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Title

Development of a Systems Front End Research Framework to inform Strategic Planning of Projects in Transnet SOC Ltd

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A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Science in Engineering.

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CANDIDATE'S DECLARATION

I declare that this research report is my own unaided work. It is being submitted for the Degree of Master of Science to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

……

(Signature of Candidate)

…….. day of ……..., ……

(day) (month) (year)

ABSTRACT

The research involved investigating the occurrence of project failure within the Transnet environment and developing a conceptual framework, called the Front End Research Framework, to guide the organisation in mitigating project failure through the application of Systems principles. Project failure, whether it be partial or complete non-delivery on the organisational and/or market needs, leads to the inefficient use of Transnet's resources including time, capital and manpower.

Twenty key causes for project failure in various industries, including transportation and logistics, were derived from critical literature review. In this thesis, these are titled the "20 Project Failure Red Flags". These 20 Project Failure Red Flags were narrowed down through archival research of Transnet project reports as well as a survey conducted on Transnet project and programme team members. The results indicated that the five most pertinent causes for project failure in Transnet were lack of sponsor support/buy in, unclear strategic direction by top management, communication breakdown among stakeholders, interdependencies not identified in the early stages of planning and lack of documented requirements and/or success criteria.

The Front End Research Framework was developed by adapting the Zachman Framework™ (Zachman, 2008) as well as the Viable Systems Model (Beer, 1989) to indicate how stakeholder engagement, needs elicitation, requirements analysis and management, Systems Engineering management and system design can be applied during the pre-project phase in order to mitigate project failure.

ACKNOWLEDGEMENTS

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To God be the Glory!

EXECUTIVE SUMMARY

Transnet SOC Ltd, from hereon in known as Transnet, is a state-owned freight logistics company in South Africa, with one of its overarching aims being 'reducing the cost of doing business' (Transnet, 2018). An integral part of Transnet's business is to roll-out projects/programmes in order to expand the organisation's capabilities. The Transnet Capital Projects – Project Lifecycle Process (PLP) was developed drawing on best practices as applied to progressive project phases (Transnet Capital Projects, 2008). This provided consistency in the approach to the preparation and management of capital investment projects; and thereby the reliability of the results achieved through the project lifecycle.

The PLP is, however, lacking a well-defined, systemic Front End Research (FER) approach that can be used to translate multiple stakeholder needs into project options to be investigated further through the Project Lifecycle Process (PLP). This missing element leads to project failures that come at a high financial cost as well as time and resource wastage. Project failure also results in lost opportunity which could have resulted in continuous improvement for the organisation.

The aim of this study was to apply Systems principles and frameworks for strategic planning which exist in other industries to develop a FER Framework which is suitable to mitigate project failure in Transnet.

One of the key outcomes of the critical literature review was a list of 20 pertinent causes for project failure in various industries, including transportation and logistics. In this thesis, these are titled the "20 Project Failure Red Flags". The FER Framework was developed through the application of Systems, specifically, the Viable System Model (Beer, 1989) and The Zachman Framework (Zachman, 2008) to address the 20 Project Failure Red Flags. The aim of the FER Framework (see Figure 1) is to guide the application of stakeholder engagement, needs elicitation, requirements analysis, Systems Engineering management and system design in pre-project phase in order to mitigate project failure in Transnet.

	What	How	Where	Who	When	Why	
Policy	Corporate Strategy (Transnet 4.0)	Problem/opportunity definition	External Environment	Transnet Group	Strategic Planning	Strategic direction	Scope Context
Intelligence	• Concept of Operations • Business Case	• Situational Analysis • Scenario Planning • Benchmarking • Requirements analysis • Verification specification	External Environment	• Group Strategy • TGC • Business Development	Pre-Project Planning	• Long term planning • New business development	Business Concept
Control	Go/ No Go Decision	Gate Review	Internal Environment	Investment Forums	Project Delivery	Accountability	System Logic
Optimisation	Strategy Execution	Quality Management Operational readiness	Internal Environment	• Group COO • TGC	PLP	Alignment and integration	Technology/ Detailed Engineering
Monitoring	Performance reports	Continuous Improvement	Internal Environment	• Business Process Optimization (BPO) • Results Monitoring Office (RMO)	Ongoing	Traceability	Tools/ Processes
Core operations	KPIs	Projectized activities	Internal Environment	Operating Divisions	Ongoing	Project delivery	Implementation

Figure 1: FER Framework

Source: Author (Adapted from (Zachman, 2008)).

Having developed the FER Framework based on the 20 Project Failure Red Flags, its suitability for Transnet was assessed. This was done by applying a Mixed Method research methodology consisting of the triangulation of the following three research strategies: archival research, survey and focus group.

Archival research provided insights into the historical and current context of the Transnet project/programme planning processes and practical applications, the surveys provided a view into how individuals view planning of projects based on their experience and the focus group, consisting of Systems professionals, provided inputs into how to improve the robustness of the FER Framework based on findings.

In assessing the manner in which FER has been conducted thus far within Transnet, it was found that the traditional Project Management Key Performance Indicators (KPIs) (Project Management Institute, 2016), which are mainly quantitative in nature, were utilised to measure the project status and progress. However, the surveys revealed that the project/programme team members were cognisant of the qualitative issues and challenges which were causing projects to fail.

The Top 5 Project Failure Red Flags in Transnet, as per this study, were found to be:

- Lack of sponsor support/buy in
- Unclear strategic direction by top management
- Communication breakdown among stakeholders
- Interdependencies not identified in time
- Lack of documented requirements and/or success criteria

Based on the findings from triangulating the research methodologies, the conclusion was drawn that the Systems Methodologies and Systems Tools to be incorporated in the FER Framework in order to address the Top 5 Project Failure Red Flags are:

Table 1: Systems Methodologies and Systems Tools to address Top 5 Project Failure Red Flags.

Project Failure Red Flag	Systems Methodology	Systems Tool
Lack of sponsor support/buy in	Identify Project Sponsor and key Stakeholders	*To be determined as part of a separate study*
Unclear strategic direction by top management	Stakeholder engagement, Needs elicitation, Requirements Analysis	Parsing Template
Communication breakdown among stakeholders	Systems Engineering Management	Systems Engineering Management plan

Project Failure Red Flag	Systems Methodology	Systems Tool
Interdependencies not identified in time	System Design	CONOPS
Lack of documented requirements and/or success criteria	Requirements Analysis and Verification specification	Parsing template

Source: Author

These Systems Methodologies and Systems Tools were incorporated into the FER Framework and the associated process and activity breakdown were developed.

Some recommendations, which, if taken into consideration might bring some positive changes to the current Transnet Project Lifecycle Process, are provided:

- The socialisation and adoption of the FER Framework should be a project sponsored by the Chief Capital Officer in Transnet Group Capital.
- Further awareness must be created within the organisation about the application of Systems in the project planning space.
- Key project/programme team members should be trained in Systems disciplines relevant to their work and in conjunction with their application of the FER Framework.

Alongside the conclusions and recommendations provided through this study, it is acknowledged that these are not exhaustive in dealing with the Top 5 Project Failure Red Flags in Transnet. The study has highlighted a number of researchable aspects that could be pursued further by those involved in studies relating to application of Systems principles to improve organisational practices.

i. A key area that was identified was the development of a Systems-based process for the identification of a project sponsor. Aspects that can be studied in detail include:

- The role of a project sponsor.
- Drawing the distinction between a project lead and project sponsor.
- The process for identifying the right project sponsor for a project.

ii. A similar framework as the FER Framework can be extended to the rest of the PLP phases.

1 INTRODUCTION

This section provides the context and rationale for conducting this research focussing on the Transnet environment. Also, Systems principles are applied to conceptualise the problem area. The key objectives of the study conclude this section, indicating the role that the research is set to play within Transnet as well as in the discipline of Systems.

1.1 Purpose of the study

This research was conducted in order to develop a Front End Research (FER) Framework to inform strategic planning of projects in Transnet SOC Ltd. The Framework draws on various Systems applications and frameworks employed in the establishment of major projects/programmes. The development of this framework is aimed at ensuring that, as explained by as Browne and Keeley (1981) the 'right questions for the desired result' are asked in the pre-project stage such that only viable project options are developed further, resulting in effective use of organisational resources including time, money and human resources.

1.2 Research Context

The FER phase of project implementation is the pre-project stage aimed at determining the stakeholder needs which must be translated into project options to be developed into detailed project solutions. The detailed design is covered in the Project Lifecycle Process (PLP) which Transnet currently implements. The PLP was developed drawing on best practices as applied to progressive project phases (Transnet Capital Projects, 2008). This provided consistency in the approach to the preparation and management of capital investment projects; and thereby the reliability of the results achieved through the project lifecycle. Figure 2 shows FER in the context of the project stages associated with Transnet's PLP.

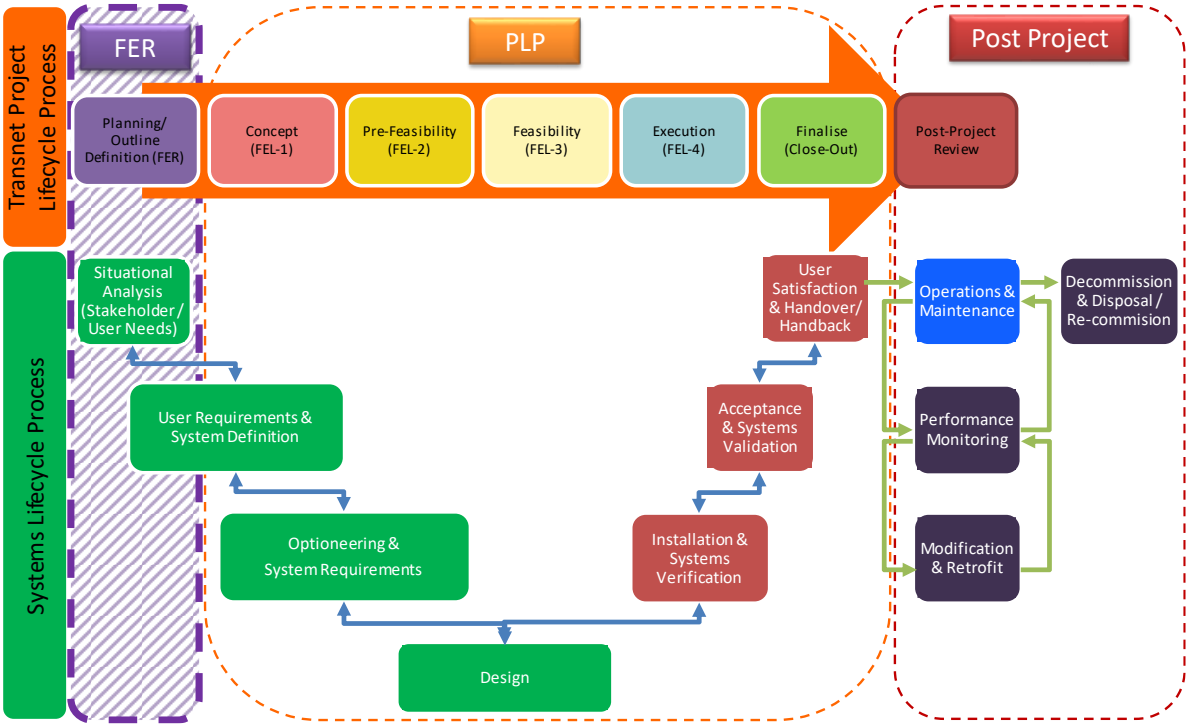


Figure 2: Research Context Diagram - FER in Transnet Context.

Source: Author (Adapted from Wits Transnet Centre of Systems Engineering Brochure 2016)

1.3 Problem Statement

There are multiple instances of project failure within the Transnet environment which is leading to the inefficient use of limited resources such as time, capital and manpower. Project failure, whether it be partial or complete non-delivery on the organisational and/or market needs, is costly to the organisation. In January 2018 Transnet appeared before the Standing Committee on Public Accounts (SCOPA) for a hearing regarding R692 million in irregular expenditure for the 2016/17 financial year (Parliamentary Monitoring Group, 2017). Approximately R300 million of this irregular expenditure was attributable to Transnet Group Capital (TGC), which is the department responsible for planning and execution of projects within Transnet (Parliamentary Monitoring Group, 2017). It was identified by the Project and Construction Management Portfolio in TGC that one of the causes for irregular and fruitless and wasteful expenditure is poor planning (Transnet Group Capital, 2018). The problem statement is unpacked further by using the '5 Whys' technique (Figure 3) which was developed and fine-tuned within the Toyota Motor Corporation as a critical component of its problem-solving training (Ohno, 2006).

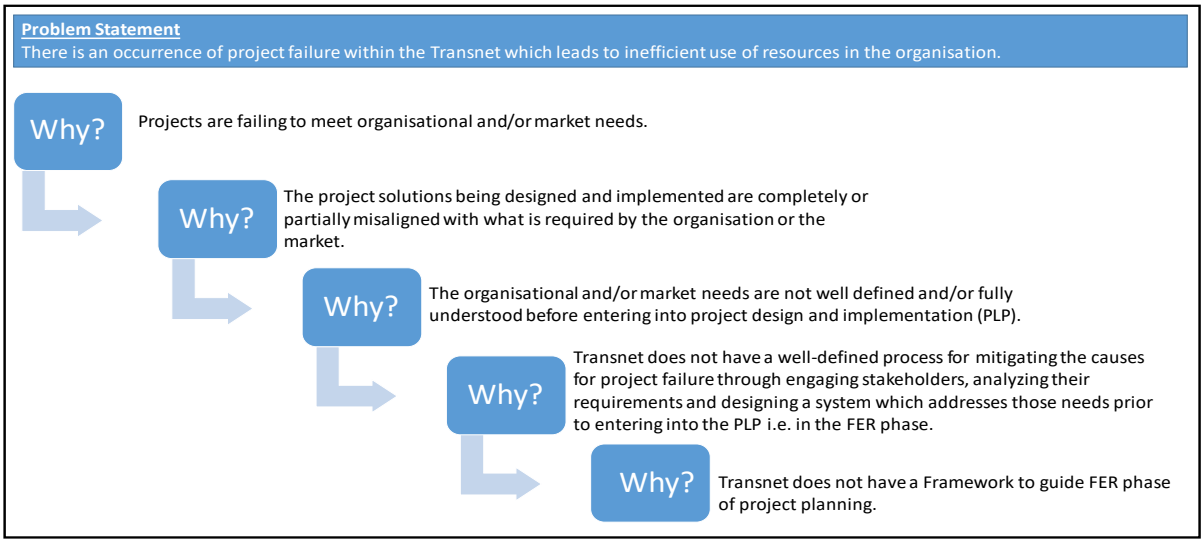


Figure 3: '5 Whys' to unpack Problem Statement.
Source: Author

1.4 Research Motivation

In the logistics sector there are various layers at which services are provided by different actors. These require varying degrees of expertise and capabilities among the actors (Swingle, 2017). Transnet is currently a Second-Party Logistics (2PL) provider i.e. an asset-based transport carrier, which actually owns the means of transportation (Chetak Logistics, 2015). The onset of a shift from the Market Demand Strategy (MDS) which was focussed on infrastructure provision, to a new strategic intent - Transnet 4.0 – that sees ambitions for Transnet to operate as a Fourth-Party Logistics (4PL) provider i.e. "an independent, singularly accountable, non-asset based integrator who will assemble the resources, capabilities and technology of its own organisation and other organisations, including 3PLs, to design, build and run comprehensive supply chain solutions for clients, sees Transnet moving into areas that are not currently its core competency."

Figure 4 below illustrates the various layers of Logistics as well as where Transnet currently operates and aspires to operate in the future as a logistics provider.

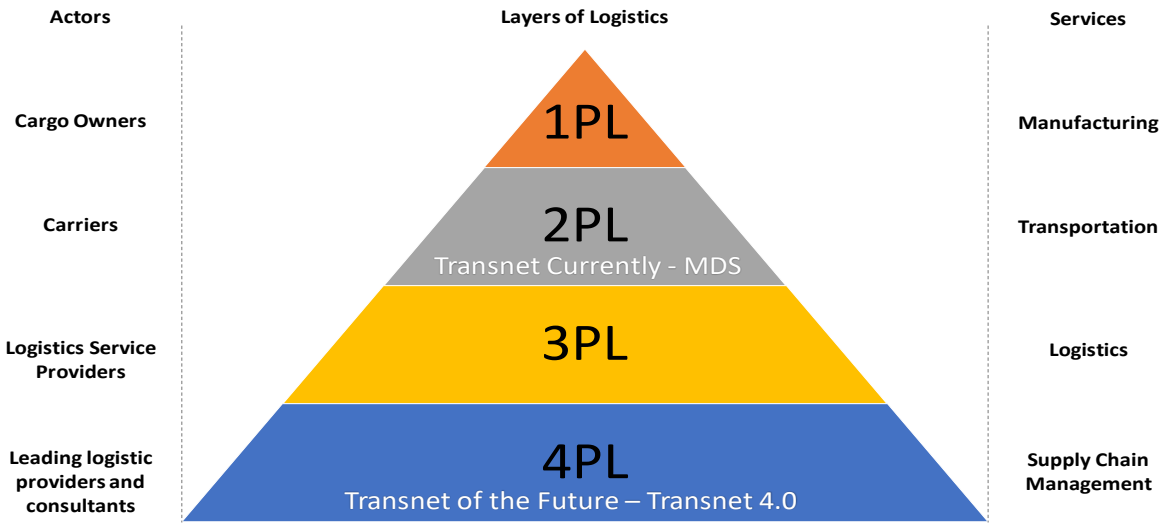


Figure 4: Layers of Logistics Transnet Today – MDS.

Source: Author (Adapted from (Norall, 2013))

The change from operating as a 2PL to a 4PL which Transnet aspires to, sees a shift in focus from infrastructure provision (which is mainly inward focused) to a more intuitive and complex business environment in which the organisation needs to be attuned to the external environment. This notion is depicted in Figure 5, author adapted from Beer (1989) in the Viable System Model (VSM) for Transnet.

