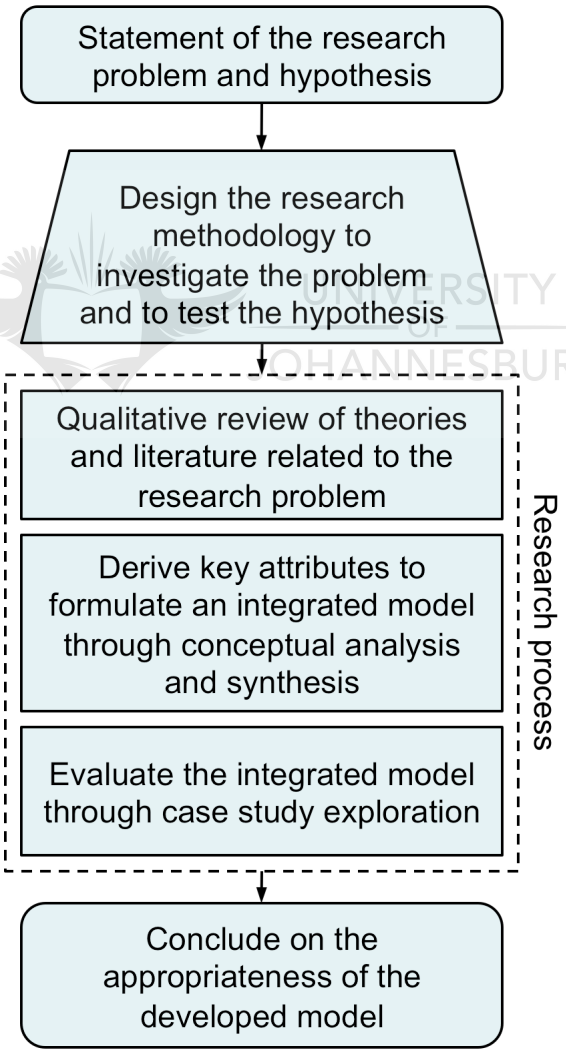

Figure 1.2: Basic structure of the research process

The research undertakes extensive literature studies of the triple constraint in project management as well as polarity management principles and practice, after which an analysis and synthesis process is conducted to determine appropriate theories and characteristics for an integrated framework. In terms of data gathering and analysis, the proposed framework is assessed through case study exploration to illustrate its practical application and ascertain its contributing value.

The research strategy and methodology for this study are portrayed in Figure 1.3.

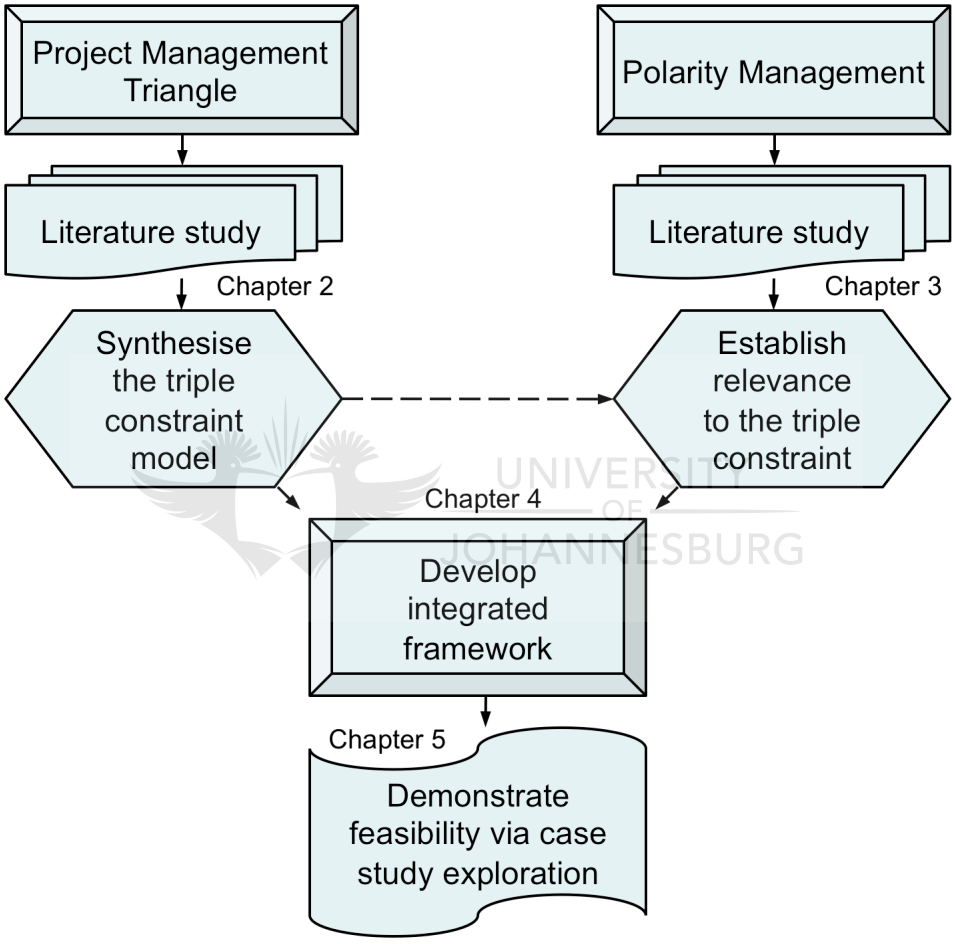

Figure 1.3: Research strategy and methodology

The research study comprises components of theory building, theory testing and theory application. In the effort to extend current theory and practice, it is important to determine the boundaries of existing versus proposed methodology and to ascertain that the problem in the study has not already been sufficiently addressed by other researchers.

1.8.1 Research design

The integrated framework (theoretical model and methodology) developed in this dissertation is highly conceptual. The emphasis in this study is therefore on qualitative reasoning both in definition, explanation and application, rather than an emphasis on heavy empirical and other quantitative techniques. Unlike experiments and surveys, in which the elements of the research design are specified prior to data collection, design elements in qualitative research are usually worked out during the course of the study (Mouton, 2008: 195).

The type of study associated with this dissertation is primarily non-empirical defined through literature studies, conceptual analysis and construction of an integrated framework using secondary (existing) data. Exploration of the integrated framework through case study analysis introduces an empirical element into the research design. According to Flyvbjerg (2006) case studies lend themselves to both generating and testing hypotheses and, according to Patton (1990), are useful in depicting a holistic portrayal. Case study is a research methodology more common in social science (Yin, 2009). It is based on a longitudinal examination of a single instance or event (a case) to explore causation in order to find underlying principles. As a result the researcher may gain a sharpened understanding of why the instance happened as it did, and what might become important to look at more extensively in future research. Yin notes that case studies should not be confused with qualitative research and points out that they can be based on a mix of quantitative and qualitative evidence. According to Lamnek (2005) case study analysis is a research approach situated between concrete data capturing techniques and methodological paradigms.

According to Mouton (2008: 92) the aim of theoretical and conceptual studies (non-empirical) is to review and discuss the most relevant and appropriate theories, models or definitions of a particular phenomenon. In many empirical studies, a review of the most pertinent theoretical positions or schools is seen as the first step in the research process. A review of such theoretical positions forms the theoretical framework for the empirical study, usually by deriving hypotheses from one or more of the accepted theories or models. In both cases the literature review should be organised around the theories or definitions.

Mouton recommends that a comprehensive and well-integrated literature review is essential to any study. It provides a good understanding of the issues and debates in the area, current theoretical thinking and definitions as well as previous studies and their results. A limitation of literature reviews is that they only summarise and organise the existing scholarship. Even a critical literature study cannot produce new, or validate existing, empirical insights. Although literature reviews often lead to theoretical insights, an empirical study still needs to be undertaken in order to test these new insights. The main sources of error associated with literature reviews, as claimed by Mouton (2008: 180), include: selectivity in the sources; unfair treatment of authors; misunderstanding the sources; selective interpretation to suit one's own viewpoint; and poor organisation and integration of the review.

Mouton (2008: 175) advocates that conceptual analysis brings conceptual clarity. Well-structured conceptual analysis makes conceptual categories clear, explicates theoretical linkages and reveals the conceptual implications of different viewpoints. Mouton warns that poor conceptual analysis may lead to conceptual confusion, theoretical ambiguities and fallacious reasoning. Conceptual errors include vague and ambiguous definitions, classifications that are not mutually exclusive and errors in reasoning such as affirming the consequent.

The goal is to integrate the themes and concepts into a theory that offers an accurate, detailed, yet subtle interpretation of the research arena.

1.8.2 Research logic

The research logic of the dissertation refers to the principles of reasoning that are employed in the construction of the main arguments. According to Mouton (2008: 112, 120) the literal meaning of dissertation is to put together a coherent, logical, clear and persuasive argument. Theory and model building in this research dissertation occurs mainly through inductive (retroductive) and deductive strategies.

Inductive modes of reasoning are manifested in statistical model-building where a model is constructed to fit certain empirical data. Inductive generalisation involves applying inferences from specific observations (such as a sample of cases) to a theoretical population (Mouton, 2008: 117, 177). Within this research study, the

results from the case study analysis are generalised to refer back to the project management body of knowledge in terms of applicability. It should be noted that the general application of the findings is limited by the sample convenience (of the case) in terms of probability.

Deductive forms of theory construction are much more formal in nature. Deductive reasoning involves drawing conclusions from premises (other statements) that necessarily follow from such premises (Mouton, 2008: 117, 177). A set of postulates, or axioms, is formulated and taken to be true. From these postulates, further theoretical propositions are deductively derived. This procedure is followed until a comprehensive set of theoretical propositions has been developed that will ultimately be tested against empirical data. The most common forms of deductive reasoning in science are:

- Deriving hypotheses from theories and models (the deductive derivation of research hypotheses from a theory or model).
- Conceptual explication (when the meaning of a concept is clarified through the deductive derivation of its constitutive meanings).

Within this research study, the derived hypothesis is that the advantages of polarity management will have the same positive effect on the mutuality of the triple constraint, i.e. implementing a known model to a new application. Conceptual explication is used to derive the integrated model through analysis and integration of concepts discovered through the literature reviews. Buys (2003: 18) states that the deduction of new theoretical propositions must be substantiated by references to real-world observations and/or past scholarship. This research study undertakes basic case study analysis as a mechanism to demonstrate that the derived model is valid and useful.

1.9 Organisation of the dissertation

The chapter structure of the dissertation is outlined as follows:

CHAPTER 1 (INTRODUCTION)

Chapter 1 presents relevant background information pertaining to the research and provides justification for conducting the study. This chapter also describes the problem statement, objectives, propositions, scope and approach of the research.

CHAPTER 2 (PROJECT MANAGEMENT TRIANGLE)

Chapter 2 provides a literature review of project management nomenclature relevant to the research problem and provides a study of the theories and concepts surrounding the project management triple constraint. This chapter constitutes the first part of the research literature study. Chapter 2 concludes with a consolidated triple constraint model.

CHAPTER 3 (POLARITY MANAGEMENT)

Chapter 3 provides a study of the theory and literature surrounding the polarity management phenomenon and considers the triple constraint elements as polarities to manage. This chapter constitutes the second part of the research literature study. Chapter 3 concludes with a consolidated triple constraint polarity model.

CHAPTER 4 (INTEGRATED FRAMEWORK)

Chapter 4 develops the integrated framework (theoretical model and protocol) through conceptual analysis of the key aspects inherited from the literature studies and synthesis of the consolidated models.

CHAPTER 5 (CASE STUDY ANALYSIS)

Chapter 5 explores the applicability and feasibility of the integrated framework against a simplified test case to indicate that the derived model and methodology are supported by the research.

CHAPTER 6 (CONCLUSIONS AND RECOMMENDATIONS)

Chapter 6 summarises the main results and conclusions of the study, and discusses implications, limitations and areas for further research.

1.10 Chapter closure

Chapter 1 presents an understanding of the problem environment and outlines the research problem of interest. The chapter provides the necessary rationale for undertaking the study and describes the research questions, objectives, propositions as well as the scope and approach of the research. An outline of the hypothesised solution parameters to the conceptual integrated framework is also identified.

The research study follows primarily a conceptual (non-empirical) approach. The research strategy is realised through the analysis and synthesis of the triple constraint and polarity management literature to deduce an integrated methodology and framework, which is validated via case study analysis.

The first part of the research literature study is presented in Chapter 2, which provides a study of the fundamentals surrounding the triple constraint in project management.

CHAPTER 2 PROJECT MANAGEMENT TRIANGLE

2.1 Chapter overview

Chapter 2 presents the first part of the research literature study. The chapter commences with a comprehensive review of common project management terms and definitions as observed across literature. The overview is followed by a study of the principles, notions and models surrounding the project management triangle, also known as the triple constraint in project management.

Concepts and conclusions in support of the integrated framework, central to this dissertation, are progressively deduced from the surveyed theory and literature throughout the chapter.

The purpose of this chapter is to investigate the problem under study with reference to the research questions identified in Section 1.4.1. At the end of this chapter a consolidated triple constraint model is concluded, which clarifies the significance of the deductions in terms of the physiology of the integrated framework.

2.2 Prologue to the literature review and study

A substantial range of literature has been considered in the literature study and represents authoritative knowledge across the field of project management. Amongst the wide variety of credible sources that have been referenced to construct the literature study, the qualifications and certifications of selected referenced researchers and authors are highlighted in support of the content and reasoning presented in this chapter. The following referenced authors, listed in alphabetical order by citation, are certified as project management professionals (PMP's) through the project management institute (PMI):

- G. Michael Campbell (Campbell & Baker, 2007)
- Tom Carlos (Carlos, 2007)
- Carl Chatfield (Chatfield & Johnson, 2008)

- Mike Crocker (Crocker, 2008)
- Michael S. Dobson (Dobson & Feickert, 2007; Dobson, 2004)
- Elyse (Elyse, 2004)
- George Jucan (Garrett, 2008)
- Duncan Haughey (Haughey, 2008; Haughey, 2010)
- Alan S. Koch (Koch, 2006; Koch, 2007)
- Rich Maltzman and Ranjit Biswas (Maltzman & Biswas, 2009)
- Dr. Keith Mathis (Mathis, 2008)
- Michael W. Newell and Marina N. Grashina (Newell & Grashina, 2003)
- Jay Siegelaub (Siegelaub, 2008)
- James A. Ward (Ward, 2003; Ward, 2005)

In addition to the PMP's, the following referenced authors are awarded doctorates in their specialist fields:

- Dr. Sunny Baker (Campbell & Baker, 2007)
- Dr. Salah E.E. Elmaghraby and Prof. Dr. Willy S. Herroelen and Dr. Roel Leus (Elmaghraby et al., 2002)
- Dr. Peter Flett (Flett, 2001)
- Dr. Jack T. Marchewka (Marchewka, 2006)
- Dr. Keith Mathis (Mathis, 2008)
- Dr. Koen Milis and Dr. Michel Meulders and Prof. Dr. R. Mercken (Milis et al., 2003)
- Dr. James L. Norrie and Prof. Dr. Derek H.T. Walker (Norrie & Walker, 2004)

- Prof. Dr. Mehran Sepehri (Sepehri, 2006)
- Dr. Karl Wiegers (Wiegers, 2008)

Project management and triple constraint theory are extensive subjects and cover a broad field. Chapter 2 does not demonstrate a complete survey of all the literature in the field, but rather summarises the relevant aspects to justify the validity of the main ideas of the study in practice.

2.3 Review of project management terms and definitions

This section provides a literature review of the impressions surrounding selected project management terms and definitions relevant to the research study.

2.3.1 Project Management Body of Knowledge

All organisations, be they small or large, at one time or other, are involved in implementing new undertakings. These undertakings may be diverse, such as, the development of a new product or service; the establishment of a new production line in a manufacturing enterprise; a public relations promotion campaign; or a major building programme. Whilst the 1980's were about quality and the 1990's were all about globalisation, the 2000's are about velocity. That is, to keep ahead of their competitors, organisations are continually faced with the development of complex products, services and processes with very short time-to-market windows combined with the need for cross-functional expertise. In this scenario, project management becomes a very important and powerful tool in the hands of organisations that understand its use and have the competencies to apply it.

The project management institute (PMI) is an international organisation dedicated to the advancement of project management worldwide. The institute establishes many standards related to project management and manages several levels of project management certification. The PMI also provides seminars and educational programs. As of 2006, the PMI reported over 200 000 members and over 180 000 project management professional (PMP) ‘certificants’ in 175 countries. At the time of writing this dissertation, approximately 370 000 people have been holding the PMP certification.

The PMI was founded by five volunteers and incorporated in 1969 to serve the interest of the project management industry. Its headquarters are in Newtown Square, outside Philadelphia, Pennsylvania. The PMI has grown to become the leading non-profit professional association in the area of project management. Based on their best practice research on projects worldwide, the PMI has established a guide for project managing called, 'A Guide to the Project Management Body of Knowledge' (PMBOK® Guide)[3]. The guide is an internationally recognised standard (IEEE Standard 1490-2003) that provides the fundamentals of project management as they apply to a wide range of projects such as construction, software, engineering and automotive, to name but a few. The guide is process-based, meaning it describes work as being accomplished by processes. Processes overlap and interact throughout a project or its various phases. The PMBOK recognises 44 processes that fall into five basic process groups and nine knowledge areas that are typical of almost all projects.

The PMBOK is important for many reasons. First, the definitions given in the PMBOK are used universally in the project management field. Second, although much of the material in the PMBOK is theoretical its framework is still very useful for planning and managing projects. It provides a comprehensive picture of what a project manager should be working to achieve as he or she delivers a project. The PMI published the first PMBOK guide as a white paper in 1987 in an attempt to document and standardise generally accepted project management information and practices. The first edition was published in 1996 followed by the second edition in 2000. In 2004 the third edition was published including major changes from the first edition. The latest version of the PMBOK guide (fourth edition), at the time of writing this dissertation, has been released in 2009.

Over the years there have been several other attempts to develop similar project management standards, which include PRINCE2™ (PRojects IN Controlled Environments); V-Modell (German project management method); HERMES method (The Swiss general project management method); OPM3 (Organisational Project Management Maturity Model); and Total Cost Management Framework (AACE International's process for Portfolio, Program and Project Management).

[3] Hereinafter referred to as the PMBOK.

The International Project Management Association (IPMA), founded in Europe in 1967, has undergone a similar development as the PMI and instituted the IPMA Competence Baseline (ICB). The focus of the ICB also begins with knowledge as a foundation, and adds considerations about relevant experience, interpersonal skills and competence. The PMI and IPMA are currently participating in the development of an ISO project management standard.

Integrated from Azzopardi (2006); Campbell & Baker (2007); PMI (2004); Wikipedia (2011); and Marchewka (2006).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the project management body of knowledge:

- The growth spurt in terms of complexity and competing demands across the diversity of emerging projects necessitates structure and guidance in terms of management.
- Various international associations and standards exist that are committed to promote and unify the project management body of knowledge.
- The PMI's PMBOK is a process-based IEEE standard that provides a common understanding and guidance within the project management profession.

Within the context of this dissertation, the PMBOK is referenced as the primary framework in terms of project management nomenclature and processes.

2.3.2 Project

The Latin word 'projectum' means, "to throw something forwards" (Kozak-Holland 2007).

A project is defined by the PMBOK as a temporary endeavour undertaken to create a unique product, service or result (PMI, 2004: 5, 368). The IPMA defines a project as a time and cost restrained operation to realise a set of defined

deliverables[4] (the scope to fulfil the project's objectives) up to quality standards and requirements (cited in Maltzman & Biswas, 2009).

According to the Tasmanian Government Project Management Guidelines (2005: 2) a project involves a group of interrelated activities that are planned and then executed in a certain sequence to create a unique product or service within a specific timeframe, in order to achieve outcomes / benefits. Turner (as cited in Duma, 2005: 1; Flett, 2001: 12) describes a project as an endeavour in which human, financial and material resources are organised in a novel way, to undertake a unique scope of work, of given specification, within constraints of cost and time, so as to achieve beneficial change defined by quantitative and qualitative objectives. Pretorius (2001: 1) specifies a project as an undertaking to achieve a predefined objective, normally in terms of budget, schedule and technical performance.

On the basis of the aforementioned definitions it is clear that projects constitute elements of finiteness and uniqueness. Noori & Radford (1995) denote a project as a set of finite activities that is usually performed once and has well defined objectives. In similar vein, Meridith & Mantel (2000) state that a project is usually a one-time (unique) task that needs to be accomplished with well-desired end results. The elements of the formal PMBOK project definition, "a temporary endeavour undertaken to create a unique product, service or result", can accordingly be broken down as follows (integrated from Mihalic, 2007: 5; Chatfield & Johnson, 2008; Aramvareekul & Seider, 2006: 12; Dobson, 2004: 38):

- 'temporary' signifies that the project has both a definite beginning and a definite expected end date;
- 'endeavour' signifies that the project involves effort and that resources, such as people and equipment, need to do work;
- 'to create' signifies that the project has an intention to produce or provide something (deliverables);

[4] The individual items of goods or services that are accomplished are referred to as the project deliverables (Newell & Grashina, 2003). The PMBOK defines a deliverable as any unique and verifiable product, result or capability to perform a service that must be produced to complete a process, phase or project (PMI, 2004: 358).

- 'unique' signifies that the product or service, including the customer's expectations, differs from project to project;
- 'product, service or result' signifies that the project has tangible results (the reason that the project was undertaken).

Thus, simply stated by the author of this dissertation, every project constitutes a defined set of related activities; has a definite lifespan; and consumes resources to create unique and concrete deliverables. According to Campbell & Baker (2007: 4) a project produces something that has never existed before; has a deadline or target date for when the project must be done; and has a budget that limits the amount of people, supplies and money that can be used to complete the project. A team or an organisation typically undertakes these endeavours, which imply that projects have a sense of being intentional, planned events (Chatfield & Johnson, 2008). The PMBOK states that the definite end is reached when the project's objectives have been achieved; or it becomes clear that the project objectives will not or cannot be met; or the need for the project no longer exists and the project is terminated (Dobson, 2004: 38). However, 'temporary' does not generally apply to the product service or result created by the project. Most projects are undertaken to create a lasting outcome (PMI, 2004: 5). Also, the presence of repetitive elements does not change the fundamental uniqueness of the project work.

Projects should not be confused with operational work. Projects and operations differ primarily in that operations are ongoing and repetitive, while projects are temporary and unique. The purpose of a project is to attain its objective and then terminate. Conversely, the objective of an ongoing operation is to sustain the business (PMI, 2004: 6). The triple constraint is an important part of understanding the transition from an operational work environment to a project environment, particularly the time constraint. While there are deadlines even in the world of operations, the deadlines do not spell the end of work, but merely the end of 'today's assignment'. For a project, the deadline ends it all (Dobson, 2004: 23). This property of being a temporary and one-time undertaking contrasts with processes, or operations, which are permanent or semi-permanent ongoing functional work to create the same product or service over and over again (Chatfield & Johnson, 2008; Wikipedia, 2007).

A program is defined by the PMBOK as a group of related projects managed in a coordinated way to obtain benefits and control not available from managing them individually. Programs may include elements of related work outside of the scope of the discrete projects in the program (PMI, 2004: 368). Programs, like projects, are a means of achieving organisational goals and objectives, often in the context of a strategic plan (Mihalic, 2007: 6). Projects often constitute critical components of an organisation's business strategy. Another way of looking at projects is as a means of organising activities that cannot be addressed within the organisation's normal operational limits. Projects are, therefore, often utilised as a means of achieving an organisation's strategic plan. Projects are typically authorised as a result of one or more of the following strategic considerations: a market demand, an organisational need, a customer request, a technological advance or a legal requirement (PMI, 2004: 7).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the definition of a project:

- Projects are distinctive.
- Projects consume resources.
- Projects are constrained with limitations and boundaries.
- Projects produce deliverables and bring about change.

The goal is to yield beneficial change or added value.

2.3.3 Project basis

Projects are undertaken to accomplish something. Newell & Grashina (2003) state that companies need projects in order to:

- Be able to develop;
- Be flexible in answering the market;
- Carry out organisational structure change;

- Grow in size; and
- Conquer new markets.

According to Marchewka (2006: 12), any project must have a goal[5] to drive the project in terms of defining the work to be done, its schedule, and its budget, and to provide the project team[6] with a clear direction. The project goal must be clearly defined and agreed in view of the fact that it sets expectations that will directly influence the customer's level of satisfaction. Carruthers (as cited in Duma, 2005: 4) state that outcomes may be open to personal interpretation in projects where they are not distinctly decided or agreed upon. Payne et al. (as cited in Duma, 2005: 4) warns that this may lead to cost and scheduling problems and ultimately poor quality.

Flett (2001: 4) observes that time and cost are the most common benchmarks in industry, with seldom any questioning as to whether they are sufficient in terms of contributing to project success and to the project process. According to Dobson (2004: xiii, 11), the most overlooked question in project management is 'why', for example:

- Why is this project undertaken? Why not a different project?
- Why this direction? Why this outcome?
- Why these specifications? Why not other ones?

Leadership's purpose is to define and scope a project so that its reason-for-being is well understood by those who can influence the project's successful execution (Norrie & Walker, 2004: 47). According to the Tasmanian Government Project Management Guidelines (2005: 4), clear understandings of why the business case is being undertaken should be established in the initiation phase.

Marchewka (2006: 12) states that a project's goal must be to produce something tangible and of value to the organisation. Simms (2008) affirms that the project

[5] Goals relate to aspirations, purpose and vision. Objectives, on the other hand, are the battle plan, the stepping-stones on the path towards the achievement of goals (Ambler, 2006: March).
[6] The project team constitute all the project team members including the project management team and the project manager as well as, for some projects, the project sponsor (PMI, 2004: 370).

basis should be the delivery of the business outcomes, benefits and value. According to Dobson (2004: xiii) the goal of the project, not the project itself, is the prime mover. Projects are usually justified in terms of corporate objectives and should be closely aligned to them (Tasmanian Government Project Management Guidelines, 2005: 4). Project objectives define target status at the end of the project, reaching of which is considered necessary for the achievement of planned benefits. The acronym SMART is a well-known mnemonic in project management that describes the key characteristics for setting meaningful objectives and for evaluating objectives (integrated from Haughey, 2010; Ambler, 2006: March). The acronym has a number of slightly different variations, which can be used to provide a more comprehensive definition for goal setting:

- S – specific (concrete, detailed, well-defined, and clear to anyone that has a basic knowledge of the project); also sometimes referred to as significant.
- M – measurable (numbers, quantity, comparison; knowing if the goal is obtainable, how far away completion is, and when it has been achieved); also sometimes referred to as meaningful or motivational.
- A – agreed upon (agreement with all the stakeholders what the goals should be); also sometimes referred to as attainable, achievable, acceptable or action-oriented.
- R – realistic (within the availability of resources, knowledge and time); also sometimes referred to as relevant, reasonable, rewarding or results-oriented.
- T – time-based (bounded with sufficient time to achieve the goal); also sometimes referred to as time-terminated, timely, tangible or trackable.

Although some projects are done by direct order, most projects have a justification (Newell & Grashina, 2003). The most credible justification is one where the identified benefits of doing the project are greater than the cost of doing the project. Newell & Grashina highlight that it is important to understand that there are many ways of describing the cost-benefit ratio for a project in order to justify it. Using monetary value is just one approach that does not have to be forced over all

projects. PRINCE2 (as cited in Siegelaub, 2008) requires the project to have a business case – a clear justification, with measurable, agreed benefits[7] that are expected to result from the project's outputs. If there is no clear justification, then the project should not be started, and if the justification disappears, or is reduced below an agreed-upon limit, the project should be stopped. As the project has deliverables that it produces, the benefits represent the value that those items are expected to have for the organisation (in financial or other terms). The benefits are affected by factors both internal and external to the project. PRINCE2 recognises that even if we are on time, on budget (cost), and meeting scope and quality expectations, a change in circumstances may indicate that it is no longer worthwhile to continue the project; i.e., the benefits have diminished or disappeared.

Norrie & Walker (2004) indicate that attaching measures to outcomes clarifies project objectives and supports well-defined and well-communicated links between the project vision and business strategy. These also enable project managers to more effectively monitor and control project activities for the purpose of improving project results. Their study also shows that balanced performance measurement is an important technique for establishing on-strategy project delivery. Norrie & Walker warn that if project leaders rely purely on the traditional measures of the triple constraint, they could, quite possibly, successfully deliver an ultimately non-strategic project on-time, on-budget and on-quality. By demanding that project team members link their own actions and decisions with the overall intended strategy of the project can assist with on-strategy project execution.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project justification:

- Effective projects bring form and function to ideas or needs, and add value.
- The rationality for undertaking a project should be clearly defined and understood by all stakeholders.

[7] Benefits represent the value the project is expected to deliver to the organisation.

- The higher purpose (rationale) of the project should tie-up with the overall strategy of the business.

- A project may be perceived as successful even when it failed to fully deliver within the planned constraints; a project may also be perceived as unsuccessful even when it did meet all the required constraints. The higher purpose of the project should fundamentally be the driver of the project.

- SMART objectives are the building blocks towards the achievement of the project higher purpose. The challenge is to optimise the allocation and integration of inputs needed to meet these objectives.

2.3.4 Project sponsor and stakeholders

The project sponsor is defined by the PMBOK as the person or group that provides the financial resources, in cash or in kind, for the project (PMI, 2004: 376). According to Marchewka (2006: 12, 13) the project sponsor may be the end user, customer, or organisational manager who will act as a champion for the project and has the ability and desire to provide organisational resources, funding and direction when needed. Carlos (2007) states that the project sponsor must assume 'ownership' of the project, and should sign an agreement stating that they will make key decisions regarding scope, schedule, resources, as well as setting priorities if changes should occur.

Although a project should have a clearly defined sponsor, a project may have many stakeholders. Project stakeholders are defined by the PMBOK as individuals and organisations that are actively involved in the project, or whose interests may be affected as a result of project execution or project completion (PMI, 2004: 24). Marchewka (2006) defines project stakeholders as individuals or groups who have a vested interest in the project's outcome. According to Newell & Grashina (2003) a stakeholder is any person who has something to gain or lose by either the doing of the project or the results delivered by the project. Stakeholders may include customers, suppliers, outside contractors and influencers as well as company management, the project sponsor and the project team.

It is important for the project team to recognise all of the stakeholders, including the project sponsor. The project team needs to determine the requirements and expectations of the stakeholders, and, to the extent possible, manage their influence in relation to the requirements to ensure a successful project. Stakeholders who ignore their responsibilities can have a damaging impact on the project objectives. Similarly, project managers who ignore stakeholders can expect a damaging impact on project outcomes (PMI, 2004: 25). Stakeholders who are not recognised will generally make their presence known toward the end of the project when they see that their needs have not been incorporated, which in turn may lead to uncontrolled changes in the scope of work.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project stakeholders:

- Project stakeholders may influence the objectives and outcomes of a project.
- The role of the project sponsor is cardinal to the project and should be clearly defined and understood by the project team.
- The scope of the project may be understated if all the stakeholders are not appropriately identified early in the life of the project.
- Latent needs may often become new requirements that have neither been funded nor scheduled, i.e. scope creep.

2.3.5 Project management

Project management is of value in making a project efficient and effective (Dobson, 2004: 61).

Project management is defined by the PMBOK as the application of knowledge, skills, tools and techniques to project activities to meet project requirements (PMI, 2004: 368). The PRINCE2 project management methodology defines project management as the planning, monitoring and control of all aspects of the project

and the motivation of all those involved in it to achieve the project objectives on time and to the specified cost, quality and performance (OGC, 2009). According to the Tasmanian Government Project Management Guidelines (2005: 3) project management is a formalised and structured method of managing change in a rigorous manner. It focuses on developing specifically defined outputs that are to be delivered by a certain time, to a defined quality and with a given level of resources so that planned outcomes / benefits are achieved. Effective project management is essential for the success of a project. Turner (as cited in Flett, 2001: 12) defines project management as a process, which is a combination of project objectives, a multi–level management process to reach those objectives, that should culminate in a successful project. Noori & Radford (1995) define project management as the planning, implementation, control and co-ordination of a project from start to finish in order to meet defined needs, to the required standards within time and to budget. According to Mihalic (2007: 9) project management is the planning, scheduling and controlling of project activities to achieve time, performance and cost objectives for a given scope of work. Mihalic's principle is indicated in Figure 2.1.

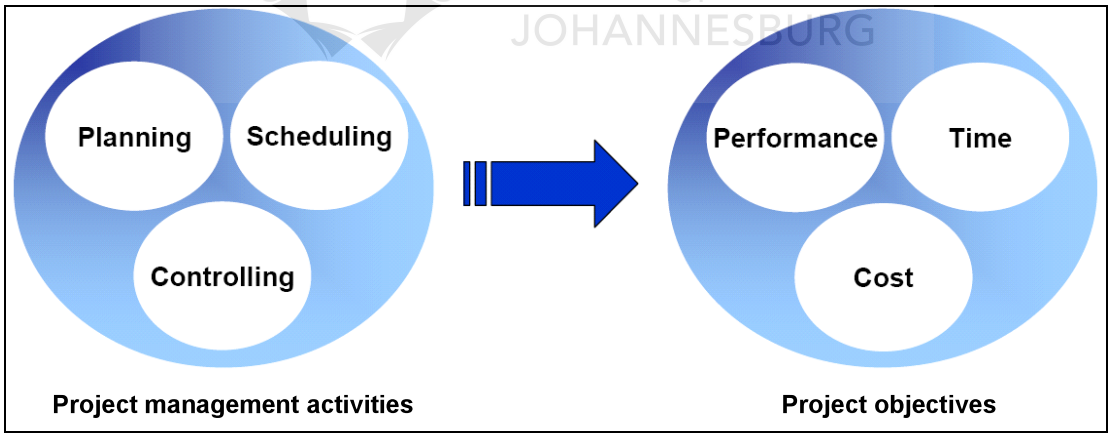

Figure 2.1: Portrayal of project management activities and objectives (Mihalic, 2007)

Mihalic maintains that the foundation of project management encompasses performance measurement, triple constraint theory, risk management and quality. According to Business Services Projects (2003: 3), the core functions of project management is scope, time, cost and quality management. Haughey (2008) proclaims that project management is about creating an environment and conditions in which a defined goal or objective can be achieved in a controlled

manner by a team of people. The team of people, the project team, is responsible to manage the work associated with the project, although project management is often the province and responsibility of an individual project manager. This work, according to the Stanford University (2008), typically involves competing demands for scope, time, cost, risk and quality as well as stakeholders with differing needs and expectations. Duma (2005: 7) states that project management is the ability to plan, organise, lead and control given resources in an uncertain environment in order to achieve these predefined outcomes. Expressed similarly, Wikipedia (2007) defines project management as the discipline of organising and managing resources in such a way that a project is completed within defined scope, quality, time and cost constraints. Ward (2003), and again in Ward (2005), promulgates that project management always involves effectively balancing the scope of effort with the resources available (cost) and within an acceptable or pre-determined time frame (schedule). Witzel (2004) concurs with Ward by claiming that one of the key goals of project management is to ensure that the triple constraint remains in equilibrium.

On a macro level, Azzopardi (2006) claims that organisations are motivated to implement project management techniques to ensure that their undertakings (small or major) are delivered on time, within the cost budget and to the stipulated quality. On a micro level, project management combined with an appropriate information management system has the following objectives: reducing project overhead costs; customising the project workplace to fit the operational style of the project teams and respective team members; proactively informing the executive management strata of the strategic projects on a real-time basis; ensuring that project team members share accurate, meaningful and timely project documents; and ensuring that critical task deadlines are met. Azzopardi however warns that whilst the motivation and objectives to apply project management in organisations are commendable, they do not assure project success. Roberts & Furlonger (2000: 2) estimate that using a moderately rigorous project management methodology, as compared to a loose methodology, can improve productivity by 20 to 30 percent. According to the PMBOK, the application of a formalised project management framework, or methodology, to projects can facilitate the clarification of project scope and help with: clarification of (and agreement to) goals and

objectives; identifying resources needed; ensuring accountability for results and performance; and fostering a focus on final benefits to be achieved (cited in the Tasmanian Government Project Management Guidelines, 2005). In recent years there have been increased accountability requirements on public sector agencies, leading to a greater focus on effectiveness and efficiency in the way business is conducted. In a rapidly changing environment with diverse issues and projects, project management can support the achievement of project and organisational goals, as well as give greater assurance to stakeholders that resources are managed effectively (PMI, 2004). Project management utilises a variety of tools to measure accomplishments and track project tasks. These various project management instruments are not described in this dissertation.

Formal project management is best described and accomplished through the application and integration of its component processes (Stanford University, 2008; Kozak-Holland, 2007). These processes can be placed, in accordance with the PMBOK (PMI, 2004: 8, 9), into five process groups (initiating, planning, executing, monitoring & controlling, and closing) and into nine knowledge areas, namely: project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management and project procurement management. According to Business Services Projects (2003) successful project management requires that all nine knowledge areas be managed effectively. It is important to note that many of the processes within project management are iterative because of the existence of, and necessity for, progressive elaboration in a project throughout the project's life cycle. Progressive elaboration is a characteristic of projects that accompanies the concepts of temporary and unique. Progressive elaboration means developing in steps, and continuing by increments. That is, as a project management team learns more about a project, the team can then manage to a greater level of detail (PMI, 2004: 8).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project management:

- Project management involves activities and processes across a broad knowledge area.
- Triple constraint considerations are central to project management.
- Effective project management yields delivery of project objectives and adds value through the achievement of the project higher purpose.

Detailed descriptions of project management models, methods, tools and techniques, and their interaction, are beyond the scope of this dissertation.

2.3.6 Project phases and project management process groups

Since every project is unique by definition, each has a large degree of uncertainty associated with it. One of the techniques that can help develop project plans effectively is to use the project life cycle as a guide (Campbell & Baker, 2007: 40). The project life cycle defines the phases that connect the beginning of a project to its end (PMI, 2004: 19).

Project managers divide projects into distinct phases to provide better management control with appropriate links to the ongoing operations of the performing organisation. These phases are collectively known as the project life cycle. The generic project life cycle is illustrated in Figure 2.2.

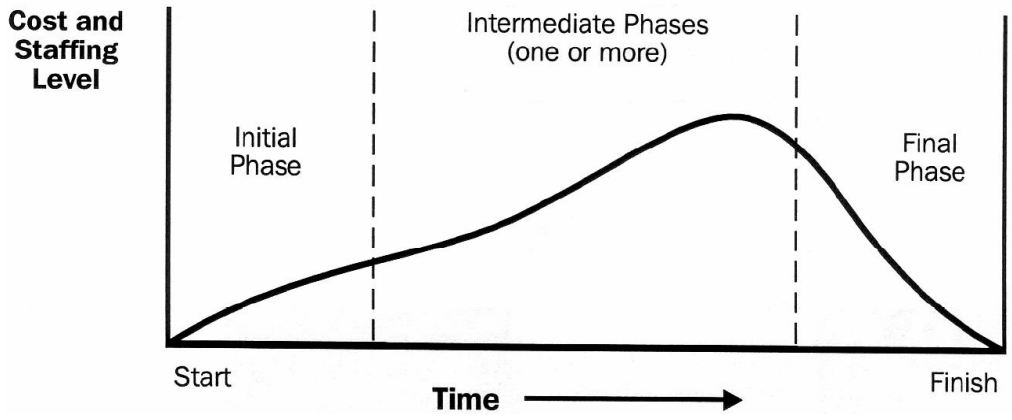

Figure 2.2: Generic project life cycle (adapted from PMI, 2004; Sepehri, 2006)

Financial, human and technological resources are used differently during the total life cycle of a project (Duma, 2005: 10). One of the common characteristics, according to the PMBOK, is that cost and staffing levels are usually low at the

start, peak during the intermediate phases, and drop rapidly as the project draws to a conclusion (PMI, 2004: 20). Figure 2.2 illustrates this pattern. According to Campbell & Baker (2007: 42) the majority of the money and time is spent during the execution phase of the project life cycle.

Projects large or small have the same life cycle format, i.e. a need is identified, plans are put in place, plans are implemented and an outcome is delivered (Duma, 2005: 10). There is no single best way to define an ideal project life cycle. Although many project life cycles have similar phase names with similar deliverables, few life cycles are identical. Some can have four or five phases, but others may have nine or more (PMI, 2004: 20, 22). Typical phases in a project life cycle may include: concept phase; design & development (planning) phase; implementation phase; termination phase; and evaluation phase (integrated from Duma, 2005; Baguley, 1995; Meridith & Mantel, 2000; Turner, 1999; Marchewka, 2006: 15). Figure 2.3 illustrates an example of a project life cycle that comprises 5 main phases.

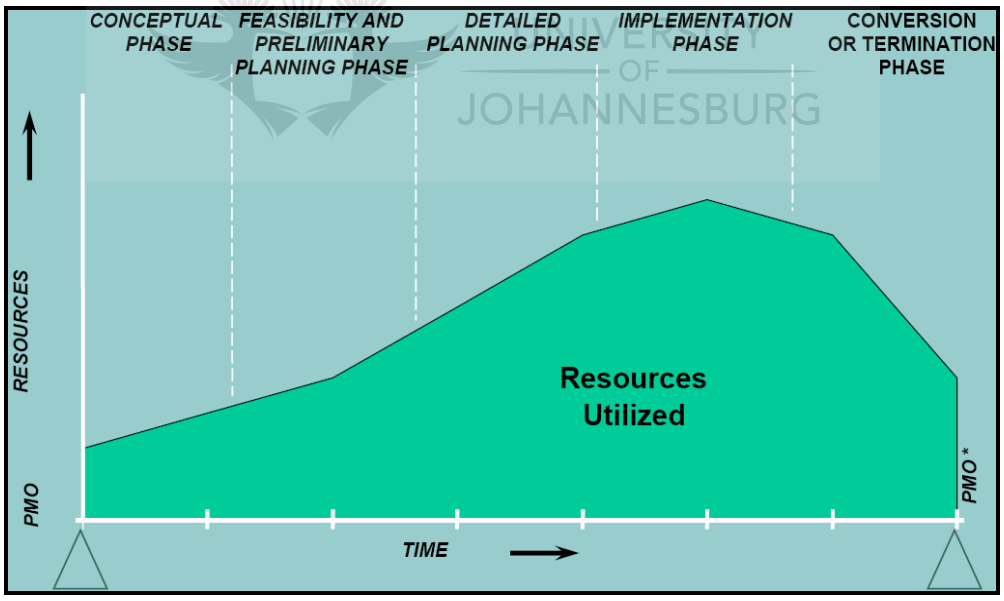

Figure 2.3: Project phases and the project life cycle (Sepehri, 2006: 8)

A project phase is generally concluded with a review of both key deliverables and project performance to date in order to determine if the project should continue (PMI, 2004; Campbell & Baker, 2007). These phase-end reviews are usually called stage gates. The deliverables, and hence the phases, are part of a generally sequential process designed to ensure proper control of the project and

to attain the desired product or service, which is the objective of the project (PMI, 2004).

Most project life cycles share a number of common characteristics, which include (PMI, 2004: 20, 21):

- Phases are generally sequential and are usually defined by some form of technical information transfer or technical component handoff.
- Cost and staffing levels are low at the start, peak during the intermediate phases, and drop rapidly as the project draws to a conclusion.
- The level of uncertainty is highest and, hence, risk of failing to achieve the objectives is greatest at the start of the project. The certainty of completion generally gets progressively better as the project continues.
- The ability of the stakeholders to influence the final characteristics of the project's product and the final cost of the project is highest at the start, and gets progressively lower as the project continues. A major contributor of this phenomenon is that the cost of changes and correcting errors generally increases as the project continues.

The number and formalism of the project phases depends on the nature, size, risk and significance of a project as well as on the (desirable) influence of the project owner (Kuster et al., 2002). Care should be taken to distinguish the project life cycle from the product life cycle. For example, a project undertaken to bring a new desktop computer to market is but one phase or stage of the product life cycle (Sepehri, 2006: 9). Also, the phases of a project life cycle are not the same as the project management process groups. The five process groups are (PMI, 2004: 41; Haughey, 2008: 2):

- Initiating process group, which defines and authorises the project or a project phase.
- Planning process group, which defines and refines objectives, and plans the course of action required to attain the objectives and scope that the project was undertaken to address.

- Executing process group, which integrates people and other resources to carry out the project management plan for the project.

- Monitoring and controlling process group, which regularly measures and monitors progress to identify variances from the project management plan so that corrective action can be taken, when necessary, to control the execution of the project and meet project objectives.

- Closing process group, which formalises acceptance of the product, service or result and brings the project or a project phase to an orderly end.

Where large or complex projects may be separated into distinct phases or sub-projects, all of the process group processes would normally be repeated for each phase or sub-project. Kuster et al. (2002: 4.1) advises that the project planning has to be structured in a way to allow the constant monitoring of the target achievement, deadlines and cost. Project control is that element of a project that keeps it on track, on time and within budget. Project control begins early in the project with planning and ends late in the project with post-implementation review. The key benefit of monitoring and controlling is that project performance is observed and measured regularly to identify variances from the project management plan. According to Haughey (2008: 2) the project manager is responsibility to direct, supervise and control the project from beginning to end.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the project phases and process groups:

- The project life cycle constitutes a logical sequence of activities to deliver the project objectives and attain the higher purpose.

- The project management process groups are integrated as part of the project life cycle phases and are of importance to the project team in order to effectively manage the project.

- Project planning needs to provide for continuous monitoring and controlling of project performance during the life cycle of the project.

Details pertaining to project life cycle phases and project management process groups are well documented and beyond the scope of this dissertation.

2.3.7 Project manager

Project manager is defined by the PMBOK as the person responsible for managing the project and accomplishing the project objectives (PMI 2004: 8, 26). According to Marchewka (2006: 13), the project manager is the team leader and is responsible for ensuring that all of the project management and technical development processes are in place and are being carried out within a set of specific requirements, defined processes and quality standards. Haughey (2008) states that it is the project manager's duty to direct, supervise and control the project from beginning to end. Some of the tasks associated with the management of projects are listed in the PMBOK as follows (PMI, 2004: 8):

- Identifying requirements.
- Establishing clear and achievable objectives.
- Balancing the competing demands for quality, scope, time and cost.
- Adapting the specifications, plans and approach to the different concerns and expectations of the various stakeholders.

The project manager seldom participates directly in the activities that produce the end result, but rather strives to maintain the progress and productive mutual interaction of various parties in such a way that overall risk of failure is reduced (Wikipedia, 2007: Project management). The roles and activities that need to be undertaken by the project manager include the following (integrated from Haughey, 2008; Stanford University, 2008):

- Define the project, reduce it to a set of manageable tasks, obtain appropriate resources and build a team to perform work.
- Provide visibility to the many tasks needed to execute the project.
- Set the final goal for the project and motivate the project team to complete the project on time.

- Work closely with the project sponsor to make sure the project is delivered as close to the forecasted time, budget and scope as possible.
- Communicate the project status and progress clearly to all stakeholders on a regular basis.
- Assess and monitor risks to the project and mitigate them.
- Learn to adapt to and manage change, since no project ever goes exactly as planned.

A project manager is often a customer representative and has to determine and implement the exact needs of the customer, based on knowledge of the firm being represented. According to Mihalic (2007: 18) the role of the project manager includes the following responsibilities:

- The project manager acts as the customer's single point of contact for the project.
- The project manager is responsible for managing the overall project and its deliverables.
- The project manager is responsible for planning, managing, and controlling the resources used to produce the product or service.
- The project manager controls the planning and execution of the project's day-to-day activities and resources to ensure that established cost, time and quality goals are met.

The ability to adapt to the various internal procedures of the contracting party, and to form close links with the nominated representatives, is essential in ensuring that the key issues of time, cost, scope and customer satisfaction can be realised. Chatfield & Johnson (2008) stress the importance that the project manager must be aware of how these essential project elements of time, cost, and scope apply to the project. Ward (2005) confirms this importance by stating that a project manager must be able to define and control three key project variables, namely the work to be done; the resources assigned to perform that work; and the time it

will take to accomplish the work. In order to achieve this task effectively, Ward argues that the project manager must understand and control the relationships and trade-offs between these key project variables. At the same time, the project manager is expected to actively manage both quality and risk. According to Carlos (2007), the project manager is responsible to deliver the project and assure that:

- The project deliverables will be met.
- The project will be completed on time.
- The cost will not exceed the budget.
- The deliverables will meet a minimum standard of quality.

Chatfield & Johnson (2008) allege that succeeding as a project manager requires that the project be completed on time and within budget, and that the customer is satisfied with the delivered results. Norrie & Walker (2004: 49) however warn that unless project managers also constantly and purposefully measure the on-strategy dimension of an organisation's projects, they may fail to successfully keep projects connected to the organisation's evolving business strategy. A successful project manager must be able to envision the entire project from start to finish and have the ability to ensure that this vision is realised (Wikipedia, 2007: Project management).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the project manager:

- The project manager fulfils a key role throughout the project life cycle towards the successful accomplishment of the project objectives.
- The project manager is responsible to strategically direct the project performance in line with the project higher purpose.
- The project manager requires a clear notion of the competing demands inherent to the triple constraint.

- The project manager must plan for risk and must be able to adapt to change, and course correct accordingly.

- The project manager needs to realise effective communication channels and facilitate collaboration between the project sponsor, project team and key project stakeholders.

2.3.8 Project constraints

A project constraint is defined by the PMBOK as an applicable restriction or limitation, either internal or external to the project, which will affect the performance of the project or a process (PMI, 2004: 355). The PMBOK endorses that every project is governed by the triple constraint of time, cost and scope, a framework for evaluating competing demands, and that the constraints must be balanced with each other to achieve project success (Koch, 2007).

In recent years there has been greater understanding of the factors impacting on a project. PRINCE2 has identified these revised factors through its focus on tolerances. While building on the core factors of scope, time and cost, PRINCE2 has added quality (as a distinct factor) along with benefits and risk to produce six constraints. PRINCE2 employs tolerances (its term for these six constraints) as key project controls, i.e. dimensions of the project for which ranges of acceptability are defined that are monitored to identify or anticipate when a plan has entered 'problematic' or 'exception' territory. According to Siegelaub (2008), these tolerances are required and used at all three planning levels of a project – the project as a whole; any one stage or phase of the project; and at the detail work package level.

The Pennsylvania State University (PSU, 2005: 2) claims that there are primarily three types of project constraints, namely technological constraints, physical constraints and resource constraints. The technological constraints relate to the sequence in which individual project activities must be completed; for example, in constructing a house, pouring the foundation must occur before building the frame. Physical constraints are caused by contractual or environmental conditions; for example, due to space limitations an activity such as painting a wall may have to be performed by only one person. Resource constraints relate to the lack of

adequate resources, which may force parallel activities to be performed in sequence. According to the Pennsylvania State University, the primary impact of project constraints is the likelihood of delaying the completion of the project.

In general, from a scheduling perspective, PSU (2005) classifies projects as either time constrained or resource constrained. A project is classified as time constrained in situations where the critical path is delayed and the addition of resources can bring the project back on schedule and the project completed by the required date. However, the additional resource usage should be no more than what is absolutely necessary. The primary focus in time-constrained projects, for purposes of scheduling, is resource utilisation. On the other hand, a project is resource constrained if the level of resource availability cannot be exceeded. In those situations where resources are inadequate, project delay is acceptable, but the delay should be minimal. The focus of scheduling in these situations is to prioritise and allocate resources in such a manner that there is minimal project delay. However, it is also important to ensure that the resource limit is not exceeded and the technical relationships in the project network are not altered. If resources are available in abundance, then the project could be accelerated to achieve shorter project duration (PSU, 2005: 3). On the other hand, if resources are severely limited, then the result more likely will be a delay in the project completion time. Depending on the type of resources, the costs of providing an abundance of such resources to accelerate project completion time can be very high. However, if resources are readily available and excess premiums are not incurred to use them on the project, then project cost should be low, as some project costs are resource related while others are likely to be time dependent. In general, projects with a shorter duration are less expensive.

According to Siegelaub (2008), time and cost are considered the standard project management constraints. Time and cost are reflected in the project estimates and presented as ranges – they are tangible measurements in terms of a due date and a budget. In PRINCE2 terms, as long as the project is delivered inside that agreed range limit, the project is considered on target (OGC, 2009). Good project management practice requires that ranges, which represent the estimating uncertainties associated with a project's particular circumstances, be provided for

these constraints. Classically, time and cost are also the first place the sponsor will look to see if a project is not meeting stakeholder expectations.

According to the Stanford University (2008), typical project constraints in the IT services include resource constraints, delivery constraints, environmental constraints, budgetary constraints and functionality constraints. Another constraint to consider, according to Elyse (2004), is stakeholder satisfaction. The PMBOK states that an output from the project initiation process should be a list of constraints on the project. Among the suggested constraints are budget, contractual provisions and sustainability. Dobson (2004: 42) stresses that the search for project constraints should extend past the boundaries of the formal or official world, and into the unofficial and political environment. This dissertation primarily focuses on the triple constraint constituting the classic project management triangle of time, cost and scope.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project constraints:

- Project constraints fall into several categories.
- Project constraints introduce limitations and influence the management of the project.
- The interrelated constraints of time, cost and scope are considered central considerations alongside project quality and risk.
- A balanced trade-off needs to be negotiated as a function of the project goal in order to optimise project success.
- The competing demands must be considered and managed throughout the project life cycle.

2.3.9 Project time

Project time is the first of one of the three key elements of the classic project management triple constraint. Across literature the term ‘project time’ is also

recognised as 'project schedule', 'time to market', 'project duration' or 'timeline', and affiliated with the expression 'fast'. A schedule constraint is defined by the PMBOK as, "any limitation or restraint placed on the project schedule that affects when a schedule activity can be scheduled and is usually in the form of fixed imposed dates" (PMI, 2004: 355). Simply put, the schedule constraint refers to the amount of time available to complete a project.

In practice, the time constraint is commonly associated in terms of project milestones, due dates and deadlines (Carlos, 2007; Witzel, 2004). According to Chatfield & Johnson (2008) time is the most important constraint to manage for many projects that create a product or event. The time constraint addresses the timing and length of the project (Elyse, 2004), and can be interpreted as elapsed calendar time, usually defined by the project schedule or target ship date (Ward, 2003). Maltzman & Biswas (2009) state that any project will have a date by which it simply must be completed; and while that date is fixed, variations in the timing and duration of contributing tasks and subtasks will inevitably put pressure on that end date. Deadlines tend to be stubbornly fixed or accelerated inwards, never pushed out. A commentator in Alleman (2005) argues that project time not only refers to when the project tasks are completed, but also refers to the scheduling of the required tasks to complete the project.

A project may be time constrained as a result of any one or a combination of the following conditions (integrated from Dobson, 2004: 8; Maltzman & Biswas, 2009):

- Calendar deadline, for example, the project needs to be completed by a specific date.
- Event-related, for example, the project needs to be completed preceding or following a specific occurrence.
- Urgency, for example, the project needs to be completed as soon as possible.

Project time management involves the project management processes concerning the timely completion of the project. These processes include activity definition, activity sequencing, activity resource estimating, activity duration estimating,

schedule development and schedule control (PMI, 2004: 10, 123). Sequencing and schedule management techniques such as network diagrams and schedule variance calculations, and sometimes the simple disciplined use of a shared project calendar, help project managers deal with the time constraint. For analytical purposes, the time required to produce a deliverable may be estimated using several techniques. An example of one method is to identify tasks needed to produce the deliverables documented in a work breakdown structure, or WBS[8] (PMI, 2004: 112). The work effort for each task is estimated and those estimates are rolled up into the final deliverable estimate. The tasks are also prioritised, dependencies between tasks are identified, and this information is documented in a project schedule (Wikipedia, 2007). The dependencies between the tasks can affect the length of the overall project (dependency constrained), as can the availability of resources (resource constrained). Project time is not considered a cost or a resource since the project manager cannot control the rate at which it is expended. This makes it different from all other resources and cost categories.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project time:

- Project time constitutes a key element of the triple constraint.
- Project time addresses the scheduling and duration of the project.
- A time-constrained project is bounded by the completion agenda.

Details pertaining to time management techniques and processes are well documented and beyond the scope of this dissertation.

2.3.10 Project cost

Project cost is the second of the three key elements of the classic project management triple constraint. Across literature the term ‘project cost’ is also

[8] A work breakdwon structure (WBS) organises the tasks of a project into hierarchies and into logical, measurable segments or milestones (Campbell & Baker, 2007: 107).

recognised as 'project budget' or 'project resources', and affiliated with the expression 'cheap'.

In practice, the cost constraint is commonly thought of in monetary and manpower terms, and is generally associated across literature with both the budget and resources available for the project. According to Chatfield & Johnson (2008) cost is ultimately a limiting constraint for virtually all projects, since few projects can go over budget without eventually requiring corrective action – funds and resources are always limited (Maltzman & Biswas, 2009).

Cost is defined by the PMBOK as the monetary value or price of a project activity or component that includes the monetary worth of the resources required to perform and complete the activity or component, or to produce the component. A specific cost can be composed of a combination of cost components including direct labour hours and other direct costs; indirect labour hours and other indirect costs; and purchased price (PMI, 2004: 356). The PMBOK defines a cost constraint as any limitation or restraint placed on the project budget such as funds available over time. A project resource constraint is defined as any limitation or restraint placed on resource usage, such as what resource skills or disciplines are available and the amount of a given resource available during a specified time frame (PMI, 2004: 355). According to Chatfield & Johnson (2008), cost includes all of the resources required to carry out the project. According to Ward (2003) resources are allocated to and consumed by any project, and are reflected in the project budget by either currency or man-hours. Elyse (2004) states that the cost constraint defines the total cost of the project, both operating and implementation costs, i.e. the budget and resources to achieve the project objectives and deliver the project (Alleman, 2005 Witzel, 2004). According to Marchewka (2006: 12), resources provide the means for achieving a project's goal and also act as a constraint. Marchewka also states that utilisation of project resources has an associated cost that must be included in the overall budget of the project.

Resources that project managers have to plan and control include the following (integrated from Newell & Grashina, 2003; PSU, 2005: 3; Ward, 2003): working capital / money; manpower / people; tools and equipment; facilities; materials; and information. Marchewka (2006: 12) also adds technology to the resource list, from

an IT perspective. According to the Pennsylvania State University (PSU, 2005), the process of refining the plan to effectively manage and schedule resources (sometimes referred to as resource modelling) comprises four major stages, namely: resource definition; resource allocation; resource aggregation; and resource levelling, which includes resource smoothing. The resource modelling stages are well documented and beyond the scope of this dissertation. The process of scheduling resources before the project begins provides the following benefits:

- If project delay is unacceptable, it allows sufficient time for considering alternatives such as cost-time trade-offs and changing of priorities;
- Provides information to prepare time-phased work package budgets with dates;
- Enables project managers to determine the amount of flexibility they have over certain resources.

A project may be cost constrained as a result of any one or a combination of the following conditions (integrated from Dobson, 2004: 8; Maltzman & Biswas, 2009):

- Budgeted expenditures, for example an allowable spending or funding limit.
- Personnel limits, for example time-allocated resources (man-hours).
- Equipment, for example capital equipment and non-consumables.
- Supplies, for example consumables.
- Overheads, for example administration and costs charged to project budget for other organisational purposes.
- Intangibles, for example use of favours, concessions, political power and negotiation.

Project cost management encompasses the project management processes concerning the planning, estimating, budgeting and controlling of costs so that the project is completed within the approved budget (PMI, 2004: 10, 157). Cost

management and budgeting techniques such as cost trend analysis and expenditure estimate models as well as net present value and internal rate of return calculations, and sometimes the simple disciplined use of a rough order of magnitude, assist project managers in dealing with the cost constraint.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project cost:

- Project cost constitutes a key element of the triple constraint.
- Project cost addresses the budget and resources of the project.
- A cost-constrained project is bounded by the scheduling of expenditure.

Details pertaining to cost management techniques and processes are well documented and beyond the scope of this dissertation.

2.3.11 Project scope

Project scope is the third of the three key elements of the classic project management triple constraint. Across literature the term 'project scope' is also recognised as 'project requirements / required deliverables', 'project effort / work' or 'project features / functions', and affiliated with the expression 'good'. The PMBOK defines project scope as the work that must be performed to deliver a product, service or result with the specified features and functions (PMI, 2004: 370). Scope is defined as the sum of the products, services and results to be provided as a project (PMI, 2004: 375).

In practice, the scope constraint is commonly associated in terms of the project work or tasks to be accomplished during the course of a project to deliver the required end results (integrated from Ward, 2003; Ward, 2005). Simply put, the scope constraint refers to the requirements specified to achieve the project objectives.

Ward (2003) argues that work is not the scope of the deliverable product, but it is directly correlated to the size of the scope. He later refined his viewpoint (Ward,

2005) stating that scope is not the requirements of the deliverable product, but it is directly correlated to the size and complexity of the product. A commentator in Alleman (2005) argues that project scope not only refers to the task requirements of the project, but also concerns the tasks that are actually being performed. Witzel (2004) agrees with this argument by stating that project scope encompasses the deliverables that the project team must create as well as the activities required to create them. Carlos (2007) adds that the project scope should also consider those requirements that are excluded from the project.

According to Siegelaub (2008), scope refers to the particular deliverables ('products' in PRINCE2 terminology) of the project, which have been agreed to by the project owners. Newell & Grashina (2003) state that the project scope baseline is the sum of these deliverables. It represents all the work that must be done to complete the project. According to Ward (2005) the scope of work can be defined as those tasks that must be performed in the course of a project to deliver the product or service. Within the context of engineering systems, for example, the amount of work (scope of effort) can be defined as a series of system development life cycle tasks that must be accomplished. The feature-set to be contained in the deliverable system, may also define this work.

Maltzman & Biswas (2009) reason that unlike the constraints set on a project by time and resources, which are consumed as the project progresses, scope is a constraint that is set and limited by the provider in agreement with the customer. Any deliverables that are not included in the scope baseline will not be delivered to any of the stakeholders (Newell & Grashina, 2003). The growth or increase of the project scope baseline, following project commencement, is generally referred to in project management as scope creep. It is the small, seemingly innocuous changes to the project, or the product of the project, and the almost unstoppable tendency a project has to accumulate new functionality (integrated from Maltzman & Biswas, 2009; Jenkins, 2008). According to Campbell & Baker (2007: 15) scope creep is the process of adding work to a project, little by little, until the original schedule and cost estimates are completely meaningless. The PMBOK describes scope creep as adding features and functionality (project scope) without addressing the effects on time, cost, and resources, or without customer approval (PMI, 2004). Jenkins (2008) observes that a certain degree of scope creep is

sometimes inevitable since the project might have been poorly defined and needs to evolve. Jenkins warns that a large amount of scope creep can however be disastrous. Simms (2008) argues that increases in scope must be assessed in terms of their impact on the project's value – 'no increase in value, no scope increase' should be the rule.

According to Witzel (2004) scope also includes the quality of the work or deliverables that needs to be created, and summarises that scope is composed of deliverables, quality and activities. Koch (2006: 2) has a different viewpoint regarding the quality aspect and points out that the quality of product deliverables is not a component of project scope, but that the grade of the product is. According to Chatfield & Johnson (2008) two aspects of scope should be considered, namely product scope and project scope. Product scope describes the intended quality, features, and functions of the product. Documents that outline this information are sometimes called product specifications. Project scope, on the other hand, describes the work required to deliver a product or service with the intended product scope. Project scope is usually measured in tasks and phases. Product scope and project scope are closely related. The project manager who manages project scope well must also understand product scope.

A project may be constrained in scope as a result of any one or a combination of the following conditions (integrated from Dobson, 2004: 8; Maltzman & Biswas, 2009):

- Functional / performance requirements, for example capacity, price, speed, accessories, features, dimensions, and restrictions.
- Result-oriented objectives, for example the desired end state, purpose / reasons why the project outcome is desired, and goals to be achieved.
- Evaluation criteria, for example a person or entity to be pleased, threshold to be met, and objective or metric to be satisfied.

According to Marchewka (2006: 12) the project scope, or work to be accomplished, is determined directly by the project goal, that is "if we know what we have to accomplish, we can then figure out how to accomplish it". The scope

constraint details the project requirements against the existing need of the project versus the expectations (Elyse, 2004).

Project scope management involves the project management processes required to ascertaining that the project includes all the work required, and only the work required, to complete the project successfully. These processes include scope planning; scope definition; work breakdown structure; scope verification; and scope control (PMI, 2004: 9, 103). Scope management techniques such as the WBS, and sometimes the simple disciplined task of defining deliverables, assist project managers in dealing with the scope constraint. Maltzman & Biswas (2009) suggest that sufficient time needs to be spent at the beginning of a project to correctly define the scope. The PMBOK lays out a process to ensure that the project team develops a proper scope statement as well as the more detailed WBS and scope statement updates that reduce ambiguity in the project. Maltzman & Biswas also recommend that the project energy needs to remain focused on communicating, defending and managing scope throughout the project.

According to Campbell & Baker (2007: 36), defining the scope of the project correctly is the key ingredient in developing a quality plan. Business Services Projects (2003: 4) encourages ensuring the scope statement has specific measures of success so that it is easier to determine if a project has been successful at meeting the objectives. The PMBOK dictates that a critical element of quality management in the project context is to turn stakeholder needs, wants and expectations into requirements through stakeholder analysis, performed during project scope management. The project scope statement is a key input to quality planning since it documents major project deliverables, the project objectives that serve to define requirements (which were derived from stakeholder needs, wants and expectations), thresholds and acceptance criteria. The result of the deliverables satisfying all acceptance criteria implies that the (quality) needs of the customer have been met (integrated from PMI, 2004: 180, 184, 185).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project scope:

- Project scope constitutes a key element of the triple constraint.
- Project scope addresses the requirements and work of the project.
- A scope-constrained project is bounded by the performance criteria of the deliverables.
- The distinction between the concepts of quality and degree of merit (grade) needs to be considered.
- An appropriate scope statement is essential and serves as a key input to quality planning.

Details pertaining to scope management techniques and processes are well documented and beyond the scope of this dissertation.

2.3.12 Project quality

The inclusion of quality as one of the key dimensions in a project is common in most project management literature (Flett, 2001: 2). According to Siegelaub (2008), the quality constraint (or quality tolerance) is in many cases quite similar to that of the scope constraint, except that quality focuses on characteristics of a deliverable, "when we address quality we are not looking to add (or delete) a new item; we are only looking to alter or provide flexibility for some feature of an already-defined item, or to assure that a particular characteristic is present and working properly". Siegelaub also argues that quality operates in the same mode as the classic constraints. For example, if a project is running late or over budget, the project manager may still be able to deliver the expected items – but they might not be tested as thoroughly, or some characteristics of that item may be reduced or eliminated.

The American Society for Quality defines quality as the degree to which a set of inherent characteristics fulfils requirements (cited in PMI, 2004: 180). The British Standard BS 4778 defines quality the totality of features and characteristics of a product and service, which bear on its ability to satisfy a stated or implied need (cited in Flett, 2001: 5). Quality is full conformance with all project requirements

and specifications (Mihalic, 2007: 52) and represents the 'fit-for-purpose' that the project must achieve to be a success (Jenkins, 2008).

The cost of quality refers to the total cost of all efforts related to quality (PMI, 2004: 181). According to Koch (2006: 3) most project managers do not adequately measure the cost of quality. Koch lists the three components of cost of quality as defect detection, defect correction and defect prevention. According to McConnell (as cited in Mihalic, 2007: 53) the further from its origin that a defect is detected, the more it will cost to fix. Koch proposes that by investing in defect prevention and early defect detection, defect correction costs can be driven down. This, in turn, results in minimising the total cost of quality – the cost of prevention will proportionally reduce the cost of failure (Burke, 2007: 268).

Kloppenborg & Petrick (as cited in Duma, 2005: 22) advocate that quality revolves around the aspects of customer focus (satisfaction); continuous improvement; people involvement; and use of qualitative methods. According to both Turner and Carruthers (as cited in Duma, 2005: 20) quality can be defined as the totality in meeting customer and stakeholder on the predefined needs. Campbell & Baker (2007: 22) maintain that, in project management, quality is always defined as meeting the requirements of the customer. Duma (2005: 20) adds that quality is a judgement by consumers as to how far they are satisfied by a product or a service that is as a result of a project. According to Maltzman & Biswas (2009), quality is producing a result for the customer of the project, which best balances the use of resources and time, and meeting all of the requirements of the scope. Merna (as cited in Flett, 2001: 5) observes that quality is the ability to manage a project and provide the product or service in conformance with the user requirements on time and to budget, and where possible maximising profits. Merna's definition of quality is intended to be compatible with the requirements of project management, and appears to describe quality as an ability to manage.

The Government of Tasmania's archetypal definition conveys what conventional quality management is meant to offer project management, "quality management is the policy and associated procedures, methods and standards required for the control of projects; the purpose of quality management is to increase certainty by reducing the risk of project failure; it also provides the opportunity for continuous

improvement" (cited in Flett, 2001: 4). The British Standard BS 4778 defines quality management as that aspect of the overall management function that determines and implements the quality policy (cited in Flett, 2001: 6).

Although project quality management applies to all projects regardless of the nature of their product, product quality measures and techniques are specific to the particular type of product produced by the project (PMI, 2004: 180). Burke (2007: 268) states that quality management includes both the quality of the management of the project and the quality of the product itself. Across literature authors warn that project teams often confuse quality with degree of merit in terms of characteristics, or grade (Koch, 2006; Campbell & Baker, 2007; Burke, 2007). Quality and grade are not the same. According to Koch (2006: 2) grade refers to the set of attributes on which the quality of a product will be judged. Once the requirements for the product have been agreed upon, its quality refers to the degree to which it meets those requirements. A lower-grade material, for example, is not necessarily a lower-quality material, as long as the grade of material is appropriate for its intended use. The International Organisation for Standardisation defines grade as a category assigned to products or services having the same functional use but different technical characteristics (cited in PMI, 2004: 180). Low quality is always a problem; low grade may not be. The PMBOK uses a software product as an example and relates quality to the number of defects and grade to the number of features. Determining and delivering the right balance between the required levels of quality and grade is the responsibility of the project manager and the project team.

Project quality management involves the project management processes required to assure that the project will satisfy the objective for which it was undertaken. The quality management processes (quality planning, quality assurance and quality control) include all the activities of the performing organisation that determine quality policies, objectives and responsibilities so that the project will satisfy the stated or implied needs (integrated from PMI, 2004: 10, 179; Business Services Projects, 2003: 4). Burke (2007: 255) describes quality management as the involvement of all project participants to ensure the goals and objectives of the project and resulting product, facility or service meet the needs of the customer, project team and other stakeholders. Crawford (as cited in Campbell & Baker,

2007: 316) states that good project management in an organisation is, in itself, a quality management process. Campbell & Baker (2007: 36) list the processes for quality in a project as follows:

- Planning to determine what the quality objectives need to be and how they will be achieved.
- Enforcing quality assurance to measure that the project is producing against the requirements.
- Checking quality control to ensure quality standards are met and that any deviations are identified and corrected.

These quality management processes interact with each other and with the processes in the other project management knowledge areas as well. Mihalic (2007: 55) lists the outputs of poor quality management as follows:

- Poor team morale.
- Significant rework (lost time).
- Additional material and labour expenses.
- Loss of credibility with stakeholders and senior management.
- Customer dissatisfaction.
- Contractual penalties.

According to a study carried out by Flett (2001), it is recognised that there is a need for a fundamental revision on how quality is both defined and measured in project management. Flett argues that existing quality management systems still exhibit their origins, which do not take into account the uniqueness and instability of the project environment. In his proposition, emphasis is placed on increasing success by the acquisition of knowledge, in contrast to the traditional quality concepts of decreasing risk by the control of activities. Table 2.1 is a basic representation of Flett's proposed definition, showing on the left-hand side the

three levels of quality that influence projects at a practical level, mapped onto existing quality models on the right-hand side.

The three levels of project quality:		Existing quality models:
1.	Meeting the specification	→ Quality control
2.	Meeting the 'real' requirements	→ Quality management
3.	Learning and improving from the project experience	→Total quality management

Table 2.1: Flett's three levels of project quality mapping (Flett, 2001: 7)

Flett's first level of quality is where a project is carried out to solely meet the contractual specification. The second level of quality is where a project organisation goes beyond just meeting the original contractual specification – it actively provides what it believes is the most appropriate product or service. The third level of quality is a quasi-theoretical state in which a project organisation continually increases its knowledge database through capturing the experiences of past projects. This knowledge is used to 'feed-forward' to increase the success of future projects.

According to Flett (2001: 8), fulfilling the project specification may not equal a successful project, for example the customer may get what was specified but this may not be what they really need. Flett (2001: 9) argues that if a project orientated organisation implements the quality management model as intended, then theoretically they would provide what the customer needs in addition to what they want. Dobson (2004: 8) adds that armed with a statement of purpose, the correctness and relevance of the functional requirements can be evaluated and possibly improved or amended in order to meet the customer's true need.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project quality:

- Project quality constitutes an integral dimension of project management and is supported by the triple constraint.

- Project quality is bounded by consumer criteria of the project deliverables in terms of requirements conformance and satisfaction.
- The project manager is responsible to maintain the correct balance between the required level of quality and grade.
- The cost of quality can be minimised through appropriate detection, correction and prevention mechanisms.
- Project quality management ensures that the project objectives and higher purpose satisfy the true needs of the customer, and provides for continuous improvement.

Details pertaining to quality management techniques and processes, as well as the wide variety of ancillary aspects surrounding the subject of quality, are well documented and beyond the scope of this dissertation.

2.3.13 Project risk

Project risk is defined by the PMBOK as an uncertain event or condition that, if it occurs, has a positive or negative effect on a project's objectives (PMI, 2004: 8, 373). Risk refers to opportunities as well as threats (Siegelaub, 2008).

All projects have an element of risk, and some projects entail more risk than others. There are a variety of risks involved in a project that may provide opportunities or threats, and include (integrated from Kuster et al., 2002; Maltzman & Biswas, 2009): uncontrollable project complexity (factual, social); new technology (largely unknown, reaching the limits of what is possible); project environment changes (politics, rules, markets); and faulty products or services. According to Marchewka (2006: 13), risk can arise from many sources, both internal and external to the project team. For example, internal risks may arise from the estimation process or from the fact that a key member of the project team could leave in the middle of the project. External risks, on the other hand, could arise from dependencies on other contractors or vendors. Dobson (2004: 43) adds that unstated project objectives and success criteria also add risk to a project.

Mihalic (2007: 45) states that the absence of a disciplined risk management process causes increasingly complex projects to underachieve or even fail. Mihalic highlights the following caveats:

- No or limited insight into what can go wrong.
- Incorrect assignment of risk ratings (impact & probability estimates) to project, sub-projects, and/or tasks.
- Failure to focus resources on major risks.
- Incorrect assignment of resources to manage risks.
- Resources used to correct problems rather than avoiding them.
- Decisions made with incomplete or inadequate information.
- Re-occurrence of similar technical, cost, or schedule problems with no formal methodology for capturing lessons-learned.

Project managers need to manage projects in response to uncertainty (PMI, 2004: 8), and reduce project risk to a reasonable level through focussed precautions (Kuster et al., 2002). According to Mihalic (2007: 45), the area of risk management is essential to achieve successful project completion. The objectives of project risk management are to increase the probability and impact of positive events and decrease the probability and impact of events adverse to project objectives (PMI, 2004: 340). While project management strives to maximise the chance of success, project risk management strives to minimise the chances of failure (Burke, 2007: 270). Project risk management processes include risk management planning; risk identification; risk analysis; risk response planning; and risk monitoring and control (PMI, 2004: 237).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project risk:

- Project risk addresses internal and external uncertainties in terms of opportunities and threats for project completion.
- Project risk management ensures that the chances for project failure are minimised.

Details pertaining to risk management techniques and processes are well documented and beyond the scope of this dissertation.

2.3.14 Project failure

Studies by the Standish Group, Gartner Group and the Project Management Institute, as well as various other literature and research in the project management domain, all indicate that a considerable number of projects often fail. Some surveys put the rate as high as 70%. According to Barker & Cole (2007: 4) much of this is due to projects being inadequately planned and poorly managed.

According to research done by the Project Management Institute, projects fail for seven key reasons (Campbell & Baker, 2007: 22):

- Poor project and program management discipline.
- Lack of executive-level support.
- No linkage to the business strategy.
- Inappropriate team members.
- No measures for evaluating the success of the project.
- Lack of a robust risk strategy.
- Inability to manage change.

There is a widespread consensus in the literature that the triple constraint elements can be seen as the three key result areas. There are numerous reports that document cases of projects delivered substantially beyond the due date and well above the outlined budget (Norrie & Walker, 2004: 47), and failing to deliver the product or service the projects were designed to produce. Ward stressed

repeatedly that projects fail in almost every instance because one or more of these key project variables are not managed effectively (Ward, 2003; Ward, 2005). Ward states that in many instances the relationships between the variables are poorly understood and not managed at all. According to Business Services Projects (2003: 1) most projects fail when one of the triple constraint areas changes and appropriate adjustments are not made to the other areas, i.e. if a deadline is moved up, what actions are required with regards to cost or scope to ensure the deadline is met without compromising the quality of the product; or if the scope of the project is increased, what actions are needed with respect to cost or schedule and how is quality affected? Ambler (2008) advises that failure to recognise the implications of the triple constraint may impact project success through the following consequences:

- Project cancellation.
- Late and/or over budget delivery.
- Poor quality delivery.
- Under delivery.

According to Damicon (2009), many projects fail as a result of very restricted or no flexibility within the triple constraint. According to Ward (2003) schedule pressure, or lack of time, is the reason that most projects are forced to face other factors causing project failure. Ambler (2008) expresses that software development projects often fail because the organisation sets unrealistic goals for the triple constraint. Simms (2008) observes that the long-term value of projects is often foregone to meet short-term constraints, for example, in order to realise the project value the budget may have to be exceeded. Simms goes on to say that it is a value trade-off that needs to be considered. Ward (2003) gives notice that low quality and high risk can also sink a project. When developing system requirements, according to Ward, attention is usually focussed to functional requirements but rarely to quality and risk attributes. Ward urges that quality and risk must be actively managed from project inception. The major causes identified by the Tasmanian Government Project Management Guidelines (2005) for

projects failing to deliver on time, on budget and to the quality of performance expected (or scope), include:

- Lack of a valid business case justifying the project.
- Objectives not properly defined and agreed.
- Lack of communication and stakeholder management.
- Outcomes / benefits not properly defined in measurable terms.
- Lack of quality control.
- Poor estimation of duration and cost.
- Inadequate definition and acceptance of roles (governance).
- Insufficient planning and coordination of resources.

As far back as the mid-1980's, Tuman (1986) and Cleland (1986) concurrently recognised, and simultaneously presented findings, that contradicted the then-common notion that on-time, on-budget and on-quality were the most strategically important and valid measures of project success. Yet now, more than two decades later, professionals in the project management field remain quite focused on this legacy and often seem committed to only using the traditional triple constraint model. According to the Tasmanian Government Project Management Guidelines (2005), and reiterated by Azzopardi (2006), the failure to deliver on time, on budget and to the required scope does not necessarily mean that the project itself was a failure. Belling, as part of a discussion group (Garrett, 2008), reasons that a project can deliver on all three triple constraint elements and still be a failure if the business case was not valid or changed mid-project, or if the end users are unable to use the 'perfectly-executed' project deliverables. Norrie & Walker (2004: 48) confirm that numerous projects are perceived as failing because of poor leadership and enfeebled articulation of the project vision or a lack of meaningful business impact.

Wilson (2008) lists the key reasons for project failure as follows:

- Project goals are poorly defined, and outcomes are not identified in specific and measurable terms.
- Project plans lack sufficient detail, leading to insufficient time allocation and inadequate financial support and/or other resources.
- Key stakeholders do not provide adequate support.
- A risk analysis is not performed.
- The project scope expands uncontrollably (scope creep).

Brown et al. (2006: 77) advocate that if education and experience are deficient, there is a high probability that a project mission will be inappropriately specified from the outset, with the result that the project delivery targets (time, cost and scope) will be compromised from the beginning. If this is the case, it is highly improbable that the resource base will be organised and mobilised to deliver the project targets successfully. Wilson (2008) found, according to project managers, that most project failures are a result of a breakdown in communication. Project managers report that key stakeholders who continue to change project parameters or make new change requests after the project start put ultimate success of their projects at risk. Wilson goes on to say that it is not change but the lack of change control that usually causes a project to fail.

Mihalic (2007: 3) provides the following reasons for project failure:

- Inadequately trained and/or experienced project managers.
- Poor requirements.
- Poor planning (unrealistic schedules and budgets).
- Inappropriate staffing.
- Inadequate communications.
- Poor change control.
- Lack of monitoring and control.

- Insufficient testing.
- Failure to set and manage expectations.
- Inadequate project reporting.

Ward (2003; 2005) puts forward that it is not projects that fail, but people, "people fail to effectively manage projects". Winters (2003) suggests the following top 10 reasons for project failure:

- Inadequately trained and/or inexperienced project managers.
- Failure to set and manage expectations.
- Poor leadership at any and all levels.
- Failure to adequately identify, document and track requirements.
- Poor plans and planning processes.
- Poor effort estimation.
- Cultural and ethical misalignment.
- Misalignment between the project team and the business or other organisation it serves.
- Inadequate or misused methods.
- Inadequate communication, including progress tracking and reporting.

There may be a variety of additional and interacting aspects that affect any particular project failure.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project failure:

- Failure to deliver the triple constraint on target does not necessarily imply project failure.

- Key measures of project failure include:
    - Poor planning as well as improper definition of the project objectives and higher purpose.
    - Insufficient understanding of the triple constraint dynamics; inability to implement effective exploitation strategies; and misalignment of the triple constraint with the strategic outcome.
    - Ineffective communication between key stakeholders and lack of support.
    - Deficient quality management, change management and risk management strategies.
    - Inadequate monitoring and controlling mechanisms as well as inappropriate measures of performance and success.
    - Inexperienced and not suitably qualified project managers as well as poor leadership.
- The motivations concluded in this section have been observed in a variety of studies amongst the top factors that affect project failure.

The reasoning behind project failure has been thoroughly studied and a wide variety of supporting factors contributing to unsuccessful project deliveries have been documented across literature, which are beyond the scope of this dissertation.

2.3.15 Project success

General agreement exists in the literature that every project is governed by the triple constraint of scope, time and cost, which must be balanced with each other in order to achieve project success (adapted from Koch, 2007). Duma (2005: 2) includes quality as another success factor. The PMBOK states that high quality projects deliver the required product, service or result within scope, on time and within budget (PMI, 2004: 8). Campbell & Baker (2007: 22) surmise that for almost all projects, success is defined as meeting the following criteria:

- Finishing the project on schedule.
- Keeping costs within budget.
- Meeting quality outcomes (or goals) that have been agreed upon by the project team and the project stakeholders.

Mihalic (2007: 32) states that the project manager is responsible to deliver results that meet customer expectations within budget, on time and with acceptable quality. According to Newell & Grashina (2003) the success of a project depends on the project team's ability to control the available resources of the project in terms of time, cost and performance. Ward (2005) suggests that the use of a contiguous work area for the project team will positively affect communication and teamwork, which further supports project success. Damicon (2009) encourages that projects will have much improved probabilities of success if the team managers are allowed to appropriately manage, and not just execute, within the triple constraint. Duma (2005: 7) carries on that the success of a project not only depends on the good management of resources but also on the good management of uncertainty and risk. Mihalic (2007: 45) is in agreement with Duma and states that the area of risk management is essential to achieve successful project completion. Business Services Projects (2003: 7) concludes that if the triple constraint is properly managed, organisations will be successful in delivering projects and meeting organisational goals.

In contrast, Shenhar & Dvir (2007) argue that the triple constraint theory is a key impediment to successfully delivering projects, because it incorrectly defines the success criteria. Shenhar & Dvir go on to state that success should not be defined just in terms of scope, time and cost, which are strictly efficiency-based – the focus should be more on business results and customer satisfaction. Business Services Projects (2003: 1) continues to state that successful project management extends beyond merely meeting the scope, time and cost goals, but is also a function of satisfying the project sponsor. Jucan, as part of a discussion group (Garrett, 2008), expresses that, "project success is in the eye of the beholder, not in blindly meeting the triple constraint". He relates this to the eternal science vs. art debate regarding project management, where the triple constraint is the science side and

the stakeholders' satisfaction is the art of achieving project success. Jucan reveals that none is complete without the other, "it is almost impossible to achieve project success without managing the bases, and simply ensuring compliance with the bases does not ensure (by itself) a successful project". Tesoro, as part of the same discussion group, states that although the triple constraint may no longer be the only way to define success, it provides the core tangible elements in determining project achievement.

Marchewka (2006) reasons that while many define success in terms of the project being completed on time and within budget, the real measure of success is the value the organisation receives when the system is finally implemented. Dobson (2004: 63) concurs that operational project success may not be a sufficient metric of overall success, Dobson asserts that while the internal measure of project success is whether the project accomplished what it was supposed to accomplish, the wider metric should include its effect on the organisation or program of which it is a part. Research conducted by Milis et al. (2003) indicates that the impact of the triple constraint on the judgement of success is rather small. Other criteria, such as 'user happiness' (customer satisfaction) and financial or commercial success are far more important.

May (as cited in Garrett, 2008) suggests that project managers need to consider value (business results and customer satisfaction) delivered with the project objectives (scope, time and cost). Briner et al., as quoted in Norrie & Walker (2004: 47), state that the most significant success factor for project teams is that they have a common and shared idea of what difference they are trying to make as a result of the project. Performance of project managers is generally measured against their goals and focuses primarily if they delivered, enabled and supported the delivery of the business value (Simms, 2008). It can therefore be stated that another key to project success lies in the definition of clear project deliverables and business outcomes as well as in the appropriate change management of these goals. According to Buchholz, as part of a discussion group (Garrett, 2008), the outcome aspect of a business case is what really drives interpretation of project success.

According to Shenhar & Dvir (2007: 26) the five basic measures of success are:

- Project efficiency (e.g. satisfying the triple constraint).
- Impact on the customer.
- Impact on the team.
- Business needs (e.g. ROI, strategic fit, competitive advantage).
- Future needs (e.g. future value).

According to Manas (2005) the impact of people, processes and technology need to be considered when analysing the success or failure of a project. Manas claims that investment in all three of these areas is required in order to secure project success. People-impact does not only refer to the investment in leadership training for project managers, but also to have an organisational structure that is aligned and not set up for conflict. Manas furthermore states that while processes are critical, some aspects are difficult to categorise under a process such as leadership and stakeholder management; and processes without the technology to make it efficient, can also be a burden.

The results presented in a study by Brown et al. (2006) suggest that investment in project management human capital by way of education and specific project management experience will produce a return in terms of improved performance. According to Chatfield & Johnson (2008), success in project management requires a rare mix of skills and knowledge about schedule practices and tools, as well as skill in the domain or industry in which a project is executed. According to Flett (2001: II) feedback is also often claimed to be a vital ingredient of successful project management – learning from past successes, and failures. Flett notes that a conduit to provide feedback is often problematic due to the very nature of projects and their finite lifespan. Ambler (2008) recommends that organisations need to improve in terms of estimation and portfolio management.

Sepehri (2006: 43) maintains that the primary success factors are: within time; within cost; within quality; and customer acceptance. Sepehri lists the secondary success factors as: customer reference; follow-on work; financial success;

technical superiority; strategic alignment; regulatory agency relations; health and safety; environmental protection; corporate reputation; employee alignment; and ethical conduct. Hudson (as cited in Garrett, 2008) argues that although the triple constraint may reflect basic performance metrics for a project, individualised key performance indicators (KPIs) are critical to plan and control a project appropriately and to measure true success. On the contrary, Hennington argues that project success should not be all about metrics but about satisfying the customer's true needs (cited in Garrett, 2008).

Performance measurement is the setting of parameters that programs, investments and acquisitions strive to meet in order to reach desired results in support of mission goals (Mihalic, 2007: 31). Mihalic argues that critical success factors (CSFs)[9] should always be the starting point for effective measurement. CSFs may include: quality of deliverable; profit margin; team satisfaction / morale; repeat business / follow-on work; experience gained / increase in intellectual capital; usage / system acceptance; and system performance. The resulting measures are tailored to the specific scope, circumstances and business objectives, and the interpretation must reflect the values and viewpoints of all stakeholders (Mihalic, 2007: 29). Although some outcomes are difficult to measure quantitatively and in some cases the cost of timely data collection and analysis may exceed the value provided by the data, Mihalic lists the benefits of performance measurement as follows (Mihalic, 2007: 33):

- Provides a clear notion of success to drive the program.
- Enables more effective management of programs and initiatives by providing performance information.
- Creates a consistent way to communicate results.
- Builds ownership and accountability – what gets measured gets done!
- Provides incentives to continuously improve performance.

[9] CSFs focus on the deliverables and KPIs focus on the execution metrics of the process (Sepehri, 2006: 43).

There may be a variety of additional and interacting aspects not discussed in this section that affect project success.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of project success:

- On-target delivery of the triple constraint does not necessarily imply project success.
- In addition to considering the motivations concluded in Section 2.3.14, key project success measures and criteria include:
    - Beneficial outcome aligned with the project higher purpose that satisfies business needs and adds value.
    - Strategic implementation that provides commercial success and ensures progressive business and predictable outcomes.
    - Management of customer expectations and realistic delivery of customer needs that satisfies excellence.
    - Provision for continuous improvement through strategic learning by gaining knowledge and experience from past failures and successes.
    - Superior project planning and clear definition of outcomes as well as definitive success criteria.
    - Effective prioritisation and management of the competing and conflicting triple constraint demands in order to procure opportunity.
    - Realisation of appropriate organisational structure as well as efficient reporting and communication channels that can address conflict and change.
    - Improvement in terms of transformation management as well as estimation and response planning techniques.

- Employment of accurate monitoring and effective controlling mechanisms to continuously manage project performance against the project management plan.
- Investment in project management and leadership training as well as adoption of good project management practices, processes and technologies.

- The motivations concluded in this section have been observed in a variety of studies amongst the top factors that affect project success.

The reasoning behind project success has been thoroughly studied and a wide variety of supporting factors that contribute to successful project deliveries have been documented across literature, which are beyond the scope of this dissertation.

2.4 Theory of the triple constraint

The triple constraint is defined by the PMBOK as a framework for evaluating competing demands and managing competing project requirements (PMI, 2004: 8, 378). The triple constraint originates from the basis for undertaking a project and the environment in which the project is executed (adapted from Dobson, 2004: 14). The PMBOK lists the constraints[10] as project scope, time and cost, "the three essential elements of any project" (Chatfield & Johnson, 2008). According to Carlos (2007) the triple constraint seeks to balance these three elements. The triple constraint indicates the key factors that both define the framework of a project, and direct project managers as to where adjustments will have to be made if one or another of the constraints become problematic (Siegelaub, 2008). Hennington (as cited in Garrett, 2008) carries on that the triple constraint supports an understanding of limited resources and how sacrifice must be made in one area to achieve another.

The triple constraint derives from the PMBOK definition of a project – a temporary endeavour undertaken to create a unique product, service or result, "finite

[10] The basic building blocks of the triple constraint have varying references across literature. Naming conventions include: constraints, elements, facets, variables, dimensions, parameters, factors, properties, and tolerances.

resources result in scarcity, and scarcity gives us the triple constraint: a deadline, a budget and at least a minimum acceptable level of performance" (Dobson & Feickert, 2007: 5). Dobson puts forward that the triple constraint leads to the discovery of hidden resources and opportunities within these set boundaries, "look at your weak constraint as an opportunity, and see how its creative exploitation can improve your project's performance; with the secrets of the triple constraint you will uncover hidden flexibility and unlock valuable new resources and discover threats before they turn into problems" (Dobson, 2004: xii). The triple constraint elements are therefore considered as the key levers that may need to be adjusted in order to deliver a project (Simms, 2008). To be effective, the project manager needs to be able to control these aspects of the project.

Review of the current project management literature revealed that the designation of the triple constraint elements is heterogeneous and not consistent. Although the PMBOK defines the traditional constraints as scope, time and cost, the following variations / conventions have been observed across literature by the author of this dissertation:

- Specification, time and cost
- Functionality, schedule and cost
- Features, time and cost
- Technical objectives, time and resources
- Scope, resources and cost
- Scope, schedule and cost
- Scope, schedule and resources
- Requirements, schedule and budget
- Tasks, time and resources
- Performance, time and cost
- Quality, time and cost

- Good, fast and cheap

Dobson (2004: 10) suggests that resources and cost can be put into a common category because both are either spent and/or consumed. Although the triple constraint theme has many variations, the basic concept is that every project has an element of limited time, a budget, and requires work to complete; i.e., it has a defined scope (Chatfield & Johnson, 2008).

Within the framework of this dissertation the scope constraint, time constraint and cost constraint have been nominated as the three key elements that bound the project management triple constraint. The current literature shows a general agreement amongst researchers and the body of knowledge in this regard (PMI, 2004; Dawson, 2004; Chen, 2005; Schwalbe, 2005; Kosavinte, 2007; Wikipedia, 2007; Elyse, 2004; Witzel, 2004; Business Services Projects, 2003; Chatfield & Johnson, 2008; Ward, 2003; Ward, 2005; Kennedy, 2008; Marchewka, 2006; Mihalic, 2007; Koch, 2006; Koch, 2007; Newell & Grashina, 2003; Ladas, 2007; Carlos, 2007; Siegelaub, 2008; Manas, 2005; Herborn, 2008; Wilson, 2008; Damicon, 2009).

The theory of the triple constraint is one of the most basic and critical concepts of project management, and is commonly explicated through the basic project triangle model.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the triple constraint notion:

- The triple constraint is a critical project management concept that originates from the project basis and provides direction for framing the project.
- The triple constraint comprises the three key elements of scope, time and cost, which co-exist in a drive for equilibrium.
- The triple constraint can be creatively exploited to improve project performance by considering relative flexibility between the elements.

2.4.1 Project triangle

As a project management graphic aid, the triple constraint can be depicted as a triangle, as shown in Figure 2.4, where the sides (or the corners) represent the parameters being managed by the project team (adapted from PMI, 2004: 378; Newell & Grashina, 2003; Wikipedia, 2008). The triangle, commonly referred to as the project triangle, illustrates the process of balancing the triple constraint of scope, time and cost. The notion is that project management is often summarised in this triangle – the three elements must remain balanced for the project to be successful, much like the three sides of the triangle must remain balanced for it to remain a triangle. According to Jenkins (2008), the project triangle demonstrates the relationships and trade-offs between the three primary forces inherent in any project. Chatfield & Johnson (2008) explain that the three sides of the triangle are connected, and changing one side of the triangle will affect at least one other side. Tesoro, as part of a discussion group (Garrett, 2008), expresses that a deeper understanding of the project triangle dynamics will allow project teams to make finer choices when trade-offs need to be made.

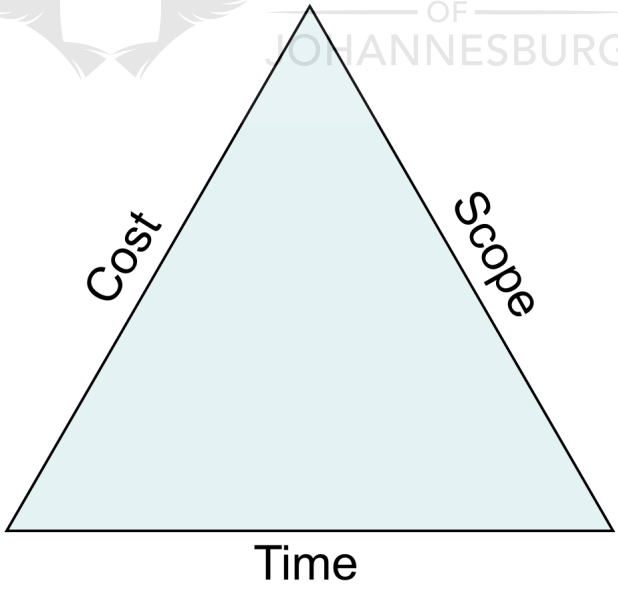

Figure 2.4: The basic project triangle model

The author of this dissertation has observed cases where the triple constraint variables are portrayed by the corners of the project triangle instead of the triangle sides. In such cases the interdependencies are delineated by the fact that each

corner of the triangle embraces the two other corners; one corner (constraint) can therefore not change without affecting the other constraints. It has furthermore been noticed in the literature that some authors modify the basic project triangle model to include additional constraints by expanding the dimension and/or by referencing the area of the triangle. The naming conventions for the project triangle are also diverse across literature and the following variations have been surveyed:

- Project management triangle
- Triangle of triple constraints
- Triad constraints
- Scope triangle
- Quality triangle
- Holy triangle
- Magic triangle
- Devil's triangle
- Titanium triangle
- Infernal triangle
- Iron triangle
- Elastic triangle

Henceforth this is referred to as the project triangle within the context of this dissertation.

The triangular depiction of the triple constraint is a basic but powerful and important premise in project management. The arms of the project triangle symbolise the three project constraints, which act as the project boundaries, and indicate that there exists a direct relationship among the scope, time and cost of any project (adapted from Witzel, 2004). According to Ladas (2007), the arms of

the project triangle represent the constraint trade-offs and the perimeter of the triangle represents the planning commitments. Mihalic (2007: 36) describes that if one of the sides of the project triangle changes length, at least one of the other sides of the triangle must change to maintain a triangle. Stated differently, if one of the dimensions changes, another dimension will have to be adapted in order to compensate for the change. Duma (2005: 6) warns that disregard of change in any dimension may have serious consequences on the other two dimensions due to the interdependent relationships. For example, if functionality problems are realised following a milestone, the activities may need to be rescheduled, and by rescheduling activities the cost will go up. Mihalic states that it is the project manager's responsibility to manage the changes during the life of the project to maintain the triangle (and maintain equilibrium among the sides of the triangle). In order to be effective project leaders, project managers must understand the relationships and implications, i.e. the dynamics, of the triple constraint project triangle (adapted from Jenkins, 2008).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the project triangle:

- The project triangle reflects the characteristic that the three key elements of the triple constraint are interdependent.
- Change within the project triangle is compensated through proportional trade-offs.
- Comprehension of the project triangle dynamics is paramount to effective project management.

2.4.2 Dynamics of the triple constraint

The triple constraint often constitutes competing and conflicting demands. It is common in many projects that one of the triple constraint elements is often fixed whilst the other two elements vary in inverse proportion to each other. For example, if the project is working to a fixed level of scope then the cost of the project will largely be dependent upon the time available. Similarly, when the

project schedule is fixed the scope of the end product will depend on the cost or resources available. These dynamics are typically illustrated through the project triangle, i.e. at least one of the other triangle sides / corners (constraints), but usually both of them, have to change in order to maintain the balance (adapted from Witzel, 2004). The author of this dissertation has also observed cases in the literature where the impact of change on the triple constraint balance is illustrated by displacing the centre of gravity within the triangle area.

Project management researchers and authors widely recognise that the dynamics of the triple constraint can be described by the following three basic relationships (Witzel, 2004; Mihalic, 2007; Chatfield & Johnson, 2008; Wikipedia, 2007; Marchewka, 2006; Koch, 2006; Ladas, 2007; Ambler, 2008; Elmaghraby et al., 2002; Carlos, 2007; Vaes, 2008; Siegelaub, 2008; Jenkins, 2008; Damicon, 2009):

- Relationship 1 - Modifying project scope usually necessitates modifying project time and/or project cost.
- Relationship 2 - Modifying project time usually necessitates modifying project scope and/or project cost.
- Relationship 3 - Modifying project cost usually necessitates modifying project scope and/or project time.

2.4.2.1 Triple constraint relationship 1

Relationship 1 signifies that a modification of project scope (S) typically necessitates a modification of project time (T) and/or project cost (C). Carlos (2007) states that as the scope of work changes, the project schedule needs to change and most likely the resource requirements as well.

The current literature reveals that relationship 1 may customarily be expressed as follows: **S↑ α T↑ C↑**, where the up-arrow (↑) implies an increase. This traditional relationship insinuates that if the scope (S) increases, the schedule (T) and/or budget (C) of the project must increase accordingly (Mihalic, 2007: 37). Stated in simple terms, growing scope will require taking more time or spending more money, i.e. scope targets can be delivered at the expense of time and cost targets. The alternative is to give up some scope elsewhere in order to balance the

relationship. Chatfield & Johnson (2008) confirm that additional time or resources may be required to complete supplementary work (scope). The inverse of relationship 1 also holds true that a reduction in project budget (C↓) or schedule (T↓) may demand a reduction in project scope (S↓).