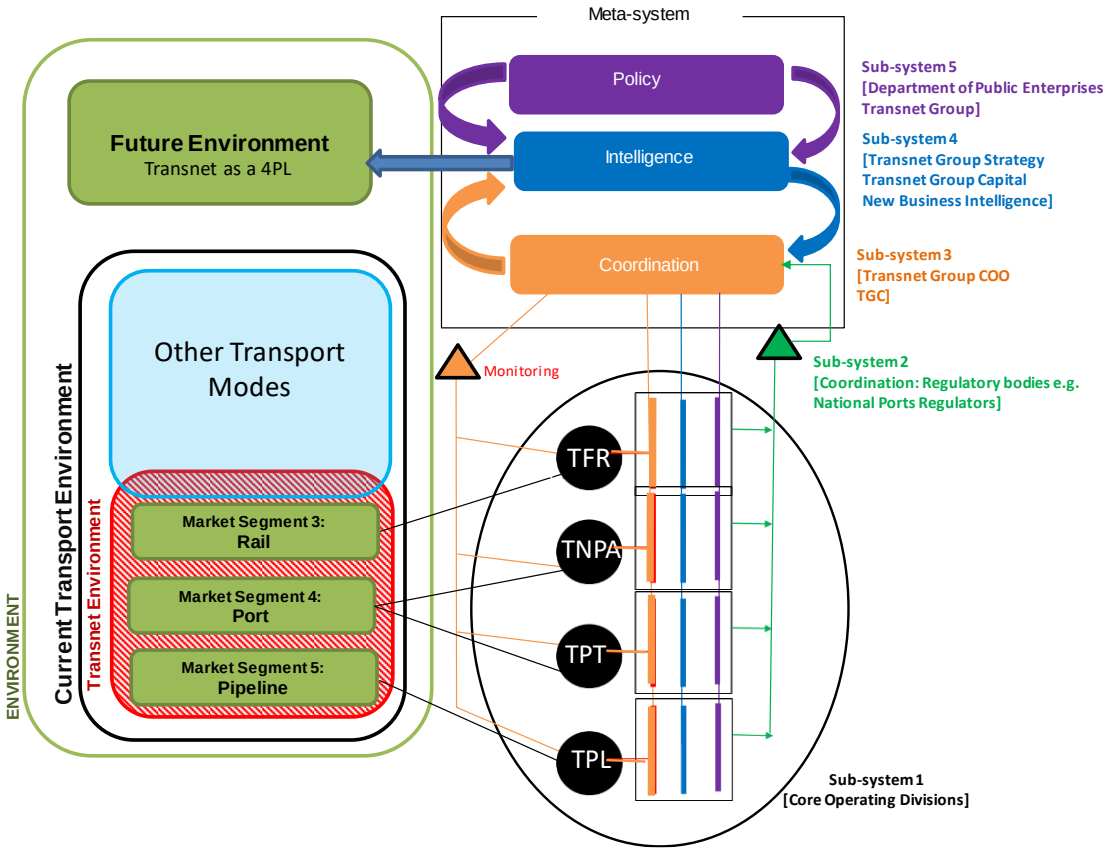


Figure 5: Viable System Model for Transnet.

Source: Author (Adapted from Beer (1989))

In the VSM, as described by Beer (1989), the operational divisions are those responsible for producing the products or services at the core of the organisation's identity. In the case of Transnet, the operational divisions produce key products and services to rail, port and pipeline. Beer (1989) continues to explain that the optimisation function aligns the operational divisions such that they play a value-adding role through activities such as project delivery. Furthermore, the functions of coordination, Intelligence and policy are described as follows:

> *"The coordination function offers regulatory and legislative guidance to ensure accountability within the operational divisions. The intelligence function is fundamental to adaptivity; firstly, it provides continuous feedback on marketplace conditions, technology changes and all external factors that are likely to be relevant in the future; secondly, it projects the identity and message of the organisation into its environment. The main roles of policy function are to provide clarity about the overall direction, values and purpose of the organisational unit; and to design, at the highest level, the conditions for organisational effectiveness* (Beer, 1989)*."*

In its new disposition, Transnet will need to be focussed on the external future environment which renders the intelligence function as crucial to Transnet's survival. The Intelligence function is the two-way link between the primary activity (i.e. Viable System) and its external environment. It is concerned with planning the way forward in light of external environmental changes and internal organisational capabilities so that the organisation can invent its own future as opposed to being controlled by the environment (Espejo & Gill, 1997).

The complexity around the intelligence function in Transnet is increased and therefore more units will be focused on outward looking activities. The TGC portfolio of Capital Planning and Advisory Services which is responsible for carrying out FER, will need to play a more dynamic part in the oranisation's Intelligence function. Moreover, the application of Systems in this function will enable a holistic view on implementation of projects in the future.

The IDEF0 model below, Figure 6, depicts the manner in which FER will be carried out as part of the Intelligence function in the project planning process. The inputs will be derived from key stakeholders, mainly project sponsors, which exist within and outside of Transnet. The process of FER will be carried out to address the causes of project failure identified as the 20 ProjectFailure Red Flags through the application of Systems principles. Project controls are implemented to ensure that accountability, quality and traceability are maintained throughout the FER process. The outputs enable decision makers to decide whether to proceed with a project option in the PLP, whether further information is required, or whether to terminate the project option without further consideration.

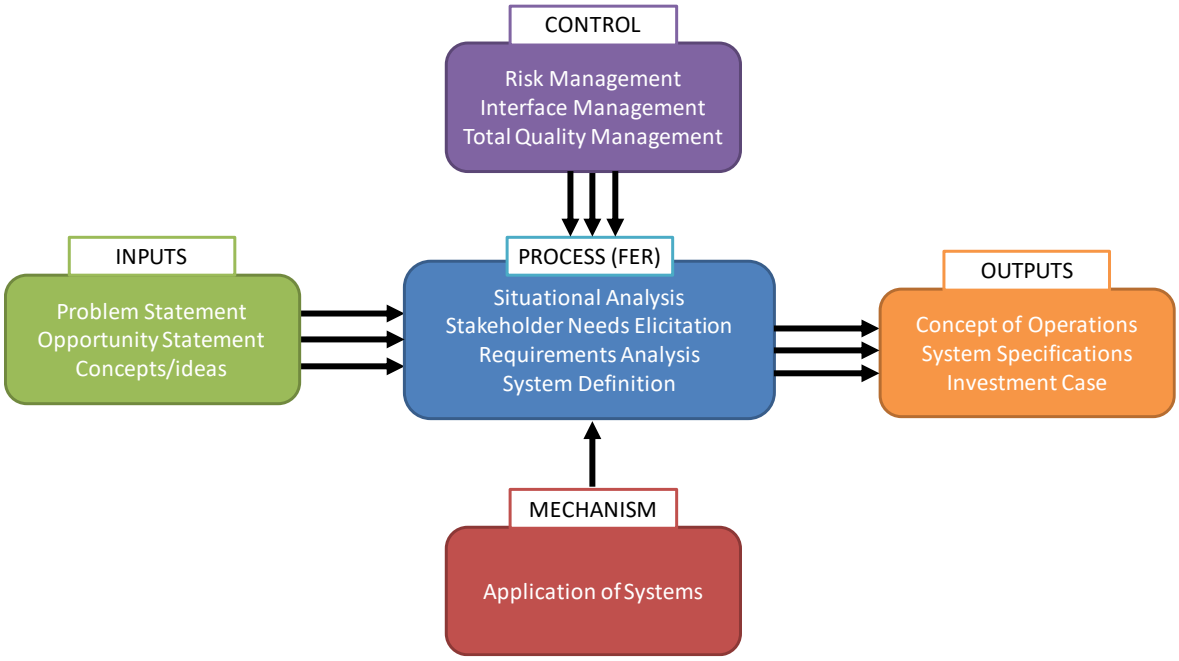


Figure 6: IDEF0 model of FER conducted as part of intelligence function in the project planning process
Source: Author (Adapted form (Defense Acquisition University Press, 2001))

1.5 Research Question

How can Systems principles and frameworks for strategic planning which exist in transportation and other industries be applied to develop a FER Framework which is suitable for Transnet?

a) How has FER been conducted in the strategic planning of projects in Transnet?
b) How has FER been conducted in the strategic planning of projects in transportation and other industries including defence, aerospace, software development and specifically the public rail industry?
c) Which Systems approaches and methodologies can be used to apply System principles in strategic planning of projects?

1.6 Research Objectives

In order to answer the research question, the following research objectives must be met:

a) Assessing the manner in which FER has been conducted in Transnet for strategic planning of projects.

b) Reviewing how FER (pre-project planning) is conducted in the strategic planning of projects in transportation and other industries including defence, aerospace, software development and specifically the public rail industry.

c) Determining which Systems approaches and methodologies can be used to apply System principles in strategic planning of projects.

2 CRITICAL LITERATURE REVIEW

The conceptual framework below (Figure 7) introduces the key focus areas for the critical literature review and shows how various topics are interrelated in their contribution towards the development of the FER Framework for Transnet.

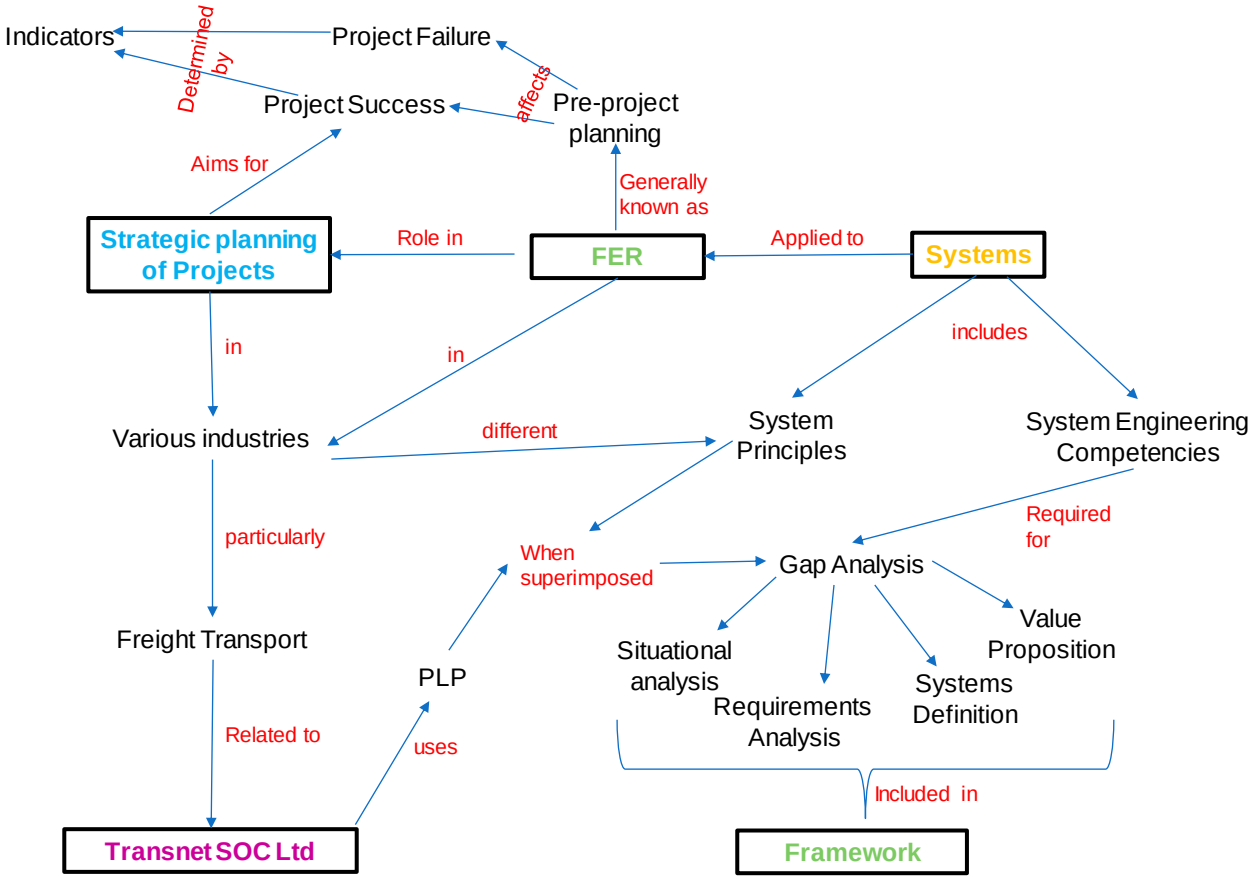


Figure 7: Mind Map of Critical Literature Review

Source: Author

2.1 Strategic Planning of Projects

Strategic planning of projects is described by the Project Management Institute (PMI) as being the linkage and oversight between strategy development and strategy delivery (Project Management Institute, 2016). Strategy development includes formulation of the vision, mission and setting of organisational objectives and the strategy delivery involves the management and execution of project activities (Sopko, 2015). This view can be linked to the interpretation of an organisation as a viable system, the functions of intelligence, monitoring, control and the core operating divisions that play specific roles within the strategic planning sphere.

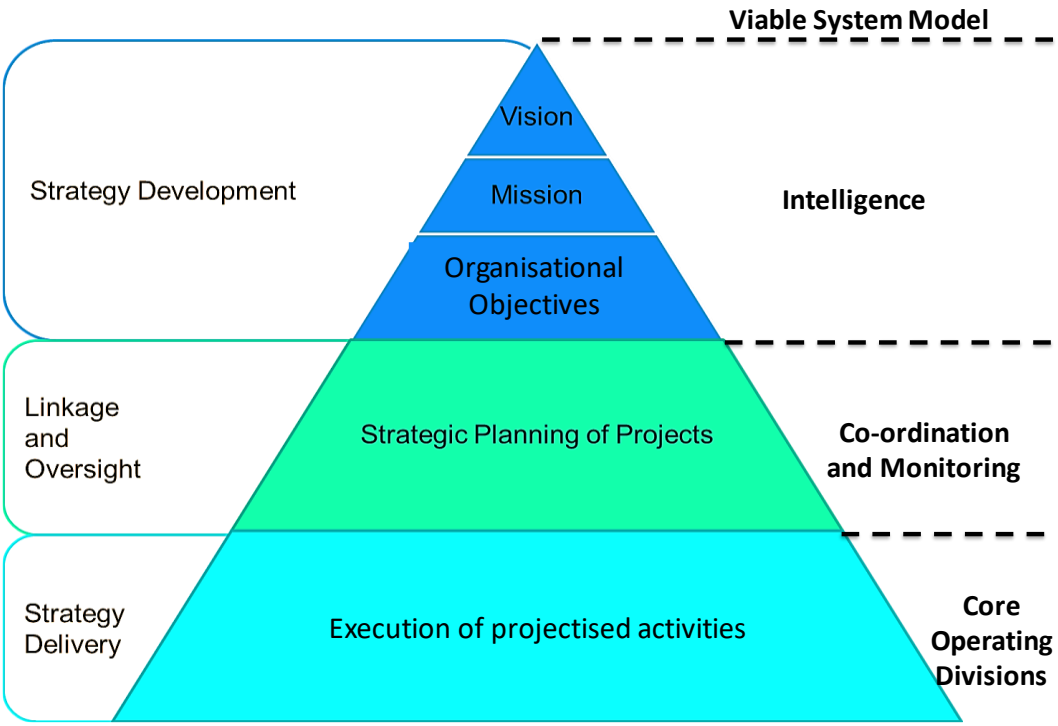


Figure 8: Strategic planning of projects as a linkage and oversight.
Source: Author (Adapted from (Sopko, 2015))

2.1.1 *Strategy Development*

The Classical approach to strategy development by Whittington (1993) captures the original school of thought of the 1960's relating strategy to the maximisation of profits through rational analysis and separation of business conception and execution. The key business problem was seen as being the ability to position an organisation in the markets where maximum profits could be earned. This profit-focussed phenomenon was described by Sloan (1963) as follows:

> "*The strategic aim of a business is to earn a return on capital, and if in any particular case the return in the long run is not satisfactory, the deficiency should be corrected or the activity abandoned."*

The focus was described by Mazucato (2006) as being about making choices of "what game to play," whereas the subsequent era – the Evolutionary era – would focus on "how well the chosen game should be played".

One of the pioneers of the Evolutionary era, Michael Porter, who developed the "competitive forces" approach, describes strategy as "deliberately choosing a different set of activities to deliver a unique mix of value" (Porter, 1996). Another view is that of Mazucato (2006), which states that activities or actions are only strategic in nature if they

allow an organisation to be better than its competitors and to sustain this competitive advantage over time.

In essence, the theorists of the evolutionary era understood that it was not good enough for an organisation to be positioned in profit-making markets, because it was only a matter of time before competitors entered those same markets and replicated the activities and processes that an organisation had developed, and even perform them better. And although profit maximisation remains the goal of any business, the key is to be the leader in the chosen market through delivering value – where value comes from delivering more than just a product or service, but offering a better experience and convenience to the customer based on their particular preferences.

The 4th industrial revolution strategy has evolved once more to accommodate and respond to the fusion of technologies. This introduces a new paradigm to the competitive focus of the Evolutionary era – the organisations which can access and dominate the information space and act speedily based on data-driven decision making processes will have the competitive advantage (Benedict, 2017).

A consideration which was seen by the author as not being covered in sufficient detail when assessing the development of strategy through the eras is how value is achieved, other than in monetary terms, within the organisation through delivering the strategy. Non value-adding activities are well detailed in literature by the topic of Lean Manufacturing, but the manner in which value is created within the organisation, particularly through strategic planning and the delivery of strategy through project activities, requires further investigation.

2.1.2 *Strategic Planning*

Strategic Planning involves coordinating, guiding and informing the preparation and consideration of an organisation's future (Martin, 2014). Although planning is an important aspect of the strategy development process, the author found that many executives delve too quickly into the planning aspect without focusing on the strategy synthesis due to discomfort of dealing with the unknown future.

This view is shared by Mintzberg (1994), who exerts that strategic planning has fallen from its former glory of the 1960's due the lack of understanding of the difference between strategic thinking and strategic planning – "Strategic planning isn't strategic thinking. One is analysis, and the other is synthesis." He went on to say that strategic planning often spoils strategic thinking because while strategic planning is seen as a

discipline, strategic thinking is not widely seen as such and is therefore not emphasised in organisations, nor is the skill developed.

If organisations had an understanding of this difference, more attention would be applied to allocate different yet adequate resources to these two activities. The area of strategic thinking or strategy synthesis should be seen as the basis for strategic planning, therefore, more emphasis should be placed on ensuring that the strategy is formulated correctly.

Furthermore, strategy synthesis does not necessarily have to be followed by strategic planning. The process of strategic planning involves planning, synthesis and execution in a cyclical feedback loop. A systematic process should be followed to determine if a formalised plan should be developed in order to execute on a strategic vision (Schmidt & Laycock, 2009). This notion is based on the theories of Fayol (2013), which state that the roles of management are not limited to planning, but also include organising, command, co-ordination and control.

This shows that not all the outputs from the strategic thinking phase will necessarily be apt to go through the strategic planning phase and doing so may result in wasted time and effort. Therefore, it is crucial to have a preliminary planning process that feeds into the planning activity which will distinguish the outcomes of the strategic thinking process; be it conceptual projects, systems, processes etc.

2.1.3 *Linking Strategic Planning and Delivery of Projects*

The goal of the strategic planning of projects should be to equip decision makers in the organisation to be capable of making sound strategic decisions (Kaplan & Beinhocker, 2003). A generic project planning process for projects developed by PMI is depicted in Figure 9 below. This process is kicked off by determining the project definition which is informed by an evaluation of the current situation including the business environment, market competitors as well as resources and capabilities. The only activity informing project definition in this case, which does not look at the current situation, is an analysis of past performance.

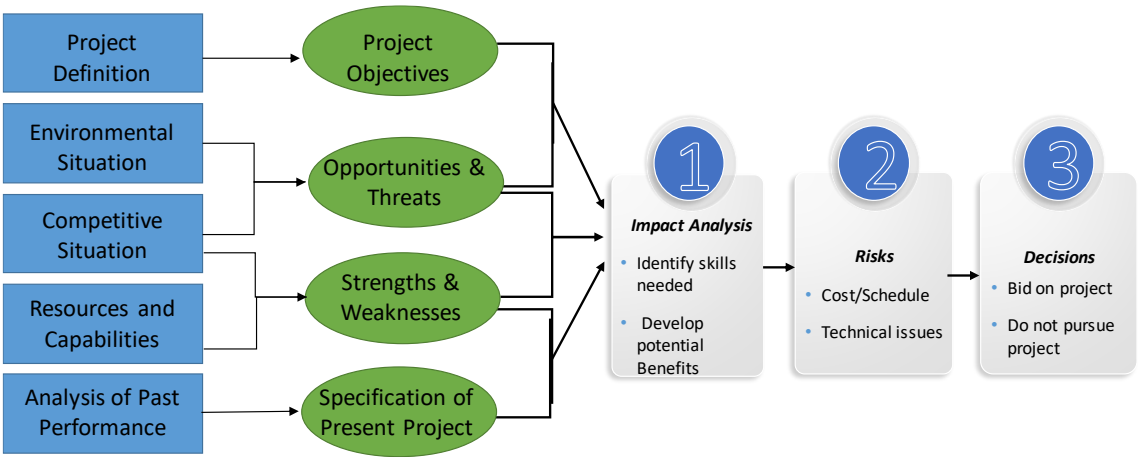


Figure 9: Project planning process.

Source: Author (Adapted from PMBok (Project Management Institute, 2006)

Deductive, i.e. analytical, approaches of looking at the past and current states to try and fulfil needs and provide solutions into the future are becoming less and less applicable in the current era where technological advancements occur at an alarming rate. For instance, according to Bloomberg New Energy Finances, the onset of the Electric Vehicles (EVs) saw the percentage market share of EVs relative to Internal Combustion Engines (ICEs) at 1:99 in 2015; the current projections show sales of EVs overtaking ICEs in 2038 with a share of 54% (Bloomberg, 2017). These projections are in line with regulatory and policy changes within many countries which are encouraging the use of "cleaner fuels" and call for an end to the sale of ICEs by 2040. Seeing as this is a new fuel alternative for vehicles, neither past nor current solutions can be applied directly to the planning of energy demand, vehicle markets/sales and in turn infrastructure requirements. This is what Ackoff (1981), a pioneer of systems thinking, defines as a dilemma – "a problem, which cannot be solved within the current world view".

Another change in the strategic project planning sphere is the type of criteria used to measure project performance. Project Management KPIs including cost variance, return on investment, schedule variance etc. are used as project performance measures (Dinsmore, 1990). These indicators mainly measure monetary and schedule performance. While still important, these KPIs are focussed on deliverables which in non-complex situations can easily differentiate between projects e.g. differentiating between a project with a higher Internal Rate of Return (IRR) and one with a lower one.

The question that emanates centres on when there is little to no information upon which these quantitative analytical conclusions can be drawn. To be of value, the information must be accurate, timely, disaggregated and widely available. This is not the case in many African countries (Beguy, 2016). This is often the issue when pursuing projects in

the rest of Africa. The discipline of Systems Thinking provides a mechanism to addressing this question, as is captured later in this research report.

Synthesis is an aspect of Systems Thinking which is defined by Brown (2008) as putting together ideas, which are usually in tension, in order to create options for an ultimate decision to be made. This relates to Systems Thinking in that decisions are made in a systematic way that balances conflicting objectives - optimizing resources such as time, money and human resources - while not compromising the ability to obtain stakeholder buy-in. Therefore, in Systems, the indicators for a successful or failed solution will be specific to the problem situation being dealt with and the process of system definition includes a design of the qualification process for verification, validation, and acceptance (Buede, 2009).

Furthermore, Systems Engineering Management emphasises the importance of decision making as it forms part of the situational analysis process as depicted in Figure 10 (Emes, 2006).

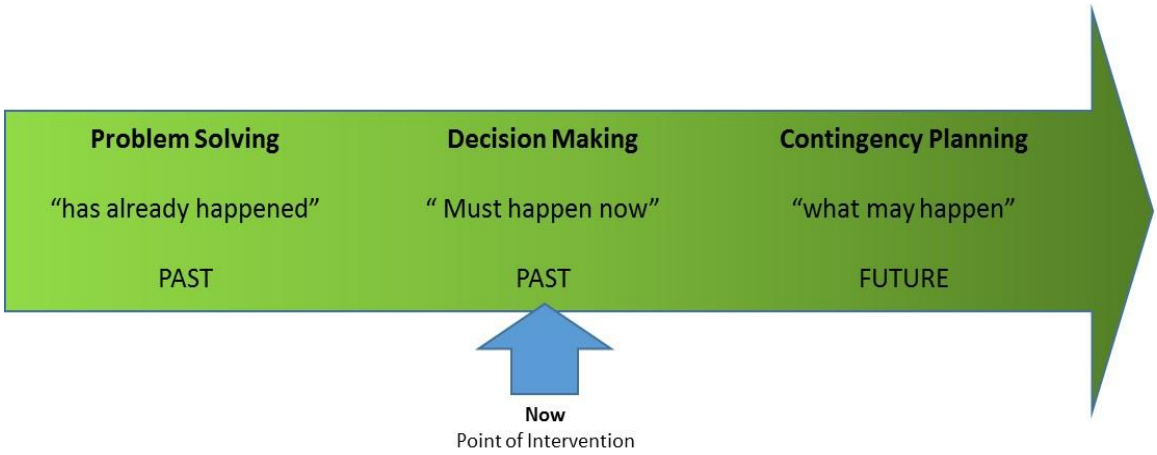


Figure 10: Situational Analysis Process
Source: Author (Adapted from (Emes, 2006))

Situational analysis differs from traditional PM processes in that it kicks off with a problem solving phase, wherein the cause of the problem is identified and part of the decision making includes choosing the best tools or approaches for the problem at hand. That is to say, situational analysis takes a step back to assess the overall problem situation, rather than starting out at the point where it has been decided that a project will be the best means to solve a given problem. In instances where it is decided that a project is the best approach, the risk involved should be identified and contingency planning be engaged to further equip decision makers to make well informed decisions (Emes, 2006).

2.2 Project Performance

This section discusses how project success is determined and, by inverse, project failure. Furthermore, this section identifies various causes of project failures in industries including Transportation. These causes for project failure are discussed and shortlisted to 20 “Project Failure Red Flags” – the term is used in this report to identify the 20 most prevalent causes for project failure identified through this research study. This term is adapted by author from the ‘early warning signs’ as used by Kappelman, Mckeeman, Zhang (2006).

2.2.1 *Project Success*

Project success is defined by people based on their specific interests and priorities. For instance, a project manager may view a project as being successful if it is delivered within budget; whereas the end user of a product or service may view it as being successful only if it meets their operational needs (Project Management Institute, 2016). A customer may seek to determine whether the product or service meets their requirements and quality specifications; whereas the project sponsor may view a project as being successful should it create value to the organisation once completed and beyond.

The views of four industry experts from various parts of the world were compiled in an opinion column by The International Centre for Complex Project Management (2006). The contributors included:

- Project Leadership Coach from the UK,
- Senior Executive with 20 years’ Project Management experience from Australia,
- Project Management software developer,
- Principal Consultant with Systems Engineering qualifications.

A common theme emerged from their contributions in that they stated that people are the most important factor in determining success or failure of projects. The technical or financial measures of success in a project are important (but only to the extent that the project can be said to be complete). It is the end users and those involved in the life of a system that are both key to its success during, and in the measuring of success of the project at its completion (International Centre for Complex Project Management, 2006).

All the contributors noted that the success of a project may not be immediately visible or tangible and a project may be classed as a failure in the short-term and then, once it has time to be entrenched and the benefits of the new software/system/ technology/infrastructure/building become apparent, it will be classed as a success.

These views are different to the traditional Project Management KPI's which are used to determine success or failure and focus on time and cost measures. A study conducted by Freeman & Beale (1992) reviewed 14 papers on the topic of project success and found that technical performance and efficiency of project execution topped the list with 93% frequency of mention as key project success indicators – supporting these traditional KPIs. The people-centred criterion of personal growth and managerial and organisational implications scored relatively low with 29% and 43% respectively (Freeman & Beale,1992). The findings from the study are depicted in Table 2 below.

Table 2: Project Success Criteria

	Success Criterion	Description	Frequency of Mention
1.	Technical performance	To what extent were the technical requirements specified at the commencement of the execution phase achieved.	93%
2.	Efficiency of project execution	The degree to which targets of time and cost were met.	93%
3.	Managerial and organisational implications	A measure of client, parent and user satisfaction, incorporating the degree to which the project was carried out without disturbing corporate culture or values.	43%
4.	Personal and user growth	The satisfaction of the project team, particularly in terms of interest, challenge and professional development.	29%
5.	Project termination	The completeness of the termination, the absence of post-project problems and the quality of post-audit analysis.	14%
6.	Technical innovativeness	The success in identifying technical problems during the project and solving them. Could also be deemed to be technical determination.	14%
7.	Manufacturability and business performance	The ease with which the product resulting from the project can be manufactured, and its commercial performance.	43%

Source: (Freeman & Beale, 1992)

Goatham (2016) provides a different perspective that is a combination of the two former views on project success. This is depicted in the "Layers in Project Success" in Figure 11. This Figure classifies the various project success criterion into different tiers as summarised in Table 3.

Table 3: Classification of various project success criterion into Project Success Tiers

	Project Delivers on:					
Tier of Project Success	Scope	Schedule	Budget	Quality Standards	Organisational Needs	Desired outcomes
Tier 1	✓					
Tier 2	✓	✓				
Tier 3	✓	✓	✓			
Tier 4	✓	✓	✓	✓	✓	
Tier 5						✓

Source: Author (Adapted from (Goatham, 2016))



Figure 11: Layers in Project Success

Source: (Goatham, 2016)

This representation of project success will be applied to the FER Framework as it answers the question which was raised in the previous section about how value is created in the organisation through the delivery of strategy and the answer is that value is created by the following:

- Delivering on the agreed scope.
- Meeting quality requirements and expectations.
- Meeting organisational and/or market needs.
- Achieving the desired outcome.

The questions that emanated from the above criteria is whether all four criteria must be met or a combination thereof are required to create value in an organisation.

Furthermore, what results in the success factors not being achieved i.e. what causes project failure? In understanding the causes of project failure, it will be possible to identify various strategies that can be put in place to avoid it.

2.2.2 *What is Project Failure?*

Numerous studies have been conducted to assess project failure in the implementation of major investment projects worldwide. PMI notes that only 62% of projects were deemed successful in 2016; that is they had met the original business intent and were aligned to strategic goals (Project Management Institute, 2016). Dorsey (2000) believes that this statistic may be understated as “few people like to admit failure”. It appears that the generally accepted figure of 50% for project failure rate is documented by authors covering this topic (Dorsey, 2000).

The “Catalogue of Catastrophe” is a record of the more noteworthy failed and troubled projects from around the world showing extensive financial losses (Goatham, 2017). Examples include project losses in excess of USD1million due to projects which failed to deliver on the intent or else having encountered other forms of perceived failure Goatham, 2017). The latest project reported on was a US Department of Defense project to procure camouflage uniforms. The project ran $28 million over budget only to find that the pattern chosen is not suitable for camouflage in the Afghanistan terrain due to the print and colour (Goatham, 2017).

Matta and Ashkenas (2003) exert that the impact project failure has is beyond financial but that these failures demoralize employees who have worked diligently to complete their share of the project work, only to never see the project materialise.

2.2.3 *Indicators of Project Failure*

Numerous views exist on the causes of project failure. Prabhkar (2008) cites one cause as being traditional problem solving methods which are restricted to a central stakeholder perspective, usually the sponsor, and are insufficient to rationally determine the best project option for implementation.

Matta & Ashkenas (2003) agree that traditional project management approaches are to blame for project failure, although for different reasons to that of traditional problem solving methods. They believe that traditional approaches shift the project team’s focus away from the end result towards the delivery of partial solutions by the smaller teams with the intent to piece the partial solutions together in the end.

Upon further reading it is found that the majority of reasons that projects fail is not technical in nature but are people and process related. Meier (2008) found that there

were early warning signs that occurred frequently in projects conducted by U.S. Federal Intelligence and Defense Agencies. Meier (2008) summarised these as follows:

- Overzealous advocacy
- Immature technology
- Lack of corporate roadmaps
- Requirements instability
- Ineffective acquisition strategy and contractual practices
- Unrealistic program baselines
- Inadequate Systems Engineering
- Inexperienced workforce and high turnover.

This view summarises the findings of Kappelman et al. (2006) in the main but there is a stark contrast regarding the first early warning sign on the list - “overzealous advocacy.” The results of Kappelman et al. (2006) are summarised under the title “The Dominant Dozen” (see Table 4 below). Kappelman et al. (2006) found that the highest ranked early warning signs out of the 53 which were identified, was “lack of top management support or commitment to the project.” But Muralidharan (2006) finds that a combination of both can occur; i.e. “sponsors either get lost in micro-management or are invisible, or even both.”

Overzealous advocacy can be detrimental in a project in the case where stakeholders influence is excessive and contributing to increased complexity. This was observed by Drummond (1998) in the Taurus IT project where the “industry is very diverse and everyone in the market wanted something different. No one was prepared to compromise the only solution open to the Stock Exchange was to combine all the various Taurus models (17 in all) into one immensely complex hybrid.”

Table 4: The Dominant Dozen Early Warning Signs of IT Project Failure

People-related	**Ranking of 53 Early Warning Signs**
Lack of top management support	1
Weak project manager or absence of Systems Engineer	3
No stakeholder involvement and/or participation	5, 10
Weak commitment of project team	8
Team members lack requisite knowledge and/or skills	11
Subject matter experts are overscheduled	17

Process-related	
Lack of documented requirements and/or success criteria	2, 7
No change control process (change management)	4
Ineffective schedule planning and/or management	6, 14, 15, 16
Communication breakdown among stakeholders	9
Resources assigned to a higher priority project	12
No business case for the project	13

Source: Author (Adapted from (Kappelman, et al., 2006))

The identified 'early warning signs' as captured by Kappelman et al. (2006) in "The Dominant Dozen" (see Table 4) have been for projects in various industries operating in the private sector. The need to assess the failure of public sector projects arose in order to verify whether the findings could be seen as being applicable to the Transnet environment. It was found that views on indicators for projects being conducted in the public sector did not differ significantly from the private sector projects.

Achterstraat (2003) audited hundreds of New South Wales Government agencies and major projects over seven years and identified the following common issues as being:

- A poor initial business case
- Unclear statements of expected outcomes
- Lack of senior management buy-in
- Inadequate gateway reviews
- Poor communication
- Inadequate stakeholder engagement
- Scope creep (or in many cases 'scope gallop')
- Conflicts of interest
- Optimism bias when assessing prospective benefits
- Lack of appreciation of the 'big picture'.

2.3 Application of Systems Engineering for Project Success

The disciplines of Systems Engineering and Project Management are closely related but different in their functions. Similarly, the Systems Engineer and Project Manager bring differing competencies and capabilities to the project space and need to work closely together in order to ensure project success. Their roles and responsibilities must be clearly outlined within the project and their relationship well understood.

2.3.1 *Relationship between Systems and Projects*

The disciplines of Systems Engineering and Project Management are different but closely related with certain areas of overlap. The relationship of the two disciplines are found where there is complexity and uncertainty in defining the project space. The success of complex technical projects relies on an integrated approach of project management and Systems Engineering (John Hopkins University, 2014).

The International Council on Systems Engineering (INCOSE) Systems Engineering Body of Knowledge (SEBoK) notes that although the relationship of the projects and systems domain have been seen to intercept in various cases, it is important to understand the scope of the work at hand in order to determine which is the best approach to follow (BKCASE Editorial Board, 2017). As depicted below in Figure 12, sourced from (NASA, 2007), there are varying degrees of intersection between Systems Engineering and project management and this will depend upon the particular project being implemented.

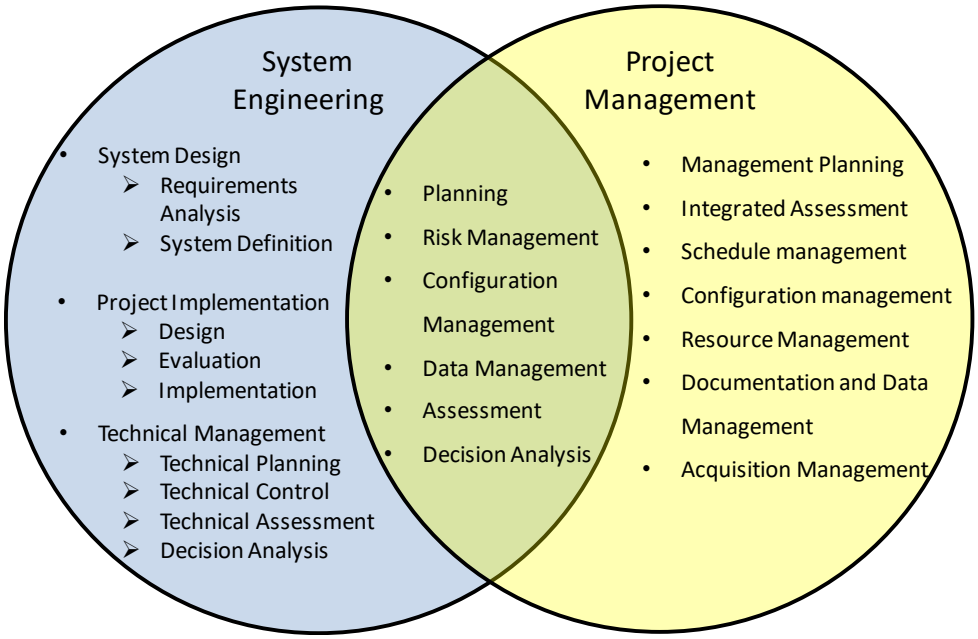


Figure 12: Relationship between Project Management and Systems Engineering
Source: Author (Adapted from (NASA, 2007))

According to Van Gemert (2013) the key relationship between project management and Systems Engineering is that projects are based on requirements i.e. a project is conceived in order to fulfil a certain need which has been identified. Systems Engineering carries out the process of synthesising those requirements. Further to this the performance requirements against which successful completion will be measured (verified) also needs to be synthesised in the initial stages of the project. Therefore, Systems Engineering will be applied across the project life cycle in the initialisation phase, in order to clearly define the project as a system as well as ensure traceability throughout the project lifecycle in order to achieve satisfactory outputs.