In order to facilitate practical comprehension, Marchewka (2006: 12) puts forward an example where the project sponsor requests that an additional feature (deliverable) be added to a developing IT project – i.e. the scope side of the triangle increases, which implies that either the cost and/or time side of the project triangle will have to increase accordingly. Marchewka asserts that any additional features will require extra resources in terms of more work on the part of the project team. Marchewka carries on that if (the same) team members must do the additional work, that their time, and the costs associated with time spent doing unscheduled work, must be added to the project schedule and budget. The author of this dissertation takes the argument further and considers the implication if the project deadline remains fixed, which will imply that additional resources (team members) may need to be added with the consequence of increasing overall project cost whilst maintaining the planned schedule. This concept is graphically illustrated in Figure 2.5. The graphic on the left depicts the triple constraint in a state of equilibrium, i.e. the initial project plan. The middle graphic depicts the requirement to add tasks or work (scope) to the project without changing the time to complete the project. The graphic on the right depicts the associated increase in cost when adding resources to compensate for the additional work in order to keep the project balanced.

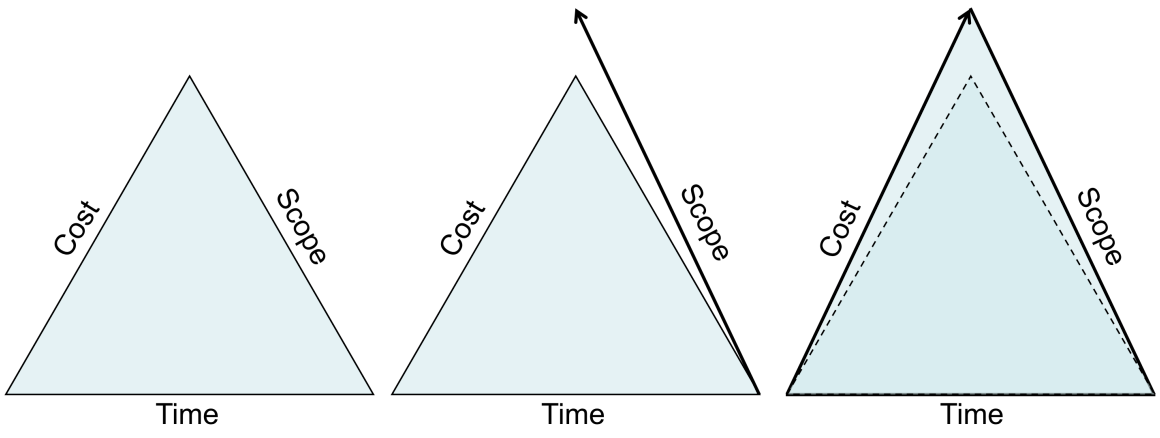

Figure 2.5: The triple constraint relationship *S↑ ∝ C↑ with T constant*

If both the schedule and budget of the project are negatively affected as a result of an increase in project scope, the relationship may be graphically illustrated as shown in Figure 2.6.

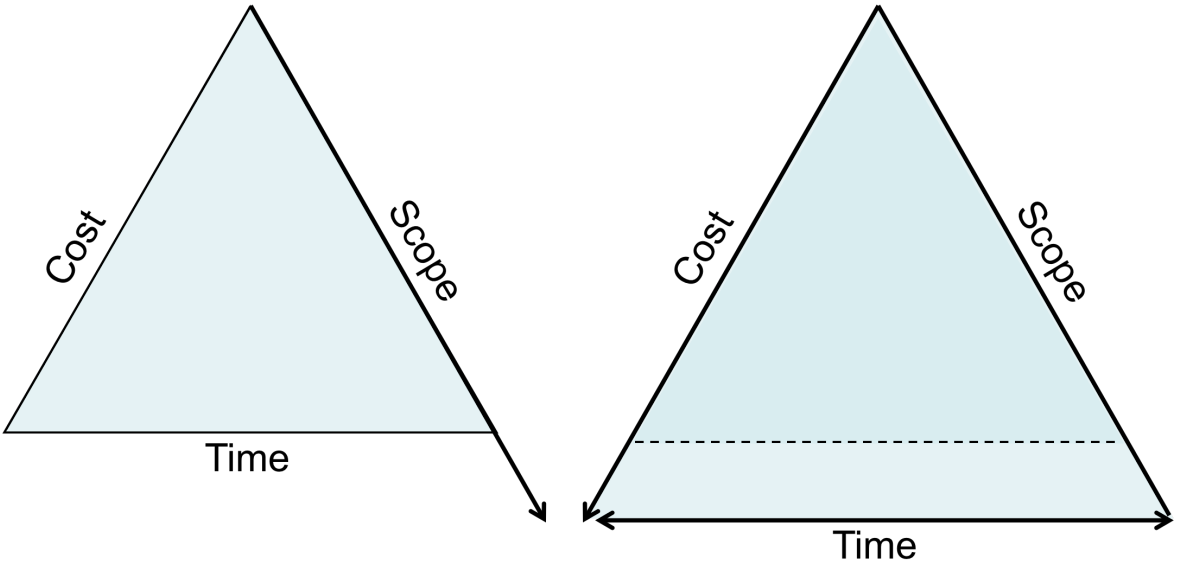

Figure 2.6: The triple constraint relationship $S\uparrow \propto T\uparrow$ and $C\uparrow$

The author of this dissertation admits that Figure 2.5 and Figure 2.6 are only two of many possible ways of how to illustrate these dynamic relationships. The two figures are merely the author's perspective and the illustrations have been derived to facilitate and improve understanding of the triple constraint dynamics. It should be noted that the illustrations also depend on which factors are fixed and which are flexible. It should also be noted that the changes are not always symmetric, i.e. if two variables need to increase, one may increase proportionally more than the other – for example, more resources may need to be added in order not to exceed the deadline by too much. The important consideration is that a connected triangle should be maintained at all times.

2.4.2.2 Triple constraint relationship 2

Relationship 2 signifies that a modification of project time (T) typically necessitates a modification of project scope (S) and/or project cost (C). Carlos (2007) states that as the schedule is changed and the project has less time, the project scope needs to decrease and the resources may need to be increased.

The current literature reveals that relationship 2 may customarily be expressed as follows: **T↓ α S↓ C↑**, where the down-arrow (↓) signifies a reduction or decrease. This traditional relationship implies that if time (T) decreases, the project scope (S) must be reduced and/or the budget (C) of the project must increase accordingly (Mihalic, 2007: 37). Stated in simple terms, a tight time constraint could mean reduced scope or increased costs, i.e. time targets can be delivered at the expense of scope and cost targets. Elmaghraby et al. (2002: 302) states that the reduction of the duration of an activity, when feasible, usually comes at a price, since it typically involves an increase in the resources utilised (for example using two trucks instead of one, or transport by air instead of by truck). Chatfield & Johnson (2008) confirm that if the duration of the project schedule decreases, the budget may need to be increased because more resources must be hired to do the same work in less time. If the budget cannot be increased, the scope may need to be reduced since the available resources cannot complete all of the planned work in less time.

The inverse of relationship 2 also holds true that a reduction in project budget (C↓), i.e. cost saving, or an increase in project scope (S↑), i.e. scope creep, may demand an increase in project schedule (T↑), i.e. additional time.

2.4.2.3 Triple constraint relationship 3

Relationship 3 signifies that a modification of project cost (C) typically necessitates a modification of project scope (S) and/or project time (T). Carlos (2007) states that if the resources are not available as expected, the project scope may need to be reduced and the final delivery date may change.

The current literature reveals that relationship 3 may customarily be expressed as follows: **C↓ α S↓ T↑**. This traditional relationship insinuates that if the cost (C) decreases, the project scope (S) must be reduced and/or the schedule (T) of the project must increase accordingly (Mihalic, 2007: 37). Stated in simple terms, a tight budget could mean reduced scope or increased time, i.e. cost targets can be delivered at the expense of scope and time targets. Chatfield & Johnson (2008) confirm that if the project budget decreases, more time may be required because it is not possible to pay for as many resources or for resources of the same

efficiency. If the time cannot be increased, the project scope may need to be reduced since fewer resources cannot complete all of the planned work within the time remaining. The inverse of relationship 3 also holds true that a reduction in project schedule (T↓), i.e. time saving, or an increase in project scope (S↑), i.e. scope creep, may demand an increase in project budget (C↑), i.e. additional cost.

The challenge to illustrate the dynamics of relationships 2 and 3 is left up the readers of this dissertation following the same rationale as in Section 2.4.2.1.

The author of this dissertation found that it is prudent to note that the distinction should be maintained between a project running late (pressure) and a project being given more time (flexibility). A project that runs late and needs to get back on track may require a reduction in scope and/or an increase in cost. On the contrary, a project that has been given more time (e.g. schedule extension) may have the effect of reducing the cost and even the opportunity to increase the scope. In similar vain, a project that runs over budget and needs to get back on track may require a reduction in scope and/or an increase in time; whereas, a project that has been given a budget extension (e.g. more money or resources) may have the effect of reducing the time and increasing the scope.

Chatfield & Johnson (2008) argue that if actual projects would always perform to the requirements of the project triangle dynamics, “you might see projects delivered late but at planned cost or with expected scope, or, projects might be completed on time and with expected scope but at higher cost, i.e. you’d expect to see at least one element of the project triangle come in as planned”. Reality however indicates that many projects, even those with rigorous project management oversight, are often delivered late, over budget, and with far less than expected scope of functionality.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the triple constraint dynamics:

- The trade-off dynamics inherent to the triple constraint may be described by the following three relationships (henceforth referred to as the key triple constraint relationships):
    - Relationship 1, S↑ α T↑ C↑, which signifies that scope targets can be delivered at the expense of time and/or cost targets.
    - Relationship 2, T↓ α S↓ C↑, which signifies that time targets can be delivered at the expense of scope and/or cost targets.
    - Relationship 3, C↓ α S↓ T↑, which signifies that cost targets can be delivered at the expense of scope and/or time targets.
- The key triple constraint relationships imply that at least one of the elements can be achieved or fixed, i.e. delivered as planned, through variation and exploitation of the remaining elements, which may not necessarily be symmetric.
- The dynamics of the key triple constraint relationships can be graphically illustrated in a variety of ways through innovative manipulation of the project triangle.
- The impact on the triple constraint trade-off dynamics needs to be differentiated in terms of pressure and flexibility.

2.4.3 Application of the triple constraint

It is inevitable in the life cycle of a project that there will be changes to the scope, time or cost of the project (Business Services Projects, 2003: 1). The significance of these changes to the basic project triangle is that the model will become lopsided as a result of the interdependencies (changes to one element will affect the others), i.e. the equilibrium will change (Carlos, 2007). Figure 2.7 depicts the impact of change on the project triangle.

Carlos (2007) expresses that any changes to the initial project (triangle) plan will impact the project and that decisions need to be made. According to Mann (2005) it is useful to have an ongoing understanding, internally as well as with the

customer, about which part of the project 'gives' when the inevitable changes happen. At the very outset of (and throughout) the project, the project manager needs to work with the project sponsor and determine how to set and reset the priorities of scope, time and cost, should there be a change in the project (Carlos, 2007). According to Campbell & Baker (2007: 6) a good project manager will make sure he or she understands which of these three elements is paramount, i.e. what is most important: the scope of work, the deadline or the budget. According to Carlos (2007) consideration must already be given to the priorities of the triple constraint elements during the project initiation phase. Once this is established, the project manager can work to keep the other elements in balance as the project progresses (Campbell & Baker, 2007: 6).

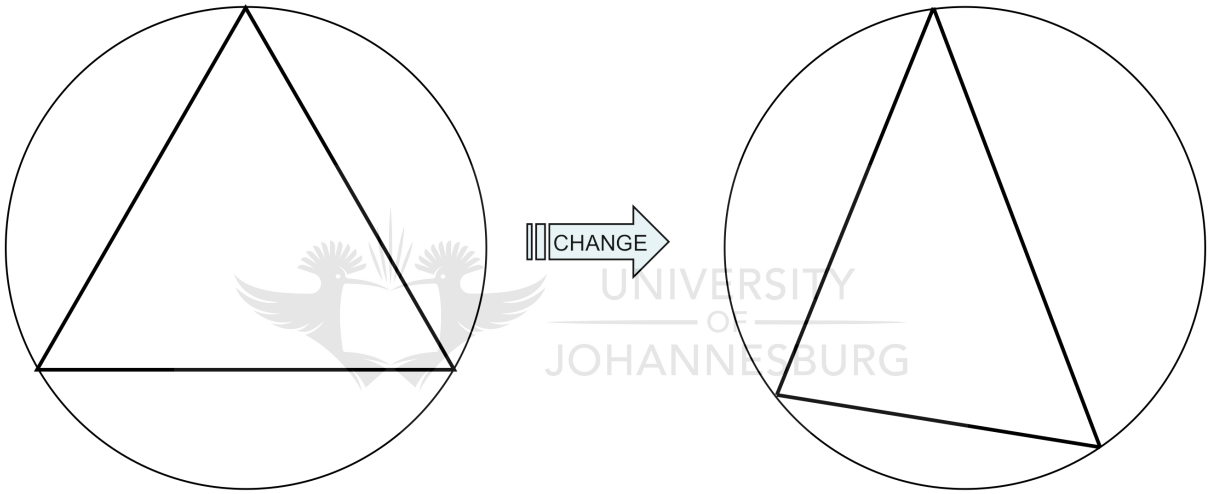

Figure 2.7: The impact of change on the project triangle

According to Mann (2005), the project triangle is an elegant way to discuss resource constraints with a customer (or the project sponsor), "but it's also a useful tool for helping your team understand the play". Newell & Grashina (2003) state that the project triangle is often used to illustrate that project management success is measured by the ability of the project team to manage the project, or part of the project, so that the expected results are produced while managing time and cost. Hudson (as cited in Garrett, 2008) argues that project management practices need to move into a consultative framework where the customer tolerance for variations in the three elemental triple constraint areas is clearly articulated and shared with key stakeholders, so that an appropriate amount of planning and control flexibility is facilitated. Marchewka (2006: 13) states that the triple constraint relationships

should be considered throughout the project life-cycle whenever a decision is made that affects the project goal, scope, schedule, or budget. Figure 2.8 depicts how the centre of gravity of the project triangle may shift as the project progresses throughout its life-cycle (adapted from Kuster et al., 2002; Kuster et al., 2008).

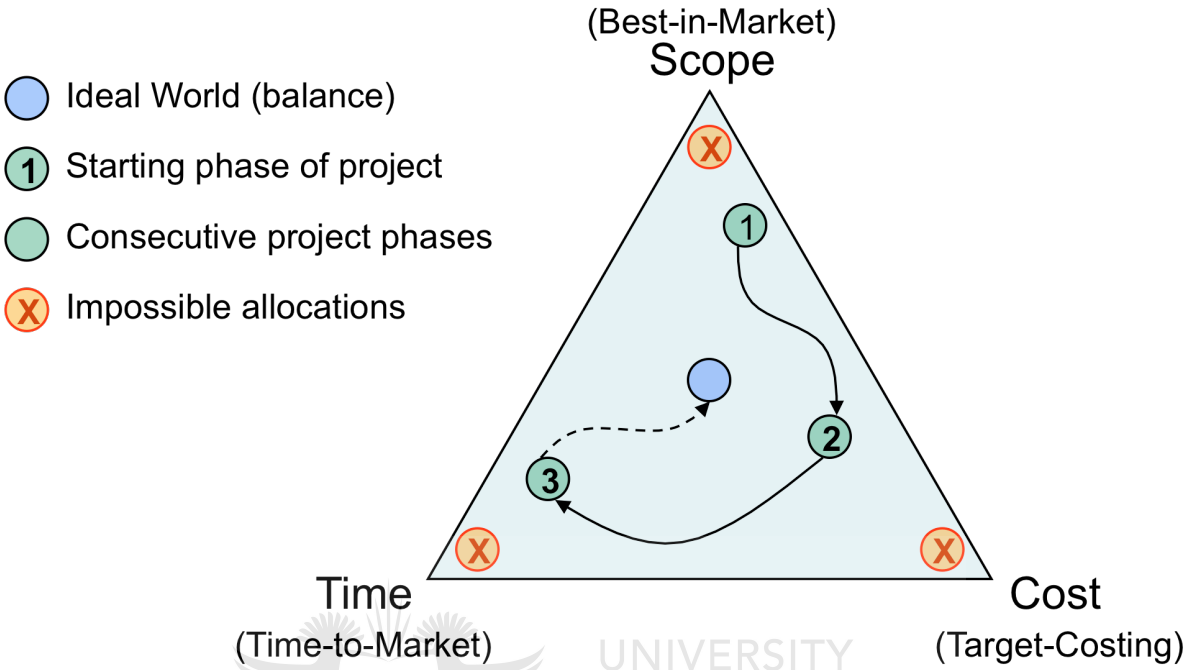

Figure 2.8: The impact of change during the project phases (adapted from Kuster et al., 2002; Kuster et al., 2008)

Kuster et al. place the three triple constraint elements (scope, time and cost) at the corners of the project triangle, instead of along the sides of the project triangle. The example may be interpreted as follows: at phase 1 of the project the focus was primarily on the scope aspect; at phase 2 of the project an agreement was reached between scope and cost; at phase 3 of the project an occurrence resulted in the time aspect to suddenly become a high priority, but with an associated cost implication (indicated by the large displacement away from the cost corner).

According to Siegelaub (2008), application of the tolerances (constraints) occurs at two key points within the PMBOK process flow. The first is in planning, where the following aspects have to be assessed:

- What the constraints should be (if they have not been previously defined).
- Who should be setting the constraints, and when.

- How the constraints are to be used by the project manager.
- How the project sponsor, board and stakeholders will be kept informed of the status of the constraints and project.

The second area, according to Siegelaub, is in monitoring and controlling where consideration needs to be given to the following aspects:

- Determining what is going on in the project (standard data collection / monitoring processes).
- Assessing how that compares against the constraints agreed by the project sponsor, board and stakeholders.
- Determining whether any of the constraints have been breeched, or threatened to be breeched[11].
- Proposing and recommending alternatives for addressing the breech.

The PMBOK prescribes that the list of project constraints should be an output from the initiating process group. According to Kuster et al. (2002), project planning has to be structured in a way to allow the constant monitoring of the target achievement, deadlines and cost. Duma (2005: 15) warns that these objectives may not be met if the project plan is not followed. Baguley (as cited in Duma, 2005: 3) states that the dimensions should be clearly defined at the beginning of each project and monitored throughout the life cycle of the project (and managed and controlled at all times). Duma (2005: 18) reckons that the progress of the project is seen during the implementation stage, the stage during which most of the project work is performed, and that there is hence a need to ensure that the scope, time and cost objectives previously agreed upon are monitored and controlled with respect to the initial plans. The project manager must aim to maintain the balance by managing the constraints throughout the entire project life cycle (Mihalic, 2007: 36).

[11] PRINCE2 emphasises the importance of dealing with constraint breeches as soon as they are forecasted rather than waiting for them to occur so that there are more options, and time, to deal with the situation (Siegelaub, 2008).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the triple constraint application:

- The triple constraint constitutes one of the primary building blocks of the project plan and is paramount to the monitoring and controlling process group.
- The cause and effect of new or changing triple constraint requirements need to be constantly negotiated during all phases of the project.
- The project triangle is a useful model to illustrate the consequences of change on the triple constraint to key project stakeholders.

2.4.4 Good, fast or cheap? Pick two

Within the project management and consulting environment, the adage 'good, fast or cheap - pick two' is commonly encountered. Good, fast and cheap refer to the three key elements of the triple constraint namely the extent of work (scope)[12], the schedule (time) and the budget (cost), respectively.

According to Anderson (2003), projects are generally constrained to choose two of the three elements, 'good, fast or cheap - pick two', and sacrifice the other in order to gain the chosen two. The notion is that if a short schedule and low budget are required, then the extent of work needs to be sacrificed (inferior work or limited scope, e.g. cut back on features); simply stated, "if you want it done quick and inexpensive, it will not be done well", i.e. fast + cheap = inferior. The corollary is that if extensive / superior work is required, then higher costs or a longer schedule must be expected; simply stated, "if you want it done well and quick, it will be expensive", i.e. good + fast = expensive; alternatively, "if you want it done well and inexpensive, it will take long", i.e. good + cheap = slow (adapted from Koch, 2006;

[12] Although the word 'good' is often used in literature to refer to the quality of the project deliverables, the author of this dissertation found that it is more appropriate to align the aspects good, fast and cheap with the key elements of the project triangle, namely scope, time and cost, respectively. Koch (2006) concurrently advocates that the adage 'good, fast or cheap - pick two' is valid as long as the word good is interpreted to be referring to grade (one of the components of project scope), and not quality.

Nielsen, 2007; SixSide, 2004; Vaes, 2008; Siegelaub, 2008). The option of all three is not considered to be practical (Nadgouda, 2007).

The 'good, fast or cheap - pick two' impression is a manifestation of what Collins & Porras (1994) term the 'Tyranny of the *Or*' – the rational view that cannot easily accept paradox, that cannot live with two seemingly contradictory forces or ideas at the same time. The 'Tyranny of the *Or*' pushes people to believe that things must be either A or B, but not both (Collins & Porras, 1994: 43). That is to say, in terms of the triple constraint, one can choose either good-and-fast, or good-and-cheap, or fast-and-cheap; but critically not all three (Anderson, 2003; SixSide, 2004).

According to Siegelaub (2008) only two of the three factors can be requested, and the third factor will be defined by the first two factors. The author of this dissertation also noticed in the industry that this rationale is sometimes informally explained by stating that the project sponsor or customer has the option to choose two factors to control, and the project manager receives whatever remains. An alternative way of looking at the 'good, fast or cheap - pick two' principle is that if any one of the three factors is chosen then at least one of the remaining two factors will have to be sacrificed.

The author also found that the following informal expressions, in line with the 'good, fast or cheap - pick two' rationale, are occasionally used in practice:

- "Do you want it good or do you want it Tuesday?"
- "Speed costs money – how fast do you want to go?"
- Within the production industry, "Cheap, light or strong? Pick two."

Nadgouda (2007) represents the 'good, fast or cheap - pick two' rationale graphically by setting the elements at the corners (points) of a triangle as shown in Figure 2.9. The theory of Nadgouda's model is that any one side (line segment) of the triangle may be chosen. The aim, according to Nadgouda, is to converge these three points.

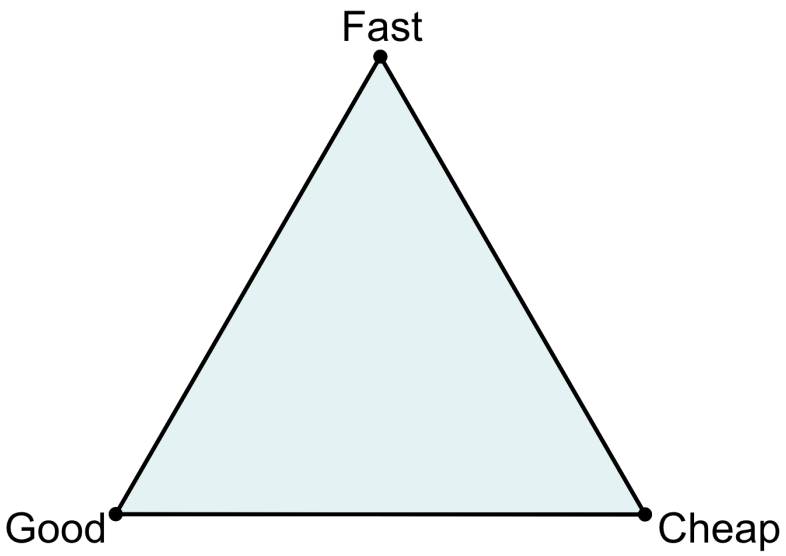

Figure 2.9: 'Good, fast or cheap - pick two' triangle (Nadgouda, 2007)

Another interesting way of illustrating the 'good, fast or cheap - pick two' rationale is using the famous 'impossible object', the Penrose triangle, depicted in Figure 2.10. The option to 'pick two' is highlighted through the dynamics of this 'undecidable' figure.

Figure 2.10: 'Good, fast or cheap - pick two' impossible object (SixSide, 2004)

The 'good, fast or cheap - pick two' trade-off can also be demonstrated with an adaptation of Barker & Cole's (2007) model, the quality seesaw. The adapted seesaw model as perceived by the author of this dissertation is shown in Figure 2.11. While remaining committed to supplying something that is fit-for-purpose, according to Barker & Cole, a project manager needs to strike the right balance

between the cost of delivery and the time required to achieve this. Typically, constraining resources is likely to lengthen timescales and vice versa.

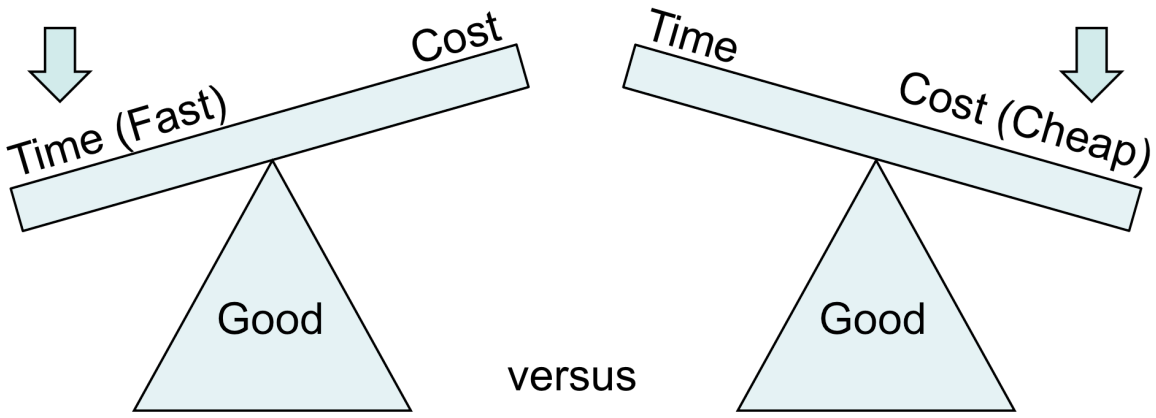

Figure 2.11: Good-and-fast vs. good-and cheap seesaws (adapted from Barker & Cole, 2007)

With reference to Figure 2.11, if pressure is put on timescales (fast) then costs can be expected to go up; alternatively, if pressure is put on costs (cheap) then timescales can be expected to go up. From the seesaw model it is clear that, with the scope of work (good) remaining pivotal, the project cannot be delivered simultaneously fast and cheap as well; one of the elements has to be flexible.

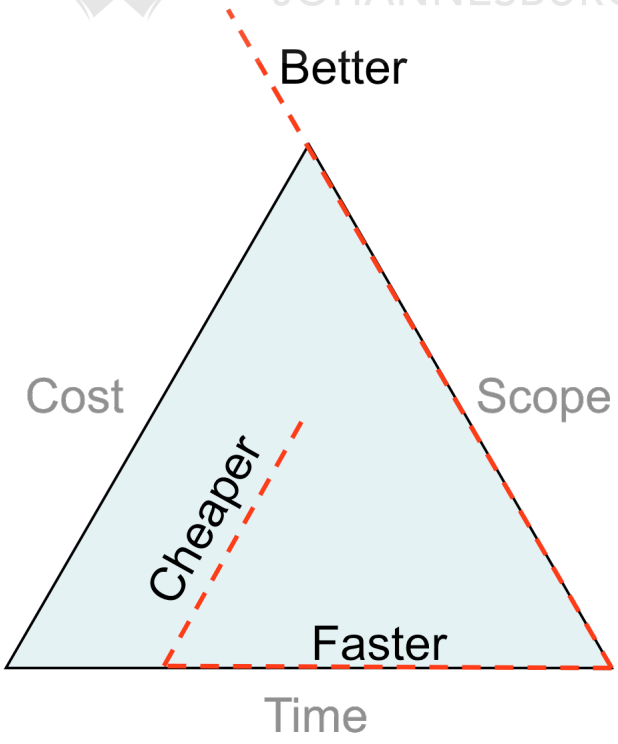

Figure 2.12: Better, faster, cheaper – is it really possible? (adapted from Mihalic, 2007: 38)

According to Damicon (2009), many projects fail right out of the starting gate because scope, time and cost are all inflexible. Damicon warns that this inflexibility may drive project managers to cut corners elsewhere on aspects such as quality, reliability, scalability and/or robustness. Mihalic (2007: 38) illustrates in Figure 2.12 that it is not possible to maintain the triple constraint as a triangle when all three aspects of good, fast and cheap are pursued. According to Ambler (2008), at least one of the three critical factors must vary, i.e. be flexible, or else the quality of the work will suffer. For example, when IT development teams are forced to deliver more functionality than they have time or resources for, they are often motivated to take shortcuts, which inevitably result in poor quality.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the 'good, fast or cheap - pick two' aphorism:

- Although the three properties of the triple constraint are interrelated, it is not customarily possible to achieve all three targets on project delivery.
- When there is pressure on the triple constraint, at least one of the properties needs to be compromised (flexible) otherwise quality may be affected.
- The following analogy may be drawn between the 'good, fast or cheap - pick two' permutations and the key triple constraint relationships:
    - Relationship 1, S↑ α T↑ C↑, implies that the effect of increasing scope (S↑), or effort (pressure) to achieve scope, necessitates an increase in time (T↑) and/or cost (C↑). If cost remains unchanged, then the project can be delivered good (because S↑) and cheap (because C fixed as planned) but not fast (because T↑).
    - Relationship 2, T↓ α S↓ C↑, implies that the effect of reducing time (T↓), or effort (pressure) to achieve time, necessitates a reduction of scope (S↓) and/or an increase in cost (C↑). If scope remains

unchanged, then the project can be delivered fast (because T↓) and good (because S fixed as planned) but not cheap (because C↑).

- Relationship 3, C↓ α S↓ T↑, implies that the effect of reducing cost (C↓), or effort (pressure) to achieve cost, necessitates a reduction of scope (S↓) and/or an increase in time (T↑). If time remains unchanged, then the project can be delivered cheap (because C↓) and fast (because T fixed as planned) but not good (because S↓).

2.4.5 Impact of supporting factors on the triple constraint

Within the context of this dissertation the three prime elements of scope, time and cost are considered central to the triple constraint. Project management literature, however, sporadically indicates quality and performance as an adjunct to or substitute for scope, and occasionally designates customer satisfaction and project risk as ancillary constraints.

Newell & Grashina (2003) believe that the concerns associated with the governing of the traditional project triangle of scope, time and cost in effect lead to the management of project quality and risk as well as other factors such as communications, integration, schedule, performance, stakeholder needs, desires, requirements, and expectations.

2.4.5.1 Quality and the triple constraint

The PMBOK states that project quality is affected by balancing the three factors of scope, time and cost (PMI, 2004: 8). Some authors argue that quality should be recognised as a fourth constraint and that the triple constraint should therefore be a quadruple constraint (Shenhar, 2007; Garret, 2008; Crocker, 2008; Maltzman & Biswas, 2009; Wikipedia, 2007; Simms, 2008; Jaques, as cited in Garrett, 2008).

The inclusion of quality as one of the key dimensions in a project is common in most project management literature (Flett, 2001: 2). Duma (2005: 3) recognises, “at the end of the twentieth century, the presence and influence of ‘quality revolution’ with its emphasis on the provision of customer satisfaction a fourth and complementary dimension – the quality or ‘fitness for purpose’ is added”. Simms

(2008) illustrates the quadruple constraint concept by adding quality as another dimension to the traditional project triangle and thus transforming the triangle into a pyramid, which Simms refers to as the 'infernal project pyramid' (Figure 2.13). According to Simms, each of the four dimensions has an impact on the project value.

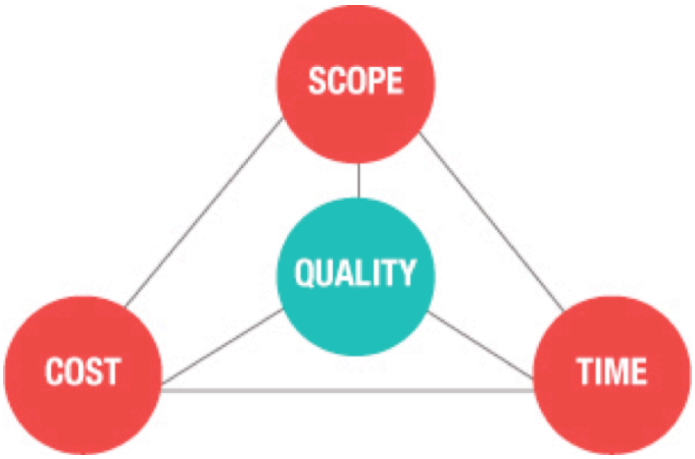

Figure 2.13: Quality as the fourth dimension to the triple constraint (Simms, 2008)

Ladas (2007) argues that it is a mistaken suggestion that there is a fourth variable of quality and claims that quality forms part of the project scope, "if a system performs the functions you say you wanted and you still don't like it, then you got the requirements wrong; if you update the requirements to address your objections, you'll discover that the scope is greater than you identified". Witzel (2004) is of the same opinion and states that scope includes the quality of the work or deliverables that need to be created.

Various project management authors integrate scope and quality on the same side of the project triangle as illustrated in Figure 2.14 (Sepehri, 2006; PDU University, 2005; Mann, 2005; Vaes, 2008; Siegelaub, 2008; Mihalic, 2007). According to Reiling (as cited in Garrett, 2008) quality to a large extent defines the criteria for scope. Campbell & Baker (2007: 36) state that defining the scope of the project correctly is the key ingredient in developing a quality plan. According to the PMBOK, a critical element of quality management in the project context is to turn stakeholder needs, wants and expectations into requirements through stakeholder analysis performed as part of project scope management (PMI, 2004: 180).

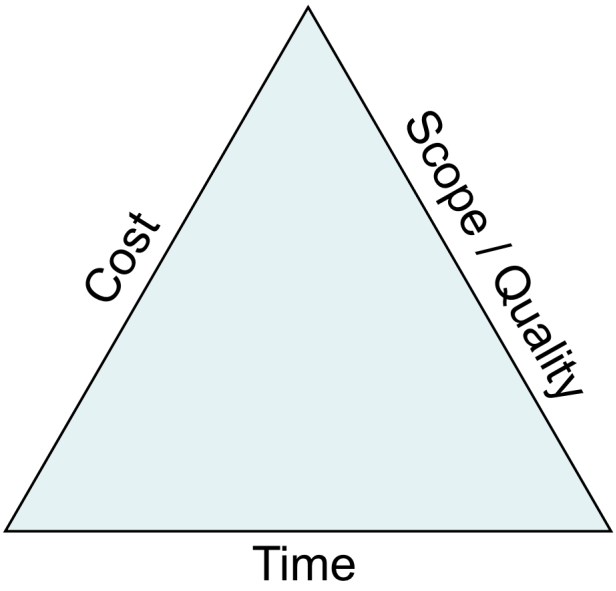

Figure 2.14: Scope and quality integrated on one side of the project triangle

Some project management literature claims quality as the third element of the triple constraint, as indicated in Figure 2.15 (Norrie & Walker, 2004; Joubert, 2002; Jenkins, 2008; Kuster et al., 2002), instead of project scope as suggested by the PMBOK.

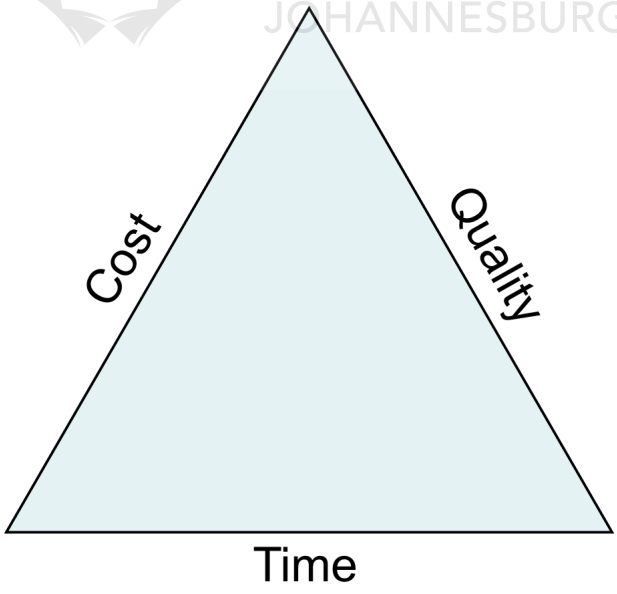

Figure 2.15: Quality instead of scope in the project triangle

Siegelaub (2008) states that in many classic situations when time or cost is constrained it is quality, usually through less testing or verification or sometimes through reduced characteristics, that is compromised. Koch (2006) argues that

when budget and schedule are constrained, it is scope that must be given up, not quality; and it is increasing scope, not quality, that increases costs or schedules. Koch is of the stance point that producing a poor-quality product does not necessarily save time or money, and explains that the misinterpretation stems from confusion between the concepts of quality and grade, as discussed in Section 2.3.12. The grade (not quality) of the product to be produced is one of the components of project scope, and so can be traded for cost or time – 'more bells and whistles will cost you more time or money'.

According to Flett (2001: 13) quality management theory, and to lesser degree project management theory, stresses that quality is sacrosanct and as such is not seen as a variable that can be compromised, "quality is therefore supposed to be ring-fenced from the resource restrictions that affect the other project objectives". Carlos (2007) claims that quality is an integral part of the project triangle and is a force that must also remain in equilibrium with the elements. Haughey (2008) agrees with Carlos and states that the three triple constraint variables form the vertices of the project triangle with quality as a central theme (Figure 2.16).

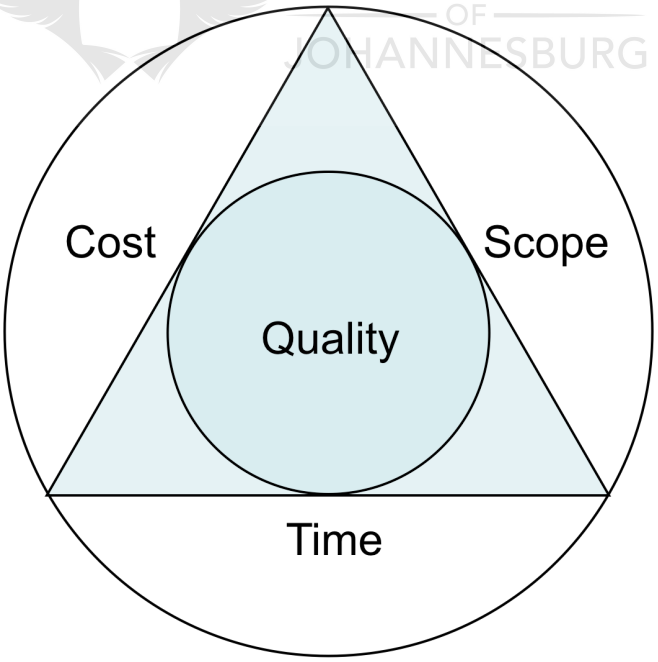

Figure 2.16: Quality as an integral part of the triple constraint (integrated from Carlos, 2007; Haughey, 2008; Ambler, 2008; Garrett, 2008; Herborn, 2008)

Carlos states that quality should be continuously measured throughout the project and that measures need to be taken to ensure that changes to the project triangle do not impact the standards set for the project. Kennedy (2008) expands on the centralised theme and depicts quality as a central result of scope, time and cost, which Kennedy refers to as the 'triad constraints' (Figure 2.17).

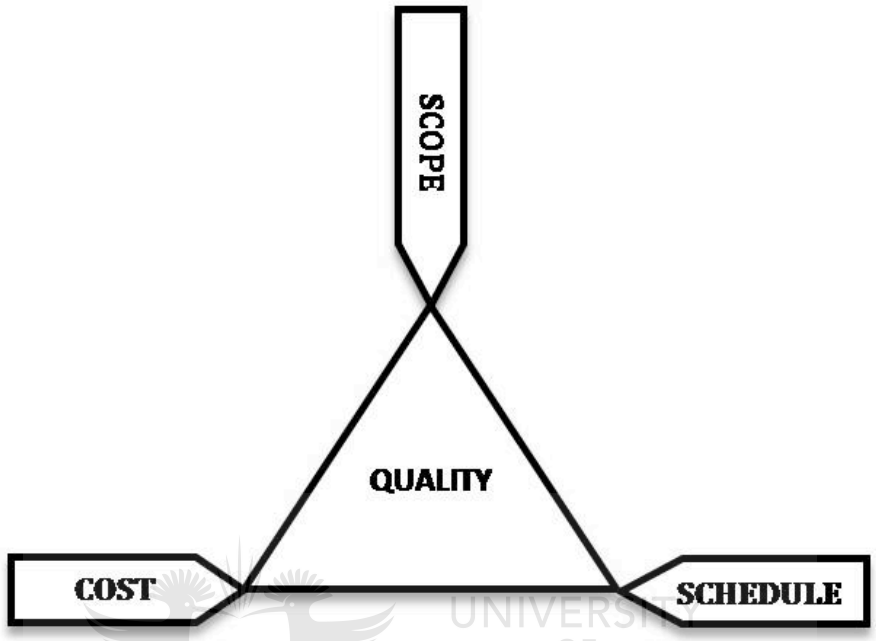

Figure 2.17: Quality as the central result of the triple constraint (Kennedy, 2008)

According to Maltzman & Biswas (2009), quality must be inherent in each of the triple constraint elements, "each facet should be imagined as having 'what the customer wants' woven into its very fabric". This is in line with the PMBOK teaching that high quality projects deliver the required product, service or result within scope, on time, and within budget. Dobson & Feickert (2007: 40) agree that quality is a customer-centred objective, whether it ends up being expressed in the form of requirements, specifications or other formal metrics. Crocker (2008) asserts that it is vital that the project manager works with the customer to state the quality definition of the deliverables in a clear and measurable way, because that definition will impact the other three metrics. The project manager and customer have to reach an agreement and an understanding on how this measurement relates to the three primary elements of the triple constraint. With this in hand, according to Crocker, the project manager can make intelligent trade-offs and provide status reporting to the customer. Crocker warns that too many times the

project drivers are to deliver fast and cheap, resulting in large numbers of projects that fail to satisfy the user, “budgets escalate and delivery dates stretch out as we get caught in the cycle of test, reject, and rework” (Crocker, 2008).

Chatfield & Johnson (2008) caution that if the duration of the project must be decreased, it should be ensured that the overall project quality is not unintentionally lowered. Testing and quality control, for example, often occur last in a software development project; if project duration is decreased late in the project, those tasks might be the ones to suffer with cutbacks. The benefits of decreasing the project duration must be weighed against the potential downside of a deliverable with poorer quality. Witzel (2004) uses an example to illustrate the impact of quality on the balance of the project triangle. In his example, with the budget, schedule, and scope balanced, the project sponsor wants to increase the scope of the project by adding more deliverables (staff training). According to the basic project triangle model, if the scope side of the triangle increases, the time side and/or the cost side must also increase to maintain the balance. The request from the project sponsor in this example, however, is to increase the number of project deliverables without increasing the budget, and to still complete the project on time. Time is ultimately saved by reducing the number of editors of a particular document and is consequently spent to deliver the staff training as requested by the project sponsor. As a result, more spelling errors may be evident in the said document, but the project manager is able to include training as a deliverable without increasing the project budget; i.e., the balance is maintained by increasing the number of deliverables while decreasing the quality of the work or reducing the number of activities.

This example of Witzel proves to be in line with Ambler’s reasoning (Ambler, 2008) that at least one of the three critical factors (scope, time or cost) must vary otherwise the quality of the work will suffer. From another perspective, Koch (2006: 3) argues that project time and money cannot be saved by minimising quality. Koch explains that the way to control the budget and schedule on a project is to minimise the total cost of quality. As already mentioned in Section 2.3.12, Koch proposes that investing in defect prevention and early defect detection can drive down defect correction costs. This in turn results in minimising the total cost

of quality. At the same time, it can compress the schedule as more time is saved in defect correction than is spent in detection and prevention.

2.4.5.2 Customer satisfaction and the triple constraint

As already discussed under Section 2.3.15, research conducted by Milis et al. (2003) indicates that project success should not be judged solely based on the traditional triple constraint, but that long term gains and customer satisfaction are important criteria as well. Kerzner (as cited in Dobson, 2004: 9) points out that if a project is to be accomplished for an outside customer, then the project has a fourth constraint, namely good customer relations. Crocker (2008) expresses that the customer is the one that decides if the project is complete, if the results are of use, and ultimately if they are satisfied with the results, "they will have some definition in their heads and unstated expectation of the quality of the deliverables, which will change as the project progresses". Newell & Grashina (2003) suggest that the sides of the project triangle embrace customer satisfaction as the triangle interior, illustrated in Figure 2.18. The proposition, according to Newell & Grashina, is that in order to create customer satisfaction, project teams must perform all of the scope that was promised for the budget and deliver it when it was promised, "the customer should always be concerned about scope, time and cost".

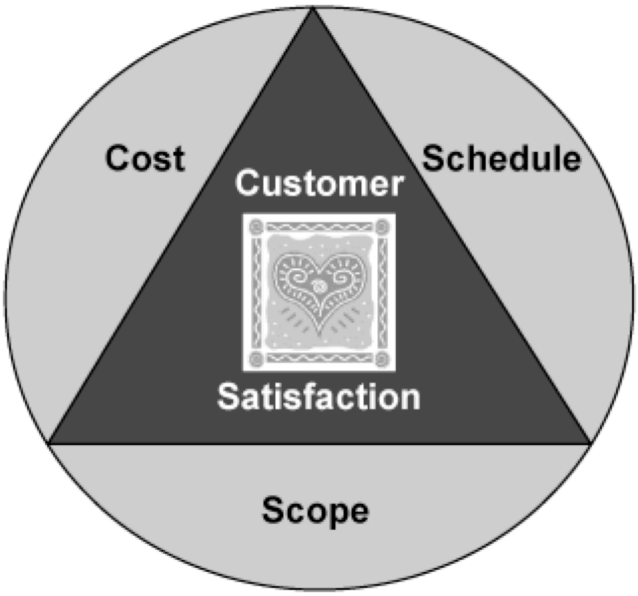

Figure 2.18: Customer satisfaction as the project triangle interior (Newell & Grashina, 2003)

According to Haughey (2008), the traditional project management triangle should give way to a project management diamond (Figure 2.19) with scope, time, cost and quality the four vertices, and customer expectations as a central theme. Mihalic (2007: 32) supports Haughey's concept by stating that project managers need to deliver project results not only within budget, on time and with acceptable quality, but also deliver project results that meet customer expectations.

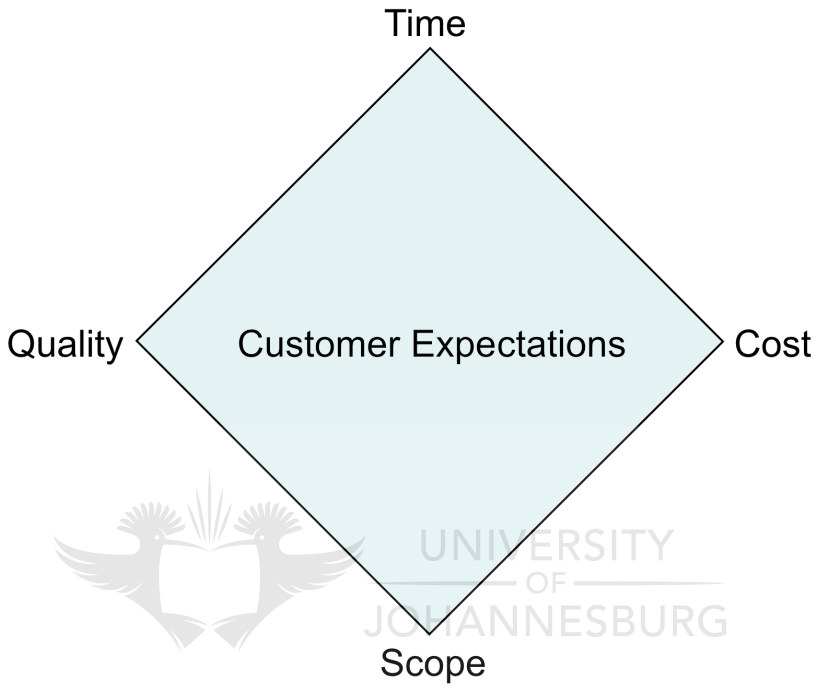

Figure 2.19: The project management diamond (adapted from Haughey, 2008)

The universal project pyramid of Campbell & Baker (Figure 2.20) demonstrates the balance between time, resources, results and customer satisfaction that is required to bring a project to a successful conclusion, "if you change one of the elements in the pyramid, you automatically change the scope of the project" (Campbell & Baker, 2007: 7).

According to Dobson (2004: 10), quality is customer-centred and states that requirements and specifications are intermediaries derived from customer goals. Customer satisfaction is in essence an evaluation-based performance criterion, and does not require an additional constraint (Dobson & Feickert, 2007: 39).

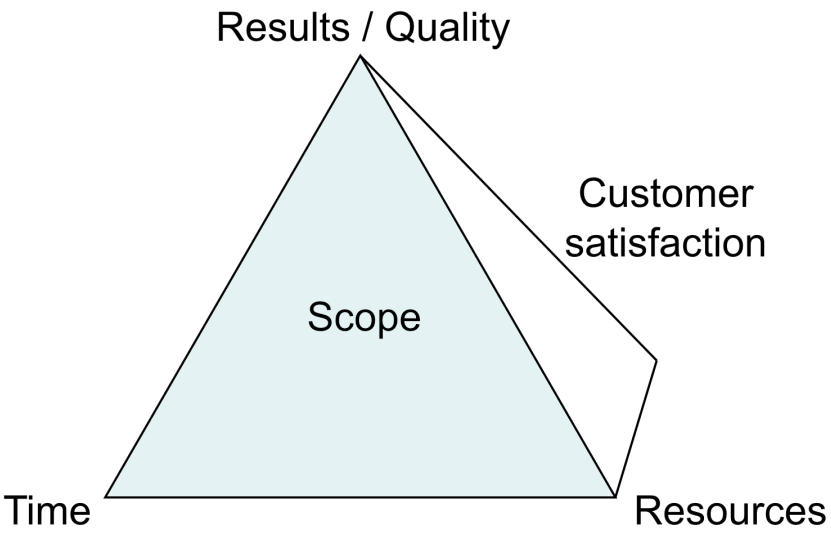

Figure 2.20: The universal project pyramid (Campbell & Baker, 2007: 7)

2.4.5.3 Performance and the triple constraint

According to Baguley (as cited in Duma, 2005: 3) traditional project management focused on the following three complementary dimensions: the final outcome or performance; the time needed to achieve the performance; and the cost of all the resources used. Dobson separates performance from scope in Figure 2.21 and expresses the triple constraint as performance, time and cost (Dobson, 2004: xi; Dobson & Feickert, 2007: 5).

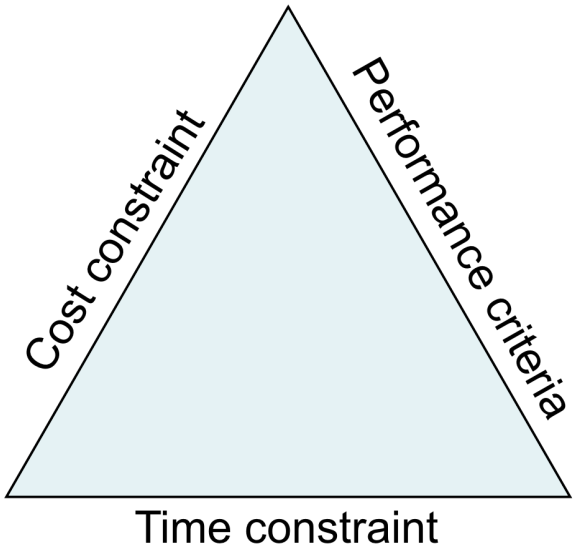

Figure 2.21: Performance instead of scope in the project triangle (Dobson, 2004: xi)

Dobson argues that scope as a substitute for performance criteria may obscure a realisation that perhaps project purpose or evaluation criteria are more central to understanding what needs to be done, especially at the early stages of the project, "scope follows purpose, so it's not necessarily a sign of problems if a project begins the initiation stage with significant vagueness; it's a problem only if the project completes initiation without a crisp understanding of scope" (Dobson, 2004: 10).

Lewis (2005) suggests that project scope represents the area of Dobson's triangle, similarly suggested by Belling (as cited in Garrett, 2008), and can be chosen as a variable to achieve project success. Lewis refers to this relationship as PCTS (performance, cost, time, scope), and suggests, with reference to the 'good, fast or cheap - pick two' rationale, that any three may be selected.

Alleman (2005) asserts that technical performance measure (TPM)[13] constitutes the third leg of the project triangle together with cost and schedule. Alleman argues that a performance measure is not scope in the traditional sense, but that technical performance measures are maturity assessment processes for the scope, "the definition of 'done' and the measure of 'how close to done are we' are critical to maintaining the balance of cost, schedule and capabilities". Alleman promotes that program managers are able to assess the progress of their entire program by combining cost, schedule and technical progress into one comprehensive management tool, "the TPM approach is the standard project management paradigm for complex, high-risk procurements" (Alleman, 2005).

Duma (2005: 3) considers performance, time, cost and quality as the key project dimensions, and illustrates the relationship between these dimensions as shown in Figure 2.22 (integrated from Duma, 2005; Meridith & Mantel, 2000; Baguley, 1995; Flett, 2001).

[13] TPM is an evolutionary program management tool, which builds on the two traditional strengths of earned value management (cost and schedule performance indicators) by adding an elusive third dimension - the status of technical achievement. The TPM approach measures the increasing compliance with the specification as the project matures. It may address considerations, for example, if it will be worth another 50% of the schedule to achieve the last 20% of the compliance if the project has already achieved 80% of the compliance at the 50% point in the schedule.

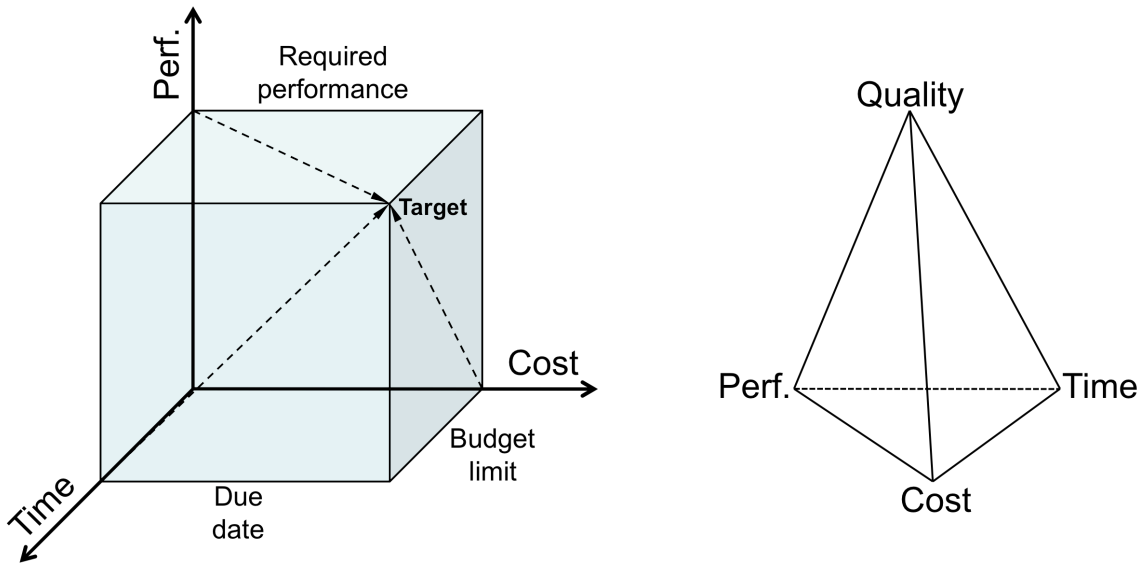

Figure 2.22: Performance, time, cost and quality as the key project dimensions (adapted from Duma, 2005: 4)

The target in the first diagram of Figure 2.22, according to Duma, represents the quality of the project.

Meridith & Mantel (2000) argue that quality (customer satisfaction) is not an additional target, but an inherent part of the project specification. Dobson (2004: 10) states that quality standards do not live solely in the performance criteria because customer goals can also include goals with respect to speed and cost, and can therefore take root in the time and cost constraints as well. According to Turner (as cited in Flett, 2001: 3) the definition of performance extends to encapsulate scope and quality thus integrating quality into the project management lexicon.

2.4.5.4 Risk and the triple constraint

Some risk practitioners suggest that risk must be considered on equal footing with the primary elements of the triple constraint, and consider risk as another dependent dimension to the project triangle (Maltzman & Biswas, 2009; Andrei, as cited in Ladas, 2007). The uncertainty posed by many project management authors, however, is whether risk is an additional constraint or simply a sub-component of the triple constraint.

Vaes (2008) places risk in the middle of the project triangle, as indicated in Figure 2.23, with quality and scope (features) sharing a common point. Vaes explains that an occurrence of risk will impact at least one of the other parameters. If a senior developer on an IT project turns sick, for example, he/she may need to be replaced by either an external consultant resulting in a possible cost increase, or by a junior developer resulting in a possible schedule delay.

Figure 2.23: Risk as a fourth and central element in the project triangle (adapted from Vaes, 2008)

Maltzman (as cited in Garrett, 2008) argues that the problem with the traditional triangular model is that it 'falls flat' due to its two-dimensional characteristic, and proposes that volume needs to be introduced into the triangle. Maltzman & Biswas (2009) introduce a dynamic three-dimensional pyramid with three triangular facets, namely scope, time and cost, and with a triangular floor representing risk / uncertainty. This pyramid, illustrated in Figure 2.24, is referred to by Maltzman & Biswas as the 'constramid'.

The risk boundaries (A, B and C) in Figure 2.24, the lines formed at the intersections (1, 2 and 3) of the triangular facets and triangular floor, represent how uncertainties relate and may cause variability (either as an opportunity or as a threat) to the project scope, time and cost respectively. Risks and uncertainties, within the context of the 'constramid' model, imply movement.

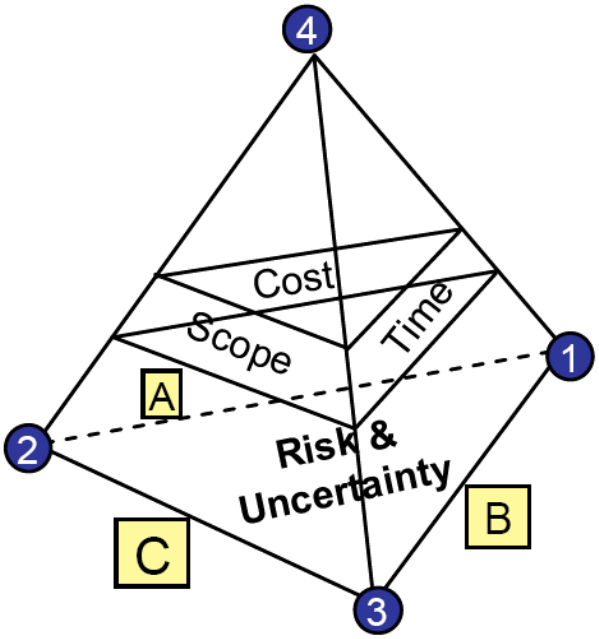

Figure 2.24: Risk and uncertainty at the base of the project triangular pyramid (Maltzman & Biswas, 2009)

The idea is, according to Maltzman & Biswas, that risk and uncertainty (the base of the constramid) can change shape and exert force on project scope, time and cost, forcing them to change as well, "picture our fiddler atop the 'constramid' (4), faced with keeping his balance while the facets of the structure are tilting and moving and perhaps the whole structure itself is being raised and lowered – managing a project is quite like the act of balancing on a slippery, sloping, shaking, shifting, shingled structure" (Maltzman & Biswas, 2009). Maltzman & Biswas assert that the main work of project managers in the real world is managing uncertainty and risk. Global Knowledge (2008) warns that poor risk management can collapse the triple constraint balance and equilibrium can effectively equal quality on the project.

According to Ward, project managers may think of their roles as if sitting before a control panel with three large knobs on it, labelled scope, time and cost, as well as two gauges representing quality and risk, "if we set one of the three knobs, say scope, we can then adjust the other two, cost and schedule, to give us a workable project plan and a good chance for success" (Ward, 2003; Ward, 2005). Jaques (as cited in Garrett, 2008) argues that risk constitutes possible outcomes that have probabilities and impacts, and is not a project constraint, "risks arise or are

lessened by the constraints, but risks do not inherently constrain a project to one solution or another". Elyse (2004) is in agreement with Jaques that risk should not be interpreted as a separate constraint, and states that risk may be seen as comprising the constraints of the project. Turner (as cited in Flett, 2001: 2) considers risk as an inherent part of the other project management objectives.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the impact of quality, customer satisfaction, performance and risk on the triple constraint:

- The three key project management properties of scope, time and cost constitute the triple constraint.
- The concepts of quality, customer satisfaction, performance and risk have an impact on the triple constraint, but do not inherently constrain the project.
- Project scope encapsulates capability and grade attributes, but performance and quality are not substitutes for scope.
- Quality is an uncompromising and inherent objective of the project specification that takes root in all three properties of the triple constraint.
- Customer satisfaction is fulfilment of the consumer requirements, expectations and needs, and constitutes a performance measure in terms of quality or excellence.
- Performance is an operational assessment metric for the triple constraint in terms of project accomplishment, which should be continuously monitored and controlled throughout the project.
- Risk impacts the performance of the triple constraint, which may precipitate change in terms of the triple constraint trade-off dynamics.

2.4.6 Other theories and models surrounding the triple constraint

Turner (as cited in Flett, 2001; Burke, 2007; Sepehri, 2006) evolved the traditional project management triangle in 1993 into a pyramid, illustrated in Figure 2.25, which allows his five project management objectives to be taken into account. According to Flett (2001: 2), the inclusion of a quality dimension as a project objective mirrors the rise in prominence of quality in business generally. The inclusion of the project environment indicates the increasing awareness of external issues, "the project environment model encourages project managers to look at the bigger picture and consider all the stakeholder's needs" (Burke, 2007: 37). The inclusion of scope and organisation breakdown structure (OBS) indicates that the scope of work was performed through an organisation structure. Turner refers to managing risk as the sixth project objective, yet he sees that as an inherent part of the five objectives.

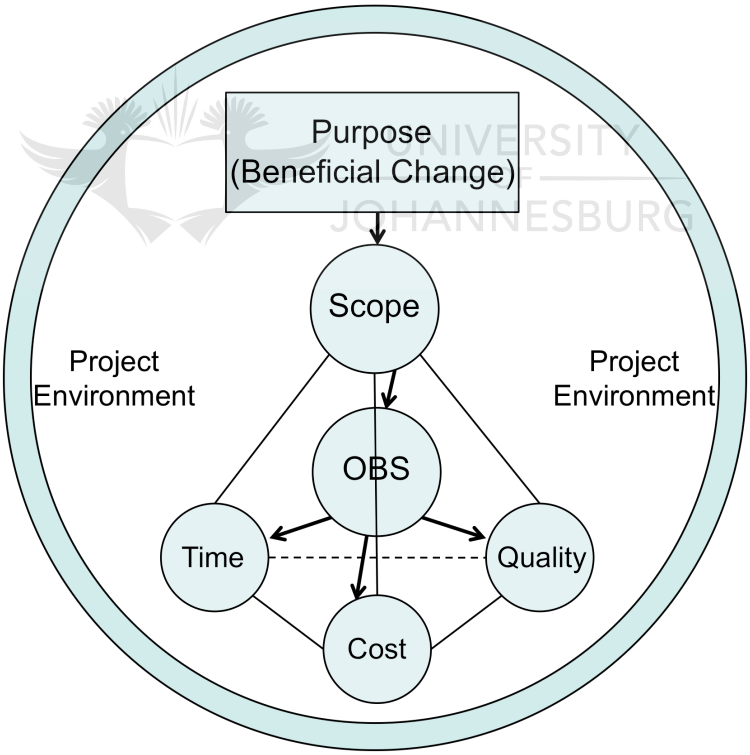

Figure 2.25: Turner's project environment pyramid (adapted from Burke, 2007: 37)

According to Marchewka (2006: 12), the project scope, or work to be accomplished, is determined directly by the project goal, that is, "if we know what we have to accomplish, we can then figure out how to accomplish it". Marchewka's model is illustrated in Figure 2.26.

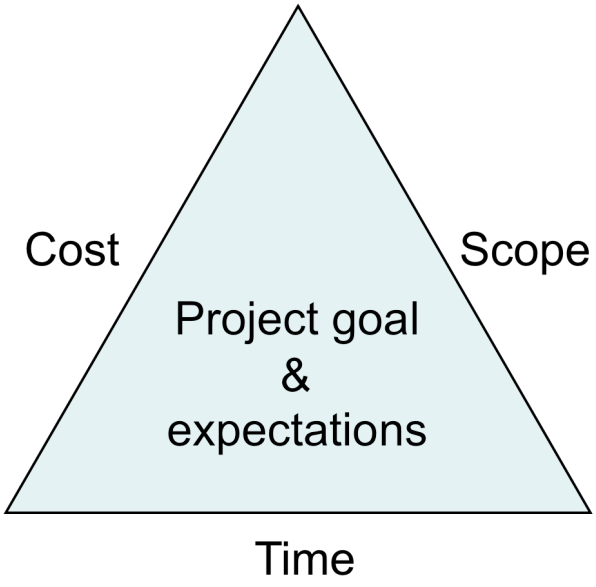

Figure 2.26: The project goal and expectations central to the triple constraint (adapted from Marchewka, 2006: 12)

Norrie & Walker (2004) reinforce the importance of strategy as an added dimension to the project triangle[14], depicted in Figure 2.27.

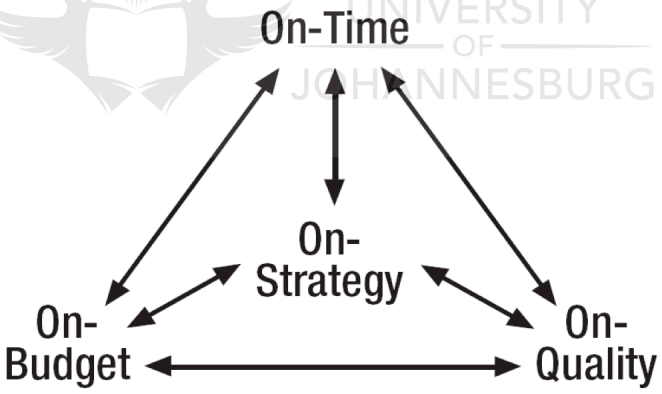

Figure 2.27: On-strategy dimension central to the achievement of the other constraints (Norrie & Walker, 2004: 48)

Norrie & Walker's diagram creates a quadruple constraint by inserting into the pyramid of the triple constraint an on-strategy dimension central to managing project success. The diagram notes that the connection of the newly added on-strategy dimension is central to the achievement of the other three constraints.

[14] In Norrie & Walker's model, quality is claimed as the substitue for scope with reference to the traditional project triangle model. The author of this dissertation, however, considers scope, time and cost as the primary elements of the triple constraint.

According to Wiegers (2008), every project must balance its functionality (features), staffing, schedule, cost and quality objectives. Wiegers proposes that each of these five project dimensions should be defined as either:

- a constraint within which must be operated;
- a driver strongly aligned with project success; or
- a degree of freedom that can be adjusted within some stated bounds.

Wiegers however states that not all factors can be constraints nor can all be drivers. The argument is that the project manager must have some flexibility to react to schedule slips, staff turnover, demands for increased functionality, and other realities. Wiegers introduces a flexibility diagram, such as shown in Figure 2.28, which visually depicts the constraints, drivers, and degrees of freedom. His model is briefly explained. A constraint is plotted at the zero value on its axis since constraints provide the project manager with no flexibility in that dimension. A driver yields a small amount of flexibility and its point is thus plotted at a slightly higher value than zero. Degrees of freedom provide varying degrees of latitude; they represent parameters the project manager can adjust to achieve the project's success drivers within the limits imposed by its constraints.

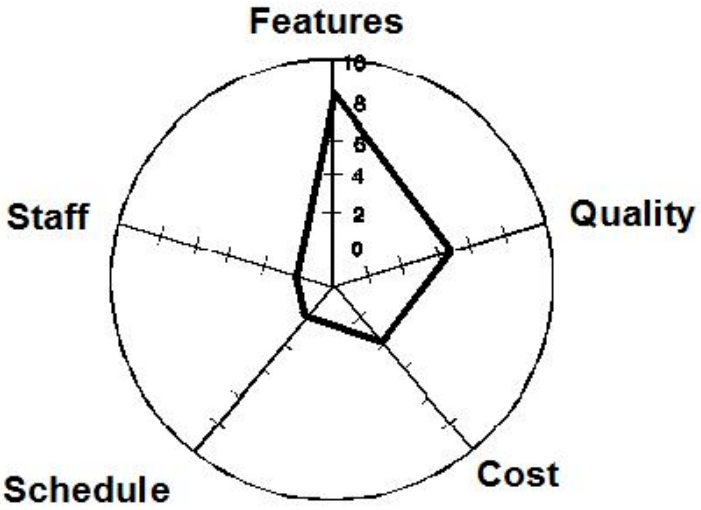

Figure 2.28: Project management flexibility diagram (Wiegers, 2008)

Figure 2.28 depicts a flexibility diagram for a project that is staff-constrained and schedule-constrained, with cost being a driver, and quality and features being

degrees of freedom. Connecting the five plotted points in this example creates an irregular pentagon. The rationale of Wiegers is that the smaller the area inside the pentagon, the more constrained the project is.

As already discussed under Section 2.3.15, a supporting factor in terms of project success lies in the achievement of the scope, time and cost objectives with the aim to satisfy the project sponsor / customer. This target objective is graphically illustrated by Business Services Projects (2003) in Figure 2.29 using a three-axis graph. This model presents a different outlook to the traditional 'flat' triangular depictions of scope, time and cost.

Figure 2.29: The triple constraint depicted via a three-axis graph (Business Services Projects, 2003: 1)

Storck (as cited in Wikipedia, 2008) uses a pair of triangles called triangle outer and triangle inner to represent the concept that the intent of a project is to be completed on or before the allowed time, on or under budget, and to meet or exceed the required scope. The distance between the inner and outer triangles, according to Storck, illustrates the hedge or contingency for each of the three elements; the distance can show bias.

Chuck (as cited in Mann, 2005) suggests that projects are viewed in terms of time to market, functions, quality and cost, which he refers to as the 'project three dimensional rectangle'. Chuck conceptualises his model as follows: "Picture the room you are in, if a wall is in front of you, look left and down to the corner and make that your origin (0,0,0). The left / right x-axis is the time to market. If the client wants it unreasonably soon, that means lots of overtime (+x axis). The vertical y-axis is the functionality. I picture it as a pile of documentation detailing the project's specifications. More functionality means more documentation (+y axis). The z-axis is the quality of the project. If the client leans forward to bang their head against the wall, that is an indicator of low functionality (user antagonistic). If they lean back at ease, it's an indicator of user friendliness (+z axis). The rectangle formed by these two points (0,0,0) and (x,y,z) is the pile of money it will take to get the project done."

Kuster et al. (2002: 4.5) extends the basic project triangle model to a pyramid to include a fourth dimension '[project] team / energy', which according to Kuster et al. can be utilised to influence the normal triangle. A similar rational is proposed by Herborn (2008), whom suggests that the project triangle should be extended to a square with the dimension, 'and we [the project team] enjoyed it [the project]' as the fourth corner. Both Kuster et al. and Herborn thus highlight the interrelationship between the triple constraint and the project team.

A participant as part of a discussion group (Anonymous, 2007) suggests that instead of a triangle, the triple constraint can be imagined as a 3-legged chair with each leg representing one of the fast, cheap and good areas. The length of each leg is how much will be spent on each area. The goal of this model is to define the scope in such a way that the customer will feel comfortable sitting on the chair after the project budget is spent.

According to J. van Nieuwenhuizen (personal communication, August, 2008) the triple constraint dynamics can be conceptualised by the effect of squeezing an inflated balloon and observing how the application of pressure (constraining) in one area (dimension) results in the balloon (triple constraint) to bulge (flex) out in another area.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of supplementary theories and models surrounding the triple constraint:

- A variety of triple constraint concepts exist which extend beyond the traditional dimensions of scope, time and cost.
- The following supporting points have been deduced from the conceptual models, some of which overlap with previous conclusions:
    - The broader impact of the project environment on the triple constraint needs be considered in terms of stakeholder requirements and risk.
    - The triple constraint is driven by strategic change and stakeholder expectations towards the achievement of the project objectives and higher purpose.
    - Flexibility within the triple constraint is central to managing a beneficial project outcome.
    - Investment in project human resource management is essential to ensure a motivated and committed project team with a clear vision of the project goal.

2.4.7 Power structure of the triple constraint

One of the challenges project managers face is the conflicting demands of the customer or project sponsor – most stakeholders want things better, faster and cheaper (Mihalic, 2007: 37). Vaes (2008) indicates that the project manager needs to decide (upfront) with stakeholders which triple constraint areas they value as important, and clarify that it is not possible to win on all three areas. An important characteristic of the triple constraint elements, according to Dobson (2004: xii), is that they are not equally constraining. The art of project management is largely about knowing how and when to make trade-offs between the project triple constraint elements, “first that means establishing priority; priority is the root of all leadership; if you can’t prioritise the competing forces in your environment, then

you are not in control of your responsibilities" (Ladas, 2007). The road to project success, according to Ladas, begins with prioritising these project trade-offs. Controlling the power structure (hierarchy) of the triple constraint can mean the difference between success and failure on virtually any project (Dobson, 2004: xii). One purpose of the hierarchy of constraints is to help analyse project trade-offs (Dobson, 2004: 17). Jenkins (2008) expresses that poor project managers will see the project triangle as a 'strait-jacket' by which their project is irrevocably constrained. Jenkins furthermore states that a good project manager will make better use of one or more of the axes and will shift the emphasis in the project to one of the other axes. Jenkins highlights that the best project managers will juggle all three elements of the triple constraint like 'hot potatoes' and will make decisions every day, which effectively trade-off scope vs. time vs. cost. Calef, as part of a discussion group (Garrett, 2008), puts forward that any view of a project is skewed when time, money, scope, quality, and satisfaction are not purposefully balanced in concert with one another, "the demand for satisfaction and quality metrics depends on the values of the organisation and its priorities".

According to Barker & Cole (2007), a project manager's starting point is to understand the customer's priorities in order to obtain an optimum balance between the constraints. Carlos (2007) and Mihalic (2007) recommend that consideration must be given to establishing priorities of the triple constraint elements at the beginning of the project during the project initiation phase. According to Carlos the project sponsor must identify how these priorities will rank in importance to each other. Witzel (2004) is in agreement with Carlos and asserts that the project sponsor should identify the most important aspect of the project. Mathis (2008) warns that, "just because the customer says the driver is cost does not mean that is the real driver; more times than not the customer will verbalise cost as the driver even when time or performance is the real one". Mihalic (2007: 39) advocates that the project manager must determine which parameter is the highest priority and use these priorities consistently in making project decisions. Dobson (2004: 15) is of the standpoint that the correct hierarchy of constraints is the one that reflects the real goals and objectives of the project. Therefore, neither the customer nor the project sponsor or manager actually 'decides' on the hierarchy, but it is rather derived from the basic reason for doing the project.

Dobson's 'hierarchy of constraints' theorem defines a project by listing the triple constraint elements in order of flexibility[15] (i.e. capacity for exploitation), from least to most, in a hierarchy of driver, middle and weak constraint (Dobson, 2004). The driver constraint is derived from the project purpose and is the constraint that has to be met otherwise the project fails, i.e. it is the driver if the penalty for failing to meet it is greatest (Dobson, 2004: xii, 56). According to Mathis (2008), the project driver is also the constraint that is consistently monitored and tracked. According to Dobson (2004: 17), there can only be one project driver at any given time, two drivers cannot exist simultaneously. It should also be noted that the flexibility of the driver is not necessarily zero, but it is the least flexible of the three constraints. The middle constraint normally has a small amount of flexibility and can either be very close to the driver in importance to the project mission or may sometimes have flexibility more akin to the weak constraint (Dobson, 2004: 6, 13). The weak constraint has the greatest flexibility, but is not necessarily the least important. Dobson's theorem proposes that exploitation of the flexibility in the weak constraint can be used as a tool to meet the absolute requirement of the driver whilst supporting the development of a strategy for managing risks and resources on the project, "we can exploit the constraints that are more flexible and even accept the failures that are less damaging to ensure that we do not fail where failure is not an option – the right kind of failure is not only an option, but sometimes it is a desirable one" (Dobson, 2004: xv, 5, 6).

The triple constraint and its hierarchy can change during the life of a project. Dobson (2004: 18, 32) lists three circumstances in which the triple constraint elements may change order (the first constituting a situational reason and the last two constituting structural reasons, i.e. true change):

- When the driver has a lot of margin in it so that the middle constraint is more constraining in practice (the flexibility only lasts as long as the margin, and if the margin evaporates, the driver re-asserts itself as the head of the line);

- When the reason for doing the project has changed; and/or

[15] Flexibility, and not importance, serves as the ranking criterion. Importance is the relative merit of the constraint considering the long-term value of the project. Flexibility is the extent to which the project manager can manipulate the constraint in order to get the job done (Dobson, 2004: 25).

- When the primary customer or stakeholder for the project has changed.

According to Mihalic (2007: 39), the project manager is responsible for monitoring shifts or changes in the triple constraint priorities. According to Carlos (2007), the project sponsor is responsible for determining the change. Carlos advises that the project manager needs to work with the project sponsor at the very outset of (and throughout) the project and determine how to reset these priorities should there be a change in the project. Sound change control processes should therefore be employed.

When a triple constraint parameter is a priority, one side of the project triangle is often fixed and therefore limits the range of possible combinations for the two remaining sides (Mihalic, 2007: 40). In cases where two sides are fixed, the third side is by Mihalic's definition determined and impelled[16]. Damicon (2009) insists that at least one of the project triangle's corners needs to have some latitude. Stated differently, Strider (as cited in Ward, 2005) asserts that the project manager must have control over at least one of the three triple constraint elements, "or he should walk away from the project". Ambler's argument, that at least one of the three elements must be able to vary (otherwise the quality of the work will suffer), is in agreement with Damicon and Ward. When trying to define the exact cost, the exact schedule, and the exact scope to be delivered there is no room for the project team to manoeuvre and failure is virtually guaranteed. Ambler furthermore points out that it is not always possible to vary just one factor. For example, it is not possible to build a fully certified air traffic control system from scratch in a single week regardless of how much money is available. Damicon (2009) suggests that it is preferable for all three factors to show varying degrees of freedom in order for the project team to make optimal business decisions throughout the life of the project.

[16] Mihalic's original text refers to the word 'constrained' instead of 'impelled'. The author of this dissertation prefers to use the latter word in the referenced context to eliminate possible ambiguity, because the word 'constrained' may be interpreted as either 'forced' or 'retricted'. For example, if the schedule and budget of a project are fixed then the project scope may be limited (restricted features and functions), whereas, if the schedule and scope are fixed then the budget may be pushed (forced to overrun) and not necessarily restricted. Ward (2003, 2005), on the other hand, often refers to the fixed sides of the project triangle as being constrained, which contrasts Mihalic's wording. The author of this dissertation believes that the word 'constrained' is open to interpretation provided the triple constraint relationships as discussed in Section 2.4.2 remain within context.

According to Ward (2003), at least one of the triple constraint variables must be fixed, or constrained, in order to provide a basis for planning the project. Ward suggests that it is possible to constrain two of the variables, within certain limits, provided the third variable is unconstrained (i.e. flexible), "if all three are constrained, there is probably no feasible way to accomplish anything meaningful; your project is in trouble from the very start". If real projects consistently perform as suggested by the triple constraint relationships identified in Section 2.4.2, one would expect to see at least one of the project triangle elements to come in as planned (Chatfield & Johnson, 2008).

The following sections provide a brief overview of each of the three triple constraint elements in its varying capacities of flexibility within a project and discuss some common trade-off strategies. It should however be noted that scope, time and cost management particulars depend on many factors too complex to discuss in detail as part of this dissertation. Basic examples are proved merely to facilitate an understanding of the core concepts.

2.4.7.1 Scope as the driver

The PMBOK states that the product description should also document the relationship between the product or service being created and the business need or other stimulus that gave rise to the project in a way that is detailed enough to support later planning. In other words, the project purpose must be part of a properly written product description to ensure full understanding of the characteristics and requirements that must be achieved (Dobson, 2004: 37). The PMBOK lays out a process to ensure that the project team develops a proper scope statement as well as the more detailed WBS and scope statement updates that reduce ambiguity in the project.

In order to define the scope up front, the requirements can be set by taking a serial approach to development where the requirements are fully defined and 'baselined' early in the project. Once the requirements are fixed for the scope-driven project, the next step is to choose to vary either the project cost or schedule, "if you want to deliver quickly then you'll need to spend more money, often on highly skilled consultants and better development tools, or if you want to maximise value you

may choose to stretch out your schedule instead; you just can't do both without harming overall quality" (Ambler, 2008). Ambler warns that the big requirements up front (BRUF) approach is very risky because it is very difficult to actually define and confine the requirements well.

According to Jenkins (2008), new functionality must be added to cover increased scope when scope starts to creep. In this situation Jenkins recommends the following three options:

- Add time – delay the project to provide more time to add the functionality.
- Add cost – recruit, hire or acquire more people to do the extra work.
- Trade-off some non-essential requirements for the new requirements.

Success with the driver constraint (scope) may be achieved by exploiting flexibility within the time and cost constraints, as suggested by the first triple constraint relationship (S↑ α T↑ C↑) in Section 2.4.2.1, i.e. by increasing the time and/or cost of the project. Chatfield & Johnson (2008) observe that changing project scope is a 'bad thing' only if the project manager does not recognise and plan for the new requirements; i.e. when the other constraints (time and cost) are not correspondingly examined and, if necessary, adjusted.

2.4.7.2 Scope as the flexible constraint

Since project sponsors and customers lack bottomless wallets and a time machine, most accept that project scope may need to 'take the blow' – in many projects there are often a definite deadline for delivery and a limited budget (integrated from Mann, 2005; Jenkins, 2008).

Constrained features can be an awkward topic to broach, "it doesn't mean the deliverable can be broken, but that strong, early decisions must be made about which features of the project are critical path components, and which are nice-to-have's" (Mann, 2005); "as long as the core requirements remain, everything will be fine" (Jenkins, 2008). The project team therefore needs to prioritise the elements of project scope as essential, desirable and optional, and group them into iterative deliverables (Damicon, 2009; Maltzman & Biswas, 2009).

According to Siegelaub (2008), there are in most cases no ranges of acceptability for scope. However, scope may be represented as a range in situations when there are essentials that the project must deliver, but there are other items that are discretionary, or can be delivered at a later date, without compromising the project's key objectives. A technique often used in the IT industry, referred to as 'timeboxing', is used to prioritise the schedule so that the essential elements are completed first.

Flexibility in the scope constraint may be exploited in the following ways (integrated from Dobson, 2004: 59; Carlos, 2007; Siegelaub, 2008):

- Re-evaluating requirements (loosen or eliminate).
- Outsourcing requirements.
- Re-evaluating quality controls.
- Cutting quality metrics ('-ilities') that do not add customer value.
- Downsizing objectives.
- Cutting entire elements of the project.

The challenge, according to Dobson (2004: 64), is to identify those aspects of scope that are not necessarily related to customer quality or are at least secondary or tertiary, and cut back on those. Simms (2008) warns that scope is a critical governance lever to control, and protects the project's value, and that no proposed scope changes should escape a rigorous value-impact challenge.

2.4.7.3 Time as the driver

The seriousness with which the project manager should enforce a deadline on the critical path must be related to the relative priority of meeting the deadline as contrasted with coming in on budget or achieving an exceptional level of scope (adapted from Dobson, 2004: 19). Examples of such deadlines include: preparing to exhibit at a major trade show; completing a response to a request for proposal (RFP); or preparing an annual submittal to a regulatory body.

If a deadline is a project driver, there will be a clear reason why. The consequence of failure or the payoff for success will be visible and significant. Time pressure creates a crisis atmosphere; constrains decision-making; reduces the opportunity to think; and can put a project into 'panic mode' in the final phases. It is therefore critical to exploit the weak constraint flexibilities early and creatively, "to give you the margin you need as the deadline approaches" Dobson (2004: 21).

Success with the driver constraint (time) may be achieved by exploiting flexibility within the scope and cost constraints, as suggested by the second triple constraint relationship ($T\downarrow \alpha S\downarrow C\uparrow$) in Section 2.4.2.2, i.e. by reducing the scope and/or increasing the cost of the project, "put all the resources into the project you can, accelerate the project, and deliver partial results as you can to slow down the decay of the company's reputation and buy yourself some time" (Dobson, 2004: 20). The project can be maintained within the desired time frame by compromising on cost (e.g. by spending more money to get it done on time) and/or by compromising on scope (e.g. reducing the scope characteristics) (Siegelaub, 2008).

In many types of projects, especially in software engineering, the analysis and definition of all the requirements and specifications prior to the start of the realisation phase is not always possible. In such cases, according to Ambler (2008), 'timeboxing' is the favourable type of contracting for projects in which the deadline is the most critical aspect. The 'timeboxing' technique enables resources and schedule to be fixed by disregarding low-priority[17] features out of an iteration when the project schedule is under pressure.

If schedule pressure is not resisted and eliminated through effective project management, it may lead to predictable results that include (adapted from Ward, 2003):

- Delayed deliverables.
- Exceeded resources and budgets.

[17] The MoSCoW prioritisation technique is often associated with 'timeboxing', and is a generally known acronym created from 'Must-have', 'Should-have', 'Could-have', 'Would-like-to-have'.

- Non-conformance of requirements.
- Unmanageable quality and risk.
- Project cancellation.

2.4.7.4 Time as the flexible constraint

The opportunity to postpone a deliverable may be a project lifesaver (Dobson, 2004: 49). The schedule may be allowed to slip to mitigate resources and cost (Maltzman & Biswas, 2009), for example using a slower but more affordable supplier. Another example of schedule exploitation is by varying the number and type of people on the project team, which enables the required functionality to be delivered at the desired cost, "if you're tight for budget, a small team may deliver the same functionality that a large team would but take longer calendar time to do so, i.e. if you want to maximise value you may choose to stretch out your schedule instead" (Ambler, 2008).

The Pennsylvania State University argues that the longer the duration of the project, the higher will be the overall project cost due to the increase in fixed costs such as overheads (PSU, 2005: 3). The reality is that as long as the work on a project is ongoing it will continue to draw resources into its orbit. Whatever the parameters of the project, it is unlikely that the relationship between cost and duration is linear. For any particular project the decision to place the project on the curve between the point of least duration with its associated higher resource requirements, and a point of increased duration with its associated lower resource requirements, depends on the particular parameters of the project. The author of this dissertation found that the PSU argument should be considered in perspective with the third triple constraint relationship (C↓ α S↓ T↑), which suggests that project cost may actually be reduced by increasing (i.e. exploiting) the time schedule and/or by cutting back on scope requirements. For example, in the transport business, more time may imply the use of road transport rather than air transport, which will reduce transport costs. Following the same rationale as discussed in Section 2.4.2.3, differentiation should be made between the implications of being given / allowed more time as a result of exploiting flexibility

vs. taking more time as a result of running late or in terms of planning (more time will cost more money).

Damicon (2009) recommends that the project team should have frequent timed deliverables, which may act as check points and provide tangible evidence of progress. Flexibility can be provided by building in some excess time-risk into the final delivery date, thereby creating opportunity for exploitation if required.

Flexibility in the time constraint may be exploited in the following ways (integrated from Dobson, 2004: 49; Carlos, 2007):

- Adjust due dates.
- Adjust the critical path.
- Allow for task interdependencies.
- Adjust workdays.
- Schedule delay to acquire out-year budget authority.
- Schedule delay to promote quality or solve problems.
- Schedule delay to coincide with resource availability.
- Schedule delay to lower resource consumption.

According to Simms (2008), time has an impact on both cost and value, “time drives more than costs, it also reduces value through delaying the realisation of benefits and, therefore, their lifetime value”. Project managers thus need to consider the project’s cash ‘burn-rate’ in order to comprehend the cost impact of any time increase. Project managers also need to know the value realisation rate in order to understand the value impact of any project delivery delay (often this is greater in the long run than the cost impact because it is ongoing).

Time flexibility helps cope with cost pressures and takes some of the burden off scope performance; it also serves as a risk mitigation factor, “if you have more time to solve problems you can do additional planning, handle it with fewer people,

look more deeply into an issue – additional time provides access to many virtues" (Dobson, 2004: 54, 55).

2.4.7.5 Cost as the driver

When the cost constraint is the driver of the project, cautious consideration is required, "a project should contribute substantially more value than it costs, or there's a real question whether we should be doing the project at all" (Dobson, 2004: 51). The cost constraint can however become the driver under the following circumstances:

- When the resources are extremely limited or not available.
- When the project has a low priority in the organisation.

Success with the driver constraint (cost) may be achieved by exploiting flexibility within the scope and time constraints, as suggested by the third triple constraint relationship ($C\downarrow \alpha S\downarrow T\uparrow$) in Section 2.4.2.3, i.e. by reducing the scope and/or increasing the time of the project.

According to Dobson, cost pressure on a project often creates a preconceived fear of project failure, and team morale suffers as a result. Resourcefulness in helping to find solutions for the cost obstacles, through creative exploitation, are thus valuable not only for the immediate practical benefits, but also for the team bonding and motivational efforts they provide (adapted from Dobson, 2004: 52).

2.4.7.6 Cost as the flexible constraint

According to Simms (2008), cost is a dimension that has high visibility outside the project, "to realise the project long term value you may have to go over budget – it's a value trade-off". Damicon (2009) advises to firstly attempt to set up a targeted cost range rather than a fixed cost amount, or establish a 'not-to-exceed' figure where the target cost is 5 to 10 % below that number. Damicon encourages to not break down the cost into too many 'buckets'.

If the scope and schedule are set then more and/or better team resources may need to be hired in order to deliver the system (Ambler, 2008). However, the more

people there are on a team, the greater the amount of money need to be spent on coordination, thus increasing overall costs. It should also be considered that a handful of highly productive people may produce better work and do so for far less money than a larger team of not-so-productive people.

Other considerations that need to be taken into account when exploiting the cost constraint:

- There is a limit to the amount of resources that can effectively be applied to any project at any time (Brooks' Law[18]) – "nine women can't deliver a baby in one month" (Ambler, 2008).
- Task splitting, sometimes referred to as multi-tasking or context switching, refers to the practice of assigning people to multiple projects. A good rule of thumb has been postulated and confirmed through examination (as cited in Ward, 2003): Assigning a person to two projects reduces overall productivity to about 80 % due to increased interruptions and conflicting priorities. Assigning the person to three projects further reduces productivity to 60 %.
- A project is 'too expensive' if it costs more than it is worth (Dobson, 2004: 55).

Flexibility in the cost constraint can be exploited by considering the following (integrated from Dobson, 2004: 35; Carlos, 2007):

- Is cash itself a flexible resource?
- Are there contingency funds available?
- Is there a degree of budget overrun that is acceptable?
- Will someone else pay part of the bill?
- Are there flexible resources?

[18] Adding resources to a late project makes that project later (Brooks, 1995). Also referred to in Economics as the 'law of diminishing returns'; each additional increment contributes less to the whole. At some point this relationship ceases to work, and additional resources will not contribute to reducing the schedule (Ward, 2005).

- Can down times / slacks be considered?
- Can additional staff, equipment or resources be borrowed?
- Are there resources whose costs are not charged to the project?
- Are there intangible resources to exploit?
- Can tasks be streamlined and optimised?
- Are there people who can exercise influence?
- Is the political environment advantageous or disadvantageous to the project?
- Are the project sponsors and other key stakeholders politically powerful and well disposed to use their influence?

There usually exists a way to obtain flexibility from at least some portion of the cost element, even when another portion of the cost element may represent the driver of the project (Dobson, 2004: 35).

2.4.7.7 Other trade-off strategy examples

There are design processes that are optimised for each of the primary trade-offs, namely scope vs. time, scope vs. cost and time vs. cost. The Lean approach, for example, is good at making scope vs. time trade-offs in the IT environment, whereas the Set-Based Development method is better at making scope vs. cost trade-offs as used for example in the Toyota Development System. Toyota holds development time fixed, and partly constrains scope. The scope constraint is that it has to be a whole vehicle, and it has to be better than the previous design of the same model (or of some comparable benchmark). They make this work by over-provisioning resources. Toyota designs multiple independent solutions for each major subsystem of the vehicle. At regular intervals, less promising designs are weeded out and more promising designs are promoted or combined. This concurrent redundancy makes it very likely that a satisfactory solution will appear within the time allotted. Additionally, Toyota leaves the requirements open until the

final design converges. In this way, Toyota strives to design the best possible vehicle in the time allowed, but not better than possible (Ladas, 2007).

It is not always practical to attain all three constraining aspects of a project, namely fast, good and cheap. Somewhere costs have to be absorbed. In some simple IT cases, however, it has become possible as a result of open source. For example, a good blog can be set up in a relatively short time using open source tools as well as the many themes available with it. In this scenario, the ones who have absorbed the cost are the open source developers and the theme designers, however, "the moment you introduce your own requirements, for example branding or functionalities, you will have to absorb the cost for that somewhere" (Nadgouda, 2007). Nadgouda proposes that by setting priorities for the project can help project managers more effectively choose between the 'Tyranny of the *Or*'.

According to Ambler (2008), it is critical to understand how flexible the project is with respect to each vertex, "perhaps your resources are limited due to financial cutbacks but you're willing to develop less functionality as the result of lower expectations due to the cutback; perhaps the schedule is critical because you have a legislated deadline to meet, and due to the potential repercussions senior management is willing to spend whatever it takes to get the job done". A common approach, according to Ward, is to constrain one variable (e.g. scope) and attempt to optimise a second variable (e.g. schedule) and determine the required level of the third variable (i.e. cost), "if I want to ship this specific product by a certain date, how much will it cost to meet that date?" (Ward, 2003). At least as common is to constrain both the scope and the cost and let that determine the schedule it will take to accomplish the project, "if I have a specific budget for this project, how long will it take to get the job done?" (Ward, 2003). On many projects where the scope is defined and costs are limited, the schedule is subsequently dictated. For some organisations, such as those producing shrink-wrap software, the cost is constrained by the amount of resources devoted to a project (or product) and there is a regular release schedule that is maintained. Therefore, the variable that is negotiable becomes the feature set (hence, the scope) that can be contained within a given release.

Ward (2005) presents the following caveat for consideration, "how many of us have seen projects where first the schedule was adjusted, possibly several times – then more resources are added late in the game to try to give 'the big push' to the project – of course, Brook's Law then takes over and the schedule gets adjusted (extended) yet again". The final result may be that the scope is cut back to the point where the system no longer meets the objectives that originally justified the undertaking of the project in the first place.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the triple constraint power structure:

- It is not commonplace to deliver the triple constraint exactly as planned.
- Flexibility is an indispensable requirement in order to accommodate shifts in project emphasis and ensure project excellence.
- Trade-offs need to be considered and priorities need to be managed in order to realise strategic decisions throughout the project life cycle.
- At least one of the triple constraint elements should be constrained by the project basis, which directs the trade-off dynamics.
- At least one of the triple constraint elements must have capacity for exploitation, i.e. be flexible.
- The triple constraint can be prioritised into a power structure by ranking the elements into a hierarchy of flexibility. The power structure derives from the project basis and may be influenced by environmental change during the life cycle of the project.
- The primary triple constraint element, the driver constraint, is the least flexible of the three elements and constitutes a key measure of project success.

- Exploitation of flexibility in the weaker (more flexible) constraints can be used as a mechanism to achieve the essential demands of the driver constraint.
- Effective management of the triple constraint power structure and dynamics is central to project success.
- The following aspects need to be taken in consideration when contemplating exploitation trade-offs within the triple constraint:
    - There are limitations to exploitation capacity and effort, which need to be assessed through 'cost' vs. value impact analyses.
    - Projects should deliver to a much greater extent in terms of value than the sacrifice of the exploitation effort.
    - Consumer needs and project excellence should not be compromised.
    - There are always minimum expectations and essentials regarding each triple constraint element that must be achieved or delivered.
    - As already concluded in Section 2.4.2, the impact on the trade-off dynamics needs to be differentiated in terms of pressure and flexibility.
    - Inventiveness, motivation and commitment are important project team trades in order to ensure effective exploitation and to realise opportunity.

Details pertaining to scope, time and cost management techniques are well documented and beyond the scope of this dissertation.

2.4.8 Consolidated triple constraint model

As a result of the various perspectives and interpretations across literature that surround the project triangle and triple constraint, the need for a unified model is clear.

On the basis of the key conclusions drawn in this chapter, the author of this dissertation has devised the consolidated triple constraint model presented in Figure 2.30. The author names this model the TRIJECT model (an acronym created from the titles 'TRIple constraint' and 'proJECT management').

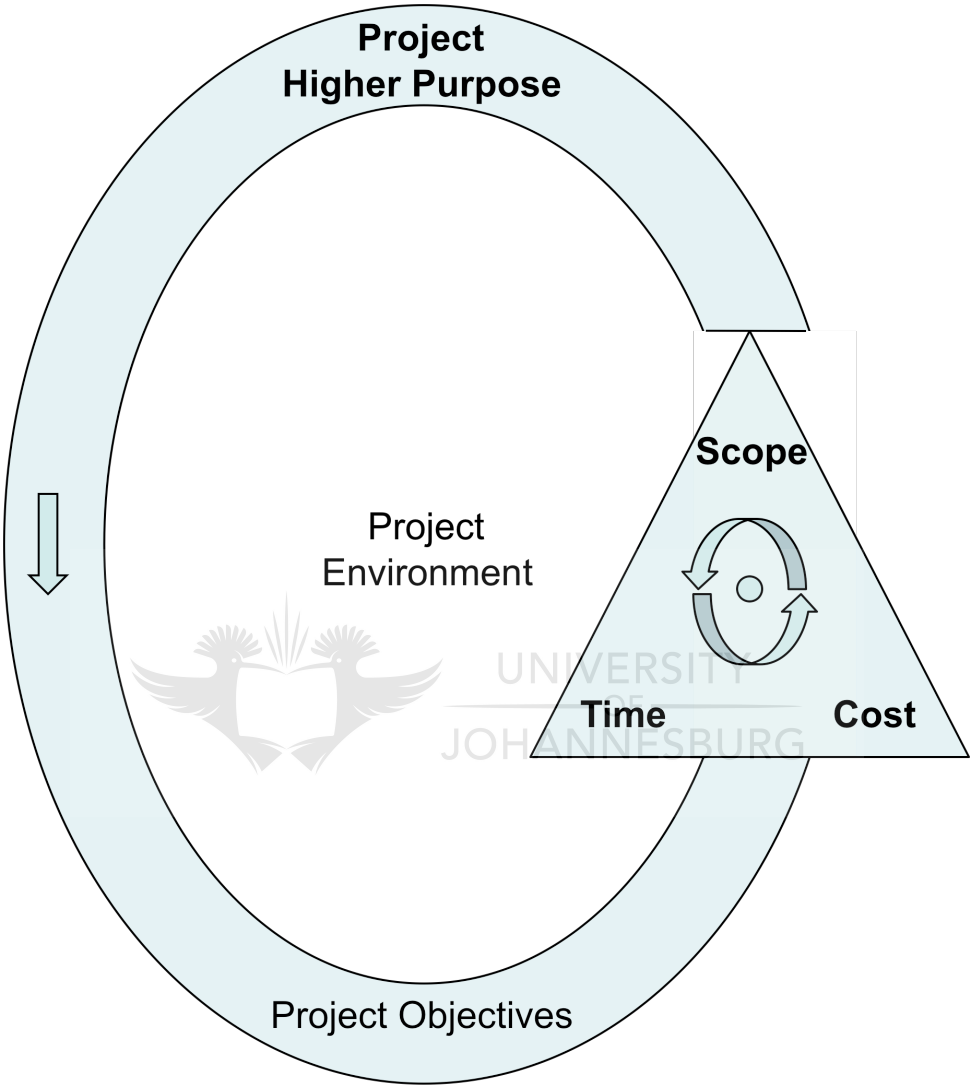

Figure 2.30: TRIJECT model

The project triangle is supported by the two flexible constraints (time and cost in this instance), which forms the foundation of the triangle. The driver constraint (scope in this instance) aligns the triangle with the project higher purpose. The triangle projection is dynamic and pivots about its axis to accommodate change within its power structure. The hierarchy may be influenced by the project environment, which impacts the higher purpose and objectives of the project. The

central presence of quality is signified by the shape of the TRIJECT model, which resembles a capital letter 'Q'.