In the case where the problem definition as well as solution synthesis are complex or involve high levels of uncertainty then the system lifecycle process is implemented throughout the project lifecycle. In such a case, the two domains completely overlap. This does not currently exist within Transnet, but will most likely become prevalent with the strategic intent to diversify to new products and services as well as new geographical markets.

For this research study, the case of partial overlap will be considered, as the projects and programmes within Transnet are being implemented using the PLP currently, therefore both Project Management and Systems Engineering disciplines are applied specifically in the planning stages. The pre-project phase is what will be addressed through the FER Framework. This should include requirements analysis, identification of verification measures as well as a means to create traceability within the PLP to ensure that the output is in-line with the requirements set out at initialisation.

2.3.2 *System Engineering Competencies*

The System Engineering Competency Framework was developed by INCOSE UK to define measurable competencies to conduct good Systems Engineering (INCOSE UK CHAPTER, 2010). The framework includes the skills and levels of practitioners associated with those skills. The SE competencies are depicted below (Figure 13) and will be discussed in detail with the exception of Systems Science – which although an integral competency, is not applied in the development of the FER Framework.

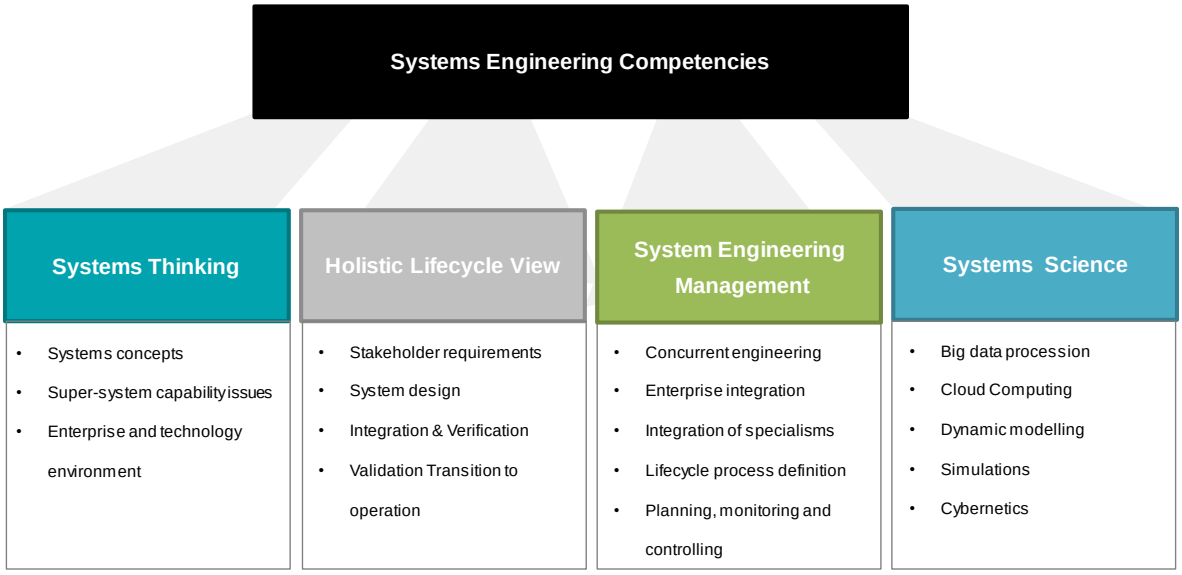


Figure 13: System Engineering Competencies

Source: Author (Adapted from (INCOSE UK CHAPTER, 2010))

2.3.2.1. Systems Thinking

Systems Thinking is described by Senge (1990) as “a process of discovery and diagnosis which is seen to be a useful approach in tackling situational analysis”. Systems Thinking is also seen as a way of incorporating “soft” systems into “hard” systems solutions where soft systems are people and process centric issues such as stakeholder management, communication management and incorporation of best practices (McConnell, 1996). Hard systems approached apply where s system is engineered to solve a problem (Averskog, 2015).

Soft System Methodologies (SSM) were developed by Peter Checkland to deal with ill-structured problems that were not handled well by the hard systems approach. A soft systems approach “seeks to work with different perceptions of reality, facilitating a systemic process of learning in which different viewpoints are examined and discussed in a manner that can lead to purposeful action in pursuit of improvement” (Jackson, 2003).

Key SSMs that can be useful in clarifying the problem and objectives of a project are the Rich Picture and Root Definition. These are soft systems thinking tools which can be used to derive the needs of a customer. The Rich Picture is a pictorial depiction of key issues relating to a particular subject matter. The elements within the Rich Picture are also then connected to show interrelatedness as well as dependencies. The tool is well defined and there are symbols and nomenclatures which are associated with the tool. Various sources have sited the usefulness of this tool within their organisations and not much criticism of the tool could be found.

Root Definition can then be used to clarify the problem situation which surfaced using the Rich Picture (Sabkaran, et al., 2010). The “CATWOE” analysis (Checkland & Scholes, 1990) is performed to develop the root definition by identifying the various elements relating to the problem definition according to the acronym CATWOE as follows:

- Customers – Those who benefit (or suffer) from the operations of the organisation, e.g. clients.
- Actors – The individuals, groups, institutions and agencies who perform the functions of the organisation.
- Transformations – The processes that transform inputs to outputs.
- Weltanschauung – The world-view or bigger picture that encapsulates the problem situation and expresses the way the organisation views the world.
- Owners – The people who have the ultimate say over the project, provide the resources and can pull the plug on the project.

- Environment – The broader constraints that act on the situation. These may be ethical limits, the law, financial constraints or limited resources.

An example root definition relating to the identified problem of the lack of a FER Framework in Transnet is given below:

"The PLP, which is owned by TGC, is carried out by project teams within TGC and ODs from FEL 1 to FEL 4. However, it does not include a process which clearly translates the needs of clients and stakeholders into project alternatives which are seen to best fulfil the client requirements. This results in financial and resource wastage through investing in projects which are later found to not deliver the desires outcomes." (Author, 2018)

2.3.2.1 Holistic Lifecycle View

Systems Engineering aims to capture stakeholder needs and transform these into a description of a holistic lifecycle, balanced system solution which satisfies overall project and system effectiveness (Halligan, 2003). The basic concepts such as Through Lifecycle Engineering, Verification and Validation and Interface Management will be modified for the FER Framework.

ISO/IEC CD 15288 is an International Standard for System Engineering, in particular System Life Cycle Processes, and it applies to the full life cycle of systems, including conception, development, production, utilisation, support and retirement of systems, and to the acquisition and supply of systems, whether performed internally or externally to an organisation.

The process as defined in ISO/IEC CD 15288 emphasises sequential performance of SE activities, whereas INCOSE (2012) departs from this view to indicate that the process of requirements definition and system design intertwine and should be aligned and integrated:

"*Systems Engineering (SE) is an interdisciplinary approach and means to enable the realisation of successful systems. It focuses on holistically and concurrently understanding stakeholder needs; exploring opportunities; documenting requirements; and synthesizing, verifying, validating, and evolving solutions while considering the complete problem, from system concept exploration through system disposal*." (INCOSE, 2012)

The area of Requirements Analysis emerges as a key Systems Engineering activity which is applicable to the FER process. The generic requirements analysis process that is applied widely is “Requirements Analysis that Works!” (Halligan, 2012).

Stakeholder identification initiates the process with the objective of identifying stakeholders that may be potential owners of requirements or affected parties of the overall system development. In the case of a complex environment, the identification of stakeholders becomes increasingly challenging therefore, deriving quality requirements from stakeholders that exhibit the ten requirements quality factors as described by (Halligan, 1993), becomes a crucial step.

Having identified the different stakeholders, it is useful to categorise the stakeholders in terms of their criticality and power to influence the outcomes of projects (Vos, 2006). This step will be beneficial if a Stakeholder Value Analysis will be performed to provide a level of prioritisation and weighting of requirements based on the owner of the requirement.

INCOSE’s Guide to Writing Requirements addresses characteristics of requirements which should ensure that the requirements are appropriately crafted (Requirements Working Group, 2012). These are summarised in Table 5 below:

Table 5: Characteristics and Attributes of Good Requirements

Characteristics of requirement statements	Characteristics of a set of requirement statements.	Attributes of requirement statements.
• Necessary • Unambiguous • Complete • Singular • Feasible • Verifiable • Correct • Conforming	• Complete • Consistent • Feasible • Bounded	• Alignment with need • Alignment with design • Alignment with evidence

Source: (Requirements Working Group, 2012)

2.3.2.2 Systems Engineering Management

Systems Engineering Management (SEM) occurs at the intersection of Systems Engineering and Project Management. This is in line with what was found to be the relationship as per Figure 12 in this research report. SEM falls within the same area of overlap where Business Case Analysis is found and in the context of FER, where there

is not enough detail to develop a complete business case, a type of investment case may be required as a means to prioritise project options. The issue of an investment case seems to fall outside of the scope of SEM and could form part of a subsequent research study.

SEM is an overarching competency which sits at a higher level than the technical design and delivery of a project, but supports the project by incorporating the management of "soft" issues such as human factors and safety, reliability and maintainability into the process (Blanchard, 2004).

An important feature of SEM is the System Engineering Management Plan (SEMP) which is a management document or the integration of all engineering activities within the project and it follows from of the Project Management Plan. The SEMP has three parts: (i) Technical Programme Planning and Control (ii) Systems Engineering Process (iii) Engineering Speciality Integration (Martin, 1997). These are described by Martin (1997) as follows:

- Part (i), Technical Program Planning and Control, describes the proposed process for planning and control of engineering efforts for the system design, development, test and evaluation.

- Part (ii), System Engineering Process, includes specific tailoring of the SE process and implementation procedures, types of models to be used for system and cost effectiveness evaluations, generation of applicable documentation and specifications.

- Part (iii), Engineering Specialty Integration, describes the integration of technical discipline efforts and parameters into the SE process and includes a summary of each technical discipline effort with a cross reference to the specific plan.

2.3.3 *Systems Engineering Frameworks*

Conceptual Frameworks represent a way of thinking about problems or representing how complex things work (Bordage, 2009). These tend to be represented pictorially as what several authors refer to as concept models. Bordage (2009) describes these as models showing the interfaces between several theories, principles and best practice which relate to the problem at hand.

Dynamism in framework planning is achieved through architectural frameworks which has its roots in military strategy studies. The Ministry of Defence Architectural Framework (MODAF) uses six viewpoints in order to generate possible eventualities.

The six viewpoints can are described by (Ministry of Defence, UK, 2005) as:

- Strategic views (StVs) define the desired business outcome and what capabilities are required to achieve it.
- Operational views (OVs) define the processes, information and entities needed to fulfil the capability requirements.
- Service oriented views (SOVs) describe the services required to support the processes described in the operational views
- Systems views (SVs) describe the physical implementation of the operational and service orientated views and, thereby, define the solution.
- Acquisition views (AcVs) describe the dependencies and timelines of the projects that will deliver the solution.
- Technical views (TVs) define the standards that are to be applied to the solution.
- All views (AVs) provide a description and glossary of the contents of the architecture.

Cloete-Hopkins (2016) adapted the MODAF to reflect viewpoints in the South African Transportation Sector (Figure 14). This view replaces the acquisition viewpoint and the services oriented viewpoint with Governance and Customers/Programmes respectively. In the SA Transport sector, the regulation and governance function are responsible for overseeing the service delivery and acquisition and procurement within the sector. Therefore, governance encompasses the acquisition and services oriented viewpoints. Further to this, Customers and Programmes are important within the Transport environment with each organisation wanting to gain the competitive edge and increase market share.

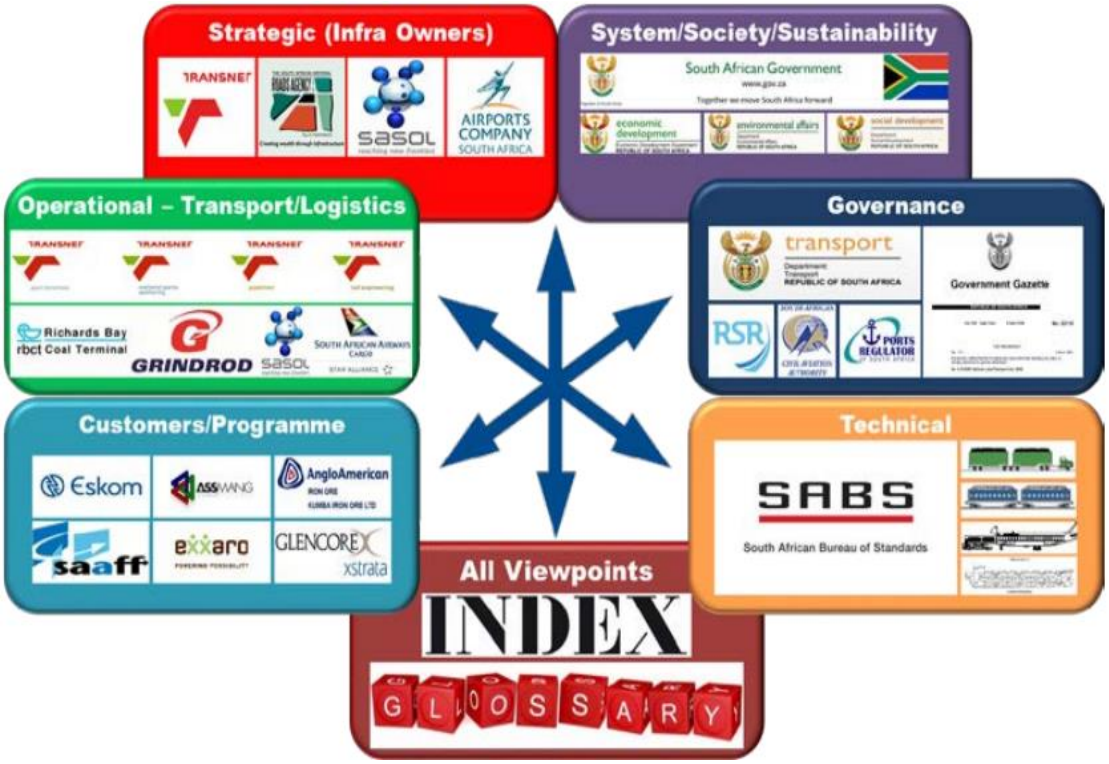


Figure 14: A visual representation of types of views in MODAF in the Transport Sector
Source: (Cloete-Hopkins, 2016)

Transnet, among other stakeholders in the transport sector, plays a part in the operational and strategic viewpoints. In light of a new strategy being developed, the strategic viewpoints will need to unpacked further, bearing in mind the interfaces with other stakeholders. Theses viewpoints will further have to be unpacked categorised and prioritised in order to generate cohesive and integrated requirements.

The FER Framework which is being developed will have elements of conceptual frameworks, in that it will guide and direct the user's way of thinking about prevailing problems, but will also have the attributes of an architectural framework, in that various stakeholder viewpoints will be taken into consideration.

Figure 15 shows the Integrated System Engineering Framework (ISEF) developed by the United States Army Research, Development and Engineering Command. ISEF was developed in order to overcome problems which were identified within the US Army including, but not limited to, silos of information, lack of continuous & lifecycle traceability, lack of real time collaboration (Umpfenbach, 2014). These issues are relevant within the context of this study. The areas which will not be included in the FER Framework at this stage, however, are models of any kind i.e. Systems Science.

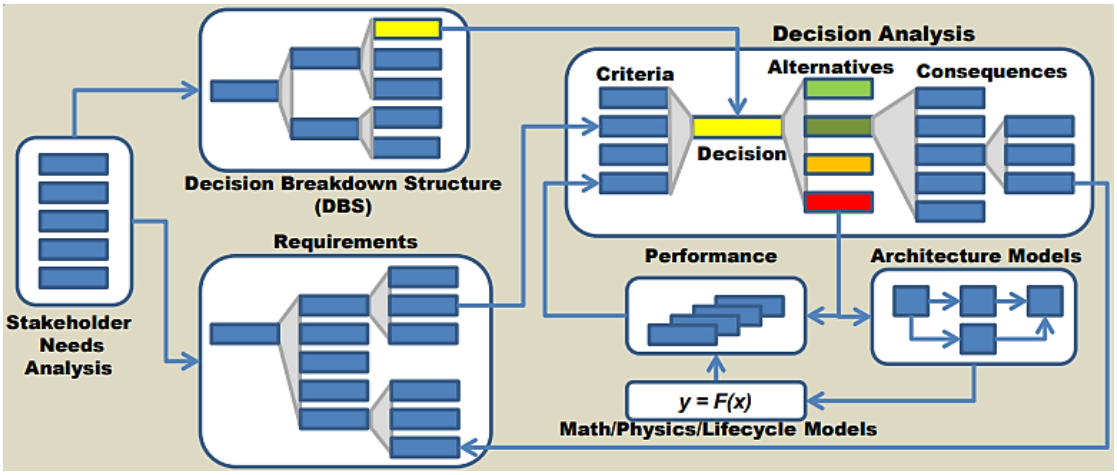


Figure 15: Integrated System Engineering Framework (ISEF)

Source: (Umpfenbach, 2014)

Another example of how Systems Frameworks have been utilised is found in the Transportation industry in the Integrated Corridor Management (ICM) system and its pilot deployment on a section of the I-210 freeway in Southern California. This was a multi-stakeholder programme which aimed to address various issues, some of which were:

- Coordination of transit and roadway operations.
- Enhancement of situational and operational awareness.
- Development of coordinated strategy management.
- Enhancement of communication with system users.