The rationale of the TRIJECT model is based on Dobson's reasoning that the flexibility in the two weaker constraints may be optimally exploited in order to ensure that the driver constraint succeeds, for the project higher purpose to be achieved. The continuous cycle implied by the model represents the ongoing and interrelated nature of this process as change is introduced into the system. Monitoring and controlling hence manifest a requisite part of this cycle.

The TRIJECT model represents a classic interpretation of the triple constraint, focussing on the 'big three'[19] of scope, time and cost without adding or subdividing. The model also accounts for the ancillary issues such as 'the why' of the project and change within the project environment as well as quality and control.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the consolidated triple constraint model:

- The consolidated triple constraint model (the TRIJECT model) considers the exploitation of flexibility in the two weaker constraints as a mechanism to ensure achievement of the absolute requirements of the driver constraint.
- The goal of the TRIJECT model is to maintain the focus of the triple constraint power structure on the project higher purpose.
- The TRIJECT model constitutes the first building block of the dissertation's integrated framework, which is described in Chapter 4.

[19] The 'big three' expression is adopted from Dobson (2004: 9), although in his work it refers to the time, cost and performance constraints.

2.5 Chapter closure

Chapter 2 provides a literature review of project management nomenclature relevant to the research problem, and provides a study of the theories and concepts surrounding the triple constraint.

The challenge in this chapter has been to fuse the totality of the current project management literature to the point where only the most relevant aspects from the existing body of knowledge, which apply to the research study, are reported on.

The chapter concludes with a consolidated triple constraint model, in support of the integrated framework, based on the key attributes deduced in this chapter. The main conclusions of this chapter are summarised in Chapter 6.

By addressing the research questions identified in Section 1.4.1, the first three supporting objectives of this study have been achieved as specified in Section 1.5, i.e.:

- Uncover the knowledge foundation of the triple constraint.
- Ascertain how flexibility within the triple constraint can be managed to ensure a beneficial outcome in terms of project success.
- Introduce a consolidated triple constraint model.

The second part of the research literature study is presented in Chapter 3, which provides a study of the fundamentals surrounding the polarity management rationale and investigates if the triple constraint elements may be considered as polarities to manage.

CHAPTER 3 POLARITY MANAGEMENT

3.1 Chapter overview

Chapter 3 presents the second part of the research literature study. The chapter starts with a comprehensive study of polarity management principles and practices as viewed across literature. The study is followed by an analysis to determine the applicability of polarity management principles on the triple constraint in project management, and proposed models are introduced.

Concepts and conclusions in support of the integrated framework, central to this dissertation, are progressively deduced from the reviewed theory and literature throughout the chapter.

The purpose of this chapter is to investigate the problem under study with reference to the research questions identified in Section 1.4.2. At the end of this chapter a consolidated triple constraint polarity model is concluded, which clarifies the significance of the deductions in terms of the physiology of the integrated framework.

3.2 Prologue to the literature study

The field of polarity management is relatively young and unexplored with limited research literature available. Amongst various polarity management sources, the doctoral qualifications of the following referenced researchers and authors are highlighted in support of the theories presented in this chapter:

- Dr. Lawton R. Burns (Burns, 1999)
- Dr. Larry Hirschhorn (Hirschhorn, 2001)
- Dr. Barry Johnson (Johnson, 1996; Johnson, 1998; Oswald & Johnson, 2009)
- Dr. Med. Martin S. Kohn (Kohn, 2007)
- Prof. Dr. Carmel McNaught (McNaught, 2003)

The notion of duality and contradiction has been around for many years. The concept of Yin and Yang is found in ancient Chinese philosophy, which describes "two primal opposing but complementary forces found in all things in the universe". The concept is that Yin and Yang are opposites that cannot exist without one another, each contains the seed of its opposite – they also consume and support each other, can transform into one another and can be further subdivided into Yin and Yang (Ambler, 2006). Capra (as cited in Ambler, 2006) observes that it is not Yin or Yang that is beneficial, but rather the dynamic balance between Yin and Yang.

Figure 3.1: The Yin and Yang symbol

The Yin and Yang opposites are often referred to in the western world as a paradox, a dilemma or a polarity. Barry Johnson's[20] polarity management model is a tool to help analyse and weigh the factors contributing to two opposing dilemmas (Cantrell et al., 2005: 16).

3.3 Theory of polarity management

Simple models of organisational problem solving assume that a given problem can be analysed in terms of the problem itself, and that a solution can be implemented

[20] Barry Johnson, founder of Polarity Management Associates in 1995, is an organisational development consultant who has been trained in Gestalt theory and practice. He has been working on the polarity management model and its sets of principles since 1975 (Caldwell, 2007; Maurer, 2002; Noll, 2002).

in isolation from other problems. However, organisational problems are usually intertwined and the way problems are perceived and defined needs attention as well (Argyris, as cited in McNaught, 2003).

Many of the current trends in business and industry are ongoing contentions and may never be resolved as problems or difficulties in the traditional sense, "often no choice exists between two apparently conflicting ideas or alternatives, as both are in play" (Kohn, 2007: 4, 5). These trends are often described as movement from one way of thinking or acting, to another. Johnson (1992) argues that by approaching these movements as 'problems to solve' may radically undermine one's ability to implement them. Ambler (2006) asserts that this default problem-orientated thinking may cause entrapment into the 'Tyranny of the *Or*', as described by Collins & Porras (1994). This entrapment results in 'either/or' thinking where the tendency is to force a definitive solution for a dilemma that cannot necessarily be solved.

Johnson (1992) insists that 'either/or' thinking, where dilemmas are treated as organisational problems, be supplemented with 'both/and' thinking, in which the opposing ideas require consideration. Johnson suggests that these trends of ongoing contentions are better understood as polarities to manage and not as problems, issues or options to solve (Johnson, 1996: xvii, 24). Polarities[21] to manage are sets of opposites or contrasts (opposing perspectives) that do not and cannot function well independently of one another and for which there are no clear solutions. For instance, situations in which both conflicting points of view are true and either side has advantages and disadvantages (integrated from Johnson, 1996; Miller, 2008; ODN Chicago, 2003). The traditional problem solving view is to choose one opposite as a solution and neglect the other. Because of their interdependence, neither side of a polarity can be chosen as a solution when the other side is ignored. The aim of polarity management is to get the best of both opposites while avoiding the limits of each (integrated from Johnson, 1996: 22; McNaught, 2003: 76). Through polarity management, polarities can thus be

[21] The author of this dissertation found that polarities to manage are also referred to across literature as paradoxes, dilemmas, contentions, interdependent opposites, wicked problems and simultaneous contradictions.

viewed as opportunities instead of confrontations (Kuramoto, as cited in Burns, 1999).

Polarities are not problems to solve. Polarities are ongoing, chronic issues that are inherently unavoidable and unsolvable, with opposites that are paradoxically interdependent. Polarities could occur at any level of system from organisational, to groups, to interpersonal (Maurer, 2002: 211). They are ubiquitous. According to Kuramoto (as citred in Burns, 1999) polarities result from a pool of predictable incompatibilities. Each of these conflicts has two extremes or poles. Each pole has its advantages and disadvantages. Generally speaking, if one pole is emphasised to the exclusion of the other, the result will be to experience the disadvantages of both poles. The problem is that polarities cannot be solved. Instead, they must be managed (Noll, 2002).

Johnson (1996: 92) identifies two main questions that may help distinguish a polarity to manage from a traditional problem to solve:

- Is the difficulty ongoing? Unlike problems to solve, polarities to manage do not have a clear, end point solution – there is a never-ending shift in emphasis or focus from one pole to the other and back. Polarities to manage require an ongoing balancing of opposites.

- Are there two poles that are interdependent? Unlike problems to solve, polarities to manage require a shift in emphasis between opposites such that neither can stand alone.

The ongoing natural tension between opposing poles can be destructive and debilitating and needs to be managed and channelled into a creative synergy, which will lead to superior outcomes. Johnson asserts that through polarity management, opposition becomes a valued resource, “there is an extreme competitive advantage to being able to supplement ‘either/or’ thinking with ‘both/and’ thinking” (Johnson, 1998: 5). Polarities function under a set of principles which, when understood and acted upon, can dramatically increase the ability to manage them well (Johnson, 1996: 132).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the polarity management notion:

- It is not feasible to approach chronic dilemmas in the traditional sense as 'problems to solve' when the dilemma is interdependent and continuous.
- The ongoing strain between paradoxical dualities can lead to discouragement and destructive change if the dilemma is not appropriately managed.
- These simultaneous contradictions do not necessarily provide for an absolute solution and are better comprehended as polarities to manage, which will enhance the ability to implement the duality.
- Polarity management supplements the 'either/or' approach with the 'both/and' mindset in which the power of contrast is harnessed within the duality by holding on to the benefits of both poles whilst appreciating their drawbacks – the challenge is to manage an optimum synergy.

3.3.1 Structure of polarity management

Johnson's polarity map, illustrated in Figure 3.2, provides a structure for addressing the complete picture of a dilemma. Kohn (2007: 4, 5) describes the polarity map as a means to integrate apparently conflicting ideas or concepts.

The polarity map structure is a square divided into four parts. The left and right halves are called poles (pole A and pole B). The upper part of each pole represents the positive results (values) from focussing on that pole. These positive aspects (advantages) are the benefits of that pole, or its upside. The lower part of each pole represents the negative results (fears) from over focusing on that pole and neglecting the opposite pole. These negative aspects (disadvantages) are the drawbacks of that pole, or its downside (adapted from Johnson 1996: 5, 14). For consistency throughout this dissertation, the upper left and right quadrants will respectively be referred to as (L+) and (R+), and the lower left and right quadrants as (L-) and (R-).

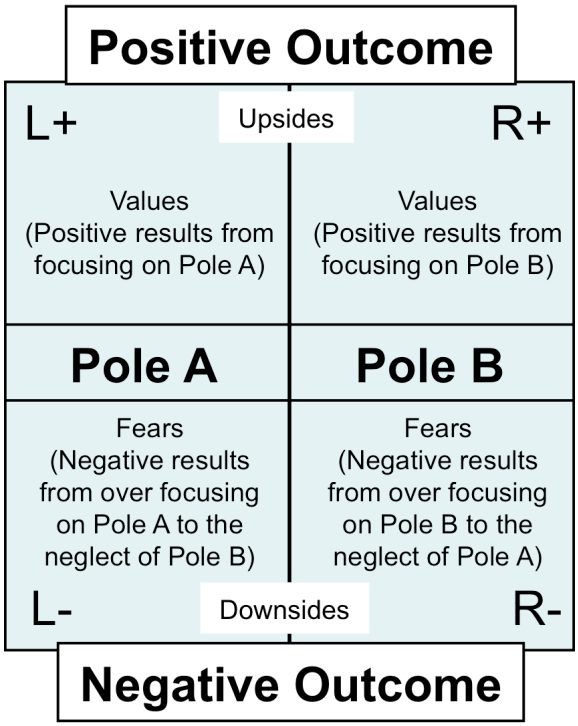

Figure 3.2: Basic building blocks of the polarity map (adapted from Johnson, 1996: 4)

The positive outcome at the top of the polarity map reflects the valued goal of balancing the polarity (the positive side of poles A and B). This contains the answer to the question, "why invest in managing this polarity?", which goes beyond just getting the upside of each pole. The negative outcome at the bottom of the polarity map reflects the deeper fear from the lack of balance (the negative side of poles A and B). The negative outcome opposes the positive outcome and reflects the worse case situation if this polarity is not appropriately managed (Ambler, 2006; Johnson, 1998).

There is no prescribed order for filling out the quadrants of the polarity map. Johnson (1996: 122) recommends starting in either of the lower quadrants, because dilemmas tend to be driven by the energy to move from the downside of one pole to the upside of the other. It is important to note that information needs to be listed in all four quadrants in order to provide a working description of the whole picture, "creating and discovering the content of all four quadrants is essential for maximum effectiveness in managing a dilemma" (Johnson, 1996: 14). Having access to both poles of a polarity is necessary in order to manage it effectively.

Johnson's polarity of respiration, depicted in Figure 3.3, facilitates a pragmatic understanding of the basic polarity map structure and constitutes a basic metaphor to polarities in general. The two opposing poles in this example are inhale and exhale. The precept is that although inhaling is essential to breathing and feels good at first (obtain fresh oxygen), it soon sinks into the downside (excessive carbon dioxide) by trying to hold on to the breath of fresh oxygen. The same rationale applies to the exhale pole, which confirms the ongoing nature of this dilemma. It is also evident that inhale requires exhale in the ongoing management of breathing, which confirms the interdependence of the two poles.

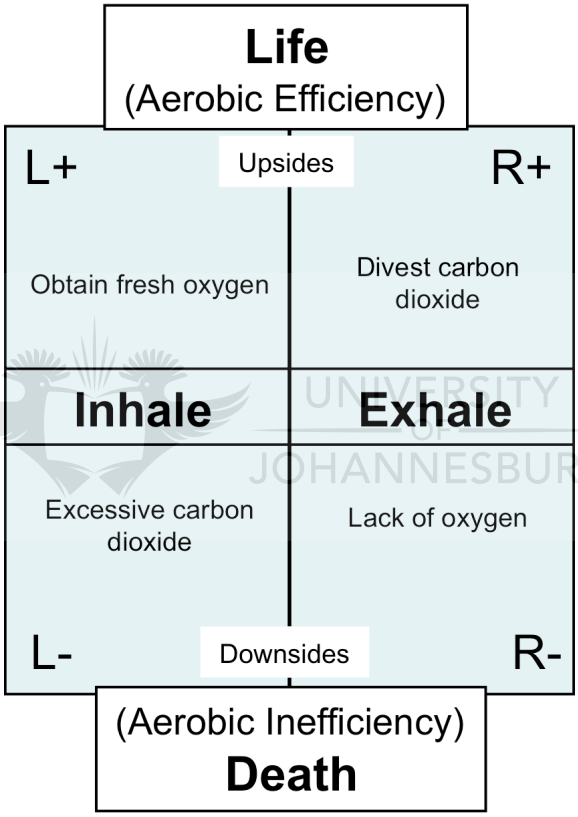

Figure 3.3: Polarity map for breathing (adapted from Johnson, 1996: 21; Johnson, 1998: 6)

The clearest opposition in the polarity map exists between the downside of one pole and the upside of the other pole, "such strong opposites that you can make a list in either quadrant, put 'not' in front of it, and you will have the beginnings of a list for the other diagonal quadrant" Johnson (1996: 10).

From the breathing polarity example it is clear that choosing to either inhale or exhale cannot solve the polarity. Although they are opposites, inhaling and

exhaling are part of the same interdependent whole, and one cannot exist without the other – each pole needs its opposite for it to be viable over time. The polarity needs to be managed by gaining the benefits of each while appreciating the limits of each (adapted from Johnson, 1996; Maurer, 2002).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the polarity management structure:

- The polarity management map provides an operational portrayal of the dilemma under review and ensures a user-friendly structure for managing the polarity.
- The polarity map exposes the values and fears of each pole and highlights the desired outcome.
- The interrelated opposition in the map is evident within its diagonals where the downside of one pole constitutes the antithesis of the upside of the other pole.
- The attraction inherent to the diagonals reflects the interdependent nature of the dilemma in that each pole requires its opposition in order for it to be sustainable over time.

3.3.2 Dynamics of polarity management

Once the full working description (map) has been defined, outcomes can be anticipated as a result of the predictable movement through the polarity map. The dynamics of the polarities are created by the natural tension that exists between two forces that shift from one pole to the other. One side is the increasing negative affects of one pole and the other is the increasing attractiveness of the positive affects of the opposite pole (Ambler, 2006).

The normal movement through the four quadrants can be pictured as an infinity loop (∞), and is referred to by Johnson (1996: 11) as the polarity two-step. This movement forms part of the dynamics of polarity management and is illustrated in

Figure 3.4. The polarity two-step starts in either lower quadrant, first moving across-and-up (1) and then down (2), and continues in a repetitive manner. The infinity loop is a sigmoid curve that turns around and back on itself (Maurer, 2002: 218).

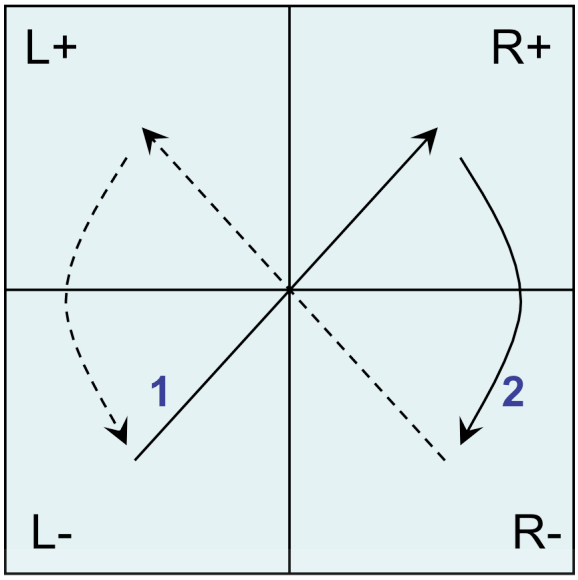

Figure 3.4: Polarity management dynamics (adapted from Johnson, 1996: 15)

The push for movement in a polarity is for a shift from one pole to the other because the downsides of the present pole are being experienced or anticipated as the 'problem', and an attraction develops to the upsides of the opposite pole, which is perceived as the 'solution'. Kohn (2007: 4, 5) describes this polarity map cycle as an oscillation between the characteristics of the left and right poles. The management of a dilemma is an ongoing process that, similar to the natural movement through the four quadrants in the pattern of an infinity loop, is never-ending (Johnson, 1996: 12).

Referring back to Johnson's basic breathing polarity example in Section 3.3.1, it is clear that the situation is not static – it is a process, an ongoing flow of shifting emphasis from inhale to exhale and back again. Johnson (1996: 22) reiterates that the difficulty of most dilemmas does not necessarily lie with one of the poles, but lies in the perception that the dilemma is a problem that can be solved by choosing either one pole or the other. Managing the breathing polarity, for example, requires choosing both inhaling and exhaling. Focussing on inhaling to the neglect of exhaling will ultimately result in the downside of inhaling being experienced, which

in turn triggers a (required) movement to the other pole, and vice versa. Breathing is the oscillation between these two polar activities. This same dynamic, according to Kruse (2005), applies to many polarities in human relationships.

The goal is to primarily manage the polarity to maintain the upsides of both poles. Knowing the content of all four quadrants and understanding the normal flow through the polarity map is a good start to managing any polarity, "the greater the difference in clarity about the content of the two sets of diagonal quadrants, the stronger someone will feel about the 'rightness' of their position and the 'wrongness' of their opposition" (Johnson, 1996: 58, 61). In order to gain and maintain the benefits of one pole, the benefits of the other pole must also be pursued (Johnson, 1996: 23).

Within the tension inherent in all polarities there exist two dynamic forces, which Johnson (1996: 55) refers to as the crusading and tradition-bearing oppositional forces. The crusaders have identified problems with the status quo and have a vision for improvement and change. These are the people who want to move from the downside of the present pole to the upside of the opposite pole. Standing as their opposition are the tradition-bearers. These are the people who see the downside of the plans lobbied by the crusaders and fear the potential negative outcomes of the proposed changes (Caldwell, 2007). These two competing sides / forces need each other in order to manage a polarity well and are discussed in more detail in the following two sections.

3.3.2.1 Tradition-bearing force

The tradition-bearing force comes from the awareness of the upsides of the present pole (for example the one the organisation is currently emphasising) and the downsides of the opposite pole. Tradition-bearers place a high value on one of the upper quadrants and have considerable fear of falling into the lower quadrant of the opposite pole. Tradition-bearers treat the dilemma as a problem to avoid, in which they have identified the problem to avoid as the downside of the other pole and the solution as the upside of the preferred pole.

The limitation of this force is that it may result in blindness to the downsides of the pole that is being preserved as well as to the upsides of the pole that is being

avoided, i.e. the tradition-bearers underestimate the downside of the present pole and the upside of the opposite pole. They keep an organisation too long in one pole until it is in real trouble (integrated from Johnson, 1996: 61, 73, 109, 260). There are at least two significant factors that contribute to the inability of tradition-bearers to see the downside of the present pole and the upside of the opposite pole:

- The degree to which tradition-bearers have insulated themselves from the realities of those benefiting least or suffering most from the present pole; and
- The degree of anticipated loss with a shift to the other pole.

"The fear of getting stuck in the opposite pole gets you stuck in your own pole; the more you stay stuck in your pole, the more you experience the downside of your pole" (Johnson, 1996: 23). The positive contribution of the tradition-bearing force towards the managing of dilemmas is that it provides the energy necessary to preserve the upside of the present pole and to avoid the downside of the opposite pole.

3.3.2.2 Crusading force

The crusading force stems from the awareness of the downsides of the present pole and the upsides of the other pole, opposite to the set of diagonal quadrants that is figural to those tradition-bearing. Crusaders treat the dilemma as a problem to solve, in which they have identified the problem as the downside of the present pole and the solution as the upside of the other pole.

The limitation of this force is that it may result in blindness to the upside of the present pole as well as to the downside of the pole that is being advocated, i.e. the crusaders promote a move which renounces any upsides to the present pole or any downsides to the opposite pole. There are at least two significant factors that contribute to the inability of crusaders to see the upside of the present pole and the downside of the opposite pole:

- The duration of the crusaders' experience in the downside of the present pole; and

- The intensity of the negativity of that downside experience.

This incomplete perception only heightens the resistance of tradition-bearers. The positive contribution of the crusading force towards the managing of dilemmas is that it provides the energy necessary to move from the downside of the present pole to the upside of the opposite pole. Johnson states that the goal of any crusade, from a polarity management perspective, is to maximise the upsides of each pole while minimising the downsides (integrated from Johnson, 1996: 60, 65, 72, 109, 260).

Johnson points out that crusading and tradition-bearing are forces and not personality types, "once the system shifted to the opposite pole, the crusaders would become the ones resisting the move back to the pole from which they had been crusading; in their resistance to move to the other pole they become the tradition-bearers" (Johnson, 1996: 109). Both the tradition-bearing and crusading forces are essential to the health of the polarity management system, "with the contributions of those who are tradition-bearing and those who are crusading, we have the contents of all four quadrants – otherwise one only has a view of half the picture", "we also have some oppositional energy to work with; managing this oppositional energy is part of the art of working effectively with dilemmas" (Johnson, 1996: 59, 61). Effective change management requires the ability to be both a crusader and a tradition-bearer (Johnson, 1996: 64).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the polarity management dynamics:

- The opposing attractions within the diagonals of the polarity map exist as a result of the perceptions that the downside of one pole is a 'problem' and the upside of the other pole is a 'solution'.

- Over focussing on one pole to the neglect of the other pole ultimately results in the benefits of the present pole to dissipate as its drawbacks are progressively experienced. This subsequently provokes an increasing attraction towards the benefits of the opposing pole.

- The perpetual and interwoven cycle (the infinity loop) of alternating emphasis through the quadrants of the polarity map serves to predict outcomes.

- Two competing forces are prominent within the dynamics of polarity management. The tradition-bearing force anticipates the dilemma as a problem to be avoided, whilst the crusading force perceives the dilemma as a problem to be solved.

- The limitation of each force, when viewed in isolation, is that only partial aspects of the dilemma are highlighted, which creates an incomplete perception of the dilemma.

- The rivalry between the tradition-bearing and crusading forces is central to the dynamics of polarity management. These two influences introduce oppositional energy into the system and need to join forces in order to gain the benefits of both poles.

- Recognising the substance of the polarity map (the structure) and anticipating the flow through the polarity map (the dynamics), are central to effective polarity management.

3.4 Interdependent perspectives

Within the ongoing conflict between the tradition-bearing and crusading forces, the question often arises “who is right and who is wrong?”.

Johnson advocates that although both sides are actually correct, both sides are also incomplete in their perspectives. He highlights the importance of seeing the complete picture through willingness to let go of one perspective and to invest in the other. Johnson uses the Gestalt[22] concepts of figure and ground as a mechanism to differentiate between what he refers to as ‘accuracy’ vs. ‘completeness’ (Johnson, 1996: 43).

[22] The word Gestalt is a German word for form or shape and is used in English to refer to an organised ‘whole’ that is perceived as more than the sum of its parts (Apple Inc. Dictionary Version 2.1.3, Copyright 2005-2009).

The famous Rubin Goblet[23] (publicised by Danish psychologist Edgar Rubin in 1915) is shown in Figure 3.5.

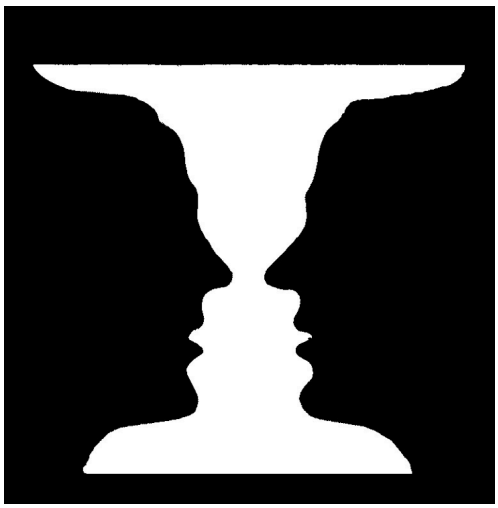

Figure 3.5: The Rubin Goblet (Dewey, 2007)

With Rubin's Goblet, the vase (cup) and faces take turns to be figure and ground. When the vase is perceived, the faces disappear into a black background. When the faces are perceived, the vase disappears into a white background (Dewey, 2007). Johnson's argument is that if one person perceives Rubin's Goblet as a picture of a vase and another person perceives it as a picture of two faces, both perspectives are accurate but neither is completely correct – neither is describing the entire whole, "it is the incompleteness combined with the conviction of the rightness (accuracy) of their perception, which is the source of a potential problem" (Johnson, 1996: 44).

The tradition-bearing and crusading forces only 'shed light' on half of a polarity when viewed in isolation. The upside of one pole and the downside of the other pole are typically perceived as figural, whilst the remaining quadrants are shifted into the background. This concept is illustrated in Figure 3.6. Tradition-bearers, for example, are blind to the upside (R+) of the pole that is being avoided as well as to the downside (L-) of the pole that is being preserved. According to Johnson, the polarity map raises questions about probable background that needs to be made

[23] The Rubin Goblet, also known as the 'figure-ground vase', illustrates a basic concept from Gestalt psychology, namely the figure-ground distinction. When a gestalt is formed (perceived) it becomes a figure (a thing apart, an entity or object). A figure is always backed up by a surrounding ground (Dewey, 2007).

figural, i.e. one needs to see what is within the black in order to appreciate the whole polarity (cited in Maurer, 2002: 218).

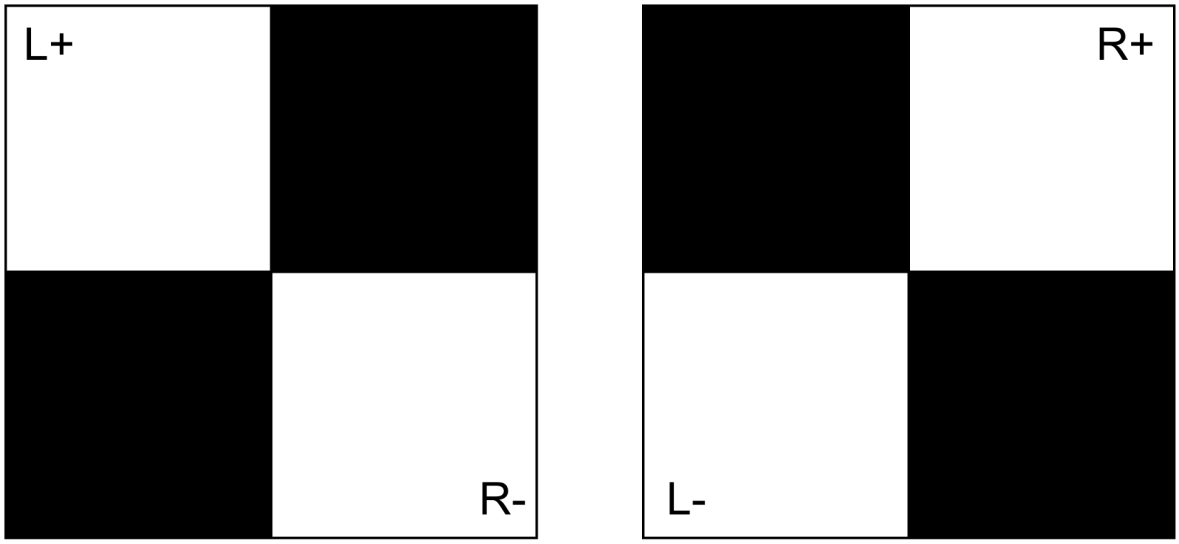

Figure 3.6: Tradition-bearing (left) and crusading (right) polarity map perspectives

In order to manage the different perspectives, each opposing view must move from figure to ground, "neither should be asked to contradict or deny their view; instead, each person's view is confirmed as accurate, then each is asked to supplement their view with a second view which is also true" (Johnson, 1996: 44). From Figure 3.5 it is clear that both the vase and the two faces cannot be perceived at the same time, and neither part can exist without the other. A pattern cannot be seen as figure and ground at the same time, "the pattern in the external world, the stimulus, does not change – only the perception of it changes" (Dewey, 2007).

Johnson asserts that in order to see one pattern clearly the other pattern needs to be relinquished, "exploring an oppositional view requires a willingness to temporarily let go of your own view and put some effort into seeing and understanding the other's view" (Johnson, 1996: 48). The rationale is that once the accuracy of the oppositional view is acknowledged, it becomes relatively easy to shift back and forth between the two perceptions. Johnson's principle encourages the opportunity to obtain a more complete picture of the dilemma that will increase the effectiveness of managing it.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the impact of Gestalt theory on polarity management:

- In order to appreciate paradoxical change it is essential to obtain the complete perception of the dilemma through willingness to temporarily let go of one perspective and to invest into acknowledging the oppositional view.
- It is important to fully acknowledge each perspective of the polarity map, its positive and negative aspects, before attempting to supplement it with the opposition.
- The outcome of a well-managed polarity strives to extend beyond the aggregate of its segments through optimising a dynamic balancing mechanism that effectively shifts back and forth between the two perspectives.

3.5 Problems to solve or polarities to manage?

Polarities to manage can be distinguished from three other types of difficulties, which Johnson (1996: 82) collectively refers to as 'problems to solve':

- 'Either/or' decisions – these include a host of problems for which choices have to be made between two or more options.
- Mystery problems – these include challenges for which end point solutions must be created or discovered.
- Continuum problems – these include challenges for which it is not necessary to shift emphasis to the opposing issue in order to maintain a polar balance. The solution in problems to solve can stand apart.

Problems have one right answer (or two or more independent answers) that provides a solution. The goal of a problem is to find a fix to the current situation and move forward to a new reality without being required to ever look back. Polarities have two or more answers that are interdependent and require ongoing

management (integrated from Ambler, 2006; Caldwell, 2007; Noll, 2002; Johnson, 1998). Sharing is a response to a polarity (Johnson, 1998: 4). Ambler lists selected characteristics of problems and polarities in Table 3.1.

Characteristics of problems:	**Characteristics of polarities:**
Problems are usually independent and can therefore be solved.	Polarities have interdependent alternatives.
Once problems are solved, they tend to go away and do not re-occur over time.	Polarities, over time, tend to be ongoing and oscillate.
Problems usually have a definite end point of resolution.	Polarities have no definitive resolution point.
Problems are easily isolated and stand alone.	Polarities are not solvable and have to be managed.
Solutions to problems usually contain no alternatives, i.e. it is clear that a particular solution solves a particular problem.	Alternatives are required to optimise and manage the situation over time.

Table 3.1: Selected characteristics of problems vs. polarities (Ambler, 2006)

In addition to Johnson's two main questions identified in Section 3.3, the following criteria can also help determine whether an issue that is being faced is a polarity that requires management (integrated from Maurer, 2002; Vista, 2009; Ambler, 2006):

- Is it necessary over time to engage both of the opposites that are in contention, i.e. is the one pole dependent upon the other pole for its sustainability over time?
- Are there two or more necessary sets of benefits?
- Will focus on one extreme undermine the higher purpose over time?

A polarity to manage, in part, may easily be interpreted as an 'either/or' problem, "when we have a 'problem', the downside of one pole, and a 'solution', the upside of the opposite pole, it seems that all we need is a strategy to move through the

gap between the problem and the solution". This concept is illustrated in Figure 3.7 through Johnson's centralised vs. decentralised polarity (Johnson, 1998: 9-10).

The highlighted parts of the maps promote change and appear as problems to solve, which are perceived to only require a good strategy (symbolised by the arrows) to overcome the breach between the 'problem' and the 'solution'. It should however be noted that those resisting the change have an equally valid, alternative view of reality. They see a potential problem in the solution being prescribed and believe in a different (and in their view a more logical) solution.

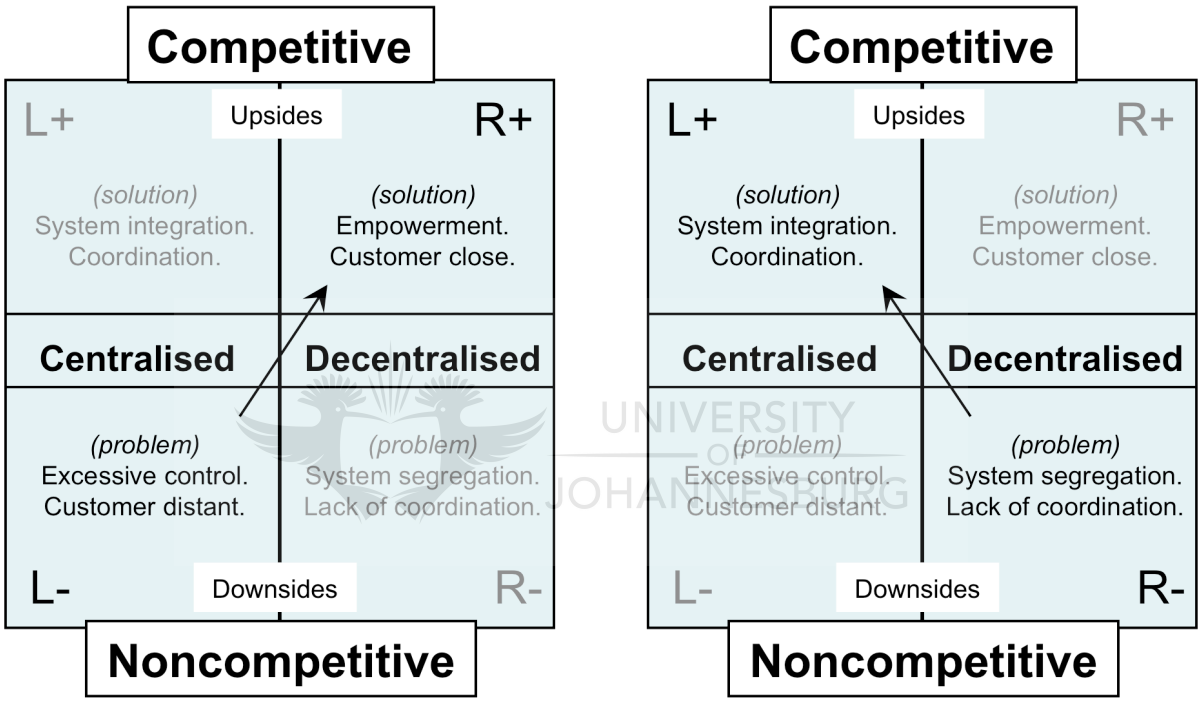

Figure 3.7: Half of a polarity perceived as a problem to solve (adapted from Johnson, 1998)

The more one change is being promoted as the better solution to the alternative, the more the alternative movement believes that their reality are being overlooked, and hence the greater the resistance to the promoted change, "both those promoting the change and those resisting it are caught in 'either/or' thinking and engage in a 'self-righteous' power struggle" (Johnson, 1998: 11). This exhibits an incomplete picture and a deficient process.

Resistance can become a resource when the perception of the issue is shifted from solving and 'either/or' problem to managing a polarity. With a polarity to manage, the focus on either pole alone is not sustainable. Any effort to move from

the down side of one pole to the upside of the other with the assumption that the upside of the other pole is the 'right answer' will generate its own resistance, which according to Johnson, will trigger one of two things:

- The resistance will be overcome, often after a costly struggle, "and you will find yourself unable to sustain the effort thus ending up in the downside of the new pole"; or
- The resistance is not overcome, often after a costly struggle, "and you return to the downside of the original pole".

In either case, competitive advantage is lost by engaging in a damaging struggle without sustainable, positive results, "when individuals, organisations, or countries treat a manageable polarity as if it were a problem to solve, they will spend unnecessary time experiencing the downsides of that polarity" (Johnson, 1996: 81). Polarity management is considered a valuable supplement to 'either/or' thinking – it is however not considered a replacement.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the distinction between problems to solve and polarities to manage:

- Polarities to manage distinctly differ from problems to solve.
- Polarities are not mutually exclusive, and comprise of interdependent oppositional elements with an indeterminate solution that needs to be managed over time.
- Polarities are often mistakenly addressed as problems that can be solved by settling on one of the two polar opposites as the perceived solution.
- The diagonal sections of a polarity map may easily be perceived as 'either/or' problems to solve. This provides only a partial portrayal of the dilemma and manifests resistance.
- Resistance can be transformed into a resource by supplementing the 'either/or' approach with the combined wisdom of the 'both/and' rationale.

3.6 Resolving resistance and sustaining change

The concept of polarity management is a powerful tool for facilitating healthy change in an organisation. Recognition of the complete picture of crusading and tradition-bearing forces realises an action plan, “not only is the current plan of action clearer, but the predictive quality of the polarity model gives a clear view of what future change will be required as a result of today’s action” (Henn, as cited in PMA, 1995).

Leading change efforts will be more effective if they are seen in the context of the larger picture (Johnson, 1996: 159). When dealing with someone who is rigidly holding on to their incomplete picture of the quadrants, it can be helpful to consider why they are unable to see the two quadrants that would complete the picture, “at that point, you might offer respect for their history, support their ‘accuracy’ (the reality of the two quadrants they see) and patience, despite your own pressing need to have them see what you see” (Johnson, 1996: 260). All polarities have two sets of values and fears that are in tension, “the reasons a person or group prefers one pole over another is they value the upside of their preferred pole and/or they fear the downside of the opposite pole” (Johnson, 1998: 12). Pole preference is a combination of values and fears. People invested in one pole will resist change, while people agitating for the other pole will insist on change. The opposite energies generated by shifting between poles can be harnessed so that conflict becomes constructive, “left unmanaged, these energies lead to destructive conflict” (Noll, 2002). Polarity management can assist in diagnosing and dealing with a group’s resistance to change, “chances are they're hung up on one horn of a dilemma, and you can help by showing them that they are right, but only half right” (Stewart & Curry, 1996). The goal is to manage better in both directions. Johnson uses such arguments to support his thesis that change in complex, dynamic organisations requires management of poles, not choosing between them. It can thus be argued that Johnson concurs with Quinn (as cited in Kohn, 2007) that change management requires resolution of apparent paradoxes precipitated by seeming antithetical forces within an organisation. Those paradoxes are irreconcilable conflicts, but are essential components of effective change management. Part of successful management of the paradoxes or poles is

the ability to listen to oppositional ideas, "it is easier to gain the cooperation of those with opposing views if they believe their position has been heard" (Kohn, 2007: 5).

Considering the centralised vs. decentralised polarity introduced in Section 3.5, if the system is in the downside of centralised, the normal expected polarity flow would be to move to the upside of decentralised. However, if this normal flow does not occur, it is because resistance in the system is holding on to the value of system integration and avoiding the system segregation fear. The basis of the resistance is in the tradition-bearer's perception of reality. They are afraid of losing whatever in their mind is the upside of (L+) and they are afraid of getting stuck in whatever in their mind is the downside of (R-), "they have built a wall between their two fears; because of this wall, you cannot follow the normal movement of the polarity model" (Johnson, 1996: 66). In order to free the system flow ('getting unstuck'), it must first be recognised as a polarity to manage (Johnson, 1998: 12). Once that is understood, the normal polarity flow needs to be reversed, "when the normal flow is blocked, turn around and go in the opposite direction; rather than increase the pressure to break down the wall, make it a bridge" (Johnson, 1996: 66). The task is to affirm the values and fears of those resisting the change, followed by the addition of the values of those promoting the change in order to combine them for the positive outcome (higher purpose).

The following generic steps (integrated from Johnson, 1998: 12-14; Johnson, 1996: 67-68) are recommended in order to conduct a crusade from a system that is stuck in the downside of one pole, and are applied to the example illustrated in Figure 3.8:

1. Affirm the upside values of the present pole, i.e. recognise the value of solid system integration and coordination (L+).

2. Recognise the potential downsides of the pole towards which the transition is intended, "now the wall becomes a bridge", i.e. acknowledge the legitimate concern that too much decentralisation could lead to system segregation and lack of coordination (R-).

3. Seek support to achieve the upside values of the pole towards which the transition is intended, i.e. recognise the value of increasing empowerment and being close to the customer (R+).

4. Offer support to hold on to the upside values of the present pole (L+).

5. Gain a mutually agreed upon positive outcome, i.e. raise the question, "How can we get the benefits of decentralisation, while holding on to the benefits of centralisation, in order to be most competitive?"

Johnson points out that as a last step, and only if required, one can move to the downside of centralised (L-), position 0, and identify some of the problems. It should be noted that the recovery process ends up at the downside of the present pole rather than starting there. The system thus becomes unstuck from acknowledging and respecting the two quadrants from which the resistance would come, "by going to the two quadrants that the tradition-bearers are concerned about, you have forced yourself to see the whole picture so you can manage it better" (Johnson, 1996: 68). When all four quadrants are visible a choice point is created, "instead of trying to overwhelm resistance, we can hold its wisdom and see its usefulness" (Johnson, as cited in Maurer, 2002: 218).

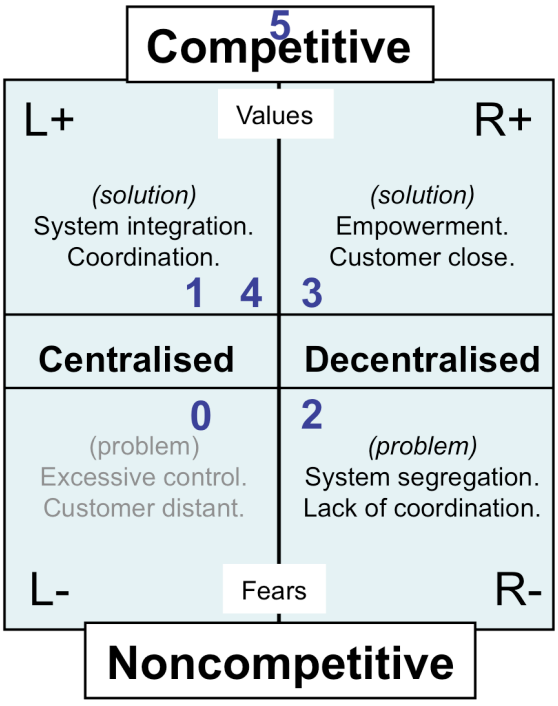

Figure 3.8: Reversing the normal flow of a stuck system (adapted from Johnson, 1998: 12)

An extension of the 'getting unstuck' orientation is the process of helping an individual, team, or whole organisation to anticipate the learning curve. For example, with reference to Figure 3.9, when an organisation has been centralised for a long period of time, attempts at decentralisation may be awkward at first, "like any new learning there is a need for some tolerance for the awkwardness without over-tolerating it" (Johnson, 1998: 13). An agreement must be reached, in advance, with those valuing centralisation to (Johnson, 1998: 14):

1. Hold on to the upsides of centralisation; and
2. Allow some slack and tolerate to some degree the anticipated downsides of the new decentralised efforts; in order to
3. Gain the benefits of decentralisation.

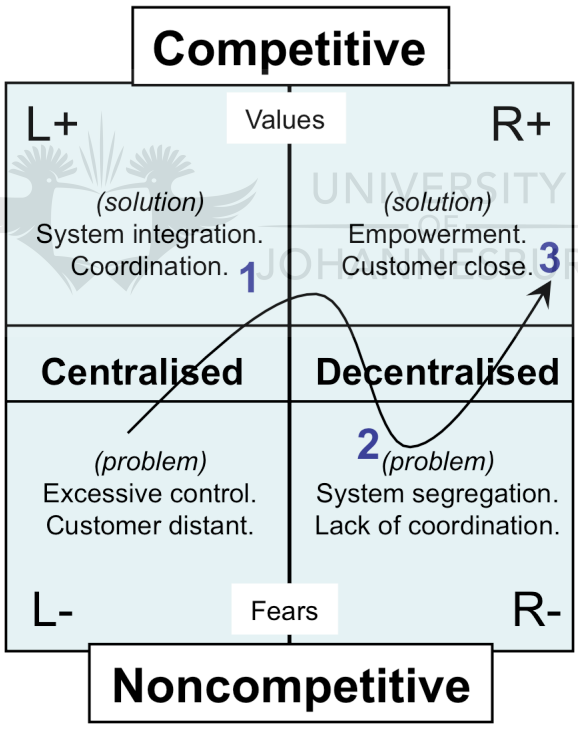

Figure 3.9: Anticipating the learning curve (adapted from Johnson, 1998: 13)

The drop into the downside of the decentralised pole as indicated in Figure 3.9 indicates the learning curve. If this downside is not anticipated, it is likely that those valuing system integration and afraid of lack of coordination will want to prematurely call the effort a 'mistake' and pull it back to the centralised pole.

Change management is usually seen in the context of problems to solve. Approaching change in the context of polarities to manage will assist in increasing the speed, attainability and sustainability of that change. Twinned with polarity management is ambiguity management, “embracing ambiguities can be a powerful way to learn about a changing world” (Stewart & Curry, 1996). A shift in mindset from seeing all difficulties as problems to solve, to a mindset that recognises some difficulties as polarities to manage, is the most powerful change readiness intervention available today (PMA, 1995).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of resolving resistance and sustaining change:

- As a result of retaining values and avoiding fears a system may often become stuck in the downside of a pole, and the normal flow to the opposite upside may become blocked as the resistance effectively holds on to the incomplete picture of the dilemma.
- Resistance may paradoxically become a resource for movement through harnessing the oppositional energies, by acknowledging the values and fears of the change resistance, thereby countering the normal flow in the polarity map and securing the complete picture.
- A key to change sustainability is to predict the challenges and complications of the movement, thus envisioning the learning curve and obtaining advance support.
- Polarity management provides an influential instrument for managing conflict and resistance, and facilitates constructive and sustainable change.

3.7 Effective management of polarities

Popular trends can be identified in business, which are crusades within a polarity to be managed. These trends often occur as a correction from a previous focus on the opposite pole. When the trends are seen as a solution to a problem rather than as a required shift in emphasis within a polarity, the polarity will not be managed

well (Johnson, 1996: 159). When leaders are presented with a dilemma and mistakenly think that they have a problem to solve instead of a polarity to manage, the tension between the opposites is converted into destructive synergy, which Johnson refers to as vicious circles – the opposite poles reinforce each other in a negative way (adapted from PMA, 1995).

Moving to an opposite pole often takes place without acknowledging the value and contribution that the present pole provides to the current business success (Vista, 2009). This orientation may lead to resistance in organisational change and difficulties in corporate governance. The disadvantages of any pole usually become apparent when the other pole is ignored (Noll, 2002). “By focussing on one pole to the neglect of the other, you will first get the downside of the pole where you focused, and then you will get the downside of the neglected pole; you end up over time getting the downside of both poles” (Maurer, 2002: 210). Ineffective tradition-bearing and crusading forces may result in a series of leaps from one downside to the opposite downside, with very little time spent in the upside of either pole, “polarities managed this way do not flow, they flip” (Johnson, 1996: 107). “The inability to see the complete picture (all four quadrants) combined with the assumption that there is a problem to solve rather than a polarity to manage results in a disastrous amount of suffering as those on both sides of the argument cling to their accuracy and miss their incompleteness” (Johnson, 1996: 261).

Leaders are often mesmerised by the virtues of one side of a dilemma, and ignore its worthy alternative. Successful leaders, according to Darling (as cited in Stewart & Curry, 1996), explore both ends. McNaught (as cited in Whitchurch, 2003) proposes to remove all oppositional ‘versus’ thinking and replace it with ways to consider how to gain maximum benefit by embracing both ends of poles. The effective management of polarities begins with the ability of those supporting each pole to recognise the dilemma as a polarity to manage, and then to manage it well. When a polarity is being managed well there is an effective alliance going on between the crusading and the tradition-bearing forces (Johnson, 1996: 106, 114). The inherent tension between the opposites is converted into a creative synergy or synthesis, which Johnson refers to as virtuous circles – the opposite poles reinforce each other in a positive way (PMA, 1995).

When managing polarities, it is important to understand that each polar opposite is involved in the balancing process and depends on each other (Ambler, 2006). In this way, the poles are interdependent. Handy (1995) states that balancing the opposites or switching between them must not be a random or haphazard act, "without a clear rationale for what is happening, the balancing and the switching can be bewildering to those on the receiving end and frustrating for anyone doing the balancing". According to Ambler (2006), a well-managed polarity is one where:

- The system benefits from the tensions that exist between the two poles;
- The system obtains the advantages from the synergy between the two poles; and
- The system achieves the higher purpose.

Well-managed polarities are acquired by staying primarily in the two upper quadrants (Johnson, 1996: 73). The elements or skills required to manage any polarity effectively, include (integrated from Johnson, 1996: 73, 106, 114; Noll, 2002):

- Awareness of the difference between a solvable problem and a polarity to be managed.
- Awareness that there is an upside and a downside to each pole.
- Becoming sensitive to the downsides as they are experienced.
- Willingness to shift poles as needed (from the downside of one pole to the upside of the other) with an awareness that the process will return to the present pole.
- Ability to be effective in both tradition-bearing and crusading as well as at mediating between these two dynamic forces, i.e. the ability to communicate effectively between the poles.

Managing a polarity well requires ongoing decision-making based on an ever-changing reality, "you need to make decisions regularly about which polarities to attend to and how" (Johnson, 1996: 133). Indecision occurs when there seems to

be equal power and equal validity to opposing views. No decision in this case is a decision in favour of inertia (things at rest tend to stay at rest and those in motion tend to stay in motion), "the problem with these decisions, which appear to be indecision, is that you are much more likely to get the downside of the pole of whichever side wins" (Johnson, 1996: 133). To effectively manage a polarity requires the ability to visualise the whole picture; understand the complete map; comprehend the dynamics that create tension; and accept that the tension inherent within the polarity needs to be managed over time (adapted from Ambler, 2006).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of managing polarities effectively:

- Recognition of a polarity to manage within a dilemma by distinguishing it from a problem to solve and supplementing the 'either/or' style with the 'both/and' strategy.
- Visualisation of the complete picture by embracing both ends of the polarity and acknowledging the contribution of each pole.
- Comprehension of the dynamic forces and resistances inherent to the polarity by exploring both ends of the dilemma.
- Appreciation of the requirement to shift emphasis as needed by realising effective communication between the poles and forming an alliance between the dynamic forces.
- The result of effective polarity management is remaining primarily in one or both of the upper quadrants and minimising the experience of the downsides of the polarity.

3.8 Polarity management process steps

Polarities are best defined by engaging with a group in discussion, including those who are directly affected by the polarity, "remember that polarities are

interdependent opposites and they work best when they're both present to balance each other" (Ambler, 2006).

The author of this dissertation has consolidated the following process steps in support of effective dilemma resolution (integrated from Johnson, 1996; Ambler, 2006; Miller, 2008; Vista, 2009):

1. Recognise the polarity.
    a. Create a group of diverse representatives to define the issue during group discussion.
    b. Define the challenge that the business or organisation is dealing with.
    c. Determine if the dilemma is a problem to solve or a polarity to manage.
    d. Gain clarity about the higher purpose and the consequences of managing the tension well or poorly.
2. Describe the polarity.
    a. Identify neutral names for each pole.
    b. Identify the upside and downside of each pole.
    c. Complete the polarity map.
    d. Reach agreement between the representatives on all four quadrants.
3. Assess the polarity.
    a. Examine the dynamics of the polarity and gain an understanding of its operation.
    b. Evaluate realities with the polarity and diagnose the critical elements.
    c. Determine on which pole the current focus is.

d. Consider the resistances that exist in the system and predict the crusading and tradition-bearing tendencies.

4. Manage the polarity.

a. Identify ways in which one pole can be gained whilst the other is still maintained.

b. Produce a polarity alarm indicator for both poles, i.e. identify a list of red flag indicators when a pole is being over emphasised.

c. Determine action steps when red flags are indicated.

d. Assess, monitor and course correct over time as the polarity is being managed.

The author describes the consolidated process steps as, “the four-by-four vehicle to effectively steer polarities”.

CONCLUSIONS

Considering the preceding review, the following conclusion is drawn in terms of the polarity management process steps:

- The consolidated procedure allows for using a common language to recognise, describe and assess a polarity in order to manage the dilemma more effectively through course correction and monitoring.

3.9 Purpose and benefit of polarity management

Polarity management supplements traditional ‘either/or’ problem solving with the ability to capitalise on chronic problems that are unsolvable, unavoidable, and indestructible (PMA, 1995). The goal of polarity management is not to solve or remove problems. The goal is rather to identify the strengths and weaknesses of the two poles that exist within a dilemma. Armed with this knowledge business leaders can predict, prepare for, and manage potential pitfalls within an organisation. The objective is not necessarily to eliminate all the negative aspects

of either pole, but rather to maximise and sustain the potential of existing within the positive sides of either pole (Caldwell, 2007).

Polarity maps provide the context for effectively addressing 'unsolvable problems'. The polarity map furnishes leaders with the insight and methodology to effectively manage organisational dilemmas (PMA, 1995). "What polarity management does is provides a user-friendly map and set of principles in order to formalise and enhance our skills with unsolvable problems" (Johnson, 1998: 16). Polarity management provides the following tools (PMA, 1995):

- Clear guidelines for determining, within a complex set of issues, which are essentially problems that can be solved and which are polarities to manage.
- A user-friendly model for seeing the structure of all polarities clearly, i.e. the impression of polarities.
- A set of principles that explains the dynamics of all polarities, i.e. the functioning of polarities.
- Action steps for addressing self-identified polarities in order to bring immediate and sustained value to an organisation.

Effective application of polarity management can provide the following benefits to leaders and organisations (integrated from Johnson, 1998: 2; ODN Chicago, 2003; PMA, 1995):

- Simplifies complexity without being simplistic.
- Provides a framework for distinguishing between problems that are inherently solvable and finite, from those that are not.
- Reduces wasted time and money spent on non-productive conflict and decisions that will result in 'failed fixes'.
- Enhances decision-making through supplementing the problem-solving mindset.

- Uncovers the basis for resistance and capitalises on diversity without alienating the diverse groups.
- Creates structure for working within the middle ground so that teams, leaders, and individuals can effectively work with opposing ideas (instead of against).
- Converts resistance-to-change to a resource for sustainable, ongoing changeability.
- Provides competitive advantage by utilising the best thinking from opposing viewpoints, i.e. creates virtuous circles and prevents vicious circles.
- Provides predictability and stability amidst accelerating change.

Johnson insists that there is significant competitive advantage for organisations that can both solve problems and manage polarities. Research has indicated that companies who tap the power of polarities outperform those that do not. Pascale (1990) studied the 43 companies identified in 'In search of excellence' five years after the original research. He discovered that 14 companies retained their 'excellent' rating and that 29 did not. The key factor that distinguished the 14 from the 29 was that they managed 7 polarities better. Pascale terms it 'managing contention'. Collins & Porras (1994) term it the 'Genius of the *And*'. This was a central distinction between the 18 'silver' companies that outperformed the stock market for the period from 1926 to 1990 by a factor of 2, and the 18 'gold' companies that outperformed the stock market during that same period by a factor of 15. The distinction was that the 'gold' companies embraced the power of polarities. Hampden-Turner (1990) terms it 're-solution of dilemmas'. His research repeatedly shows that companies who effectively manage key organisational dilemmas, result in better bottom line performance than those that do not manage the same dilemmas well (Johnson, 1998: 5).

Polarity management increases in value as the system or issue increases in complexity, diversity, speed of change, and resistance to change (Johnson, 1998: 2). Johnson however warns that polarity management can be over-used and misused just like any other management tool, "it is an over-use to apply it to

problems which can and need to be solved; it is a misuse to use it as an excuse for avoiding issues or not making decisions" (Johnson, 1996: 134).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the purpose and benefit of polarity management:

- Polarity management provides direction within involved dilemmas to recognise polarities that can be managed.
- Polarity management offers a 'both/and' interpretation that compliments the 'either/or' problem-solving approach to provide a beneficial alternative.
- Polarity management provides a simplified methodology and creates structure to enhance dilemma resolution.
- Polarity management exploits diversity and provides predictability to resolve resistance and sustain balanced change.
- Polarity management collates potential and gains a sustainable value to provide competitive advantage.
- Polarity management does not provide the answer to all dilemmas, and care should be taken in terms of appropriate application.

3.10 Application of polarity management

Polarity management has multiple applications in a variety of situations. The secret is to identify key polarities within the environment of operation and capitalise on the natural tension between the poles. The goal is to create a channel for creative energy that will result in superior outcomes (ODN Chicago, 2003).

The author of this dissertation has observed an assortment of disciplines and functions across literature where polarity management is employed, which include:

- Mitigate ongoing tension and manage unresolved conflict (Noll, 2002);

- Negotiations between the opposing sides in heated labour disputes including conflicts as great as Apartheid in South Africa;
- Manage diversity in organisations and capitalise on the best of two or more cultures involved in mergers and acquisitions (PMA, 1995);
- Strategic planning and collaboration (Sanchez, 2007);
- Core competency in leadership development (Ambler, 2006; Burns, 1999; Caldwell, 2007; Stewart & Curry, 1996);
- Complement effective project management practices in the pharmaceutical industry (Hirschhorn, 2001);
- Strategic learning through the power of contrast (Harburg, 2005);
- Innovation and change in higher education (McNaught, 2003; Whitchurch, 2003);
- Involvement of scientists in advocacy through integration of scientific results into management decisions (Cantrell et al., 2005);
- Key challenge for integrated healthcare (Burns, 1999);
- Understand and manage change to provide the value in health information technology (Kohn, 2007);
- Reflection on ministry and congregational movements (Kruse, 2005; PK Advantage, 2002; Oswald & Johnson, 2009).

The reason, according to Johnson, that the 'diversity' issue has not yet been solved by even the most highly invested organisations is because diversity is not a problem to solve. Diversity is a series of polarities to manage (and some problems to solve). The challenge is to learn how to manage the key polarities within diversity (PMA, 1995). Polarity management involves more than simply balancing perspectives, "it may entail pursuing both directions simultaneously" (Burns, 1999). Similar findings are presented in empirical studies on leadership (McGregor, as cited in Burns, 1999), which in years past debated whether leaders should display

theory X behaviours (initiating structure, autocratic leadership) or theory Y behaviours (consideration, participative democracy). Blake & Mouton's 'management by grid' approach suggests that effective leaders combine both consideration and initiating structure styles (cited in Burns, 1999). Misumi & Peterson (as cited in Burns, 1999) provide more recent, supporting evidence for this view in their study of Japanese leaders, although leaders were not extremists on either set of behaviours. The essence of leadership, from the perspective of polarity management, becomes managing ambiguities and multiple directions (Burns, 1999). Similar conclusions are also reached in qualitative studies of successful companies. In a study of enterprising companies, their success is explained in terms of their ability to avoid the 'Tyranny of the *Or*' and embrace the 'Genius of the *And*' (Collins & Porras, 1994). Such companies found it easier to live with paradoxes and seemingly contradictory ideas at the same time. They sought to achieve both sides of a polarity simultaneously by achieving high performance in both the short-run and the long-run, or by preserving core values while stimulating radical change (Burns, 1999).

Leaders in organisations who understand the strength of managing polarities are more effective due to the following reasons (Caldwell, 2007):

- They save time and energy not trying to solve problems that are unsolvable.
- They have a better understanding of the resistance they may face to organisational changes they wish to make.
- They will be more effective in negotiating with those in opposition to their changes.
- They may serve as more effective mediators.
- They will be able to anticipate and minimise problems that occur within a workplace when polarities are not managed well.
- They will be more effective in decision-making.

Based on field research in a biotechnology company, project managers in high technology companies face the ongoing task of managing the polarities that shape

their work. The polarities derive from the project manager's dual role of representing the singular needs of a project, and representing the overall needs of the company, "to succeed, the project manager should be aware of these polarities, learn skills for creating 'win-win' solutions when faced with them, and learn to identify the moment when one or another polarity has created unexpected tension in the flow of the work" (Hirschhorn, 2001: 16). Hirschhorn suggests that good project managers are able to manage the following six polarities: (1) take account of the big picture of the project vs. pay attention to the details; (2) help team members advance a project vs. help team members shut down a project; (3) play a supporting role to enable the project leader to lead vs. provide project leadership; (4) be responsible for the outcome of a particular project vs. be responsible for the outcome of the company's portfolio of projects; (5) get resources for the team from the functional groups vs. protect the functional groups from excessive demands on their time, attention and resources; and (6) focus on the demands of the project itself vs. focus on the context for the project.

As a learning strategy, positive appreciation for contrast offers powerful 'medicine'. "Most learning strategies focus only on what is required to improve or correct a situation or skill, but it is often more useful to examine that which sends our attention and efforts in opposing directions" (Harburg, 2005: 20). For example, a business team can employ the power of this approach when doing a robust lessons-learned session. At the conclusion of a successful or unsuccessful experience, project or event, some enlightened organisations take the time to look at what went right and what went wrong. It can however be much more powerful to examine the benefits and liabilities of the differing assumptions that drove the actions. Such an analysis often reveals that the key to a team's effectiveness turns on its ability to genuinely consider the benefits and the drawbacks of the opposing options available at critical points on the path. New alternatives emerge when opposing perspectives are acknowledged at these significant decision points (Harburg, 2005).

McNaught (2003) describes how effective change in universities can be realised as the management of multiple dimensions or polarities. She frames the application of polarity management to higher education around the following set of dimensions: top-down vs. bottom-up decision making; management vs.

scholarship; audits vs. evaluative feedback; central vs. devolved funding; integrated vs. piecemeal support; mass change vs. growing individuals; and, competition vs. collaboration. These series of polarities intersect in what McNaught refers to as the 'zone of effective change'. She argues that the 'zone of effective change' can only be formed by the inclusion and balancing of both ends of each dimension (McNaught, 2003: 82).

Integrated health systems are confronted with numerous dilemmas that must be managed. Many of these dilemmas are an inherent part of the system's structure, given that multiple competing hospitals, medical groups, and (sometimes) health plans are often under one organisational roof. Burns (1999: 2) argues that a key challenge in such integrated health systems is managing the tensions and conflicts inherent in such structures. His study outlines the following nine types of polarities that exist in physician-to-system, physician-to-physician, and hospital-to-hospital relationships: (1) hospital systems want to be organisations of physicians; (2) system expansion by growing the physician component; (3) system centralisation and physician decentralisation; (4) centripetal and centrifugal forces involving physicians; (5) system objectives and physician interests; (6) system centralisation and hospital decentralisation; (7) primary care physicians and specialists; (8) physician autonomy via collectivisation; and (9) vertical and virtual integration.

Kruse (2005) reflects on ministry and argues that the Apostle Paul used the analogy of 'the body' to illustrate his perspective on how the various gifts should function in the church, in the same way as Johnson uses the human function of breathing. The body is a myriad of managed polarities like breathing, "as the body of Christ, we need to learn better how to breathe" (Kruse, 2005). In their book 'Managing Polarities in Congregations' Oswald & Johnson (2009) describe why managing polarities is important to congregational health in light of the following polarities: tradition vs. innovation; spiritual health vs. institutional health; management vs. leadership; strong clergy leadership vs. strong lay leadership; reaching out vs. reaching in; entrenchment vs. transformation; making disciples, easy process vs. challenging process; and, call vs. duty. PK Advantage (2002) highlights the following polarity examples that exist in the Christian church: non-Christians as enemies vs. non-Christians as neighbours; focus on the individual vs. focus on the denomination; competing with other religions and denominations

vs. collaborating with them; celebrating our differences vs. celebrating our commonalities; centralised leadership and authority vs. congregational governance; standardised worship vs. changing worship; and, individual growth vs. church growth.

The author of this dissertation has identified the following additional examples of polarities across literature (integrated from Johnson, 1996; Ambler, 2006; Miller, 2008; Noll, 2002; McNaught, 2003; Stewart & Curry, 1996): market driven vs. product driven; innovation vs. standardisation; planning vs. taking action; activity vs. rest; business unit vs. company; focus vs. flexibility; idealistic vs. pragmatic; action vs. reflection; effective vs. efficient; critical analysis vs. encouragement; being clear vs. being flexible; my job vs. my place; word vs. deed; individual responsibility vs. organisational responsibility; doing vs. being; stress vs. tranquillity; broad-based leadership vs. high-visibility leaders; independence vs. interdependence; long term vs. short term; creativity vs. discipline; trust vs. change; bureaucracy busting vs. economies of scale; people vs. productivity; leadership vs. capability; revenue growth vs. cost containment; equality (whole) vs. uniqueness (part); and, common computer systems vs. custom computer systems. This list is not meant to be exhaustive. There exist many additional possible renderings.

Sanchez (2007) indicates that polarity management can also be used alongside methods such as Appreciative Inquiry (AI), Open Space Technology (OST), and The World Café (TWC) in order to foster the capacity for conscious leadership and strategic collaboration. Sanchez advocates that polarity management may be practiced as part of the 'destiny phase' of AI. "These methods can be blended to deepen communication through conversations that matter and liberate self-organisation so that people can strategically collaborate by taking responsibility for their passion" (Sanchez, 2007).

Johnson points out that two significant, yet different polarities may occasionally be mistaken as one and the same dilemma, "when this happens, separate the two and make sure each is being managed well" (Johnson, 1996: 196).

CONCLUSIONS

Considering the preceding review, the following conclusion is drawn in terms of polarity management application:

- The principles of polarity management cultivate multiple applications within a wide range of settings where simultaneous contrast is pursued to realise collaborative change.

3.11 Polarity management and the triple constraint

The project sponsor announces, “here is what I need; I need it by the first of the month, and it cannot cost any more than this; oh, by the way, the quality must be good too” (Koch, 2007). In most projects, the project sponsor dictates the scope, time and cost constraints, and usually insists that negotiations are limited. The mandate is decreed and the project manager is typically responsible for completing as much work as possible, as quickly as possible, and at the lowest possible cost. These ‘unreasonable’ demands usually stem from the project sponsor’s lack of knowledge regarding the intricacies and interactions of the triple constraint elements and its harmony, “not knowing (exactly) what the project will require, he makes a best guess, then pushes beyond it to ensure that the project time and money are well spent” (Koch, 2007). Stakeholders often lack the information (incomplete picture) to make the correct decisions. Koch argues that project managers can influence senior stakeholder decisions by providing hard data and useful information (to complete the picture), “when your sponsor begins to believe in your data, you are finally in the position to negotiate project constraints that are workable and realistic”. According to Ambler (2008), the fundamental problem is that each major group of stakeholders has a different, and often conflicting, set of priorities. For example, IT professionals lean towards scope requirements, financial people may seem more interested in the overall cost, senior management in the schedule, and end users in quality, “although these are clearly stereotypes we’ve all been in situations where someone was overly focused on ‘their issue’ to the exclusion of others” (Ambler, 2008). The problem is that when each issue has its own protagonists, it becomes difficult to negotiate a reasonable approach to the project, “when nobody budges from their

position, or is forced to budge, the project team is positioned for failure" (Ambler, 2008).

Conflict is a reality that exists within all firms – it is part of the organic nature of companies and, to extrapolate, human nature (Anonymous, as cited in Manas, 2005). Friction often occurs in communication as a result of different perspectives. This in turn can either lead to greater understanding or stalling of a project. The communication effort, however, needs to be managed correctly, "but I don't believe it can be set-up at the beginning of a project with the assumption that it will take care of itself; to assume that everything needs to be set up right from the very beginning will simply lead to analysis paralysis" (Manas, 2005). Accepting that there will be conflict and that it has to be managed correctly is a more useful form of insight.

Trade-offs and choices are created by the limitations and friction inherent to the triple constraint. Noll (2002) suggests that when a conflict seems to endure and appears to move back and forth between contradictory values, a polarity probably exists. According to McNaught (as cited in Whitchurch, 2003), innovation and change involve balancing multiple and highly interrelated polarities. Polarity management may thus be considered a critical problem-solving skill of navigating between divergent goals and interests that are important to key stakeholders (Burns, 1999).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the triple constraint within the polarity management milieu:

- The simultaneous tensions and competing perspectives inherent to the triple constraint foster conflicts and trade-offs.
- The trade-offs need to be managed to optimise conflicting priorities and to attain a deeper comprehension of the strategic picture.
- It is speculated that polarity management techniques may support the effective management of the triple constraint to facilitate beneficial change and sustained value.

3.11.1 Considering the triple constraint elements as polarities

The author of this dissertation has conducted an exhaustive search to ascertain if the interdependencies between the triple constraint variables (elements) have been considered anywhere in literature as polarities to manage. Apart from limited information that materialised as part of a personal discussion with Dr. Barry Johnson, no results were found and no research has been recorded in this field.

The three triple constraint relationships identified in Section 2.4.2 are repeated hereunder for convenience:

1. $S\uparrow \alpha T\uparrow C\uparrow$
2. $T\downarrow \alpha S\downarrow C\uparrow$
3. $C\downarrow \alpha S\downarrow T\uparrow$

As discussed in Section 2.4.2, the dynamics of these relationships are indicative of the interrelated trade-offs between the three primary forces (scope, time and cost) inherent in the triple constraint. Following a similar argument as Burns (1999) regarding his assessment of integrated health systems, the analysis of the triple constraint relationships suggests that the three elements are interdependent rather than mutually exclusive. That is to say, they are appropriately viewed as crosscutting axes rather than opposite ends of a continuum.

It has become commonplace in many projects to view the triple constraint elements as 'either/or' choices. However, viewed from the interdependent standpoint, the role of the project manager becomes an ongoing balancing act of the rival priorities and perspectives. The author of this dissertation deduces that the triple constraint elements may be paired as polarities, with reference to the polarity criteria identified in Sections 3.3 and 3.5.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the reasoning for considering the triple constraint elements as polarities to manage:

- The triple constraint relationships are interdependent and the trade-offs are ongoing.
- The triple constraint elements cannot be viewed in isolation and depend on each other for sustainability over time.
- During the project life cycle there is a continuous shift in focus between the triple constraint elements.
- At any given time there are both advantages and disadvantages when over focussing on one of the elements, with a corresponding impact on the project higher purpose.
- Management of the triple constraint requires a progressive venture to achieve and/or maintain an optimum balance.

3.11.2 Triple constraint polarity models

The term polarity refers to the state of having two opposite or contradictory tendencies, opinions, or aspects (Apple Inc. Dictionary Version 2.1.3, Copyright 2005-2009). The challenge at hand is to determine how to deal with three opposing aspects, i.e. how to apply the polarity management rationale to the triple constraint.

One consideration is to see both time and resources (money) as different dimensions of the cost factor with both of them on the same pole interdependent with scope (adapted from B. Johnson, personal communication, May 08, 2008). The author of this dissertation conceptualises this model as indicated in Figure 3.10. The ongoing perplexity is to understand how the scope of work can best be achieved while at the same time reducing cost in time and/or resources. The aim is to achieve project success by harnessing the benefits of investing in the optimisation of both project cost and scope, and minimising the downsides of the trade-off (illustrated by the area sweep of the infinity loop). The population of the polarity map and further assessment of its dynamics are left up to the readers of this dissertation.

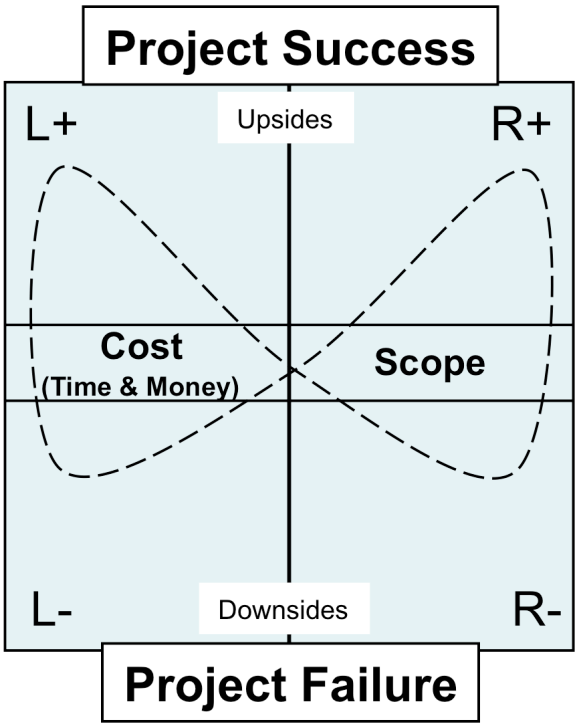

Figure 3.10: The 'cost vs. scope' triple constraint polarity map

Another alternative is to lay the triple constraint elements out as, what Johnson refers to, a 'multarity' of three, which looks like a triangle with an upside and a downside to each extremity. The essence of 'multarities' is that the infinity loop embraces all the poles of the 'multarity' to each other in a combination of pairs. When the loop has rounded a pole of the 'multarity' it will head to the pole in greatest need; when it rounds that pole it will go to the next one in greatest need. The sequence is influenced by internal and external circumstances, but the energy system wraps around all the poles in the same way as it wraps around the two poles of a polarity over time.

The author of this dissertation depicts his unique impression of the 'multarity' notion being applied to the triple constraint in Figure 3.11. The author puts forward the following basic interpretation of the project triangle 'multarity' model: When the downside of a pole is experienced, the system has the option to transition to either one of the upsides of the other two poles (through the infinity loop via the indicated nodes), whilst maintaining a perspective on the higher purpose of the project. Analysis and implementation of this model are left up to the readers of this dissertation and may be considered as further research.

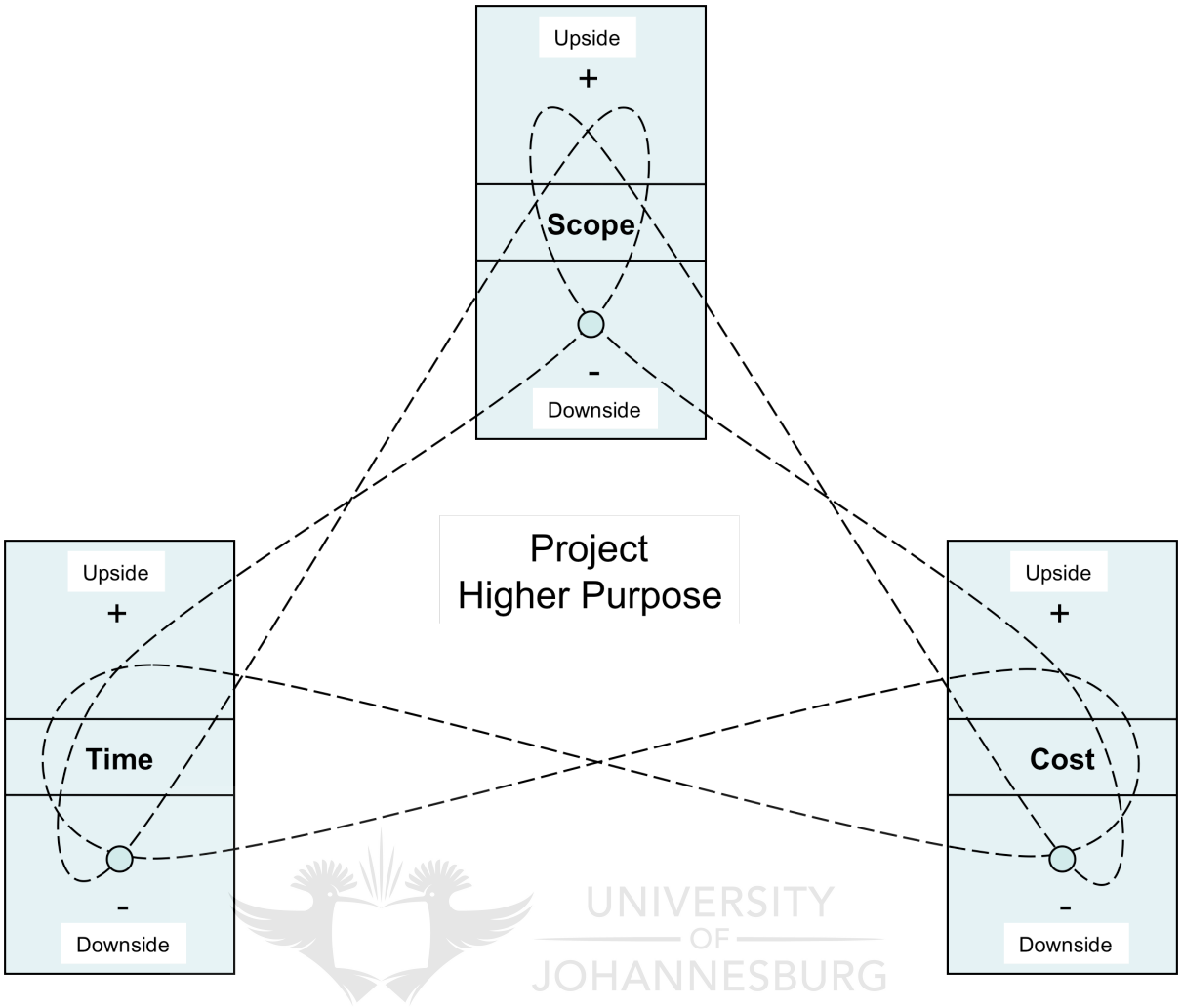

Figure 3.11: The triple constraint outlined as a 'multarity' to manage

The crux of a 'multarity', according to Johnson, is that when the focus is on one pole, all those who have another pole preference are being asked to allow the energy (focus) to be on what for them is a less preferred pole. In the context of the 'multarity' view, this is possible for a period of time but not sustainable over time. This is the same truth that exists within a polarity (B. Johnson, personal communication, May 09, 2008).

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of triple constraint polarity models:

- The traditional polarity management perspective primarily involves dualities in opposite parts.

- The triple constraint presents three intrinsic polar separations, which captivate a refreshed perspective in terms of traditional polarities.
- The triple constraint elements may be managed as polarities by considering the following proposed models:
    - Integrate time and cost as one pole, interdependent with scope as the opposite pole.
    - Disseminate scope, time and cost as an interdependent 'multarity' of three.

3.11.3 Consolidated triple constraint polarity model

The author of this dissertation hypothesises a third triple constraint polarity model by fusing the central attributes of the TRIJECT model, presented in Section 2.4.8, with the triple constraint polarity justification and requirements described in Section 3.11.1. The proposed polarity map for this model is shown in Figure 3.12. The author names this model the POLSTRAINT map (an acronym created from the titles 'POLarity management' and 'triple conSTRAINT').

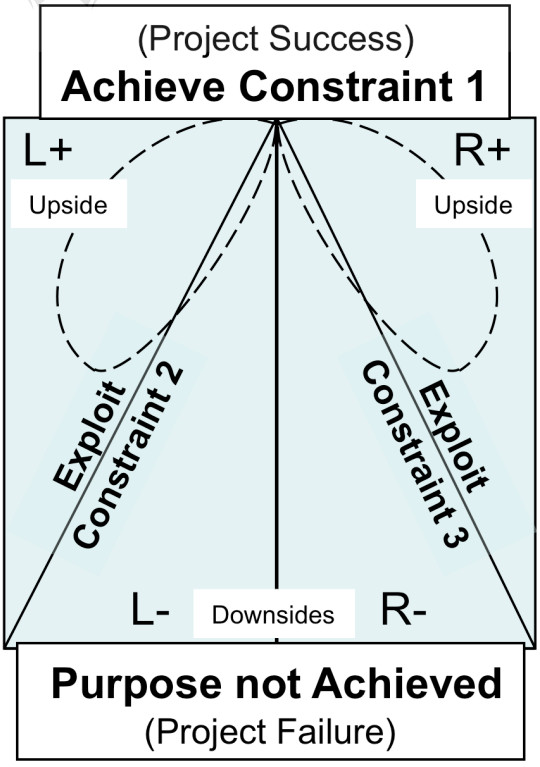

Figure 3.12: POLSTRAINT map

The POLSTRAINT map provides a triangular perspective by dividing the upside and downside of each pole into right triangles instead of Johnson's rectangular polarity map approach. The triangle is aligned towards the achievement of the driver constraint (constraint 1), which is connected to the success of the project.

The rationale of this model is to unlock creative opportunity within the project triangle in order to ensure achievement of the driver constraint. This is accomplished by managing the exploitation trade-offs between the two flexible constraints (constraints 2 and 3) as polarities. For example, in order to ensure that the required scope of work is achieved for the project to succeed, the project manager may on the one hand need to accommodate a delay in the project schedule, while on the other hand pursue more money and resources. The aim is for the opposing constraints to reinforce the exploitation effort in an optimum way by minimising the negative trade-offs and ensuring project success.

CONCLUSIONS

Considering the preceding review, the following conclusions are drawn in terms of the consolidated triple constraint polarity model:

- The consolidated triple constraint polarity model (the POLSTRAINT map) considers the exploitation trade-offs between the two flexible constraints as polarities to manage.
- The goal of the POLSTRAINT map is to capitalise on the trade-offs with some degree of optimum balance in order to ensure achievement of the driver constraint over time.
- The POLSTRAINT map constitutes the second building block of the dissertation's integrated framework, which is described in Chapter 4.

3.12 Chapter closure

Chapter 3 provides a study of the theory and literature surrounding the polarity management phenomenon, and considers the triple constraint elements as polarities to manage.

The challenge in this chapter has been to extract substantiating polarity management literature and formulate structure from a relatively young and limited body of knowledge.

The chapter concludes with a consolidated triple constraint polarity model, in support of the integrated framework, based on the triple constraint model derived in Chapter 2 as well as the key attributes deduced in this chapter. The main conclusions of this chapter are summarised in Chapter 6.

By addressing the research questions identified in Section 1.4.2, the final three supporting objectives of the study have been achieved as specified in Section 1.5, i.e.:

- Uncover the knowledge foundation of polarity management.
- Establish the feasibility of applying polarity management principles to the triple constraint.
- Introduce a consolidated triple constraint polarity model.

The integrated framework of the research study is presented in Chapter 4.

CHAPTER 4 INTEGRATED FRAMEWORK

4.1 Chapter overview

Chapter 4 integrates the main conclusions from Chapter 2 and Chapter 3 into a conceptual model and methodology.

The chapter begins by highlighting the key aspects deduced from the literature studies followed by the realisation of the conceptual model and assessment of the integrated framework. A process method is introduced and implementation of the model is discussed.

The purpose of this chapter is to investigate the problem under study with reference to the research questions identified in Section 1.4.3.

4.2 Relevant theories and concepts

The following fundamental characteristics are consolidated from the project management and polarity management literature studies in support of the development of the conceptual model:

- The triple constraint elements are integrated into an interdependent triangle of scope, time and cost, with quality as a central function of the balanced requirements.
- The interrelationships and dynamics of the triple constraint are described by the three primary triple constraint relationships, namely:
  - $S\uparrow \alpha T\uparrow C\uparrow$ (relationship 1).
  - $T\downarrow \alpha S\downarrow C\uparrow$ (relationship 2).
  - $C\downarrow \alpha S\downarrow T\uparrow$ (relationship 3).
- The triple constraint elements are ranked in a hierarchy of flexibility, which is a function of the project objectives, higher purpose and environment.

- The primary triple constraint element, the driver constraint, is the least flexible of the constraints.
- The primary triple constraint element is connected to the fundamental reason and desired outcome of the project.
- The requirements of the primary triple constraint element are pursued through exploitation of flexibility within the two more flexible elements.
- The ongoing tensions and conflicting priorities of the exploitation trade-offs require management in order to achieve some degree of equilibrium and ensure an optimum outcome.
- The exploitation trade-off between the two flexible elements may effectively be managed as polarities in order to ensure achievement of the absolute requirements of project success over time.
- The polarity management component capitalises on the benefits of exploiting both poles and converts resistance to a sustained resource for creative opportunity.
- The polarity management component also provides a deeper understanding of the strategic picture as well as predictability, which enhances decision-making.

4.3 Conceptualisation of the integrated framework

The grand theoretical model is created by integrating the TRIJECT model, as proposed in Section 2.4.8, and the POLSTRAINT map, as proposed in Section 3.11.3, into a conceptual framework. The merger concept is indicated in Figure 4.1.

The matured model that is formed by merging the POLSTRAINT map into the TRIJECT model is presented in Figure 4.2. The author of this dissertation names this integrated framework the TRIPOLJECT model (an acronym created from the titles ‘TRIple constraint’, ‘POLarity management’ and ‘proJECT management’).

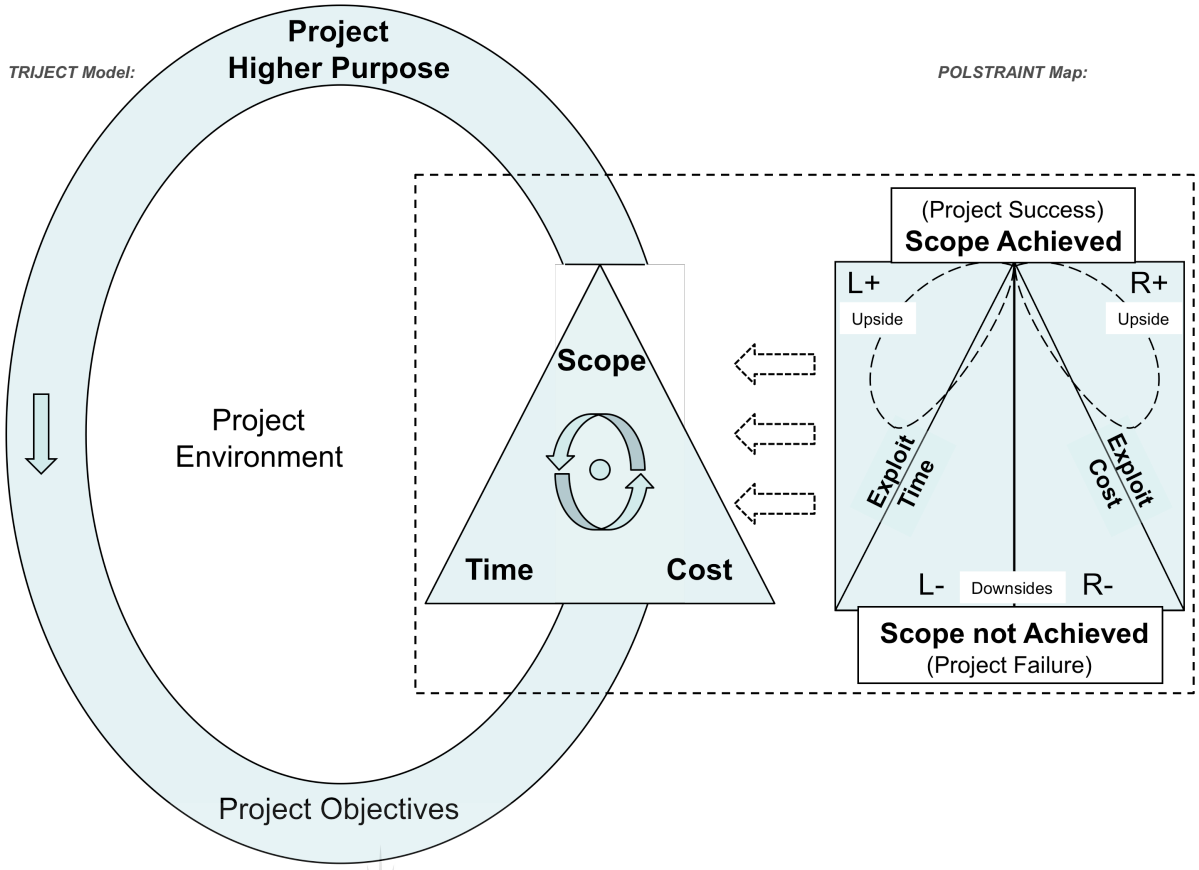

Figure 4.1: Merging the POLSTRAINT map into the TRIJECT model

The POLSTRAINT map, the heart of the TRIPOLJECT model (Figure 4.2), constitutes a triangular polarity map that is projected towards the successful outcome and higher purpose of the project. The rotational property of the map is indicative of the dynamics that exist within the power structure of the triple constraint, which is a function of change within the project environment that may impact the higher purpose and objectives of the project. Each left and right halve of the map, consisting of two parts each, represents a pole of a flexible constraint with its associated upside and downside, i.e. each pole is categorised into its high or low state. The two upper right-angled triangles (L+ and R+) contain the positive results (upsides) of exploiting each respective pole. The two lower right-angled triangles (L- and R-) contain the negative results (downsides) of over exploiting one pole to the neglect of the other. The primary triple constraint element (the driver) is illustrated as both the direction and foundation of the project triangle. It exemplifies both the positive outcome (project success) and the negative outcome (project failure). The outcome is dependent on the achievement of the primary

triple constraint element through the exploitation of the two more flexible constraints and alignment with the project higher purpose.

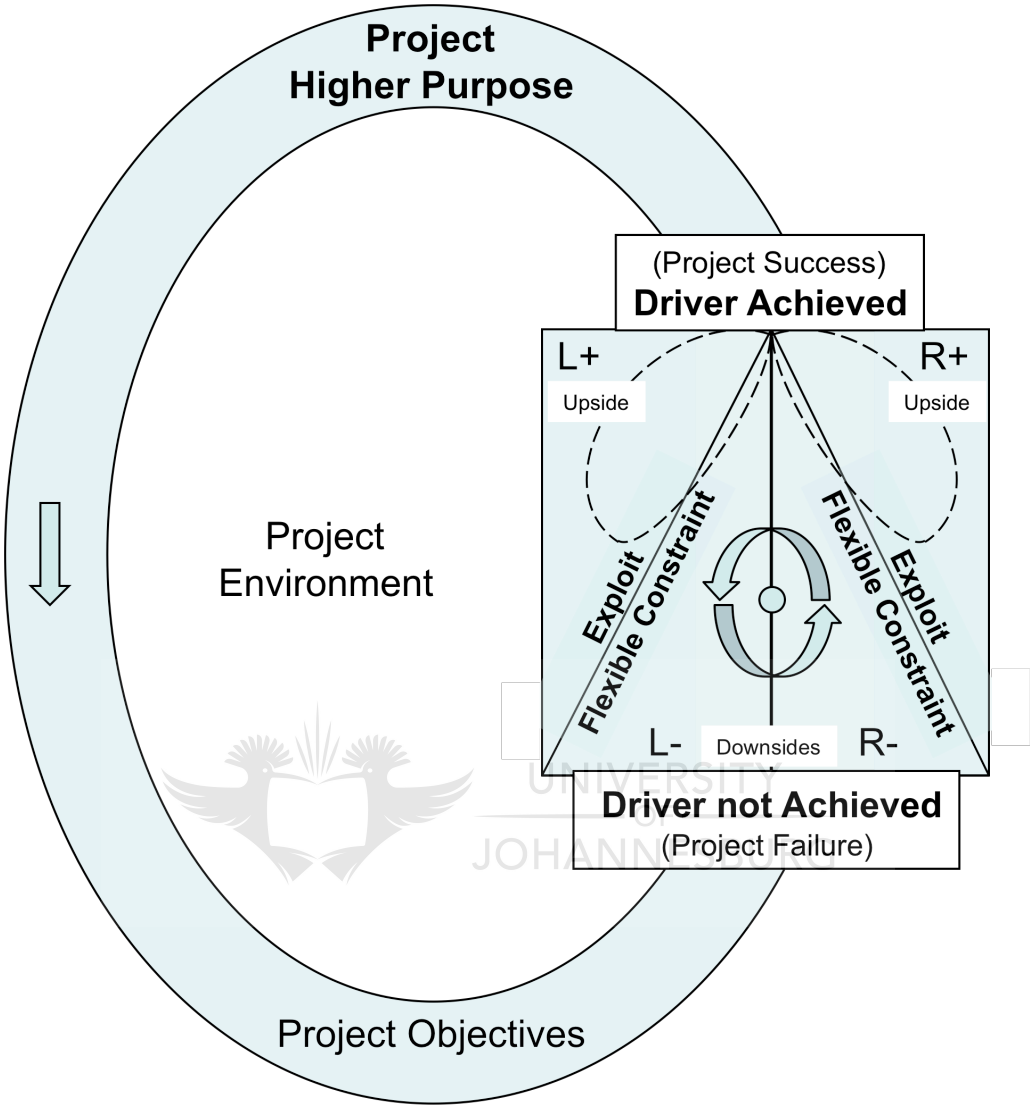

Figure 4.2: TRIPOLJECT model chart

The graphic outline of the TRIPOLJECT model may be imagined to take the form of a capital letter 'Q', which signifies the central presence of quality and customer satisfaction. The continuous oval loop portrayed by the model suggests the introduction of change as well as the iterative process of monitoring and control towards project success.

The fundamental hypothesis of the integrated framework is that the exploitation trade-off between the two more flexible triple constraint elements can effectively be managed using polarity management principles in an ongoing effort driven by

the primary triple constraint element to ensure a positive outcome and to achieve the project higher purpose, whilst aiming to minimise the downsides and to maintain a balanced trade-off compromise (illustrated by the warped infinity loop in Figure 4.2).

4.4 Dimensions of the integrated framework

The essence of the TRIPOLJECT model resides within the POLSTRAINT map, which has three dimensions to consider, namely:

1. The scope (S) constraint as the primary triple constraint element (the driver), with time (T) and cost (C) as the more flexible (weaker) constraints.
2. The time (T) constraint as the driver, with scope (S) and cost (C) as the weaker constraints.
3. The cost (C) constraint as the driver, with time (T) and scope (S) as the weaker constraints.

The three respective dimensions are analysed and discussed in the subsequent sections.

4.4.1 First dimension: Scope as driver

4.4.1.1 Examining the triple constraint relationships with scope as driver

The three primary triple constraint relationships are repeated hereunder, with the scope element highlighted, in order to facilitate ease of reference:

1. **S**↑ α T↑ C↑
2. T↓ α **S**↓ C↑
3. C↓ α **S**↓ T↑

Relationship 1 signifies that the project scope may be augmented (S↑) through a combination of extending the project schedule (increased time T↑) and utilising more project resources (increased cost C↑). Within the context of the 'good, fast or cheap - pick two' rationale, relationship 1 thus implies that the project will be

delivered good (S↑), but neither fast (because T↑) nor cheap (because C↑). This implication is in line with the literature premise that it is highly desirable that at least one element of the project triangle come in as planned (or better than planned) – project scope in this instance. A further interpretation of relationship 1 may be that the effect of increasing the scope (S↑) requires an increase in either time (T↑) or cost (C↑), but not necessarily both. For example, if a time increase is pursued (T↑) in an effort to increase the scope (S↑) then the budget can remain unchanged, which implies that the project will be delivered good (because S↑) and cheap (because C fixed as planned) but not fast (because T↑). Similarly, the project may be delivered good (S↑) and fast (T fixed as planned) but not cheap (because C↑). It can be concluded from relationship 1 that although the exploitation of both weaker constraints (time and cost) may be beneficial in order to ensure achievement of the driver constraint (scope), consideration in particular projects must be given to the benefits of capitalising on the exploitation of only one constraint (time or cost).

Relationship 3 signifies that in order to optimise project resources (C↓), as a minimum either the scope of the project must be retrenched (S↓) or the project schedule must be augmented (T↑). The first dimension of the POLSTRAINT map fixes the project scope as the driver constraint that has to be fulfilled as planned. The time constraint in relationship 3 therefore has to be flexible, i.e. exploited (T↑), in order to reduce project cost (C↓). Relationship 3 thus implies that the project can be delivered cheap (C↓) and good (S fixed as driver) but not fast (because T↑). Congruently relationship 2 connotes that the project can be completed fast (T↓) and good (S fixed as driver) but not cheap (because C↑). Relationships 2 and 3 affirm the 'good, fast or cheap - pick two' rationale in that one can either have it good and cheap, or good and fast, but not good-and-cheap-and-fast. This affirmation is in line with the literature premise that it is highly unlikely to attain all three constraints as planned. It can be concluded from relationships 2 and 3 that in order to deliver the scope as planned, interdependent trade-offs exist between the project schedule and budget namely: C↓ α T↑ and T↓ α C↑. The significance of this conclusion implies that the exploitation of the two weaker constraints (time and

cost) needs to be appropriately managed in order to achieve a balanced compromise.

With reference to the joint interpretations concluded in the foregoing paragraphs, the three triple constraint relationships insinuate that in addition to completing the project good (S fixed as driver), the project may also be delivered either fast (T↓) or cheap (C↓). It can thus be deduced that in order to ensure the successful achievement of the driver constraint (scope), the trade-off between delivering the project within scope and schedule (good and fast) and within scope and budget (good and cheap) needs to be managed, whilst optimising the exploitation of the flexibility within the associated weaker constraint. For example, delivering good and fast requires the exploitation of flexibility within the cost constraint; on the other hand, delivering good and cheap requires exploitation of flexibility within the time constraint.

The exploitation trade-off between the time and cost constraints can graphically be presented by a seesaw metaphor, devised by the author of this dissertation, and is depicted in Figure 4.3. The interdependent trade-offs between time and cost are positioned at each end of the seesaw with scope remaining pivotal to project success. The change of state of the seesaw, the up and down swing, is a collaborative function of constraining pressure and exploitation weight. For example, exerting more constraining pressure (containment of expenditure) on the project schedule (T↓) may require the exploitation weight (utilisation of flexibility) of the project budget to increase (C↑).

The combination of these two forces (downward pressure on time and weight of additional cost), metaphorically speaking, results in the seesaw to lean towards the right. In other words, the flexibility to increase cost (**C**↑) outweighs the flexibility to increase time (T↑) in this example due to the requirement to constrain (exert pressure on) the project schedule (T↓) – thus delivering the project good (scope pivotal) and relatively fast (T↓), but not cheap (C↑).

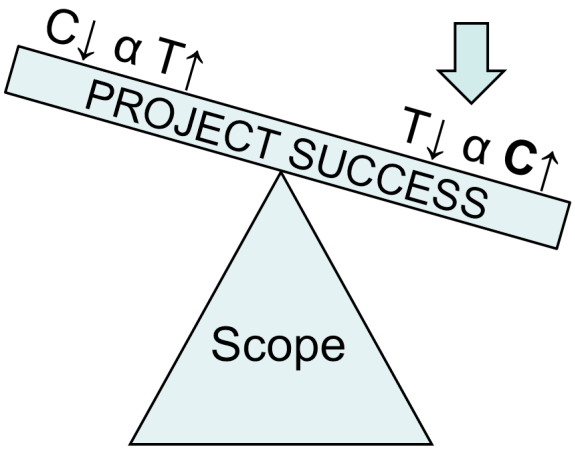

Figure 4.3: Scope seesaw with the flexibility of cost outweighing the flexibility of time

Considering priorities within the triple constraint hierarchy, the ongoing aim is to find an optimum balance between the cost of delivering the desired scope and the time required to accomplish this. The challenge is how to manage this effective utilisation and efficient compromise between time and cost.

4.4.1.2 Constructing the POLSTRAINT map with scope as driver

It is conjectured that the POLSTRAINT map provides a mechanism to optimally manage the exploitation and trade-offs towards the achievement of project success.

Figure 4.4 depicts the POLSTRAINT map with scope as the driver constraint and is referred to as the first dimension of the TRIPOLJECT model. The driver constraint is the constraint that has to be accomplished as planned in order to ensure project success. The identified polarity to manage is the trade-off between the exploitation of the two flexible constraints, namely increasing time (T↑) and increasing cost (C↑). The two identified poles conform to Johnson's polarity criteria, i.e. the constraints are interdependent and the trade-off is ongoing.

The success of the driver constraint (scope) is projected as the positive and negative outcome at respectively the top and bottom of the map. The left pole represents the exploitation of the time constraint (T↑) and the right pole represents the exploitation of the cost constraint (C↑). This model encourages maximum exploitation (T↑ and C↑) whilst aiming at managing a balanced compromise in terms of inherent trade-offs.