For the ICM project the following Systems Framework was utilised:

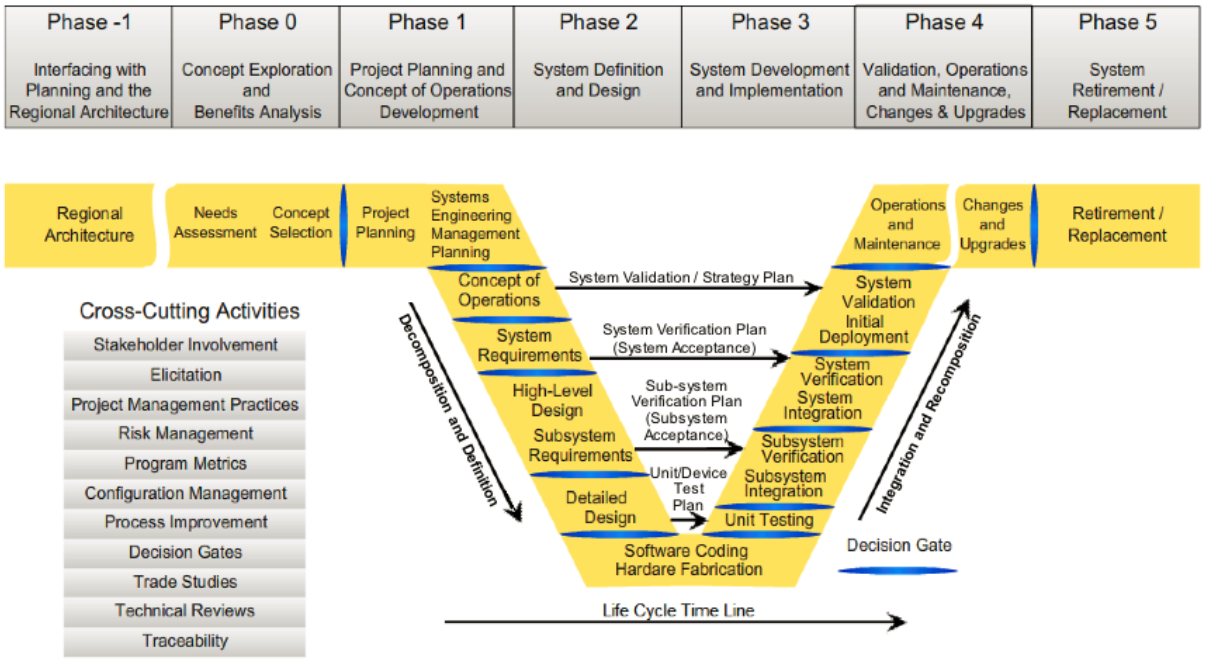


Figure 16: System Engineering Framework Guiding the ICM Programme

Source: (Connected Corridors, 2013)

The Framework developed for the ICM demonstrates the full lifecycle process and application of the framework ensured traceability from phase 1 to phase 5. This represents an example of a project/programme where the entire lifecycle was conducted through application of SE, where in particular, the cross-cutting activities in between phase 1-0, represent the role of FER in the project lifecycle.

Another framework which was considered in terms of its applicability to FER is the Zachman Framework™. This is a fundamental structure for Enterprise Architecture and provides a total set of descriptive representation for describing an Enterprise (Zachman, 2008). The Zachman Framework is represented as a 6x6 matrix grid, showing various perspectives – comparable to those considered in MODAF - in the vertical axis, and classification names which interrogate “what”, “how”, where”, “who”, “when” and “why” in relation to the various perspectives (Zachman, 2008). Moreover, there are secondary axes which provide the enterprise names and model names relating to the intersections which describe the various representations of the Enterprise.

Figure 17 shows the latest version 3.0, of the Zachman Framework. The framework was first published in 1987 and has been developed over the years to its current depiction (Zachman, 2008).

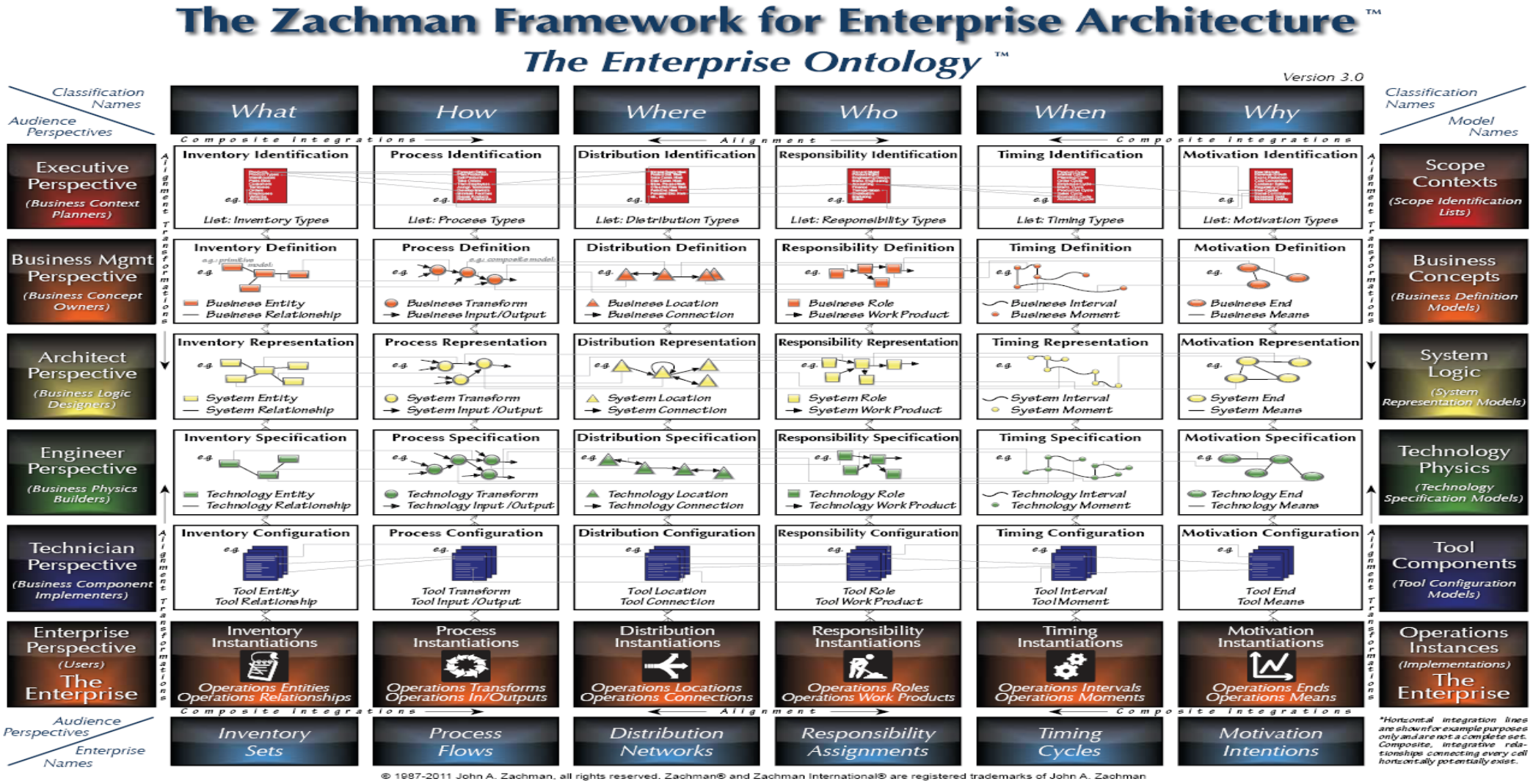


Figure 17: Zachman Framework 3.0

Source: (Zachman, 2008)

There is an overlap between the Zachman Framework and the Concept of Operations (CONOPS). The CONOPS is a formal document that provides a high-level, user-oriented view of operations developed in part to help communicate this view to the other stakeholders and to solicit their feedback (Federal Highway Administration Research and Technology, 2006). The CONOPS captures the operational and support environments; functionality; and characteristics of the system as well as the user's point of view on "What", "Who", "When", "Where", "Why", and "How" a system is used throughout its lifecycle (Federal Highway Administration Research and Technology, 2006). This is comparable to the classification names represented in the Zachman Framework which are used to describe the various perspectives of an enterprise.

Figure 18 depicts the questions addressed by a CONOPS document which will also be applied alongside the Zachman Framework to develop the FER Framework.

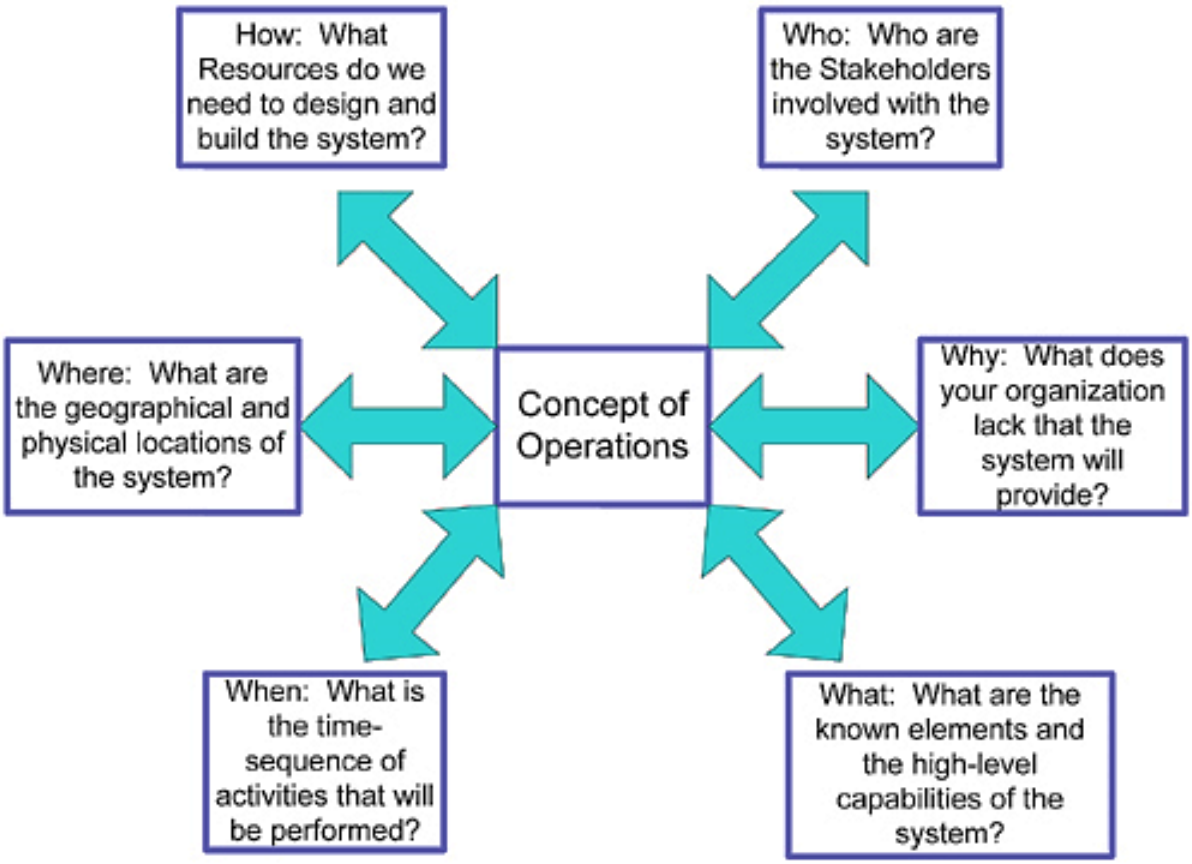


Figure 18: Questions addressed by a CONOPS document

Source: (Federal Highway Administration Research and Technology, 2006)

2.4 Front End Research Framework

The FER Framework was developed through the application of Systems, specifically, the Viable System Model (Beer, 1989) and The Zachman Framework (Zachman, 2008) to address the 20 Project Failure Red Flags. The aim of the FER Framework is to guide the application of Stakeholder engagement, needs elicitation, Requirements Analysis, Systems Engineering Management and System Design in pre-project phase in order to mitigate project failure in Transnet.

The Framework is shown in Figure 19 on the following page.

Having developed the FER Framework based on the 20 Project Failure Red Flags, its suitability for Transnet was assessed. This was done by applying a Mixed Method research methodology consisting of the triangulation of the following three research strategies:

- Archival research,
- Survey and
- Focus group.

The research methodology is discussed in the following section.

	What	How	Where	Who	When	Why	
Policy	Corporate Strategy (Transnet 4.0)	Problem/opportunity definition	External Environment	Transnet Group	Strategic Planning	Strategic direction	Scope Context
Intelligence	• Concept of Operations • Business Case	• Situational Analysis • Scenario Planning • Benchmarking • Requirements analysis • Verification specification	External Environment	• Group Strategy • TGC • Business Development	Pre-Project Planning	• Long term planning • New business development	Business Concept
Control	Go/ No Go Decision	Gate Review	Internal Environment	Investment Forums	Project Delivery	Accountability	System Logic
Optimisation	Strategy Execution	Quality Management Operational readiness	Internal Environment	• Group COO • TGC	PLP	Alignment and integration	Technology/ Detailed Engineering
Monitoring	Performance reports	Continuous Improvement	Internal Environment	• Business Process Optimization (BPO) • Results Monitoring Office (RMO)	Ongoing	Traceability	Tools/ Processes
Core operations	KPIs	Projectized activities	Internal Environment	Operating Divisions	Ongoing	Project delivery	Implementation

Figure 19: FER Framework.

Source: Author (Adapted from (Zachman, 2008))

The process and the steps to be implemented when applying the FER Framework are shown below. In addition, the Systems tools that can possibly be applied are indicated.

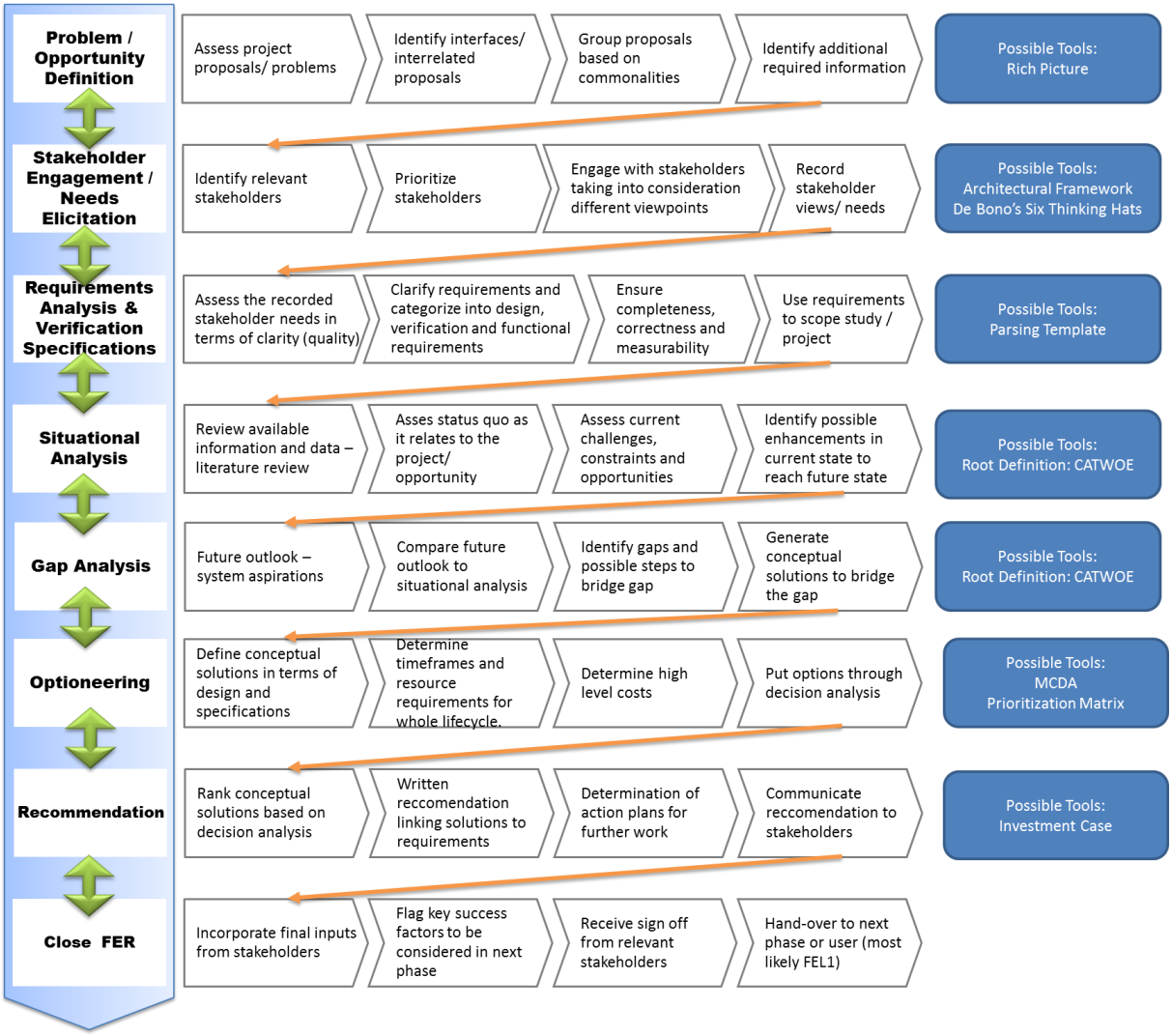


Figure 20: FER Framework Activities Breakdown.

Source: Author

3 RESEARCH METHODOLOGY

3.1 Research Design

The research methodology that was used is Design and Development Research which is described as a “bridging” function that begins with the initial conceptualisation of a problem and culminates in evaluation of the impact of one or more artefacts on that problem (Ellis & Levy, 2010). These artefacts can include the development of a new tool, product, or process (Richey & Klein, 2007).

In this case the problem which is being conceptualised is the occurrence of project failure within the Transnet environment which is leading to the inefficient use of limited resources. The artefact that was developed as a means to remedy the problem is the Front End Research Framework. The research will follow the Systems-based process depicted in the V-Diagram shown in Figure 21.

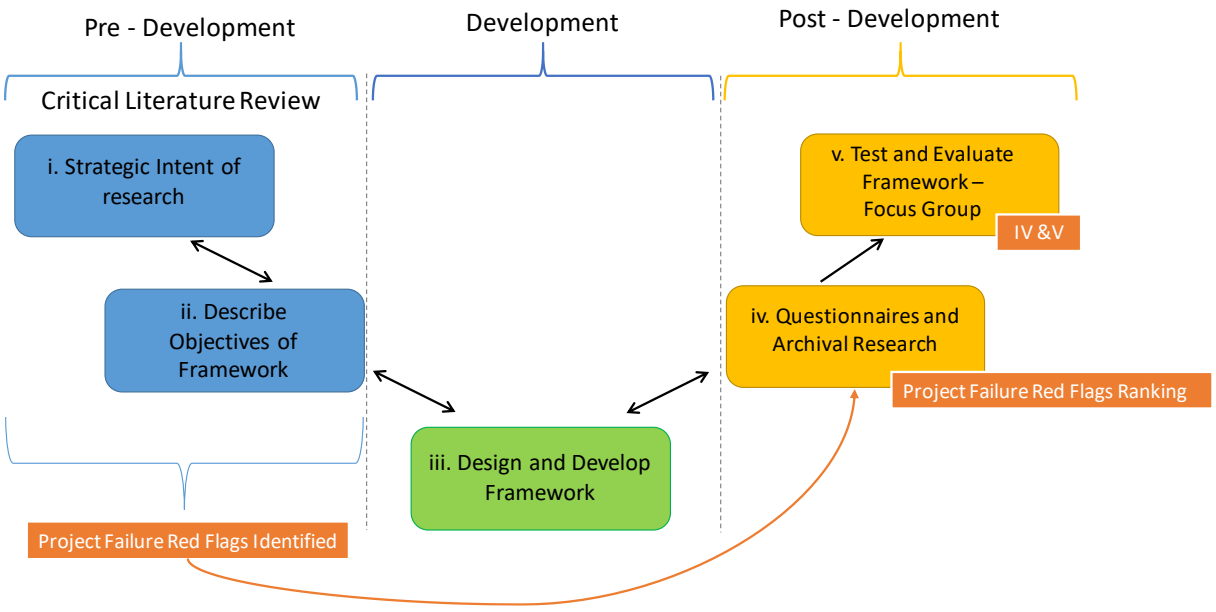


Figure 21: V-diagram showing Research Methodology
Source: Author

3.1 Research Framework

The research ‘onion’ of Saunders et al. (2009) was used as a framework to identify the details around the research methodology for this study such as research philosophy, research approach, research strategy, choice of method, time horizons as well as data collection techniques and procedures.

The research design depicted by Saunders et al. (2009) is found to be suitable for this study as it is targeted at students conducting business research. Business research, as in this case,

is practical applied knowledge which is used by organisation for making decisions and/or developing policy; this knowledge is very dependent on having an understanding of the context (Greener, 2008).

The emergent research onion for this study is depicted in Figure 22 below:

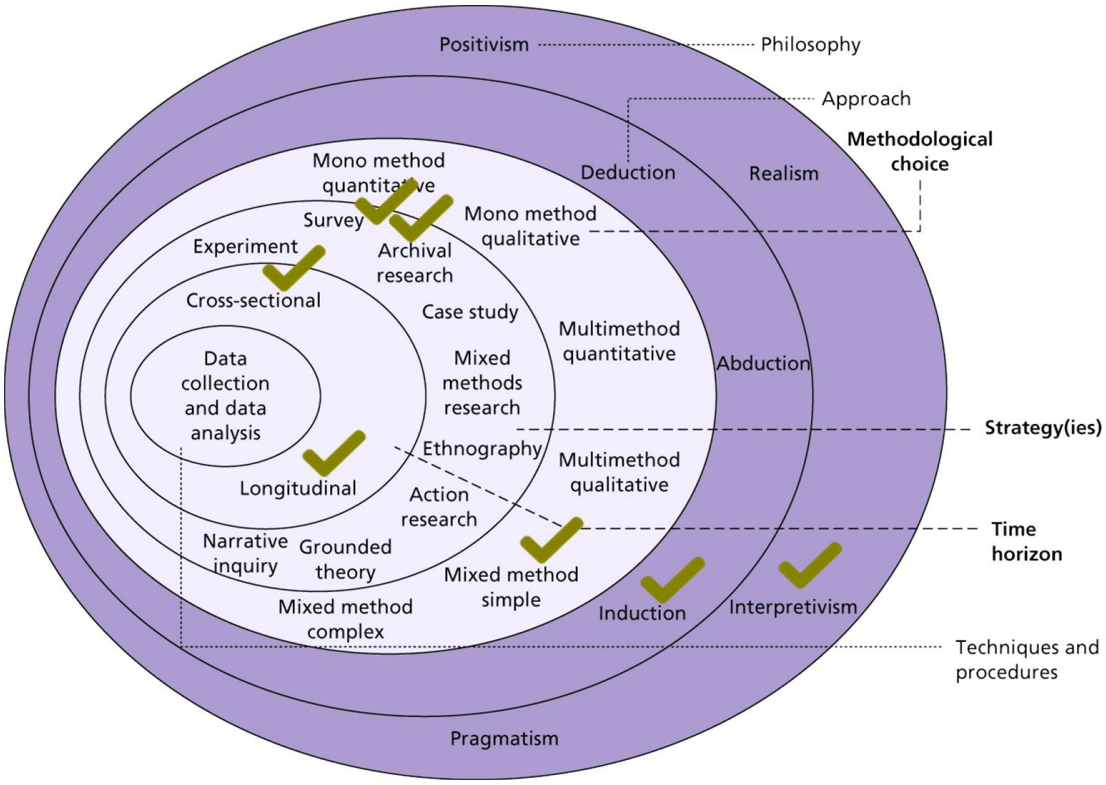


Figure 22: Research onion for this study

Source: Author (Adapted from (Saunders, et al., 2009))

3.1.1 *Research Philosophy: Interpretivism*

Interpretivism, involves researchers to interpret elements of the study, thus interpretivism integrates human interest into a study (Dudovskiy, 2016). This research philosophy is a qualitative methodology which relies upon both the researcher and the human subject as the instruments to measure some phenomena and typically involves both observation and interviews. The interpretive paradigm is concerned with understanding the world as it is from subjective experiences of individuals (Antwi & Hamza, 2015). A criticism of interpretivism is that it tends to be subjective and bias from the researcher and does not represent a general view in the way that positivism does (Photongsunan, 2010). In this study, the researcher is part of the environment being studied i.e. project planning within Transnet, therefore some bias is inherent. In order to overcome bias, triangulation will be used to gain different perspectives on the research being undertaken.

3.1.2 *Research Approach: Induction*

An inductive approach is concerned with the generation of new theory emerging from data (Gabriel, 2013). This approach aims to generate meaning from the data set collected in order to identify patterns and relationships to build a theory; however, inductive approach does not prevent the researcher from using existing theory to formulate the research question to be explored (Dudovskiy, 2016). Inductive reasoning, is further described by Dudovskiy (2016) as being based on learning from experience. A criticism of the approach is that it is not as robust for model development, but it does provide a simple, straightforward approach for deriving findings in the context of focused evaluation questions (Thomas, 2006).

3.1.3 *Methodological Choice: Triangulation Mixed Method*

A triangulation mixed method is a type of methodology in which different but complementary data is collected on the same topic in order to offer different perspectives, thus aiding the researcher in understanding their research area better (Cresswell, 2008). In this study archival research (qualitative instrument), surveys (quantitative instrument) and focus group (qualitative instrument) were used. The archival research and surveys were conducted concurrently, followed by a focus group. Emphasis is placed equally on all three methods. A concurrent triangulation model, such as the one followed in this study is depicted below. In the case of this study, the comparing of results and further development of the FER Framework was conducted through the focus group session.

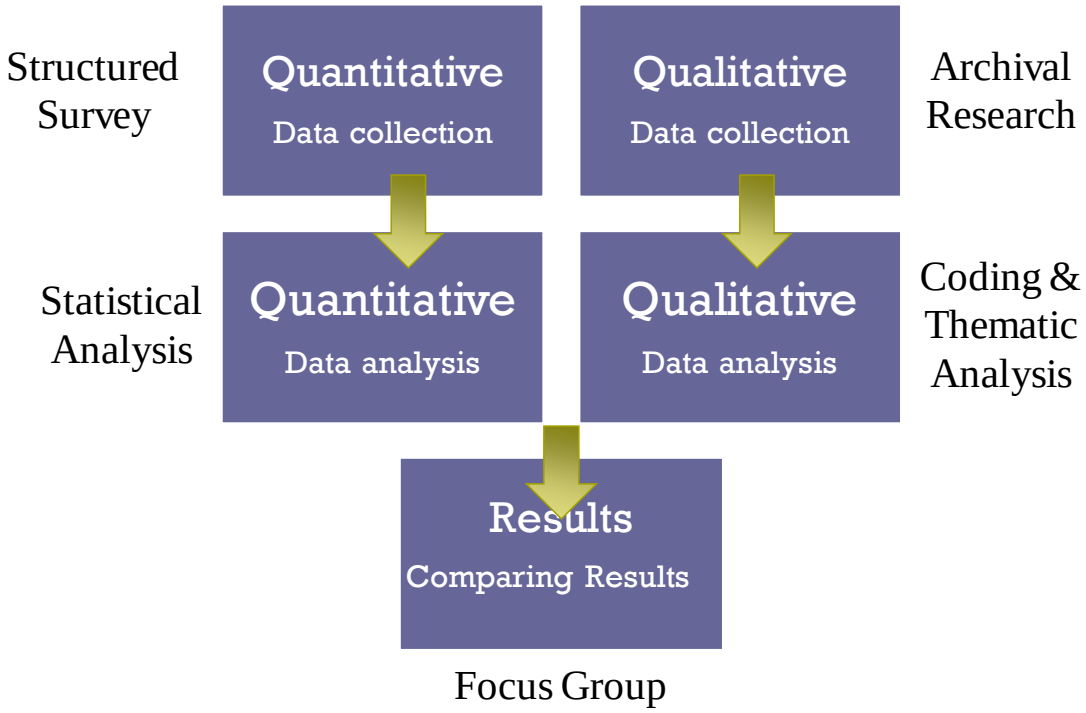


Figure 23: Concurrent Triangulation Design Visual Model

Source: (Cresswell, 2008)

3.1.4 *Research Strategies: Archival Research, Survey and Focus Group*

3.1.4.1 Archival Research

Archival research was used in order to determine how FER has been dealt with in the past to date in Transnet. This was interrogated by comparing the Project Failure Red Flags identified through critical literature review to the challenges and project failures that were being reported within the Key Capacity Development Initiatives (KCDI) reports which are updated on a monthly basis. The type of data collected from the archival research is secondary, as it is not compiled by the researcher. In order to protect the sensitive and confidential project information contained in these reports, specific names and details of the projects were not disclosed in the report.

Archival research was chosen due to its strength in application which is described as “providing a detailed description of events” (Universiy of Washington, 2013). This is elaborated upon, saying that archival research is objective and offers more complete evidence than any other form of data collection while also providing multiple viewpoints over time. In this study, the archival research was applied over a longitudinal time horizon spanning two years i.e. the data was collected by analysing 10 projects recorded over a 2-year period.

In order to facilitate analysis of the archival research data and render it comparable to the quantitative data produced from the survey, the data collection technique of coding was utilised. A code in qualitative research is most often a word or short phrase that symbolically assigns a “summative, salient, essence-capturing, and/or evocative attribute for a portion of language-based or visual data” (Saldaña, 2008). The data can consist of interview transcripts, participant observation field notes, journals, documents, literature, artefacts, photographs, video, websites, e-mail correspondence, and so on.

A-priori coding, described by (Saldaña, 2015) as the application of pre-existing theoretical frameworks (or pre-set codes) to analyse the documents, was applied. In this case, the pre-set codes were the 20 Project Failure Red Flags which were identified as part of the critical literature review. For consistency and an ability for comparative analysis, the same pre-set codes were used in the survey.

The analysis was done such that emergent codes were considered and could be identified and recorded accordingly. These “emergent codes” are those ideas, concepts, actions, relationships, meanings, etc. that come up in the data and are different than the pre-set codes (Saldaña, 2015). In many cases, Saldaña (2015) explains, the emergent

codes form the basis of interesting stories and may indeed become part of the major storyline told in your evaluation.

Each of the codes, including any emergent codes, were checked in terms of their prevalence in the 10 chosen KCDI reports. The frequency of occurrence was recorded and thus a quantitative process could be utilised to analyse and compare findings to the survey findings as well as for discussion. The archival research template is contained in *Appendix B***.**

3.1.4.2 Survey

Concurrent with archival research, a survey (quantitative instrument) was used to explore the criticality of the Project Failure Red Flags based on structured, closed-ended questions which were set out to produce numeric data which could be analysed statistically. The data produced is primary data.

The sample group for this exercise was not chosen at random, but a non-probabilistic approach was followed. The quota sampling technique was employed in selecting the sample group members. The specific criteria used was as follows:

Each sample group member must have worked as a Project/Program team member in one of Transnet's strategic projects/programs which have a minimum capital cost of 1 Billion Rand.

The people fulfilling this criterion were identified through the known Mega-projects currently running within Transnet, followed by a snow-ball approach where identified sample group members were permitted to refer other known colleagues meeting the criterion. A complete sample group of 30 was requested to participate in the survey.

The expected advantages of using the quota system was a higher level of reliability of the outcomes than if a random sample had been taken as well as a higher level of buy-in from participants because of the relevance of the study to their daily tasks (Jackson, 2003).

A survey method, in the form of an online questionnaire, explained by Jackson (2011) as "questioning individuals on a topic and then describing their responses", was utilised in order to rank the Project Failure Red Flags in order of criticality as well as offer a weighting of the importance of a Red Flag within the projects domain at Transnet.

Each sample group member was contacted via email and informed of the research study as well as the information that was required of them. A Letter of Consent was issued to

each sample group member, which contained assurance that confidentiality and anonymity would be maintained at all times according to the Ethics requirements of the Faculty of Engineering and the Built Environment (School of Mechanical, Industrial and Aeronautical , 2017).

The questionnaire contained two sections. The first section was in the form of a Likert Scale requesting each participant to provide their views on a 5-point scale. The question was stated as:

The 20 statements below describe reasons for project failure identified as part of a literature review. On a scale of 1 (Strongly Disagree) to 5 (Strongly Agree), do you agree that these factors lead to project failure?

The second section of the online questionnaire requested participants to select and rank their “Top 5” most critical 20 Project Failure Red Flags. Of the 20 statements, please select and rank the top 5 reasons that projects fail. The survey is shown in *Appendix C.*

3.1.4.3 Focus Group

The research done through the survey and archival research provides insights into the processes and viewpoints that are present within Transnet. However, it was seen as being necessary to draw on an independent view which can offer additional inputs into the Systems perspective of the study and to ensure that the Systems principles have been sufficiently incorporated.

Powell et al. define a focus group as a group of individuals selected and assembled by researchers to discuss and comment on, from personal experience, the topic that is the subject of the research (Powell, et al., 1996). In this instance, the focus group consisted of members of the Transnet Centre of Systems Engineering - the focus group participants have awareness of Transnet through the various interactions with projects and employees, but are not direct employees of Transnet. This was seen as an advantage in that they were able to offer an informed view while still maintaining independence. Three participants were invited due to availability and relevance to the topic.

There are various advantages of focus group interactions described by several authors but limitations also exist. One advantage is that the interaction during a focus group highlights differing views and participants can ask each other questions which sometimes re-shape their understanding of their specific experiences (Kitzinger, 1994). Another advantage is that the researcher is able to find out more information than when tools

such as surveys or archival research are used – the researcher can find out why a matter is salient and what aspects are salient about it (Morgan, 1988).

A limitations of focus groups is that the researcher cannot fully plan for or anticipate the data that will be produced (Morgan, 1988), although careful and detailed planning will assist in this regard. Another limitation is that this research strategy is not likely to be used as a stand-alone research strategy, but as a follow up to other research e.g. as a means to derive meaning from- or interpret previous data (Villard, n.d.).

In order to provide direction for the focus group discussion, participants were provided with the questionnaire prior to the focus group session starting. The questionnaire is contained in *Appendix D*.

4 RESULTS AND DISCUSSION

The results for the research study will be discussed in relation to the research question – and its subsets - that was set out in section 1.5 of this thesis

How can Systems principles and frameworks for strategic planning which exist in other industries be applied to develop a FER Framework which is suitable for Transnet?

a) How has FER been conducted in the strategic planning of projects in Transnet?
b) How has FER been conducted in the strategic planning of projects in other industries including defence, aerospace, software development and specifically the public rail industry?
c) Which Systems approaches and methodologies can be used to apply Systems principles in strategic planning of projects?

As the researcher is an employee of Transnet who is exposed to the project/ programme planning space and the existing processes, it was prudent to conduct methodological triangulation in order to minimize bias. Therefore, the results were drawn from three research strategies as detailed in the Research Methodology section (3) of this report:

- Archival Research – review of KCDI reports
- Surveys – Project/Programme management team members
- Focus Group – Transnet Centre of Systems Engineering personnel

The four reasons for triangulation proposed by Denzin (1989) proved to all be applicable in the research study conducted:

- Enriching: The outputs of different informal and formal instruments add value to each other by explaining different aspects of an issue.
- Refuting: Where one set of options disproves a hypothesis generated by another set of options.
- Confirming: Where one set of options confirms a hypothesis generated by another set of options
- Explaining: Where one set of options sheds light on unexpected findings derived from another set of options.

The three research strategies used provided different perspectives into the research outcomes. The archival research provided insights into the historical and current context of the Transnet project/programme planning processes and practical applications, whereas the surveys provided a view on the manner in which individuals view planning of projects in Transnet based on their experience and outlooks and the focus group, consisting of Systems

professionals, provided inputs into the application of Systems principles in the study and how to improve the robustness of the FER Framework based on findings.

4.1 Archival Research Results

The archival research was used in order to determine how FER is being dealt with in Transnet in the past to date. This was interrogated by comparing the Project Failure Red Flags identified through critical literature review, to the challenges and project failures that were being reported within the Key Capacity Development Initiatives (KCDI) reports which are updated on a monthly basis.