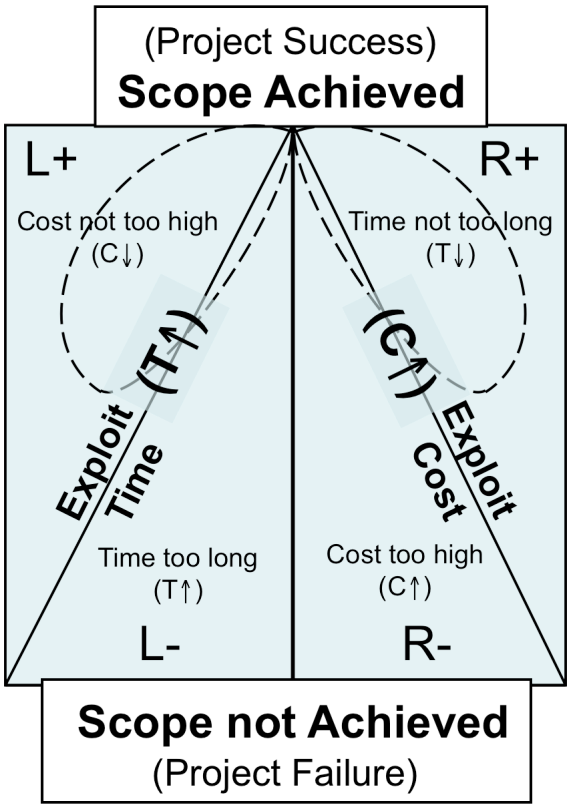

Figure 4.4: POLSTRAINT map: Scope as driver (TRIPOLJECT model 1st dimension)

Each pole is categorised into its 'high' or 'low' state. The upside (L+) from focussing on the T↑ pole is that exploitation of the cost constraint is minimised, i.e. the project budget is contained (Cost not too high). The downside (L-) from over focussing on the T↑ pole to the neglect of exploiting cost is that the project schedule will run too late (Time too long). The upside (R+) from focussing on the C↑ pole is that exploitation of the time constraint is minimised, i.e. the project schedule is contained (Time not too long). The downside (R-) from over focussing on the C↑ pole and neglecting to also exploit time is that the project will be too much over budget (Cost too high).

The diagonal quadrants of the map constitute opposing forces that drive for a shift from the downside of one pole towards the upside of the other pole, as described by Johnson's polarity management model. The opposing diagonals within this POLSTRAINT map are respectively quadrant L- (Time too long) vs. quadrant R+ (Time not too long), and quadrant R- (Cost too high) vs. quadrant L+ (Cost not too high). Over focussing on the exploitation of the project schedule (the T↑ pole) in an effort to ensure achievement of the driver constraint (scope) may eventually

result in the benefits of the T↑ pole to dissipate as the system moves into its downside (Time too long), i.e. excessive schedule overrun. This causes an increasing awareness of the absence of the other pole, which in turn drives the action toward the upside of the C↑ pole (Time not too long) to further pursue exploitation of the project budget rather than the project schedule in an effort to ensure achievement of the driver constraint (scope) – as the cycle repeats, the inherent trade-offs within the poles become apparent. This dynamic and interwoven flow through the four quadrants of the POLSTRAINT map takes the form of a buckled infinity loop as depicted in Figure 4.4 that cycles around the two polar activities of time and cost exploitation.

A closer look at the upsides and downsides of the POLSTRAINT map reveals that the interdependent trade-offs between project time and cost, as discussed in Section 4.4.1.1, in essence constitute the poles of the polarity. The upside of the T↑ pole (Cost not too high) reflects that deviation from the planned budget is minimised by focussing exploitation on schedule flexibility (left pole) rather than on resource flexibility, thereby in effect optimising project cost (C↓). Correspondingly, the upside of the C↑ pole (Time not too long) reflects that deviation from the planned schedule is minimised by focussing exploitation on budget flexibility (right pole) rather than on schedule flexibility, thereby in effect optimising project time (T↓). Over focussing on any pole results in either an excessive schedule (T↑) or budget (C↑) overrun as indicated in the respective downsides of the poles.

The upside of exploiting time (L+) can therefore be depicted as C↓ (optimising project budget), and the downside (L-) as T↑ (excessive schedule overrun). In similar fashion the upside of exploiting cost (R+) can be depicted as T↓ (optimising project schedule), and the downside (R-) as C↑ (excessive budget overrun). It can therefore be stated that the left pole, Exploit Time, indirectly represents the C↓ α T↑ trade-off and that the right pole, Exploit Cost, encompasses the T↓ α C↑ trade-off. It can hence be reasoned that while the system is focussed on the left pole the project will be delivered good (scope achieved) and relatively cheap (C↓) but not fast (T↑), and while the system is focussed on the right pole the project will be delivered good (scope achieved) and relatively fast (T↓) but not cheap (C↑).

The effective management of this polarity through the TRIPOLJECT model endeavours to sustain the benefits of both poles by staying primarily in the two upper quadrants and achieve the higher purpose whilst aiming to minimise the negative aspects in the lower quadrants. This principle is represented in Figure 4.4 by the bubbled convexity of the infinity loop into the upper quadrants, similar to Johnson's virtuous circles concept. It may therefore be argued from a conceptual perspective that by sustaining mainly the 'Cost not too high (C↓)' and 'Time not too long (T↓)' upsides, insinuates that the project can be delivered good (project scope achieved as planned), relatively cheap (budget exploitation optimised) and relatively fast (schedule exploitation optimised).

4.4.2 Second dimension: Time as driver

4.4.2.1 Examining the triple constraint relationships with time as driver

The three primary triple constraint relationships are again repeated hereunder in order to facilitate ease of reference, with the time element highlighted:

1. S↑ α **T**↑ C↑
2. **T**↓ α S↓ C↑
3. C↓ α S↓ **T**↑

Relationship 2 signifies that the project schedule may be shortened (T↓) by either shrinking the project scope (S↓) or by utilising more project resources (C↑). For example, if the exploitation of scope (S↓) is pursued in an effort to reduce the schedule (T↓) then the budget can remain unchanged. This in turn implies that the project will be delivered fast (T↓) and cheap (C fixed as planned) but not good because scope has been cut back (S↓). Similarly, the project may be delivered fast (T↓) and good (S fixed as planned) but not cheap because more resources have been invested (C↑). This implication is in line with the 'good, fast or cheap - pick two' rationale, in that the project can therefore be delivered either fast and cheap, or fast and good, but not fast-and-cheap-and-good. A further interpretation of relationship 2 is that the project schedule may be shortened (T↓) through a combination of both cutting back project scope (S↓) and utilising more project

resources (C↑). This in turn implies that the project will be delivered fast (T↓), but neither good (because S↓) nor cheap (because C↑). This implication satisfies the literature premise that it is highly desirable that at least one element of the project triangle come in as planned (or better than planned) – project time in this case. It can be concluded from relationship 2 that although the exploitation of both weaker constraints (scope and cost) may be beneficial in order to ensure achievement of the driver constraint (time), consideration in particular projects must be given to the benefits of capitalising on the exploitation of only one constraint (scope or cost).

Relationship 3 signifies that in order to optimise project resources (C↓), as a minimum either the scope of the project must be cut back (S↓) or the project schedule must be augmented (T↑). The second dimension of the POLSTRAINT map fixes the project time as the driver constraint that has to be fulfilled as planned. The scope constraint in relationship 3 therefore has to be flexible, i.e. exploited (S↓), in order to reduce project cost (C↓). Relationship 3 thus implies that the project can be delivered cheap (C↓) and fast (T fixed as driver) but not good (because S↓). Congruently relationship 1 connotes that the project can be completed good (S↑) and fast (T fixed as driver) but not cheap (because C↑). Relationships 1 and 3 reaffirm the 'good, fast or cheap - pick two' rationale in that one can either have it cheap and fast, or good and fast, but not good-and-fast-and-cheap. This affirmation is in line with the literature premise that it is highly unlikely to attain all three constraints as planned. It can be concluded from relationships 1 and 3 that in order to deliver the time as planned, interdependent trade-offs exist between the project scope and resources namely: S↑ α C↑ and C↓ α S↓. The significance of this conclusion implies that the exploitation of the two weaker constraints (cost and scope) needs to be appropriately managed in order to achieve a balanced compromise.

With reference to the joint interpretations concluded in the foregoing paragraphs, the three triple constraint relationships insinuate that in addition to completing the project fast (T fixed as driver), the project may also be delivered either good (S↑) or cheap (C↓). It can thus be deduced that in order to ensure the successful achievement of the driver constraint (time), the trade-off between delivering the

project within schedule and scope (fast and good) and within schedule and budget (fast and cheap) needs to be managed, whilst optimising the exploitation of the flexibility within the associated weaker constraint. For example, delivering fast and good requires the exploitation of flexibility within the cost constraint; on the other hand, delivering fast and cheap requires exploitation of flexibility within the scope constraint.

The exploitation trade-off between the cost and scope constraints can also be presented by the seesaw metaphor, and is depicted in Figure 4.5. The interdependent trade-offs between cost and scope are positioned at each end of the seesaw with time remaining pivotal to project success. As already discussed in Section 4.4.1.1, the change of state of the seesaw is a collaborative function of constraining pressure and exploitation weight. For example, exerting more constraining pressure (containment of cutbacks) on the project scope (S↑) may require the exploitation weight (utilisation of flexibility) of the project budget to increase (C↑).

The combination of these two forces (pressure on scope, and weight of additional cost) results in the seesaw to lean towards the left. In other words, the flexibility to increase cost (**C**↑) outweighs the flexibility to cutback on scope (S↓) in this example due to the requirement to constrain (exert pressure on) the project scope (S↑), i.e. restrict cutbacks – thus delivering the project fast (time pivotal) and relatively good (S↑), but not cheap (C↑).

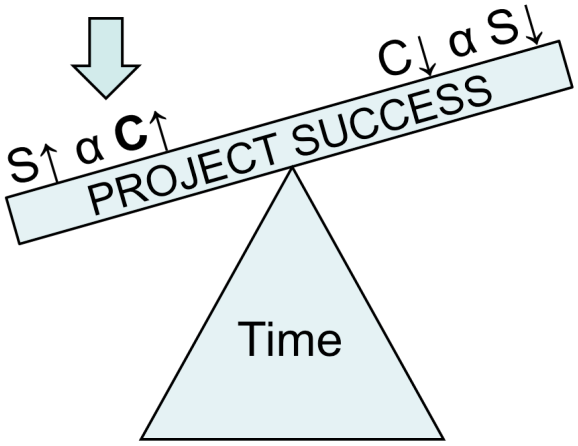

Figure 4.5: Time seesaw with the flexibility of cost outweighing the flexibility of scope

The seesaw will tilt towards the right as more constraining pressure (containment of expenditure) is exerted on the project budget (C↓) and the subsequent exploitation weight (utilisation of flexibility) of the project scope increases (S↓), i.e. increase cutbacks. Considering priorities within the triple constraint hierarchy, the ongoing aim is to find an optimum balance between the cost of delivering the desired schedule and the extent of scope required to accomplish this. Similar to the time vs. cost polarity described in Section 4.4.1, the effective utilisation and efficient compromise between cost and scope can also be optimally managed through the POLSTRAINT map.

4.4.2.2 Constructing the POLSTRAINT map with time as driver

Figure 4.6 depicts the POLSTRAINT map with time as the driver constraint. This map reflects the second dimension of the TRIPOLJECT model. The two flexible constraints in this dimension are increasing cost (C↑) and decreasing scope (S↓). The trade-off between the exploitation of these two constraints constitutes the polarity to manage.

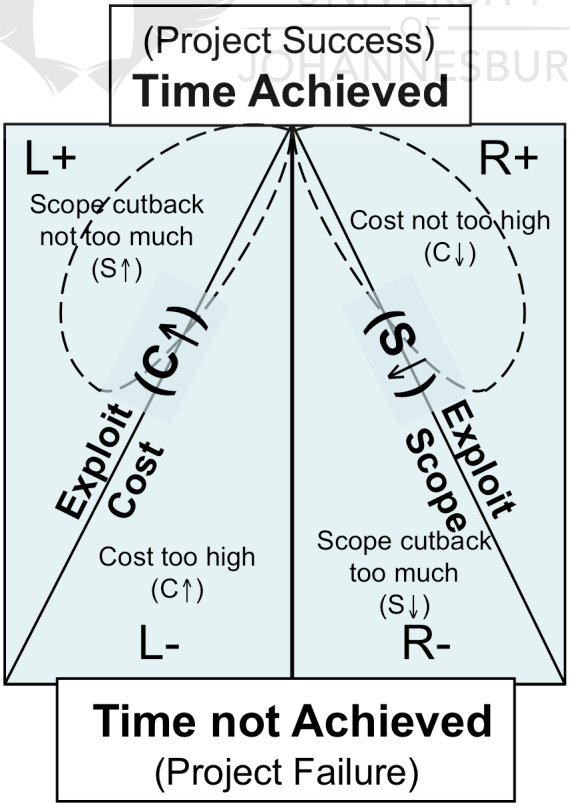

Figure 4.6: POLSTRAINT map: Time as driver (TRIPOLJECT model 2nd dimension)

The two identified poles conform to Johnson's polarity criteria, similar to the time vs. cost polarity described in Section 4.4.1.2, i.e. the constraints are interdependent and the trade-off is ongoing. In this dimension of the TRIPOLJECT model, the success of the time constraint (the driver) is projected as the positive and negative outcome at respectively the top and bottom of the POLSTRAINT map. The left pole represents the exploitation of the cost constraint (C↑) and the right pole represents the exploitation of the scope constraint (S↓). The model encourages maximum exploitation (C↑ and S↓) whilst aiming at managing a balanced compromise in terms of inherent trade-offs.

The upside (L+) from focussing on the C↑ pole is that exploitation of the scope constraint is minimised, i.e. the project scope is contained (Scope cutback not too much). The downside (L-) from over focussing on the C↑ pole to the neglect of exploiting scope is that the project will be too much over budget (Cost too high). The upside (R+) from focussing on the S↓ pole is that exploitation of the cost constraint is minimised, i.e. the project budget is contained (Cost not too high). The downside (R-) from over focussing on the S↓ pole and neglecting to also exploit cost is that the project scope will be too much reduced (Scope cutback too much).

As previously mentioned, the diagonal quadrants of the map constitute opposing forces that drive for a shift from the downside of one pole towards the upside of the other pole. The opposing diagonals within this map are respectively quadrant L- (Cost too high) vs. quadrant R+ (Cost not too high), and quadrant R- (Scope cutback too much) vs. quadrant L+ (Scope cutback not too much). Over focussing on the exploitation of the project budget (the C↑ pole) in an effort to ensure achievement of the driver constraint (time) may eventually result in the benefits of the C↑ pole to dissipate as the system moves into its downside (Cost too high), i.e. excessive budget overrun. This causes an increasing awareness of the absence of the other pole, which in turn drives the action toward the upside of the S↓ pole (Cost not too high) to further pursue exploitation of the project scope rather than the project budget in an effort to ensure achievement of the driver constraint (time) – as the cycle repeats, the inherent trade-offs within the poles become apparent. This dynamic and interwoven flow through the four quadrants of the POLSTRAINT

map takes the form of a buckled infinity loop as shown in Figure 4.6 that cycles around the two polar activities of cost and scope exploitation.

A closer look at the upsides and downsides of Figure 4.6 reveals that the interdependent trade-offs between project cost and scope, as discussed in Section 4.4.2.1, in essence constitute the poles of the polarity. The upside (Scope cutback not too much) of the C↑ pole reflects that deviation from the planned scope is minimised by focussing exploitation on budget flexibility (left pole) rather than on scope flexibility, thereby in effect optimising project scope (S↑). Correspondingly, the upside (Cost not too high) of the S↓ pole reflects that deviation from the planned budget is minimised by focussing exploitation on scope flexibility (right pole) rather than on resource flexibility, thereby in effect optimising project budget (C↓). Over focussing on any pole results in either an excessive budget overrun (C↑) or scope cutback (S↓) as indicated in the respective downsides of the poles.

The upside of exploiting cost (L+) can therefore be depicted as S↑ (optimising project scope), and the downside (L-) as C↑ (excessive budget overrun). In similar fashion the upside of exploiting scope (R+) can be depicted as C↓ (optimising project cost), and the downside (R-) as S↓ (excessive scope cutback). It can therefore be stated that the left pole, Exploit Cost, indirectly represents the S↑ α C↑ trade-off and that the right pole, Exploit Scope, encompasses the C↓ α S↓ trade-off. It can hence be reasoned that while the system is focussed on the left pole the project will be delivered fast (time achieved) and relatively good (S↑) but not cheap (C↑), and while the system is focussed on the right pole the project will be delivered fast (time achieved) and relatively cheap (C↓) but not good (S↓).

The effective management of this polarity is represented in Figure 4.6 by the bubbled convexity of the infinity loop into the upper quadrants, similar to Figure 4.4. It may therefore again be argued, from a conceptual perspective, that the project can be delivered fast (i.e. project schedule achieved as planned), relatively good (i.e. scope exploitation optimised), and relatively cheap (i.e. budget exploitation optimised), by sustaining mainly the 'Scope cutback not too much (S↑)' and 'Cost not too high (C↓)' upsides.

4.4.3 Third dimension: Cost as driver

Details pertaining to the analysis of the third dimension of the TRIPOLJECT model are left up to the readers of this dissertation to derive following the same arguments as in Sections 4.4.1 and 4.4.2.

Figure 4.7 depicts the POLSTRAINT map with cost as the driver constraint and is referred to as the third dimension of the TRIPOLJECT model. The identified polarity to manage in this dimension is the exploitation trade-off between increasing time (T↑) and decreasing scope (S↓).

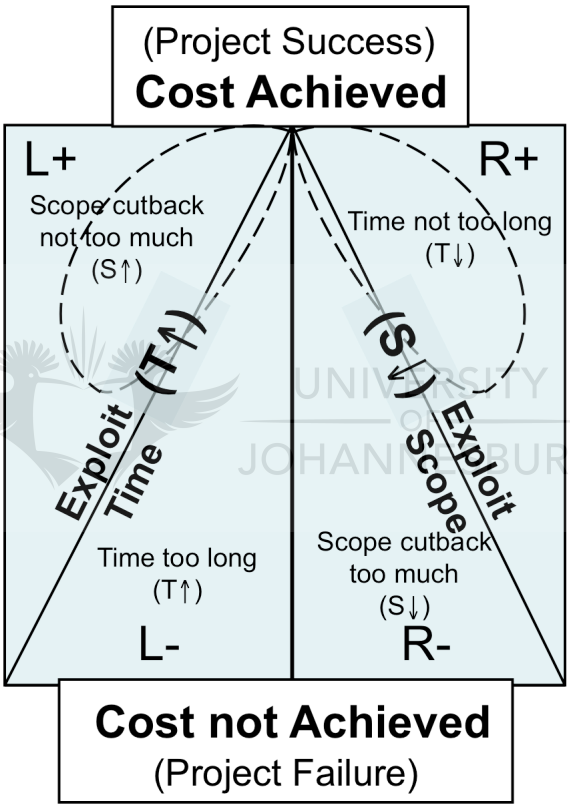

Figure 4.7: POLSTRAINT map: Cost as driver (TRIPOLJECT model 3rd dimension)

Analysis of this dimension yields that while the system is focussed on the left pole the project may be delivered relatively good (S↑) and cheap (cost achieved) but not fast (T↑), and while the system is focussed on the right pole the project may be delivered relatively fast (T↓) and cheap (cost achieved) but not good (S↓). It can thus be deduced that in order to ensure the successful achievement of the cost constraint in this dimension, the trade-off between delivering the project within scope and budget (good and cheap) and within schedule and budget (fast and

cheap) needs to be appropriately managed. Favourable exploitation of the flexibility within the associated weaker constraint may need to be considered, such as to achieve a balanced compromise.

Adhering to the same reasoning as with the other dimensions, the effective management of this polarity translates into achieving the driver constraint (cost), and ultimately the project higher purpose, by sustaining mainly the 'Scope cutback not too much (S↑)' and 'Time not too long (T↓)' upsides whilst aiming to minimise the negative aspects in the lower quadrants. This suggests that the project may be delivered cheap (project budget achieved as planned), relatively good (scope exploitation optimised) and relatively fast (schedule exploitation optimised).

4.5 Integrated framework protocol

4.5.1 Purpose

The integrated framework facilitates a powerful tool that leverages the best of apparent opposites by the inclusion and balancing of both ends of each dimension, which results in win-win solutions. Co-ordination and communication are essential when applying the TRIPOLJECT model. The project team, project sponsor and key stakeholders need to work with close reference to each other in order to achieve the common project goal.

The TRIPOLJECT model aspires to provide the following benefits:

- Encourages close collaboration between the key stakeholders during the planning phase of the project life cycle and effectively leads cross-functional teams along the monitoring and controlling process group.
- Highlights the *raison d'etre*[24] for the project in order to provide a deeper understanding of 'the why' and consequently 'the what' of the project, thereby producing a clear definition of the triple constraint power structure.
- Furnishes a complete picture of the trade-off implications and dynamics within the hierarchy of constraints, which allows for the exploitation trade-off

[24] Raison d'être is a French phrase referring to the most important reason or purpose for existence (Apple Inc. Dictionary Version 2.1.3, Copyright 2005-2009).

to be well understood, appropriately communicated and effectively managed.

- Monitors movement within the triple constraint, which facilitates strategic planning and change anticipation.
- Maintains the project management focus on the higher purpose of the undertaking by ensuring the successful delivery of the primary triple constraint element (the driver constraint) through the optimum exploitation of flexibility within the two weaker constraints.
- Converts the interdependent exploitation between the two more flexible constraints (the weaker constraints) into a resourceful cooperation that supplements each other in an effort to attain the best of both trade-offs.
- Ensures fluid system dynamics by permitting control measures to maintain optimum exploitation efforts and overcome gridlock complications when conciliating the trade-offs, thereby minimising the cost of quality.
- Endeavours to successfully deliver the project 'as good as cheap as fast as it gets' through sustained excellence.

4.5.2 Procedure

The author of this dissertation has expanded Johnson's polarity management process steps and adapted the convention to encompass Dobson's hierarchy of constraints within the project management environment. The proposed ten-step procedure for utilising the TRIPOLJECT model, towards improving the effective management of the triple constraint, is consolidated as follows:

1. Convene a meeting [the project manager] and include the project team as well as key stakeholders.
2. Confirm that the undertaking satisfies the requirements for constituting a project.
3. Identify the higher purpose of the project and review the consequences of not attaining the objectives.

4. Establish the triple constraint elements and describe the scope, time and cost attributes.

5. Analyse the power structure (hierarchy) of the triple constraint.

    a. Determine the least flexible constraint with reference to the project higher purpose, i.e. the driver constraint, which is ultimately the measure of success or failure of the project.

    b. Distinguish the relative flexibility of the remaining constraints, noting that they are not necessarily less important than the driver but certainly more flexible.

6. Acquire a working description of the complete picture by mapping the TRIPOLJECT model.

    a. Confirm the polarity, i.e. specify the interdependence between the two weaker constraints and their constant trade-off.

    b. Populate all four quadrants of the POLSTRAINT map with appropriate information.

    c. Reach agreement between the stakeholders on all four quadrants.

7. Diagnose the system status and dynamism.

    a. Determine the pole and quadrant in which the system is currently located and consider the exploitation weight.

    b. Identify the crusading and tradition-bearing influences within the project.

        i. Ascertain who is crusading, what they are critical of and what they are promoting.

        ii. Ascertain who is tradition-bearing, what they are afraid of losing and what they are afraid the crusade will lead to.

    c. Anticipate complications.

i. Predict resistances, i.e. ascertain where the resistance to those crusading for change will come from.

ii. Predict the consequence of neglecting the concerns of the opposition.

8. Prescribe guidelines to release a stalled system, and predict the learning curve through appropriate communication mechanisms (cross-reference Section 3.6).

9. Prescribe guidelines to manage the trade-offs effectively and define a risk strategy.

   a. Define structures, policies or practices that will ensure fluent system dynamics, e.g. action steps to gain and primarily maintain the positive results of the two upper quadrants.

   b. Identify useful indicators (early warnings) as a measure of change, e.g. red flags that will alert the system when it slides into one of the lower quadrants. The indicators may signal that a valued project objective will not be met or a valued stakeholder will be dissatisfied.

   c. Determine control measures when early warnings are detected and ensure that effective communication channels are in place.

10. Continuously gauge the dynamics within the hierarchy of constraints to identify variances from the project higher purpose so that corrective action can be taken to maintain focus on the driver constraint while aiming to optimise[25] the trade-off compromise and achieve equilibrium.

    a. Establish performance measures for each respective exploitation pole and provide recognition to the project team and/or key stakeholders for good work.

    b. Establish when it is time to interchange the exploitation effort, i.e. to shift focus from one pole to the other.

[25] The flexibility in the weaker constraints is not unlimited since there is always a minimum that must be achieved.

c. Establish productive communication conventions.

4.5.3 Application

Although there may be a growth of applications for the TRIPOLJECT model, the author of this dissertation anticipates the following key practices:

- Project planning.
    - Definition of the project higher purpose; refinement of the project objectives; and categorisation of the triple constraint.
    - Concurrence of the trade-off implications; and contemplation of the anticipated progression through exploration of the working description.
    - Establishment of the performance management attributes; and prescription of the monitoring and controlling mechanisms to address change.
- Project execution.
    - Realisation of the capitalisation strategy to achieve the project objectives; and integration of productive communication protocols.
    - Exploitation of the creative opportunity within the triple constraint; and optimisation of a balanced trade-off compromise.
    - Execution of the conventions to attain and maintain virtuous performance that are aligned with the higher purpose of the project.
- Project monitoring.
    - Assimilation of the triple constraint interactions; diagnosis of the system status in terms of exploitation weight; and assessment of variances from the strategic planning.
    - Verification of the resisting influences within the system; prediction of complications; and anticipation of change.

- Validation of virtuous performance; identification of interchange requirements; and evaluation of the communication mechanisms.

- Project controlling.

  - Acknowledgement of virtuous performance; recognition for good work; and promotion of strategic learning to explore both sides as a means to overcome resistance to change.

  - Negotiation of trade-offs when the exploitation has exceeded or is anticipated to exceed agreed limitations; facilitation of disputes; and recommendation of alternatives to address change.

  - Mediation of corrective action when necessary to ensure fluent system dynamics towards meeting the strategic business goals.

4.6 Integrated framework conclusions

The TRIPOLJECT model (integrated framework) is realised through conceptual synthesis of the TRIJECT model (consolidated triple constraint model) and the POLSTRAINT map (consolidated triple constraint polarity model).

The novelty of the TRIPOLJECT model is evident in that two known concepts, namely polarity management and the triple constraint, are integrated and applied within a new framework and protocol. The model provides a conventional rendering of the triple constraint of scope, time and cost and accounts for the supporting considerations such as project milieu (environment), project strategy (purpose and objectives), project risk (change), project excellence (quality), and project performance (monitoring and controlling).

The model embodies three dimensions, in which each facet of the triple constraint may drive the project. Assessment of the respective dimensions suggests that the driver constraint may effectively be delivered as planned, whilst delivering the remaining constraints optimum relative to the strategic picture. Following this inference throughout all three dimensions of the TRIPOLJECT model, presents a refreshed perspective in terms of the ‘good, fast or cheap - pick [only] two’

rationale. In light of this challenging proposition, the author of this dissertation sets forth for consideration the devised axiom 'as good as cheap as fast as it gets'.

Notwithstanding the idealistic goal to deliver projects within scope, budget and schedule (i.e. good, cheap and fast), the reality of priorities and flexibility within the triple constraint hierarchy needs to be considered. In most projects a power struggle between stakeholders can be expected to make one pole or the other prevail. It is hence not always possible to permit a fluent balancing of the exploitation paradoxes nor is it always possible to gain and maintain the positive results of both upsides. For example, with scope as driver, if the project schedule is more constrained than the project budget, i.e. the flexibility of cost outweighs the flexibility of time, the focus will primarily be on the pole to exploit cost. The project will hence be delivered good and relatively fast, but not cheap. The caveat of primarily focussing on one pole is that the system may progressively shift until the downside of this pole becomes predominant. This in turn may result in the trade-off flow to become blocked and consequently losing the advantages of the exploitation effort. This is typically what happens when the issue is seen as a problem to solve in which those in power are able to keep a focus on one pole to the neglect of the other. The change becomes dysfunctional over time as the other pole is neglected, which in effect leads to first losing the benefits of that pole and then also losing the benefits of the current pole. If either party 'wins', it will thus negatively impact the project.

The aim of the TRIPOLJECT model and protocol is to create an optimum synergy by capitalising on the positive results of the exploitation trade-off for the benefit of the individual parts of the system as a whole. In other words, if the joint exploitation effort can be conducted effectively in obtaining the benefits of both upsides, the combined effort will lead to the sustainment of the drive to progressively fulfil the higher purpose of the project, which will be beneficial for all the stakeholders involved in the system.

The methodology and propositions presented in Section 4.5 are conceptual and have not been trialled in real-time project management scenarios. In practice the framework is expected to overlap and interact dynamically with the project management process groups. According to the PMBOK, the project manager and

the project team are responsible for determining what processes will be employed, by whom, and the degree of rigour that will be applied to the execution of those processes to achieve the desired project higher purpose.

4.7 Chapter closure

Chapter 4 develops an integrated framework (the TRIPOLJECT model) through conceptual analysis of the key aspects inherited from the literature studies and synthesis of the TRIJECT and POLSTRAINT models.

The challenge in this chapter has been to realise a feasible protocol for the integrated framework in terms of purpose, procedure and application, from a highly conceptual model. The main conclusions of this chapter are summarised in Chapter 6.

By addressing the research questions identified in Section 1.4.3, the following primary objective of this study has been achieved as specified in Section 1.5, i.e.:

- Develop a framework and methodology that integrate the polarity management approach as part of the hierarchical rationale of the triple constraint, which facilitate the management of flexibility within the triple constraint to optimise the delivery of project success.

The feasibility of the TRIPOLJECT model is explored through a simple case study analysis in Chapter 5.

CHAPTER 5 CASE STUDY ANALYSIS

5.1 Chapter overview

Chapter 5 explores the practicality and appropriateness of the integrated framework (TRIPOLJECT model and methodology), derived in Chapter 4, through simple case study analysis.

The chapter begins by describing the case study approach followed by the case study assessment. The chapter concludes by discussing the observed facts and salient points in support of the research rationale.

5.2 Case study approach

The case study analysis is limited to the exploratory review of the integrated framework against a simplified real-world case.

In the interest of brevity, the case study is condensed and the exploration is presented in a narrative format that integrates key information around the focus of the study. The approach taken is more analytical and conceptual rather than descriptive, and case information is limited to central particulars.

The following case study structure is followed:

1. Case overview.
    a. Project mission.
    b. Triple constraint definition.
2. Case analysis.
    a. Triple constraint hierarchy.
    b. Operational description.
    c. System diagnosis and dynamics.
3. Case recommendations.

a. Guidelines to anticipate change and ensure system flow.

b. Guidelines to effectively manage the exploitation trade-offs.

A concluding discussion of the case study analysis is provided at the end of this chapter.

5.3 Case: Smithsonian Institution, National Air and Space Museum

This case, adopted and integrated from Dobson (2004: 21-27) and Dobson & Feickert (2007: 59-65), illustrates the second dimension of the TRIPOLJECT model, i.e. Time (T) as the driver (least flexible) constraint, and scope (S) and cost (C) as the weaker (more flexible) constraints.

5.3.1 Case overview

The Smithsonian Institution had its first brush with flight in 1876, when the Chinese Imperial Commission donated a number of kites following the close of the Philadelphia Centennial Exposition. There would be many more. The third Smithsonian secretary, Samual P. Langley, was a pioneer of early aviation and inventor of the Langley Aerodrome, which failed in a catapult accident about two months before the Wright Brothers flew successfully at Kitty Hawk in 1903. As early as 1915, the fourth Smithsonian secretary, Charles Walcott, proposed a separate museum for aeronautics.

Paul E. Garber, who joined the museum staff in 1919, rose to become Assistant Curator of a newly formed Section of Aeronautics within the Smithsonian's National Museum of History and Technology in 1933. A growing collection of aircraft was housed in the old Arts & Industries building and in a hangar fronting on Independence Avenue known as the Aircraft Building, which was where the famous Liberty Engine had been designed.

It was not until 1946 that the National Air Museum[26] became a separate museum within the Smithsonian structure, with Garber as its first Assistant Director for

[26] The name was changed in 1966 to the National Air and Space Museum, or NASM.

Aeronautics. The first proposal for a building for the museum was made in 1953. Nothing came of it, nor of a proposal made as part of a comprehensive redevelopment plan for southwest Washington D.C., later in the 1950s. In 1966, Congress authorised plans for the new building, with Gyo Obata of Helmuth, Obata and Kassabaum as the designer. The project also came to a halt, with funding delayed as a result of the Vietnam War.

By 1971, inflation had made the approved original design prohibitively expensive, so Obata had to redesign the project to stay within the $40 million congressional appropriation; address the huge challenges of a building that would fit on the National Mall (and pass the various approval hurdles); accommodate the expected traffic; and handle the large aircraft and spacecraft that were to be displayed.

Also in 1971, Apollo 11 command module pilot Michael Collins was named director of the museum. In 1972, ground was broken for a brand new building on the Mall, planned for opening on July 4, 1976, the nation's Bicentennial celebration. This would be by far the largest project ever tackled by the museum, and the entire staff, augmented for this special project, focussed all its energies on the fast-approaching deadline.

5.3.1.1 Project mission

It should be noted that the National Air and Space Museum as an institution does not constitute a project because it is not a temporary endeavour, even though it offers a unique product and service. The work of the NASM involves maintaining its collections of air and spacecraft and associated artefacts and serving as a research centre for the history, science and technology of aviation and space flight. This work is not a project, although projects may certainly be done within the mission. There is nothing temporary, no ending and no conclusion to the process. Building the museum on the Mall, however, is a project because that activity does come to an end and that particular project does not have to be done again.

The mission, essentially, was to build a world-class aviation and space museum for a budget of approximately USD 40 million and open it on July 4, 1976. There is a defined end and the project is clearly temporary in nature. A key part of the Smithsonian's ability to get congressional funding unlocked for the project involved

the national focus on the upcoming Bicentennial celebrations. National attention would be focussed on Washington, D.C., and the National Mall during the festivities, and the President of the United States would be on hand to cut the ribbon[27].

5.3.1.2 Triple constraint definition

The project mission statement satisfies the triple constraint, which is defined as follows:

- Time constraint = July 4, 1976
- Cost constraint = USD 40 million
- Scope constraint = World-class aviation and space museum

5.3.2 Case analysis

5.3.2.1 Triple constraint hierarchy

The consequences of missing the Bicentennial would have been hugely humiliating for the Smithsonian and for the National Air and Space Museum team. The time constraint can thus be tentatively assigned in the lead position as the driver for this project. The assignment is tentative at this stage because further analysis of the other constraints may result in a change of perspective. Before settling on the driver, the critical question of why this project is being undertaken needs to be reviewed.

The term 'world-class' may constitute a variety of potential meanings, each with different consequences for time and cost. For example, how many air and spacecraft should hang in the new building, or how complicated should the audiovisual exhibits be. Again, the distinction between the work of the NASM and the project of the NASM needs to be considered. The project ends, but the work is ongoing. What must be done to meet the demands of opening day is only a prelude to the indefinite lifespan of the open museum. It can therefore be argued that the scope constraint, although probably the most important, is also the most

[27] Actual opening day was shifted from 4 July to 1 July and the ribbon was cut by a robot arm triggered by a signal from Viking 1, then approaching Mars.

flexible. Since importance is the relative merit of the constraint considering the long-term value of the project and flexibility is the extent to which the constraint can be manipulated to get the job done, as previously cited, the constraints should be ranked by flexibility and not by importance. By that standard, the scope constraint may therefore be judged to be the weak (most flexible) constraint for this project.

The USD 40 million federal appropriation is a definite number, but not an exact one. Major construction projects often have a contingency reserve of up to 10 % of the budget for change orders and other problems. If the project had ended up anywhere in the range of ± 5 %, it would probably have been considered acceptably close to target. Considering flexibility and following the process of elimination, cost may be identified as the middle constraint for this project.

The power structure of the triple constraint for this project is concluded as follows in order of increasing flexibility:

1. Time as the driver constraint (the least flexible constraint and ultimately the measure of failure or success of the project).
2. Cost as the middle constraint (relatively flexible constraint).
3. Scope as the weak constraint (the most flexible constraint but not necessarily the least important).

5.3.2.2 Operational description

Following the determination of the project mission as well as the power structure of the triple constraint, the TRIPOLJECT model outline for this project can be constructed as illustrated in Figure 5.1. This chart reflects the second dimension of the TRIPOLJECT model.

The exploitation polarity to manage is the trade-off between the exploitation of the USD 40 million budget (the cost constraint), and the requirements / features that constitute a world-class museum (the scope constraint). The two identified poles conform to Johnson's polarity criteria, i.e. the constraints are interdependent and the trade-off is ongoing. The success of this project is driven by the deadline (the

time constraint) to open the museum on the nation's Bicentennial celebration July 4, 1976 in order to attain national focus (the higher purpose).

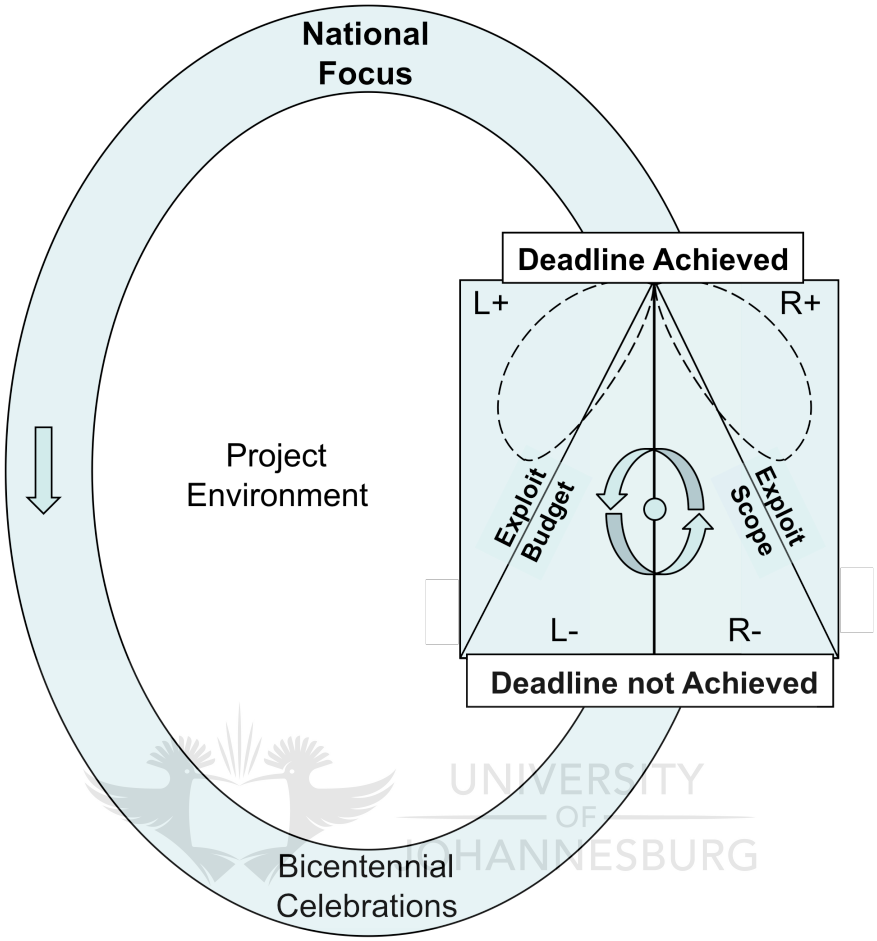

Figure 5.1: TRIPOLJECT model chart for the NASM case

Exploitation of the project budget (C↑) alleviates the pressure to rollback on the museum's scope requirements, and supplements the effort to ensure that the deadline for opening the museum is met (more money and resources can be spent to get the same or more work accomplished within a limited period of time). The cost constraint includes both cash and non-cash resources. Resources can, for example, allow the National Air and Space Museum team to pursue multiple options simultaneously in order to speed up critical project activities. It is also useful to determine the degree of appropriation flexibility that is acceptable. With this particular project the political environment may also be advantageous as well as the influence of key stakeholders in order to exploit the full potential of the congressional appropriation to ensure that the deadline is met. Successful exploitation of the budget constraint (additional money and resources) may also

ensure that the museum complies with the world-class requirement in terms of artefacts and exhibits, thus controlling (optimising) the project scope. Additional money and resources also improve capability and mitigate risk. Over focussing on the exploitation of cost and resources may however lead to an adverse increase in overall project cost and resistance from Congress. Complications may also include an adverse effect on capability and risk, due to added resources and complexity, and neglecting the benefits of exploiting scope towards achieving the deadline. The law of diminishing returns, in terms of schedule impact, should also be considered when cost and resources are added.

Exploitation of the project scope (S↓), on the other hand, alleviates the pressure to add additional cost and resources to the museum budget, but also supplements the effort to ensure that the deadline for opening the museum is met. Exploiting flexibility in the scope constraint should however not compromise quality, i.e. the museum's world-class criteria, which Congress values. One mechanism for exploiting the scope of the museum building programme is to downsize selected objectives and quality metrics that do not add customer value. There are certain air and spacecraft of such overwhelming historical significance, for example the Spirit of St. Louis, that they must be displayed, but after those have been accounted for there are numerous candidates for the remaining space. In addition to historic and popular significance, it is proper to consider how much shop time the artefacts need before they are in a displayable condition; how expensive it will be to house them; and other practical issues. If troublesome issues come to light in the restoration of a particular artefact, it may be possible to replace it with another one (if early in the project) or even drop it (if late in the project). Audiovisual exhibits are another consideration where the project scope can be exploited (trimmed) since these exhibits add complexity, cost, time and staff to the project. Whilst satisfying the word-class requirement, limitations can be placed on the number of exhibits and inoperative ones can even be stored away to get past opening week. None of these mechanisms are inconsistent with a strong focus on quality. Successful exploitation of the scope constraint (downsizing scope) may also ensure that cost remains within the USD 40 million federal appropriation, thus containing (optimising) the project budget. Over focussing on the exploitation of scope (cutbacks), however, may result in the museum not complying with a world-

class standard, for example too few significant artefacts and/or exhibits. Complications may also include the risk of sacrificing entire elements of the programme, compromising quality and neglecting the benefits of exploiting cost towards achieving the deadline.

In order to facilitate presentation, the quadrants (L+ L- R+ R-) of the POLSTRAINT map are detailed in a simplified format in Table 5.1. The contents of these quadrants represent the respective quadrants of the POLSTRAINT map.

<table>
<tr><th colspan="2">Deadline Achieved</th></tr>
<tr><td>L+
Effective exploitation of cost (additional money and resources to save time).
Ensure a world-class aviation and space museum.
Scope cutbacks limited.
Ensure that the most significant artefacts are restored and displayed.
Ensure that appropriate audiovisual exhibits are in place.</td><td>R+
Budget overrun limited.
Effective exploitation of scope (cutbacks to save time).
Save restoration time and cost by limiting the number of air and spacecraft for the initial opening.
Trim back on complicated audiovisual exhibits.</td></tr>
<tr><td>Exploit Budget (C↑)</td><td>Exploit Scope (S↓)</td></tr>
<tr><td>Total project cost excessively over budget.
Exceeding the limit where additional resources can effectively be applied (law of diminishing returns).
Not attaining the benefits of also exploiting the scope requirements.
Increased restoration time and cost due to numerous artefact restorations.
Added time and cost due to complex audiovisual exhibits.
L-</td><td>Not attaining the benefits of also exploiting the budget.
Not delivering a world-class aviation and space museum due to excessive scope cutbacks.
Not displaying adequate classical air and spacecraft.
Lack of appropriate audiovisual exhibits.
R-</td></tr>
<tr><th colspan="2">Deadline not Achieved</th></tr>
</table>

Table 5.1: Simplified POLSTRAINT map for the NASM case

The respective opposites in the downside of one pole and upside of the other pole are evident from Table 5.1 and provide an indication of the expected flow through the POLSTRAINT map. For example, 'Not displaying adequate classical air and spacecraft' (R-) is opposed by 'Ensure that the most significant artefacts are restored and displayed' (L+); and 'Increased restoration time and cost due to numerous artefact restorations' (L-) is opposed by 'Save restoration time and cost by limiting the number of air and spacecraft for the initial opening' (R+).

The premise of the TRIPOLJECT model is that the deadline of this project can be ensured by primarily focussing on the positive aspects of both poles through an integrated exploitation effort, whilst avoiding the respective downsides of each pole.

5.3.2.3 System diagnosis and dynamics

It can easily be argued that the system is initially located in the right pole since it is simpler to manipulate the 'world-class' scope requirements than it is to exploit the congressional budget. Considering the flexibility of the two poles, the time seesaw as discussed in Section 4.4.2 will lean towards the right since the flexibility of the scope requirements outweighs the flexibility of the budget in the NASM case. The risk, however, is that over focussing on the exploitation of the scope requirements may eventually result in the benefits of this pole to dissipate as the system moves into its downside (R-). This down shift can conceptually be illustrated by superimposing the polarity map over the tilted seesaw as indicated in Figure 5.2.

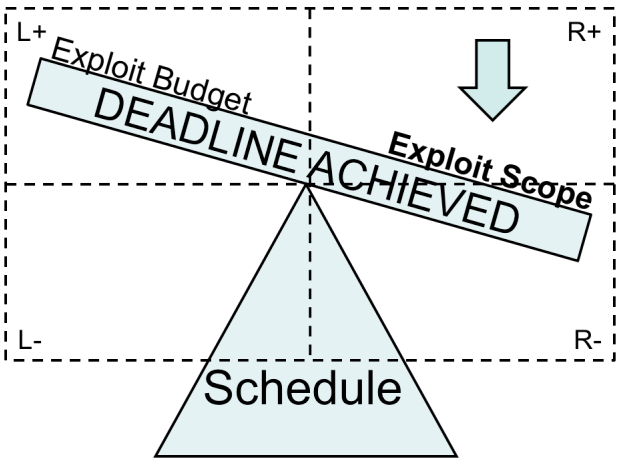

Figure 5.2: Seesaw model for the NASM case

As the negative results of over focussing on the exploitation of scope are being experienced, an increasing awareness of the absence of the other pole (budget exploitation) develops. This awareness is attracted by the opposing diagonal solution and drives the system for a shift to the positive results of exploiting the budget. This shift will only be possible if the focus of exploitation shifts by sliding the exploitation weight up the seesaw from R- to L+ in an effort to balance the system. The cycle will repeat as the trade-offs are compromised and the exploitation weight shifts.

Within the context of the NASM case, the crusaders can be identified as those project representatives whom are passionate for the world-class element of the museum and whom are critical of cutbacks on artefacts and exhibits. These crusaders are disapproving of scope exploitation and identified its disadvantages (R-) as the problem. They are promoting the advantages of exploiting the budget (L+) as a perceived solution to the problem. The crusaders treat the perceived dilemma as a problem to solve and are crusading for exploitation change.

The tradition-bearers can be identified as those project representatives whom are more focussed on cost saving and efficient utilisation of the USD 40 million federal appropriation. These tradition-bearers are afraid of loosing the congressional funding and thus holding on to the advantages of scope exploitation (R+). They are disapproving of budget exploitation and are concerned that a crusade will lead to the disadvantages of exploiting the budget (L-). Tradition-bearers treat the perceived dilemma as a problem to avoid.

Another important aspect of analysing the project via the TRIPOLJECT model is to anticipate resistance and complications. With a clear description of the POLSTRAINT map quadrants (Table 5.1) it is relatively simple to predict certain outcomes. From the NASM case it is apparent that the resistance to those crusading towards conserving scope requirements, and rather pursue additional money and resources to ensure the deadline is met, will come from the tradition-bearers whom are focussed on containing the budget and rather exploit scope to ensure the deadline is met. If the crusading group however ‘wins’ and the concerns of those who are tradition-bearing are completely neglected, the system will transition into the negative results of quadrant L-. The project may be

completed substantially over budget, and the project schedule may also be expected to slip due to the restoration of additional artefacts and the incorporation of complex exhibits. Similarly, if the tradition-bearing group 'wins' and the concerns of those who are crusading are neglected, the negative results from quadrant R- will be prolonged. The project may not deliver a world-class aviation and space museum, with inadequate artefacts and exhibits.

5.3.3 Case recommendations

5.3.3.1 Guidelines to anticipate change and ensure system flow

The predicted resistances and complications could be mitigated through the process of helping the project representatives to anticipate the learning curve and ensuring support in advance. A prior agreement must be negotiated with those project representatives valuing budget conservation and promoting scope exploitation (the tradition-bearers) to:

- Hold on to the positive results of scope exploitation (R+); and to
- Allow some slack and tolerate to some degree the anticipated negative results of the proposed budget exploitation efforts (L-); in order to
- Gain the benefits of exploiting the budget (L+).

Through this process the chances of sustaining the effort to gain the benefits of the other pole are greatly enhanced, since the focus on either pole alone will generate its own resistance and is not sustainable.

When the system moves into the downside of scope exploitation, the normal flow (dynamic infinity loop) is expected to be towards the upside of budget exploitation. It is however possible that considerable resistance may be experienced in an effort to transition the system via the normal infinity loop from R- to L+ due to the tradition-bearers holding on to their value of cost saving and avoiding their fear of an excessive budget overrun – the system effectively becomes stuck. The flow can be unlocked by affirming the values and fears of those resisting by effectively reversing the flow (moving from R- to R+ to L- to L+). In order to achieve this, the NASM project manager has to systematically address the following aspects with

those project representatives whom are afraid of losing the congressional funding and thus holding on to the perceived advantages of scope exploitation (the tradition-bearers):

- Recognise the value of conserving the budget and trimming back on artefacts and exhibits (R+), i.e. the project manager must let the tradition-bearers know that he/she is aware of this quadrant and, like them, wants to preserve it;

- Recognise the legitimate concern that exploiting the budget too much could lead to an excessive budget overrun as well as schedule slippage (L-), i.e. the project manager must let the tradition-bearers know that he/she is aware of the problems they have identified with this pole and, without ignoring this downside, is excited about the positive aspects of the upside;

- Raise the question how the benefits of exploiting the budget can be obtained (L+) and seek the necessary support for this change while offering support to also hold on to the benefits of exploiting the scope, in order to ensure achievement of the common goal – i.e. achieving the Bicentennial celebration deadline.

- Only if necessary, reflect on the downside of over focussing on the exploitation of scope and identify some of the problems that have become evident (R-), for example the risk of not delivering a world-class museum due to excessive scope cutbacks and due to a very tight budget.