It was found that the key challenges which were being reported on in the KCDI reports were mainly in line with the traditional Project Management KPIs as discussed in the critical literature review. These are mainly concerned with cost variance, return on investment, schedule variance etc. and are used as project performance measures (Dinsmore, 1990). The manner in which the KCDIs reports are recorded is in terms of the S.M.A.R.T principle of (Doran, 1981) which are defined as:

- **S**pecific: target a specific area for improvement.
- **M**easurable: quantify, or at least suggest, an indicator of progress.
- **A**ssignable: specify who will do it.
- **R**ealistic: state what results can realistically be achieved given available resources.
- **T**ime-related: specify when the result can be achieved.

This brings about a limitation in terms of focussing only on “measurable” performance i.e. quantitative factors which are relatively simple to track and, for the most part, lie within the realm of control of the project team. However, qualitative factors, such as those identified within the Project Failure Red Flags were not being reported extrinsically or in as much detail. This was found to be due to a lack of existing processes in place to analyse such information and due to unclear accountability for the qualitative causes of project failure.

In addition to the 20 Project Failure Red Flags that were identified in the study, an additional reason for project failure emerged from the analysis of the KCDI reports: “Interdependencies not identified early.” This referred to a tendency for projects to be looked at on an individual basis or a singular benefit that is being expected, and not utilizing a holistic outlook in order to determine the effects and impacts that the project/programme will have on current or future projects and/or operations.

The results from the archival research are summarised below. The 'x' indicates the Project Failure Red Flags that apply to the 10 projects/programmes analysed in the KCDI reports.

Table 6: KCDI report results

Project Failure Red Flag description	KCDIs										Comments
	1	2	3	4	5	6	7	8	9	10	
Lack of sponsor support/buy in											
Unclear strategic direction by top management											
Inexperienced project team											
Lack of stakeholder involvement and/or participation			x								Misalignment with Corporate Plan
Low morale of project team											
Subject matter experts are overscheduled											
Lack of documented requirements and/or success criteria	x		x				x			x	Mainly in light of EIA and other success factors which could have been anticipated and planned for.
No change control process					x						No adaptability to external issues e.g. changing economic climate
Ineffective schedule planning and/or management											
Communication breakdown among stakeholders		x					x			x	External stakeholders e.g. affected communities causing delays due to resistance to projects
Scope creep						x					`

Decision-makers being too imbedded in the project											
Immature technology	x		x								Incompatibility in designs e.g. electrification of rail etc.
Unclear statements of expected outcomes											
Undefined roles and responsibilities											
Project milestones not met on schedule	x	x								x	Project Delays
Budget overruns		x		x							Project costs exceed budget
Budget cuts							x	x			Budget optimisation
Inexperienced Project Manager											
Project benefits not clearly defined											
Interdependencies not identified early				x		x			x		Road/rail/port interfaces not identified causing additional scope or cost

Source: Author

The interpretation of the KCDI reports was further analysed quantitatively by tallying the number of 'x' against the different Project Failure Red Flags and plotting these findings on a bar graph in order to identify the causes for project failure which emerged most frequently in this analysis.

The graphical representation of the data showed that the top 4 frequently appearing causes for project failure were as follows:

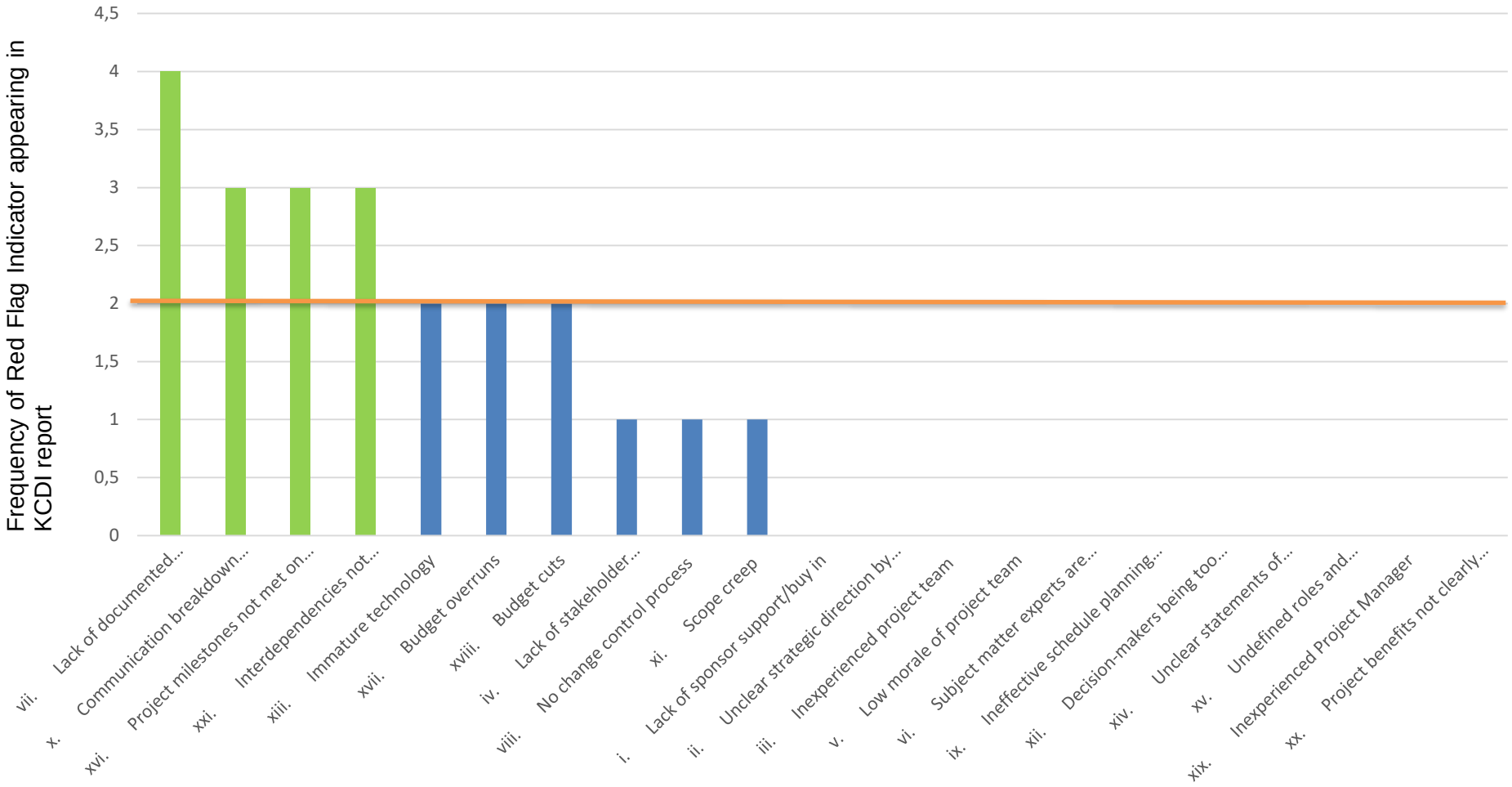


Figure 24: KCDI report results (graphical representation)
Source: Survey

4.2 Survey Research Results

Participants were requested to take part in an online survey consisting of two questions dealing with the Project Failure Red Flags. The survey questions were done as a Likert Scale testing whether participants agree with the 20 Project Failure Red Flags that were identified, and the second question requested the participants to rate the Project Red Flags to indicate the “Top 5.”

The request to complete the surveys were sent out to 30 Transnet project/programme team members, and 17 respondents were recorded at the given closing date and time, giving a 56.7% response rate. This response rate is seen as being satisfactory as compared to the average response rate for internal surveys (40%) recorded by online survey platform Survey Gizmo (2017).

The response completion rate of 100% as well as average completion time of under 6 minutes were successful aspects of the survey. However, based on suggestions for improving response rates presented by online survey platform *Survey Monkey,* the response rate could have been improved by presenting an incentive for completing the survey e.g. having a giveaway attached to completing the survey; or by sending reminders to the participants.

Based on the responses that were recorded, it was found that although the survey participants are Transnet employees who are exposed to the current project processes and methodologies which lean strongly towards the traditional Project Management practices, they are also aware and in agreement with the qualitative reasons for projects failure that were examined.

This finding is in line with the view presented in the (BKCASE Editorial Board, 2017), which was presented in the literature review, that indicates that in more complex projects where there exists a higher degree of uncertainty and complexity, the pre-planning phases of Project Management and Systems Engineering may intersect. According to Van Gemert (2013) the key relationship between Project Management and Systems Engineering is that projects are based on requirements i.e. a project is conceived in order to fulfil a certain need which has been identified. Systems Engineering carries out the process of synthesising those requirements. Further to this, the performance requirements against which successful completion will be measured (verified) also needs to be synthesised in the initial stages of the project.

Also consistent, were the findings about the importance of stakeholder involvement as well as requirements analysis being conducted in the pre-project planning phase as shown in Figure 25 below.

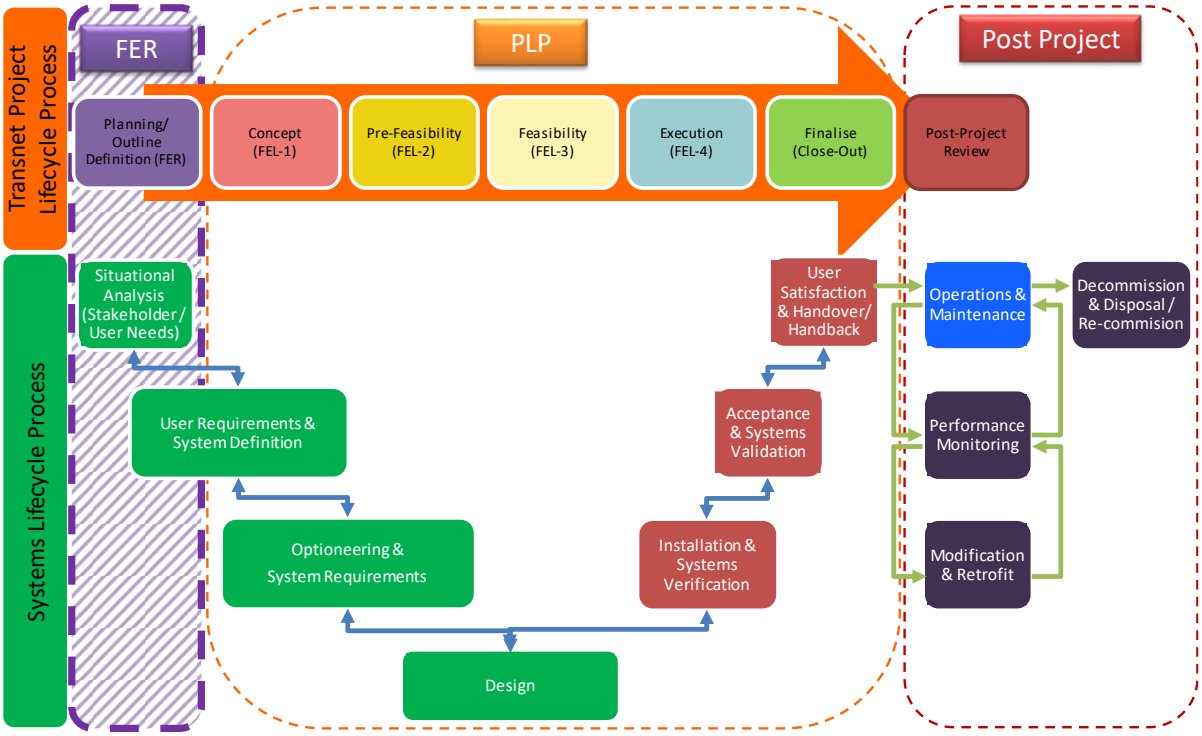


Figure 25: Systems Lifecycle Process and Transnet's Project Lifecycle Process
Source: Author (Adapted from (TCSE, 2016))

The findings of the two survey questions are presented in graphical format in Figures 26 and 26. The results were closely aligned for the two survey questions but offered a different perspective than that achieved from the archival research even though the survey participants are to some extent involved in the compilation of the KCDI reports.

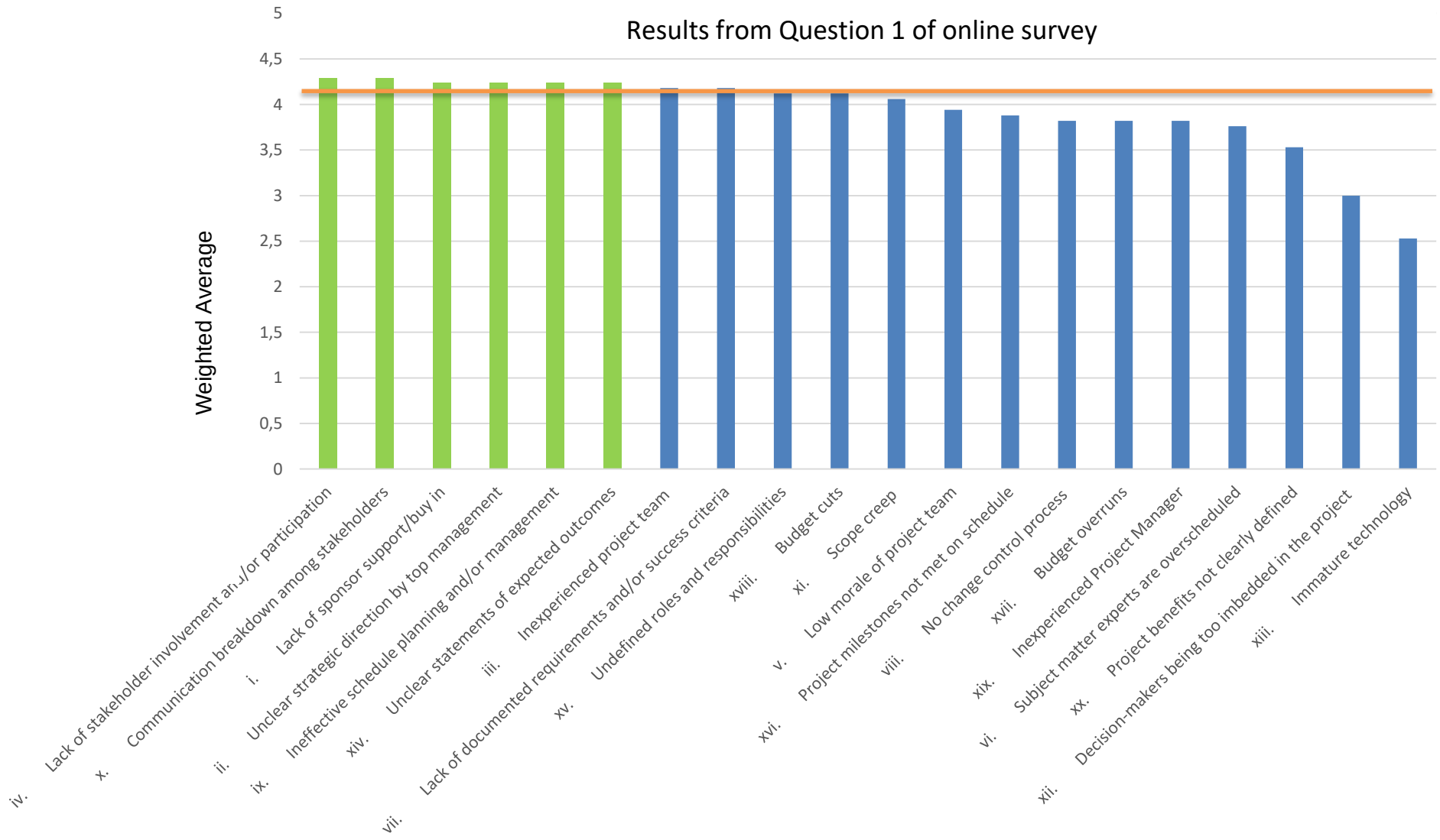


Figure 26: Results from Question 1 of online survey
Source: Author

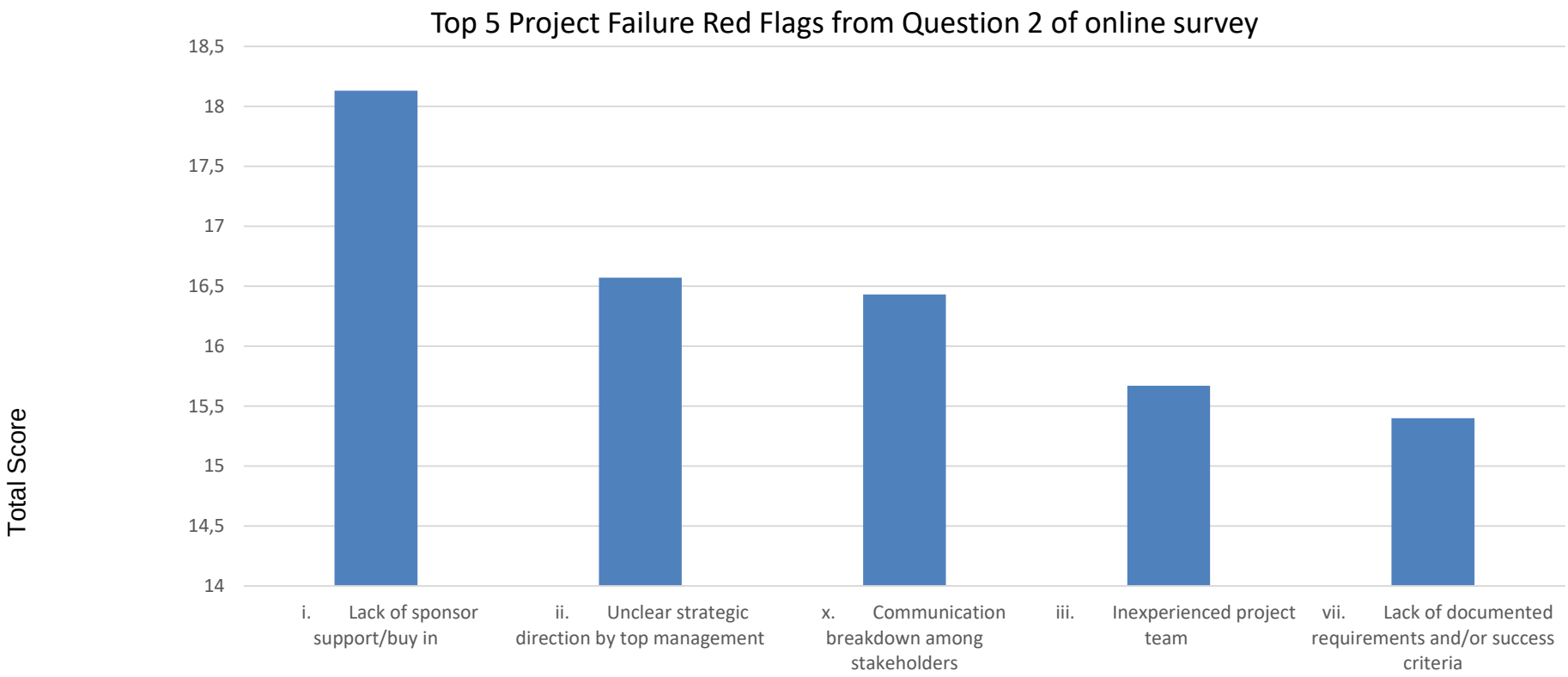


Figure 27: Top 5 Project Failure Red Flags from Question 2 of online survey.
Source: Survey

4.3 Focus Group Results

The focus group was conducted with members of the Transnet Centre of Systems Engineering with the intention of gaining insights into ways in which the Systems aspects of the study can be interpreted and ways in which the findings can be utilised to improve the FER Framework which had been developed based on findings from the critical literature review.