The objective is the ongoing, effective management of the budget vs. scope exploitation trade-off by benefitting primarily from the positive results of the two upper quadrants (L+ and R+) in an effort to ensure that the driver constraint (schedule) is met, thus delivering the project fast as well as relatively cheap and relatively good. In order to achieve this, the time spent in the lower quadrants (L- and R-) should be minimised. This principle can graphically be represented by the dynamics of the seesaw metaphor depicted in Figure 5.3.

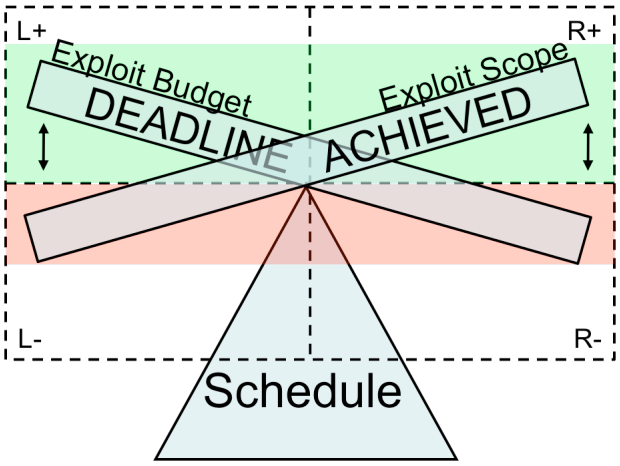

Figure 5.3: Effective management of the NASM case

The goal is to primarily spend time in the green zone (the upsides of the seesaw) and minimise the time spent in the red zone (the downsides of the seesaw) through the optimum management of the exploitation trade-off.

5.3.3.2 Guidelines to effectively manage the exploitation trade-offs

In order to effectively manage the exploitation trade-off polarity, the project manager needs to put measures in place to ensure that the project primarily benefits from the positive results (green zone) of the POLSTRAINT map and that the negative results (red zone) are avoided.

The project manager needs to consider each of the positive results in the upper quadrants and define how to gain or maintain the positive results. In order to effectively exploit the budget, the project team needs to be well acquainted with the mechanisms of project cost management and the techniques to effectively exploit resource flexibility to uncover hidden resources. Considerations to obtain and sustain the positive results of the L+ quadrant, as listed in Table 5.1, include:

- Find out what degree of budget overrun will be acceptable.
- Find out if contingency funds are available.
- Investigate if additional staff and equipment can be borrowed.
- Determine which costs will not be charged to the project.

- Establish how political influence can be achieved in order to pursue budget flexibility.
- Examine the consequences that the various interpretations of the 'world-class' requirement may have on the project.
- Reach a common understanding with the stakeholders on the importance they place on the delivery of each scope requirement, and ascertain the 'must-have's' and 'should-have's'.
- Identify the air and spacecraft which posses overwhelming historical significance.
- Discern how time and cost of artefact restorations can be optimised.
- Determine the appropriate requirement and level of complexity for the museum's audiovisual exhibits.
- Take the law of diminishing returns into consideration.

In order to effectively exploit the scope requirements, the project team needs to be well acquainted with the mechanisms of project scope management and the techniques to effectively exploit scope flexibility with minimal project impact. Considerations to obtain and sustain the positive results of the R+ quadrant, as listed in Table 5.1, include:

- Establish effective and proven practices to efficiently manage and control the project budget.
- Identify those aspects of the project scope requirements that are not quality related.
- Target areas for exploitation where scope creep is detected.
- Reach a common understanding with the stakeholders on the importance they place on the delivery of each scope requirement, and ascertain the could-have's and would-have's.

- Ensure that the 'world-class' criterion is not dismissed due to excessive artefact and exhibit cutbacks.
- Investigate where initial objectives may be downsized, for example lowering the planned number of air and spacecraft for opening day.
- Discern how time and cost of artefact restorations can be optimised.
- Determine quality metrics that do not add customer value, for example trimming back on complicated audiovisual exhibits.

A risk strategy is also required. The project manager needs to consider each of the negative aspects in the lower quadrants and define indicators that will alert the project team when the project dips into the red zone of negative results in order to avoid spending unnecessary time in these downsides. Red zone indicators (early warnings) when the project falls in the L- quadrant of Table 5.1 include:

- Resistance from Congress regarding the increased project cost.
- Spending additional money and resources have reached the point where it no longer adds value to the project schedule, i.e. recognising the law of diminishing returns.
- Artefact restorations and audiovisual exhibits fall behind schedule.

Red zone indicators (early warnings) when the project falls in the R- quadrant of Table 5.1 include:

- The 'world-class' requirement of the museum comes into question.
- Criticism regarding the appropriateness of artefacts and degree of exhibits.

The project manager needs to monitor the dynamics within the triple constraint power structure throughout the life cycle of the project, in order to identify variances from the project strategy and implement corrective action as required. Sound communication provisions are imperative.

5.4 Case study conclusions

The integrated framework (the TRIPOLJECT model) provides a simplified methodology and practice with clear guidelines to project managers.

Success in the NASM case study is driven by achievement of the project deadline, which defines time as the driver constraint. Application of the integrated framework on this case illustrates how to manage the optimum exploitation between the cost and scope requirements towards project success. The competing and conflicting demands in this case reflects a classic example of the tensions described by the triple constraint.

The NASM project representatives have been classified in two categories, namely the crusading stakeholders and the tradition-bearing stakeholders. The crusaders are passionate regarding the world-class element of the NASM and treat the trade-off as a problem to solve. The tradition-bearers, on the other hand, are more focused on cost saving and efficient utilisation of the project budget, and treat the trade-off as a problem to avoid. In the NASM project the budget is however more constraining than the scope requirements, i.e. the flexibility of the project scope outweighs the flexibility of the project cost.

An important aspect of analysing the NASM project via the TRIPOLJECT model is that it provides project managers with the opportunity to anticipate these resistances and complications, and also take note of the learning curve, which follows change. When the larger picture is clear for both parties, agreement can be negotiated that will transform resistance to resourceful opportunity. This in effect ensures fluent trade-off dynamics with minimum stagnation scenarios.

In order to effectively manage the exploitation effort, the project manager needs to put measures in place to ensure that the project benefits from the positive results (green zone) of each trade-off, and that the negative results (red zone) are avoided, which in effect may reduce the cost of quality. The project manager needs to consider each of the advantages in the upper quadrants and define how to obtain it. The project manager also needs to consider each of the disadvantages in the lower quadrants, and define early warnings that will alert the project team when the project slips into the red zone. By focusing on the positive

aspects of both poles, the motivation will be high amongst the project representatives, which are further augmented by having specific performance measures in place and providing recognition when needed to team members. As project management is a dynamic environment, this approach should ensure that the project manager is continuously taking corrective action when needed to avoid pitfalls while establishing and maintaining good communication paths between all involved.

It can be concluded, through conceptual and corroborative observation, that the integrated framework does provide the proposed benefits as discussed in Section 4.5.1 by following the procedure as stipulated in Section 4.5.2. It has also been observed that the TRIPOLJECT model provides a constructive mechanism to circumvent project failure and promote project success by:

- Underlining the project mission and encouraging a motivated project team.
- Prioritising and aligning the triple constraint with the project higher purpose.
- Presenting the complete picture and providing a structured understanding of the exploitation trade-off dynamics.
- Anticipating resistance and interchanging the exploitation emphasis as required.
- Capitalising on the integrated exploitation trade-offs of both poles and striving for a balanced compromise.
- Employing risk strategies for monitoring and controlling virtual (green zone) as well as vicious (red zone) performance.
- Implementing productive communication and reporting between key stakeholders.
- Adapting tactics as required and maintaining focus on the ultimate goal.

The advantages of employing the integrated framework are clear. The discipline of the TRIPOLJECT model, within the context of this case study, has been demonstrated to provide the tools and techniques that enable the project team to

organise and manage their work, in order to meet the absolute requirements of the project. In the case of the NASM project, this may imply that the project can be delivered fast (deadline achieved) as well as relatively good and relatively cheap (exploitations optimised). The exploration of policies and practices, which will ensure a well-managed exploitation trade-off polarity, needs to evolve as the project progresses. The methodology will become more efficient as the project team becomes more familiar with the dynamics of the TRIPOLJECT model.

The considerations and indications defined under this section are merely a simplified summary of the NASM case analysis in order to facilitate a conceptual understanding of the integrated framework in practice. There is no claim that this case is representative of the general project management milieu.

5.5 Chapter closure

Chapter 5 explores the applicability and feasibility of the integrated framework (TRIPOLJECT model and protocol) against a simplified test case to indicate that the derived model and methodology are supported by the research.

The challenge in this chapter has been to demonstrate the full protocol of the integrated framework within a viable project management scenario.

The chapter concludes with a consolidation of the case study analysis results. The main conclusions of this chapter are summarised in Chapter 6.

The goal of the research study, as specified in Section 1.5 in support of the primary objective, has been achieved via the case study analysis, i.e.:

- Show that the integrated framework (theoretical model and methodology) is valid and feasible for solving the generic problem addressed in Section 1.4, i.e. to improve the interpretation of the triple constraint trade-offs and dynamics in an effort to advance the effective and strategic management thereof.

The main conclusions and recommendations of the research study are presented in Chapter 6.

CHAPTER 6 CONCLUSIONS AND RECOMMENDATIONS

6.1 Chapter overview

Chapter 6 presents the key findings from the literature studies, and summarises the main conclusions in terms of the integrated framework.

The larger relevance and value of the study is discussed, followed by the identification of limitations as well as recommendations regarding further research.

6.2 Summary of literature study findings

6.2.1 Main findings from literature study part one

The main findings of the project management triangle literature study (Chapter 2) are:

1. Projects strive to produce outcomes that yield beneficial change. The growth spurt in terms of complexity and competing demands across the diversity of emerging projects necessitates structure and guidance in terms of management. The rationality for undertaking a project should be clearly defined and understood by all stakeholders.

2. The project life cycle constitutes a logical sequence of activities to deliver the project objectives and attain the higher purpose. The project management process groups are integrated as part of the project life cycle phases and provide mechanisms to effectively manage the project. The project manager is responsible to strategically monitor and direct the project performance in line with the project higher purpose during the life cycle of the project.

3. The measures and criteria in terms of project success extend over a range of interpretations. There exists no simple or definitive basis for project failure. Key considerations that are highlighted within the context of this dissertation include: project manager; planning; purpose; triple constraint; quality; change; communication; monitoring and controlling; and

improvement. Effective projects deliver the essential project objectives and add value through the achievement of the project higher purpose.

4. The triple constraint is a critical project management concept. The triple constraint introduces limitations and influences the management of the project. The triple constraint is driven by strategic change and stakeholder expectations towards the achievement of the project objectives and higher purpose.

5. Project scope (S), time (T) and cost (C) constitute the key elements of the triple constraint. Project time addresses the scheduling and duration of the project. Project cost addresses the budget and resources of the project. Project scope addresses the requirements and work of the project. The concepts of quality, customer satisfaction, performance and risk have an impact on the triple constraint, but do not inherently constrain the project. Quality takes root in all three properties of the triple constraint. The cost of quality can be minimised through appropriate detection, correction and prevention mechanisms.

6. The triple constraint constitutes one of the primary building blocks of the project plan and is paramount to the monitoring and controlling process group. The cause and effect of new or changing triple constraint demands need to be constantly negotiated during all phases of the project. The project triangle is a useful model to illustrate the consequences of change on the triple constraint to key project stakeholders. The project triangle reflects the characteristic that the three key elements of the triple constraint are interdependent. Change within the project triangle is compensated through proportional trade-offs.

7. The trade-off dynamics inherent to the triple constraint may be described by the following key relationships:

    a. Relationship 1, S↑ α T↑ C↑, which signifies that scope targets can be delivered at the expense of time and/or cost targets.

b. Relationship 2, T↓ α S↓ C↑, which signifies that time targets can be delivered at the expense of scope and/or cost targets.

c. Relationship 3, C↓ α S↓ T↑, which signifies that cost targets can be delivered at the expense of scope and/or time targets.

8. The impact on the triple constraint trade-off dynamics needs to be differentiated in terms of pressure and flexibility. A balanced trade-off needs to be negotiated as a function of the project goal in order to optimise project success. It is not commonplace to deliver the triple constraint exactly as planned. Projects may be delivered either good and cheap, or good and fast, or fast and cheap, but customarily not good-and-cheap-and-fast. The project manager requires a clear notion of the competing demands inherent to the triple constraint, and needs to realise effective communication channels to plan for risk and manage change, and facilitate collaboration between the key stakeholders.

9. The triple constraint can be creatively exploited to improve project performance by considering relative flexibility between the elements. The triple constraint can be prioritised into a power structure by ranking the elements into a hierarchy of flexibility. The power structure derives from the project basis and may be influenced by environmental change during the life cycle of the project. The primary triple constraint element, the driver constraint, is the least flexible of the three elements and constitutes a key measure of project success. Exploitation of flexibility in the weaker (more flexible) constraints can be used as a mechanism to achieve the essential demands of the driver constraint.

10. Projects should deliver to a much greater extent in terms of value than the sacrifice of the exploitation effort. There are always minimum expectations and essentials regarding each triple constraint element that must be achieved or delivered. Consumer needs and project excellence should not be compromised.

11. Investment in project human resource management is essential to ensure a motivated and committed project team with a clear vision of the project

goal. Inventiveness, motivation and commitment are important project team trades in order to ensure effective exploitation and to realise opportunity.

6.2.2 Main findings from literature study part two

The main findings of the polarity management literature study (Chapter 3) are:

1. The ongoing strain between paradoxical dualities can lead to discouragement and destructive change if the dilemma is not appropriately managed. Some simultaneous contradictions do not necessarily provide for an absolute solution and are better comprehended as polarities to manage.

2. It is not feasible to approach chronic dilemmas in the traditional sense as 'problems to solve' when the dilemma is interdependent and continuous. Polarities to manage distinctly differ from problems to solve. Polarities are not mutually exclusive, and comprise of interdependent oppositional elements with an indeterminate solution that needs to be managed over time.

3. In order to appreciate paradoxical change it is essential to obtain the complete perception of the dilemma through willingness to temporarily let go of one perspective and to invest into acknowledging the oppositional view. Polarity management supplements the 'either/or' approach with the 'both/and' mindset in which the power of contrast is harnessed within the duality by holding on to the benefits of both poles whilst appreciating their drawbacks – the challenge is to manage an optimum synergy.

4. The polarity map provides an operational portrayal of the dilemma under review and ensures a user-friendly structure for managing the polarity. The polarity map exposes the values and fears of each pole and highlights the desired outcome. The interrelated opposition in the map is evident within its diagonals where the downside of one pole constitutes the antithesis of the upside of the other pole. The attraction inherent to the diagonals reflects the interdependent nature of the dilemma in that each pole requires its opposition in order for it to be sustainable over time.

5. The opposing attractions within the diagonals of the polarity map exist as a result of the perceptions that the downside of one pole is a 'problem' and the upside of the other pole is a 'solution'. Over focussing on one pole to the neglect of the other pole ultimately results in the benefits of the present pole to dissipate as its disadvantages are progressively experienced. This subsequently provokes an increasing attraction towards the benefits of the opposing pole. The perpetual and interwoven cycle (the infinity loop) of alternating emphasis through the quadrants of the polarity map serves to predict outcomes.

6. Two competing forces are prominent within the dynamics of polarity management. The tradition-bearing force anticipates the dilemma as a problem to be avoided, whilst the crusading force perceives the dilemma as a problem to be solved. The limitation of each force, when viewed in isolation, is that only partial aspects of the dilemma are highlighted, which creates an incomplete perception of the dilemma. The diagonal sections of the polarity map may then be perceived as 'either/or' problems to solve, which manifest resistance. The rivalry between the tradition-bearing and crusading forces is central to the dynamics of polarity management. These two influences introduce oppositional energy into the system and need to join forces in order to gain the benefits of both poles.

7. As a result of retaining values and avoiding fears, a system may often become stuck in the downside of a pole and the normal flow to the opposite upside may become blocked as the resistance effectively holds on to the incomplete picture of the dilemma. Resistance may paradoxically become a resource for movement through harnessing the oppositional energies. This is achieved by acknowledging the values and fears of the change resistance, thereby countering the normal flow in the polarity map and securing the complete picture. A key to change sustainability is to predict the challenges and complications of the movement, thus envisioning the learning curve and obtaining advance support. Polarity management provides an influential instrument for managing conflict and resistance, and facilitates constructive and sustainable change.

8. Recognising the substance of the polarity map (the structure) and anticipating the flow through the polarity map (the dynamics), are central to effective polarity management. The result of effective polarity management is remaining primarily in one or both of the upper quadrants and minimising the experience of the downsides of the polarity. The outcome of a well-managed polarity strives to extend beyond the aggregate of its segments through optimising a dynamic balancing mechanism that effectively shifts back and forth between the two perspectives.

9. The principles of polarity management cultivate multiple applications within a wide range of settings where simultaneous contrast is pursued to realise collaborative change.

6.3 Summary of main conclusions

6.3.1 Conclusions from literature study

The following key attributes are derived from the conclusions drawn in the two literature study parts (Chapters 2 and 3):

1. The higher purpose of the project should fundamentally be the driver of the project. The triple constraint originates from the project basis and provides direction for framing the project.

2. The triple constraint comprises the three elements of scope, time and cost. The three elements are interrelated, and it is not commonly practical to optimise all three – one may always suffer. Failure to deliver the triple constraint elements on target does not necessarily imply project failure.

3. Flexibility is an indispensable triple constraint requirement in order to accommodate shifts in project emphasis, and ensure a beneficial project outcome. The implication of the key triple constraint relationships suggests that at least one of the elements must be fixed (constrained) otherwise there is no baseline for planning. The relationships also suggest that at least one of the elements must be flexible (capacity for exploitation) otherwise quality may be affected.

4. The triple constraint elements are ranked in a hierarchy of flexibility, which is a function of the project objectives, higher purpose and environment. The primary triple constraint element, the driver constraint, is the least flexible of the constraints, and is connected to the fundamental reason and desired outcome of the project. The requirements of the primary triple constraint element are pursued through exploitation of flexibility within the two more flexible elements.

5. The consolidated triple constraint model (the TRIJECT model) considers the exploitation of flexibility in the two weaker constraints as a mechanism to ensure achievement of the absolute requirements of the driver constraint. The goal of the TRIJECT model is to maintain the focus of the triple constraint power structure on the project higher purpose.

6. The simultaneous tensions and competing perspectives inherent to the triple constraint foster conflicts and trade-offs. The trade-offs need to be managed to optimise conflicting priorities and to attain a deeper comprehension of the strategic picture.

7. Polarity management capitalises on the benefits of interdependent trade-offs, and converts resistance to a sustained resource for creative opportunity. It also provides a greater understanding of the strategic picture as well as predictability, which enhances decision-making.

8. The traditional polarity management perspective primarily involves dualities in opposite parts. The triple constraint presents three intrinsic polar separations, which captivate a refreshed perspective in terms of traditional polarities. The triple constraint elements may be paired as polarities to manage, based on the following reasoning:

    a. The triple constraint relationships are interdependent and the trade-offs are ongoing.

    b. The triple constraint elements cannot be viewed in isolation and depends on each other for sustainability over time.

c. During the project life cycle there is a continuous shift in focus between the triple constraint elements.

d. At any given time there are both advantages and disadvantages when over focussing on one of the elements, with a corresponding impact on the project higher purpose.

e. Management of the triple constraint requires a progressive venture to achieve and/or maintain an optimum balance.

9. The consolidated triple constraint polarity model (the POLSTRAINT map) considers the exploitation trade-offs between the two flexible constraints as polarities to manage. The goal of the POLSTRAINT map is to capitalise on the trade-offs with some degree of optimum balance in order to ensure achievement of the driver constraint over time.

10. Comprehension of the triple constraint power structure and dynamics is paramount to effective project management. Polarity management techniques support the effective management of the triple constraint, and facilitate beneficial change and sustained value.

6.3.2 Conclusions from integrated framework

The following central attributes are concluded from the conceptual model and methodology (Chapter 4):

1. The TRIPOLJECT model (integrated framework) is realised through conceptual synthesis of the TRIJECT model (consolidated triple constraint model) and the POLSTRAINT map (consolidated triple constraint polarity model).

2. The integrated framework embodies three dimensions, in which each facet of the triple constraint may drive the project. Assessment of the respective dimensions suggests that the driver constraint may effectively be delivered as planned, whilst optimally delivering the remaining constraints, relative to the strategic picture. Following this inference throughout all three dimensions of the integrated framework, presents a refreshed perspective

in terms of the 'good, fast or cheap - pick [only] two' rationale. In light of this challenging proposition, the author of this dissertation sets forth for consideration the devised axiom 'as good as cheap as fast as it gets'.

3. The aim of the integrated framework is to create an optimum synergy by capitalising on the positive results of the exploitation trade-off for the benefit of the individual parts of the system as a whole. In other words, if the joint exploitation effort can be conducted effectively in obtaining the benefits of both upsides, the combined effort will lead to the sustainment of the drive to progressively fulfil the higher purpose of the project. This will be beneficial for all the stakeholders involved in the system.

4. The proposed benefits as well as the recommended procedure and application of the integrated framework are detailed in Section 4.5.

6.3.3 Conclusions from case study analysis

The following conclusions are drawn from the exploratory case study (Chapter 5), through conceptual and corroborative observation:

1. The integrated framework does provide the proposed benefits as detailed in Section 4.5.

2. The integrated framework provides a constructive mechanism to circumvent project failure and promote project success by:

    a. Underlining the project mission and encouraging a motivated project team.

    b. Prioritising and aligning the triple constraint with the project higher purpose.

    c. Presenting the complete picture and providing a structured understanding of the exploitation trade-off dynamics.

    d. Anticipating resistance and interchanging the exploitation emphasis as required.

e. Capitalising on the integrated exploitation trade-offs of both poles and striving for a balanced compromise.

f. Employing risk strategies to monitor and control virtual (green zone) as well as vicious (red zone) performance.

g. Implementing productive communication and reporting between key stakeholders.

h. Adapting tactics as required and maintaining focus on the ultimate goal.

3. The discipline of the integrated framework provides the tools and techniques that enable the project team to organise and manage their work, in order to meet the absolute requirements of the project.

4. The exploration of policies and practices, which will ensure a well-managed exploitation trade-off polarity, needs to evolve as the project progresses. The methodology will become more efficient as the project team becomes more familiar with the dynamics of the integrated framework.

6.4 Assessment and implications of main conclusions

The author's conviction in terms of the relevance and value of the integrated framework include the following central interpretations:

- The integrated framework provides a refreshed perspective in support of the effective management of the triple constraint in project management through polarity management techniques.

- The novelty of the TRIPOLJECT model is evident in that two known concepts, namely polarity management and the triple constraint, are integrated and applied within a new framework and protocol.

- The TRIPOLJECT model provides a conventional rendering of the triple constraint of scope, time and cost and accounts for the supporting considerations such as project milieu (environment), project strategy

(purpose and objectives), project risk (change), project excellence (quality), and project performance (monitoring and controlling).

- The integrated framework provides a simplified methodology and practice with clear guidelines to project managers to adopt and make their own. The anticipated outcome of the management philosophy of the integrated framework is the alignment of project success with the higher purpose through achievement of the driver constraint as a result of the appropriate and optimised exploitation of the two flexible constraints, while appreciating their priorities and trade-offs.

- In practice the integrated framework is expected to overlap and interact dynamically with the project management process groups in support of the achievement of the project and organisational goals. The framework is also anticipated to provide a greater assurance to stakeholders that trade-offs are being managed effectively.

- The integrated framework provides a basis for contributing towards the emerging global project management body of knowledge and practices.

6.5 Limitations of conclusions

It is unlikely that all the research questions in any study can be completely answered with final authority.

6.5.1 Shortcomings of literature study conclusions

The following key shortcomings have been identified in terms of the conclusions drawn from the literature studies:

- The literature studies constitute a subjective organisation and summary of the existing scholarship.

- The large body of knowledge on project management is overwhelming, and Chapter 2 may not demonstrate a complete survey of all the appropriate literature in the field.

- The naming conventions of the triple constraint as well as the designation of its elements are heterogeneous and not consistent across project management literature. A variety of triple constraint concepts exist which extend beyond the traditional dimensions of scope, time and cost.

- Polarity management theory is relatively new with limited research literature available.

- Polarity management does not provide the answer to all dilemmas, and care should be taken in terms of appropriate application. Polarity management can easily be over-used or misused.

6.5.2 Uncertainties of integrated framework conclusions

The following key uncertainties have been identified in terms of the implied value of the integrated framework:

- There are boundaries to exploitation capacity and effort, which need to be assessed through 'cost' vs. value impact analyses – there is always an essential minimum that must be achieved.

- The integrated framework is conceptual and the protocol has not been trialled in real-time project management scenarios. The findings of this research study should thus be considered as preliminary rather than conclusive, pending further research. The integrated framework is a useful tool but not necessarily a reflection of the real world, which is the case with most simple models of complex subjects.

6.5.3 Restrictions of case study conclusions

The following key restrictions have been identified in terms of the conclusions drawn from the case study analysis:

- The case study analysis is limited to the exploratory review of the integrated framework against a simplified real-world case, which amounts to inadequate diversity. Exploratory case study condenses the case study process.

- The exploratory analysis is based on subjective observation from a conceptual viewpoint, which may seem convincing enough to release premature conclusions.

- The considerations and indications defined under the case study analysis are merely a simplified summary of the NASM case in order to facilitate a conceptual understanding of the integrated framework in practice. There is no claim that this case is representative of the general project management milieu.

6.6 Recommendations for further research

Direction regarding further research includes the following areas for consideration:

- Further research to ascertain the practical applicability of the integrated framework via empirical / quantitative studies. The exploratory case study in this dissertation may serve as a preliminary pilot study to safeguard investment for a large-scale investigation.

- Further research to investigate the deeper mathematical properties and interpretation of the key triple constraint relationships in terms of congruency and equivalence relations.

- Further research to consider modelling beyond the triple constraint to a quadruple or quintuple constraint.

- Further research to understand the dynamics and application of 'multarities' within the polarity management framework. Integral theory, for example, contains a number of polarities that could be seen as a 'multarity'.

- Further research to determine how project managers can become effective at managing polarities within the project environment, and determine how project managers can develop the required skills to effectively manage the triple constraint.

- Further research to explore how polarity management may be related to systems-thinking and systems dynamics.

6.7 Chapter closure

Chapter 6 summarises the main results and conclusions of the study, and discusses implications, limitations and areas for further research.

The challenge in this chapter has been to consolidate the main consequences of the research endeavour and provide a succinct account of the study. The research study has focussed extensively on conceptual theory building with limited theory evaluation in terms of practical application.

The final conclusion is that the stated objectives and goal of this study have been achieved, as specified in Section 1.5, i.e.:

- Uncover the knowledge foundation of the triple constraint.
- Ascertain how flexibility within the triple constraint can be managed to ensure a beneficial outcome in terms of project success.
- Introduce a consolidated triple constraint model.
- Uncover the knowledge foundation of polarity management.
- Establish the feasibility of applying polarity management principles to the triple constraint.
- Introduce a consolidated triple constraint polarity model.
- Develop a framework and methodology that integrate the polarity management approach as part of the hierarchical rationale of the triple constraint, which facilitate the management of flexibility within the triple constraint and optimise the delivery of project success.
- Show that the integrated framework is valid and feasible for solving the generic problem addressed in Section 1.4, i.e. to improve the interpretation of the triple constraint trade-offs and dynamics in an effort to advance the effective and strategic management thereof.

The next section lists the resources that have explicitly been referred to in the dissertation.

LIST OF REFERENCES

[1] Alleman, G.B. (2005, May 16). *The iron triangle (again)*. Herding Cats. Ideas, comments and resources about project management field experiences from resources of www.niwotridge.com. Available online: http://herdingcats.typepad.com/my_weblog/2005/05/the_iron_triang.html [Accessed 26 May 2008].

[2] Ambler, G. (2006, October 15). *How practicing leaders can manage paradox, dilemma and polarity*. The Practice of Leadership. Available online: http://www.thepracticeofleadership.net/2006/10/15/how-practicing-leaders-can-manage-paradox-dilemma-and-polarity/ [Accessed 30 October 2009].

[3] Ambler, G. (2006, March 11). *Setting SMART objectives*. The Practice of Leadership. Available online: http://www.thepracticeofleadership.net/2006/03/11/setting-smart-objectives/ [Accessed 25 September 2010].

[4] Ambler, S.W. (2008, August 15). *The broken iron triangle: Software development anti-pattern*. Available online: http://www.ambysoft.com/essays/brokenTriangle.html [Accessed 20 March 2009].

[5] Anderson, D.J. (2003, December 09). *Good, fast, cheap – Pick 3*. AgileManagement.net. Management Science for Software Engineering. Available online: http://www.agilemanagement.net/Articles/Weblog/GodFastCheap-Pick3.html [Accessed 13 May 2008].

[6] Anonymous. (2007, May 05). *Fast, good and cheap*. iFaceThoughts discussion group. Commentator number 2. Available online: http://ifacethoughts.net/2007/05/04/fast-good-and-cheap/ [Accessed 13 May 2008].

[7] Aramvareekul, P., Seider, D.J. (2006). Cost-time-risk diagram: Project planning and management. *Cost Engineering*, November 2006, vol. 48, no. 11, pp. 12-18.

[8] Azzopardi, S. (2006, October 05). *The evolution of project management*. Ezine @rticles. Available online: http://ezinearticles.com/?The-Evolution-of-Project-Management&id=318812 [Accessed 01 July 2008].

[9] Baguley, P. (1995). *Managing successful projects.* London: Pitman Publishing.

[10] Barker, S., Cole, R. (2007). *Brilliant project management: What the best project managers know, say and do*. Harlow: Pearson Prentice Hall Business.

[11] Brent, A. (2006, April 10). *Research proposal*. Department of Engineering and Technology Management. University of Pretoria.

[12] Briner, W., Hastings, C., Geddes, M. (1996). *Project leadership.* Aldershot: Gower Pub. Co.

[13] Brooks, F.P. (1995). *The mythical man-month: Essays on software engineering*. 20th Anniversary ed. Reading, MA: Addison-Wesley.

[14] Brown, A.W., Adams, J.D., Amjad, A.A. (2006). The relationship between human capital and time performance in project management: A path analysis. *International Journal of Project Management* 25 (2007), pp. 77-89.

[15] Burke, R. (2007). *Project management techniques*. Oxford: Burke Publishing.

[16] Burns, L.R. (1999). Polarity management: The key challenge for integrated health systems. *Journal of Healthcare Management*, January 1999, vol. 44, no. 1, pp. 14-33.

[17] Business Services Projects. (2003, April 03). *Best practices for project management*. Available online:

http://www.purdue.edu/bscompt/doc/BSBestPracticesProjectMgmt.doc [Accessed 19 February 2008].

[18] Buys, A. (2003, April 09). *Research guide for post-graduate students*. Department of Engineering and Technology Management. University of Pretoria.

[19] Caldwell, M. (2007, January 16). *Polarity Management*. Ezine @rticles. Available online: http://ezinearticles.com/?Polarity-Management&id=419987 [Accessed 06 January 2009].

[20] Campbell, G.M., Baker, S. (2007). *Project management.* 4th ed. New York: Alpha, member of Penguin Group (USA).

[21] Cantrell, C., Kennedy, T., Morss, R., Moser, S., Poulos, G., Wesley, D. (2005). *Advocacy in the atmospheric sciences: Summary of findings from the UCAR Leadership Academy "advocacy" project*. Leadership Academy, June 2005.

[22] Carlos, T. (2007, March 09). *The triple constraint and RSS matrix*. Thomas Carlos Consulting. Available online: http://www.carlosconsulting.com/resources.html [Accessed 12 April 2009].

[23] Chatfield, C., Johnson, T. (2008). *A short course in project management*. Microsoft Corporation. Available online: http://office.microsoft.com/en-us/project/HA102354821033.aspx [Accessed 29 August 2008].

[24] Chen, K.C. (2005). Real world pedagogy for E-business applications – project management approach. 5th IEEE International Conference on Advanced Learning Technologies (2005: Taiwan). *ICALT 2005*, pp. 688-690.

[25] Cleland, D.I. (1986). Measuring success: The owner's viewpoint. *Proceedings*. Montreal: Project Management Institute's Annual Seminar & Symposium, pp.6-12.

[26] Collins, J.C., Porras, J.I. (1994). *Built to last: Successful habits of visionary companies*. New York: HarperCollins Publishers.

[27] Crocker, M. (2008, March 18). *Remember, quality is the hidden fourth constraint*. The Project Management Hut. Available online: http://www.pmhut.com/remember-quality-is-the-hidden-fourth-constraint [Accessed 14 August 2009].

[28] Damicon. (2009). *The titanium triangle approach to project management*. Damicon – Linking the left brain and the right brain. Available online: http://www.damicon.com/resources/triangle.html [Accessed 15 August 2009].

[29] Dawson, L. (2004). The application of project management tools. IIE Annual Conference and Exhibition (2004: Houston). *IIE Annual Conference and Exhibition 2004*, pp. 3741-3768.

[30] Dewey, R. (2007). *Gestalt psychology*. Available online: http://www.psywww.com/intropsych/ch04_senses/gestalt_psychology.html [Accessed 28 September 2009].

[31] Dobson, M.S. (2004). *The triple constraints in project management*, Project management essential library series. Vienna: Management Concepts, Inc.

[32] Dobson, M.S., Feickert, H. (2007). *The six dimensions of project management: Turning constraints into resources*. Vienna: Management Concepts, Inc.

[33] Duma, J. (2005). *Managing projects with special focus on quality*. Dissertation, (M.Phil). University of Johannesburg.

[34] Elmaghraby, S.E.E., Herroelen, W.S., Leus, R. (2002). Notes on the paper 'Resource-constrained project management using enhanced theory of constraint' by Wei et al. *International Journal of Project Management* 21 (2003), pp. 301-305.

[35] Elyse. (2004, June 05). *Triple constraints*. AntiClue – Musings based upon adventures in Healthcare IT. Available online: http://www.anticlue.net/archives/000249.htm [Accessed 13 May 2008].

[36] Flett, P. (2001). *The role of quality in the management of projects*. Thesis, (Ph.D.). University of Stirling.

[37] Flyvbjerg, B. (2006). Five misunderstandings about case study research. *Qualitative Inquiry*, April 2006, vol. 12, no. 2, pp. 219-245.

[38] Garrett, D. (2008, May 21). *Is the triple constraint the wrong way to define success ?*. Gantthead – The online community for IT project managers. Available online: http://www.gantthead.com/blog/project-management-2.0/917/ [Accessed 26 August 2008].

[39] Global Knowledge. (2008). *Triple constraints of project management*. Course notes (course code 2812). Global Knowledge Training LLC.

[40] Hampden-Turner, C. (1990). *Charting the corporate mind: Graphic solutions to business conflicts*. New York: The Free Press.

[41] Handy, C.B. (1995). *The empty raincoat: Making sense of the future*. New ed. London: Arrow Books.

[42] Harburg, F. (2005). Contrast: The mother of learning. *Chief Learning Officer*, November 2005, vol. 4, no. 11, pp. 20-20.

[43] Haughey, D. (2008). *An introduction to project management*. Project Smart. Available online: http://www.projectsmart.co.uk/introduction-to-project-management.html [Accessed 04 July 2008].

[44] Haughey, D. (2010, July 15). *SMART goals*. Project Smart. Available online: http://www.projectsmart.co.uk/pdf/smart-goals.pdf or http://www.projectsmart.co.uk/smart-goals.html [Accessed 25 September 2010].

[45] Herborn, P. (2008, January 18). *The project management triangle*. Phil Herborn. Available online: http://philherborn.com/the-project-management-triangle [Accessed 04 July 2008].

[46] Hirschhorn, L. (2001). Manage polarities before they manage you. *Research-Technology Management*, September-October 2001, vol. 44, no. 5, pp. 12-16.

[47] Jenkins, N. (2008, February 05). *A project management primer – Basic principles – Scope triangle*. The Project Management Hut. Available online: http://www.pmhut.com/a-project-management-primer-basic-principles-scope-triangle [Accessed 06 January 2009].

[48] Johnson, B. (1996). *Polarity management: Identifying and managing unsolved problems*. Amherst: HRD Press, Inc.

[49] Johnson, B. (1998, September). *Polarity management: A summary introduction*. Polarity Management Associates. Available online: http://files.meetup.com/206999/Polarity%20Management%20Guide.doc [Accessed 30 September 2009].

[50] Johnson, J., Boucher, K.D., Connors, K., Robinson, J. (2001). *Collaboration: Development & management - Collaborating on project success*. Software Magazine and Wiesner Publishing. Available online: http://www.softwaremag.com/archive/2001feb/CollaborativeMgt.html [Accessed 05 March 2008].

[51] Joubert, W. (2002). *Defining the critical success factors for the implementation and maintenance of a total quality management system in South African construction companies involved in building*. Dissertation, (M.Sc). University of Pretoria.

[52] Kennedy, J.M. (2008, June 26). *The triad constraints*. Wikimedia Foundation, Inc. Available online: http://en.wikipedia.org/wiki/Image:The_triad_constraints.jpg [Accessed 25 September 2008].

[53] Koch, A.S. (2006). *We cannot trade quality for schedule or budget*. Global Knowledge. Expert Reference Series of White Papers. Global Knowledge Training LLC.

[54] Koch, A.S. (2007, August 31). *Negotiating the triple constraints*. The Project Management Hut. Available online: http://www.pmhut.com/negotiating-the-triple-constraints [Accessed 06 January 2009].

[55] Kohn, M.S. (2007). *Rapid change in healthcare organisations*. Work product of the Hot Topics Work Group of the Management Engineering and Process Improvement Task Force. HIMSS, 2007.

[56] Kosavinte, S. (2007). Integration of CAD software with DSS for engineering and architectural project design. *Computer-Aided Design and Applications*, 2007, vol. 4, no. 1-6, pp. 467-476.

[57] Kozak-Holland, M. (2007). *What determines a project success or failure*. Lessons-from-History series. Available online: http://www.lessons-from-history.com/Level%201/Site%20map_page.html [Accessed 25 February 2008].

[58] Kruse, M. (2005, September 27). *Polarity management*. Kruse Kronicle. Available online: http://krusekronicle.typepad.com/kruse_kronicle/polarity_management/ [Accessed 20 February 2008].

[59] Kuster, J., Huber, E., Lippmann, R., Schmid, A., Schneider, E., Witschi, U., Wüst, R. (2008). *Handbuch Projektmanagement.* 2nd ed. Berlin: Springer.

[60] Kuster, J., Witschi, U., Lippmann, R., Schmid, A., Schneider, E., Wüst, R. (2002). *Projekt-Management, der BWI-Leitfaden f*ür Teamführung und Methodik. 7th ed. Zurich: Industrielle Organisation.

[61] Ladas, C. (2007, April 27). *More than one solution to the project triangle*. Lean Software Engineering – Essays on the continuous delivery of high quality information systems. Available online:

http://leansoftwareengineering.com/2007/04/27/more-than-one-solution-to-the-project-triangle [Accessed 01 March 2009].

[62] Lamnek, S. (2005). *Qualitative Sozialforschung*. Lehrbuch. 4. Auflage. Beltz Verlag. Weihnhein, Basel, 2005

[63] Lavingia, N.J. (2003). Improve profitability through effective project management and total cost management. *Cost Engineering*, November 2003, vol. 45, no. 11, pp. 22-24.

[64] Lewis, J.P. (2005). *Project planning, scheduling & control*. 4th ed. New York: McGraw Hill.

[65] Manas, J. (2005, October 12). *Project success equation – the real triple constraint*. PMThink – Project Management Through Leadership. Available online: http://www.pmthink.com/2005/10/project-success-equation-real-triple.htm [Accessed 26 August 2008].

[66] Mann, M. (2005, April 01). *Getting real: Pick two – scope, timeframe or budget*. 43 Folders. Jason Fried on The Project Triangle. Available online: http://www.43folders.com/2005/04/01/jason-fried-on-the-project-triangle [Accessed 04 July 2008].

[67] Marchewka, J.T. (2006). *Information technology project management: Providing measureable organizational value*. 2nd ed. New Jersey: John Wiley & Sons, Inc.

[68] Maltzman, R., Biswas, R. (2009, May 21). *The fiddler on the project*. Fiddlerontheproject – Collaborative Workspace. Available online: http://fiddlerontheproject.wikidot.com [Accessed 23 August 2009].

[69] Mathis, K. (2008, March 24). *Project drivers*. The Project Management Hut. Available online: http://www.pmhut.com/project-drivers [Accessed 31 May 2009].

[70] Maurer, R. (2002). Managing polarities: An interview with Barry Johnson, Ph.D. *Gestalt Review*, 2002, vol. 6, no. 3, pp. 209-219.

[71] McNamara, C. (2007). *Basics of developing case studies*. Authenticity Consulting, LLC. Available online: http://www.managementhelp.org/evaluatn/casestdy.htm [Accessed 12 October 2007].

[72] McNaught, C. (2003). Innovation and change in higher education: Managing multiple polarities. *Perspectives*, 2003, vol. 7, no. 3, pp. 76-82.

[73] Meridith, J.R., Mantel, J.S. (2000). *Project Management: A managerial approach*. 4th ed. New York: John Wiley & Sons, Inc.

[74] Mihalic, J. (2007). *Fundamentals of project management*. Booz, Allen, Hamilton. American Society of Military Comptrollers (ASMC). Professional Development Institute (PDI) 2007. Course presentation. Available online: http://www.asmconline.org/files/PDI/Workshop99.pdf [Accessed 08 May 2008].

[75] Milis, K., Meulders, M., Mercken, R. (2003). A quasi-experimental approach to determining success criteria for ICT projects. *Proceedings*. Big Island: 36th Hawaii International Conference on System Sciences, January 2003.

[76] Miller, J. (2008, March 07). *Polarity management: Handling unsolvable problems*. BNET. Available online: http://blogs.bnet.com/mba/?p=145&tag=col1;post-144 [Accessed 30 October 2009].

[77] Morris, P.W.G., Hough, G.H. (1987). *The anatomy of major projects*. New York: John Wiley & Sons.

[78] Mouton, J. (2008). *How to succeed in your master's & doctoral studies*. 11th ed. Pretoria: Van Schaik Publishers.

[79] Nadgouda, A. (2007, May 04). *Fast, good and cheap*. iFaceThoughts. Available online: http://ifacethoughts.net/2007/05/04/fast-good-and-cheap/ [Accessed 13 May 2008].

[80] Newell, M.W., Grashina, M.N. (2003). *The project management question and answer book*. New York: Amacom.

[81] Nielsen, J. (2007, January 02). *Fast, cheap and good: Yes, you can have it all*. Useit.com. Jakob Nielsen's Alertbox. Available online: http://www.useit.com/alertbox/fast-methods.html [Accessed 13 May 2008].

[82] Noll, D.E. (2002). Some conflicts can only be managed, not resolved. *The Business Journal*, March 2002, pp. 10-10.

[83] Noori, H., Radford, R. (1995). *Production and operations management: total quality and responsiveness*. New York: McGraw-Hill.

[84] Norrie, J.L., Walker, D.H.T. (2004). A balanced scorecard approach to project management leadership. *Project Management Journal*, December 2004, vol. 35, no. 4, pp. 47-56.

[85] OGC (Office of Government Commerce). (2009). *An introduction to PRINCE2: Managing and directing successful projects*. Norwich: TSO (The Stationery Office).

[86] Organisation Development Network (ODN). (2003). *Polarity management*. ODN Chicago. Course Description. Available online: http://www.odnetwork.org/odnc/PolarityManagementInfo.html [Accessed 22 November 2009].

[87] Oswald, R.M., Johnson, B. (2009). *Managing polarities in congregations: Eight keys for thriving faith communities*. Herndon: The Alban Institute.

[88] Pascale, R.T. (1990). *Managing on the edge: How the smartest companies use conflict to stay ahead*. New York: Simon & Schuster.

[89] Patton, M.Q. (1990). *Qualitative evaluation and research methods*. 2nd ed. Newbury Park: Sage Publications, Inc.

[90] PDU University. (2005). *Organisational project management*. Triple Constraint Inc. Available online: http://www.tripleconstraint.com [Accessed 09 November 2010].

[91] PK Advantage. (2002). *Why polarity management*. Management and Consulting Services. Available online: http://www.pkadvantage.com [Accessed 20 March 2010].

[92] Polarity Management Associates (PMA). (1995). *Polarity management*. Available online: http://www.polaritymanagement.com [Accessed 26 January 2011].

[93] Pretorius, Y. (2001). *Aspects of engineering project failure: A managerial approach*. Dissertation, (M.Eng). University of Johannesburg.

[94] Project Management Institute (PMI). (2004). *A guide to the project management body of knowledge (PMBOK® Guide)*. 3rd ed. Newtown Square: Project Management Institute.

[95] Pennsylvania State University (PSU). (2005). *Lesson 8: Scheduling resources*. MANGT 520: Planning and Resource Management. Course presentation. Available online: https://courses.worldcampus.psu.edu/welcome/pmangt/samplecontent/520lesson08/lesson08_01.html [Accessed 25 August 2008].

[96] Roberts, J.P., Furlonger, J. (2000). *Successful IS project management*. Gartner Group.

[97] Sanchez, C.W. (2007). *Methods for strategic collaboration*. Facilitators Network Singapore. Workshop, Singapore.

[98] Schwalbe, K. (2005). *Information technology project management*. 4th ed. Thompson.

[99] Sepehri, M. (2006). *Project management*. Sharif MBA – Fall 1385, Session 3. Tehran: Sharif University of Technology. Available online:

http://gsme.sharif.edu/~projectmanagement/PMSession3.pdf [Accessed 26 May 2008].

[100] Shenhar, A.J., Dvir, D. (2007). *Reinventing project management: The diamond approach to successful growth and innovation*. Boston: Harvard Business School Publishing.

[101] Siegelaub, J. (2008, April 04-16). *Six constraints: An enhanced model for project control*. The Project Management Hut. Available online: http://www.pmhut.com/six-constraints-an-enhanced-model-for-project-control-introduction [Accessed 31 May 2009].

[102] Simms, J. (2008, February 26). *The infernal project triangle*. Value Delivery Management – Blog. Available online: http://www.valuedeliverymanagement.com/blog/2008/02/the-infernal-project-triangle/ [Accessed 23 August 2009].

[103] SixSide. (2004). *Fast, good or cheap. Pick two*. SixSide.com. Available online: http://www.sixside.com/fast_good_cheap.asp [Accessed 25 March 2008].

[104] Stanford University (2008, February 15). *Project Management Office*. Information Technology Services. Available online: http://www.stanford.edu/dept/its/projects/PMO also sub-link /files/linked_files/templates/typical_constraints.pdf [Accessed 14 August 2009].

[105] Stewart, T.A., Curry, S.R. (1996). *The nine dilemmas leaders face*. Time Inc. The College of St. Scholastica. Available online: http://faculty.css.edu/dswenson/web/lead9.html [Accessed 18 January 2008].

[106] Tasmania. Department of Premier and Cabinet. (2005, March). *Tasmanian government project management guidelines*. 6th ver. Tasmania: Inter Agency Policy and Projects Unit, Government Information and Services Division. Available online:

http://www.egovernment.tas.gov.au/__data/assets/dpac_file_desc/0017/13481/pman-reso-open-tgpmg-6.0-the-basics.pdf [Accessed 01 July 2008].

[107] Tuman, J. (1986). Success modelling: A technique for building a winning project team. *Proceedings*. Montreal: Project Management Institute's Annual Seminar & Symposium, pp.94-108.

[108] Turner, R.J. (1999). *The handbook of project-based management*. 2nd ed. Berkshire: McGraw-Hill.

[109] Vaes, K. (2008, January 10). *Devil's triangle of project management*. The Project Management Hut. Available online: http://www.pmhut.com/devils-triangle-of-project-management [Accessed 06 January 2009].

[110] Vista. (2009). *Polarity management*. Vista Services. Available online: http://www.vista.uk.com/library/polarity-management.php [Accessed 18 January 2010].

[111] Ward, J.A. (2003). The key project constraints: Relationships and trade-offs. *Proceedings*. Dallas: 13th International Conference on Software Quality. Available online: http://www.jamesaward.com/key%20project%20constraints.htm [Accessed 23 July 2008].

[112] Ward, J.A. (2005). The project manager as Houdini: Escaping the triple constraint. *Proceedings*. Atlanta: PMI Southeast Regional Conference, June 2005. Richmond: Local PMI Chapter Meeting, October 2005.

[113] Whitchurch, C. (2003). Hybrid identities. *Perspectives*, 2003, vol. 7, no. 3, pp. 61-61.

[114] Wiegers, K.E. (2008, August 02). *Identify project drivers, constraints and degrees of freedom*. The Project Management Hut. Available online: http://www.pmhut.com/identify-project-drivers-constraints-and-degrees-of-freedom [Accessed 31 May 2009].

[115] Wikipedia. (2007). *Project management*. Wikimedia Foundation, Inc. Available online: http://en.wikipedia.org/wiki/Project_management [Accessed 24 September 2007].

[116] Wikipedia. (2008, April 29). *Project triangle*. Wikimedia Foundation, Inc. Available online: http://en.wikipedia.org/wiki/Project_triangle [Accessed 26 May 2008].

[117] Wikipedia. (2011, February 28). *Project management body of knowledge*. Wikimedia Foundation, Inc. Available online: http://en.wikipedia.org/wiki/Project_Management_Body_of_Knowledge [Accessed 23 June 2008].

[118] Wikipedia. (2011, March 07). *Project management institute*. Wikimedia Foundation, Inc. Available online: http://en.wikipedia.org/wiki/Project_Management_Institute [Accessed 23 June 2008].

[119] Wilson, K. (2008, February 08). *Microsoft Office Project 2007 tackles scope creep*. Projects@Work. Available online: http://www.projectsatwork.com/content/articles/240465.cfm [Accessed 14 August 2009].

[120] Winters, F. (2003, August 11). *The top ten reasons projects fail*. 7th part. Gantthead – The online community for IT project managers. Available online: http://www.gantthead.com/article/1,1380,187449,00.html [Accessed 01 July 2008].

[121] Witzel, B. (2004, September 07). *The great balancing act: The scope triangle*. Charity Village® Research. Available online: http://www.charityvillage.com/cv/research/rom14.html [Accessed 13 May 2008].

[122] Yin, R.K. (2009). *Case study research: Design and methods*. 4th ed. Los Angeles: Sage Publications, Inc.