The broad aims of the focus group session can be summarised as:

- To discuss research findings.
- To supplement knowledge gained from the surveys and archival research with Systems view.
- To gain a Transnet-independent view which is insightful and relevant.
- To independently validate & verify the Front End Research Framework.

A key outcome from the discussion with regards to the archival research was to note that the findings were closely in line with the PMI project KPIs. In this regard, a suggestion was made by a participant to elaborate on how the Project Management principles align with the Systems principles in this study. This was elaborated upon in the previous section (4.1.).

Further to this, an outcome that emerged from the discussion of the survey results was the importance of the project sponsor role. All focus group participants attested to incidents where they witnessed unclear lines of accountability and/or responsibility within projects in Transnet, especially at the higher levels of the project structure. This observation was raised in line with outcomes from both the survey questions, where the Project Failure Red Flag of “lack of sponsor buy in/support” came out in the top 3 findings, alongside other related red flags such as “Lack of stakeholder participation” and “Unclear strategic direction from top management”.

It was identified through the focus group discussion that the issues relating to project sponsorship were not unique to Transnet and that it may be an area of future research which can aim to unpack the following:

- The role of a project sponsor
- Drawing the distinction between a project lead and project sponsor
- The process for identifying the right project sponsor for a project.

With regards to the application of Systems principles in the FER Framework various inputs were provided by the participants following the discussion and review of results:

I. An additional activity should be incorporated into the FER Framework at the very start of the process. This process should be aimed at identifying the correct sponsor for any given project. The new step will be incorporated into the framework as shown in Figure 28 below.

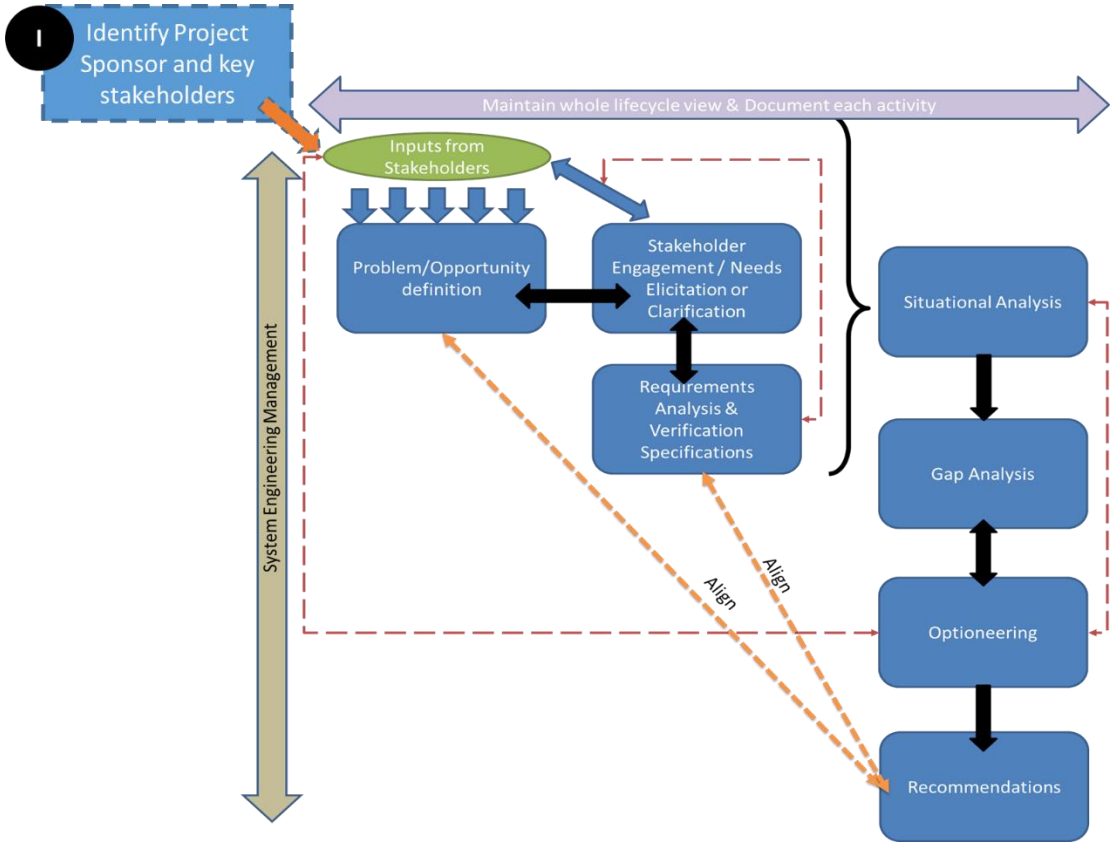


Figure 28: Additional activity: "Identify Project Sponsor and key stakeholders"
Source: Author

II. Another activity which was proposed by a participant of the focus group was to develop a Concept of Operations (CONOPS) after carrying out stakeholder engagements but before the Requirements Analysis. This was suggested in order to improve the robustness of the system definition by not only considering the viewpoint of the internal stakeholders or those involved in commissioning the design, but also getting the views from the users/operators of a given system.

Figure 29 below indicates how the FER Framework would need to be altered.

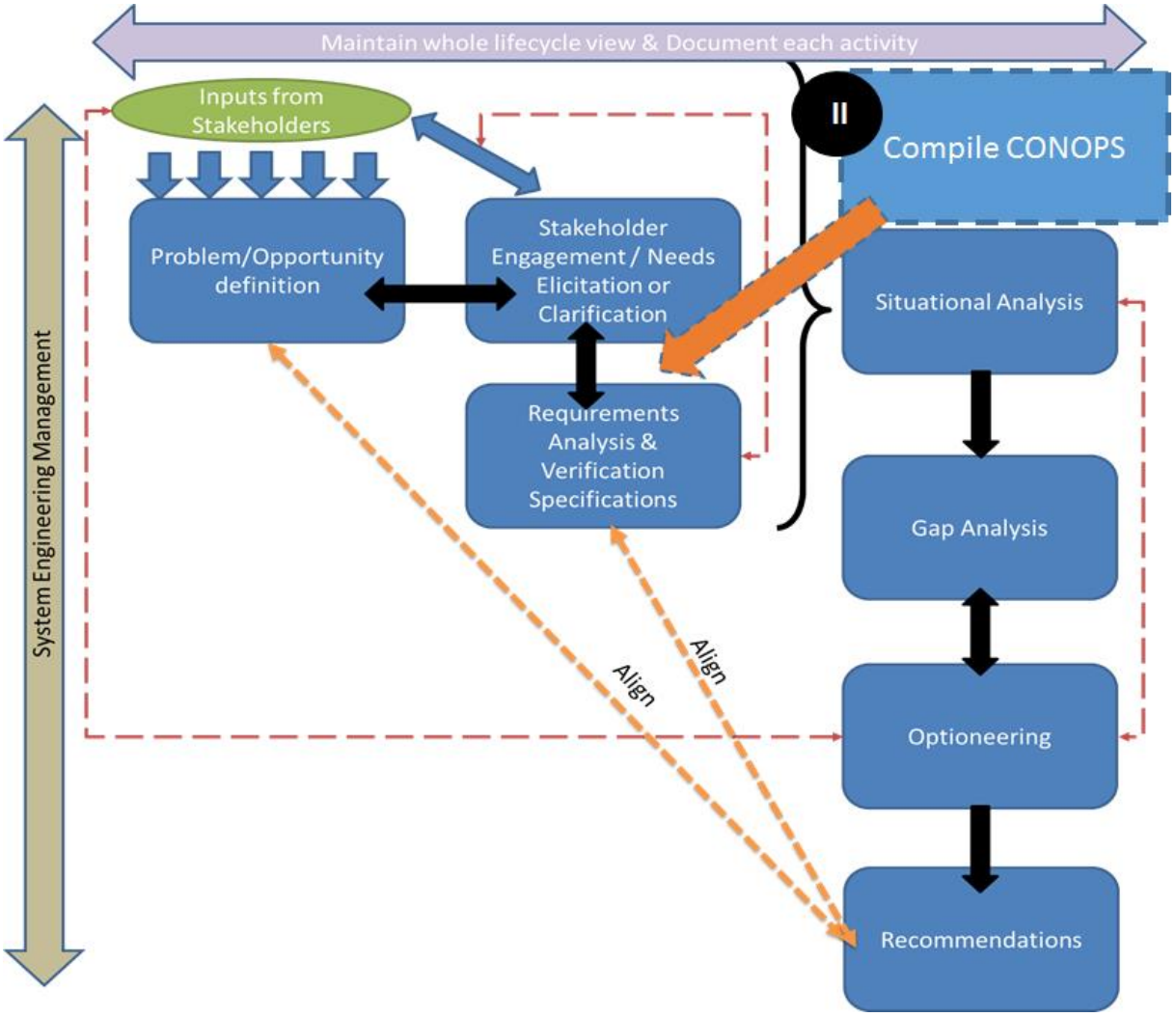


Figure 29: Additional Activity: "Compile CONOPS"

Source: Author

III. A participant noted that in some cases, the naming of the projects can play an important part in the problem/opportunity definition. An example was given of a project where the name that was presented at the first stakeholder engagement already eluded to the solution that was being sought which channelled the discussion in a set direction. This is not desirable, because at the FER stage various options should be assessed. Therefore, a note will be included for users of the framework that as much as possible, neutral/generic project titles should be used especially at initialisation.

IV. Another key outcome from the discussion was that the FER Framework activities should be clearly linked to the Project Failure Red Flags in order to indicate how the various issues experienced in projects will be addressed through the practical application of the framework.

4.4 Triangulation of Results

The results generated from the various research tools were compared in order to determine the Project Failure Red Flags which the FER Framework should address as a matter of priority.

Figure 30 indicates the model that was used to determine the most critical Project Failure Red Flags.

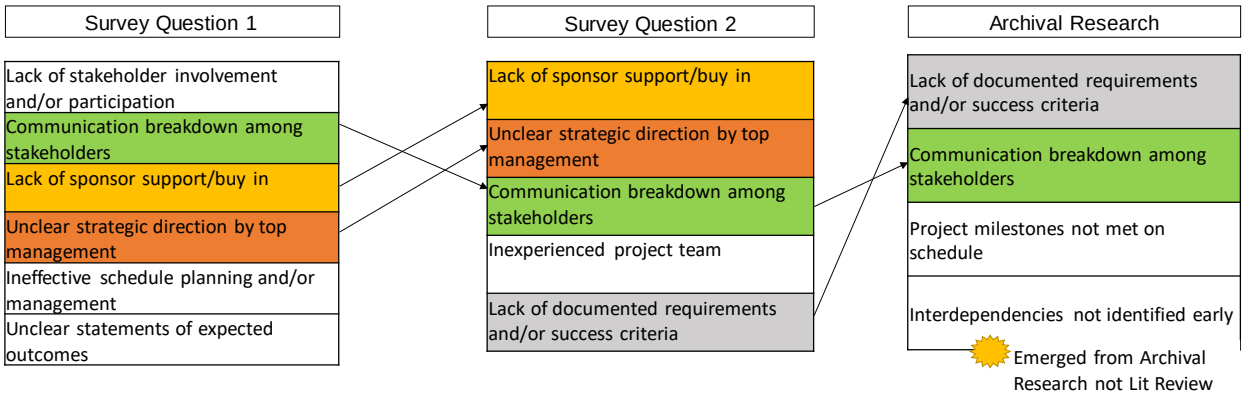


Figure 30: Triangulation of results

Source: Author

From the triangulation exercise the “Top 5” Project Failure Red Flags determined from this study are presented, in no particular order, in Table 7.

Table 7: Top 5 Project Failure Red Flags

Lack of sponsor support/buy in
Unclear strategic direction by top management
Communication breakdown among stakeholders
Interdependencies not identified early
Lack of documented requirements and/or success criteria

Source: Author

5 CONCLUSION AND RECOMMENDATIONS

5.1 Summary of Study

The research objectives can be restated as follows:

a) Reviewing how FER (pre-project planning) is conducted in the strategic planning of projects in other industries including defence, aerospace, software development and specifically the public rail industry?

b) Assessing the manner in which FER has been conducted in Transnet for strategic planning of projects?

c) Determining which Systems Methodologies and Systems Tools can be used to apply Systems principles in strategic planning of projects?

Through following the triangulation mixed method, which included archival research, a survey and focus group, the above objectives were addressed and all incorporated in the FER Framework.

The review of strategic planning of projects in other industries revealed that pre-planning is viewed as an opportunity to minimize project failure, however it may be defined for that particular project, further down the project lifecycle. The 20 Project Failure Red Flags that were utilised a basis for this research study were compiled from the literature review as a summary of causes of project failure which have been prevalent in industries across the board.

In assessing the manner in which FER has been conducted thus far within Transnet, it was found that the traditional Project Management KPI's, which are mainly quantitative in nature, were being used to measure the project status and progress within the monthly reports. However, the surveys revealed that the project/programme team members were cognisant of the qualitative issues and challenges which were causing projects to fail, and as such, the qualitative Project Failure Red Flags were ranked as being most critical.

The Top 5 Project Failure Red Flags, as per this study, were found to be:

- Lack of sponsor support/buy in
- Unclear strategic direction by top management
- Communication breakdown among stakeholders
- Interdependencies not identified early
- Lack of documented requirements and/or success criteria

5.2 Conclusions

The Front End Research (FER) Framework (along with the process and its activities) was developed based on the findings from the Critical Literature Review, Surveys, Archival Research and Focus Group session. The FER Framework (*Appendix F*) is an adaptation of the Zachman Framework of enterprise architecture developed by Zachman (2006) and combines the various functions as depicted in the Viable System Model as possible audience perspectives, these are:

- Policy
- Intelligence
- Optimisation
- Co-ordination
- Monitoring
- Core Operations

The FER Framework is intended to provide guidance for the preparation of possible solutions for problems, opportunities or new ideas/ concepts which are of interest to Transnet. Hence the following should be noted:

- The FER Framework can be adjusted on a per project/study basis.
- The stakeholders will differ per project/study
- Almost every stage of the process will require stakeholder engagement either for clarification or feedback, but formal engagements occur as indicated.
- All the activities are to be documented. Development of documentation templates does not form part of this research study.

The Systems Methodologies and Systems Tools to be incorporated in the FER Framework in order to address the Top 5 Project Failure Red Flags are shown in Table 8 below:

Table 8: Systems Methodologies and Systems Tools to address Top 5 Project Failure Red Flags

Project Failure Red Flag	Systems Methodology	Systems Tool
Lack of sponsor support/buy in	Identify Project Sponsor and key Stakeholders	To be determined as part of a separate study
Unclear strategic direction by top management	Stakeholder engagement, Needs elicitation, Requirements Analysis and Management	Parsing Template
Communication breakdown among stakeholders	Systems Engineering Management	Systems Engineering Management plan

Project Failure Red Flag	Systems Methodology	Systems Tool
Interdependencies not identified early	System Design	CONOPS
Lack of documented requirements and/or success criteria	Requirements Analysis and Verification specification	Parsing template

Source: Author

In view of the practical application of the developed FER Framework, it will be socialised within the organisation among the relevant parties. The first forum that will be engaged is the Capacity Planning Committee which is chaired within Transnet Group Capital but includes project planning colleagues from operating division throughout Transnet.

The FER Framework will also be developed further on an ongoing basis. The intention is to improve its applicability and ease of use by developing a digital platform which can be made accessible to project planning teams.

5.3 Recommendations

In the light of the above, the researcher wishes to make some recommendations, which, if taken into consideration, might bring some positive changes to the current Transnet Project Lifecycle Process.

- The socialisation and adoption of the FER Framework should be a project sponsored by the Chief Capital Officer.
- Further awareness must be created within the organisation about the application of Systems in the project planning space.
- Key project/programme team members should be trained in Systems disciplines relevant to their work and in conjunction with their application of the FER Framework.

5.4 Limitations of the study and further research

The study has highlighted a number of researchable aspects that could be pursued further by those involved in studies relating to application of Systems principles to improve organisational practices.

i. A key area that was identified was the development of a Systems-based process for the identification of a project sponsor. Aspects that can be studied in detail include:

- The process for identifying the right project sponsor for a project
- The role of a project sponsor as opposed to project lead

ii. A similar framework as the FER Framework can be extended to the rest of the PLP phases.
iii. An investigation on how failure of the logistics support system, after project commissioning will be indicated by red flags.
iv. Apportioning project failures to PM, SE and Discipline Engineer. Which discipline is most responsible for project failures.
v. The value of having a Systems Engineer on a project has been demonstrated throughout the study due to the competencies which they bring. These competencies can form research areas all on their own. The competencies below were adapted by Transnet Centre of System Engineering (2018) from INCOSE UK Chapter (2015).

- Architectural design
- Concept generation
- Design for…
- Functional analysis
- Interface management
- Maintaining design integrity
- Modelling and simulation
- Select preferred solution
- System robustness
- Systems concepts
- Super-system capability issues
- Enterprise and technology environment

Based on the nature of the project being undertaken there are specialist areas that are very critical for the implementation of Systems Engineering as they form the foundations of Systems Theory. The specialist areas are given by (INCOSE UK CHAPTER, 2010); include but are not limited to:

- Human factors;
- Reliability, Availability, Maintainability and Safety (RAMS);
- Requirements management; and
- Interface management.

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7 APPENDICES

Appendix A: Ethics Clearance

Ethics Clearance was granted by the School of Mechanical, Industrial and Aeronautical Engineering Ethics Committee.

The ethics clearance number for this research report is MIAEC 002/18.

Appendix B: Archival Research Template

Table 9 below, indicates the template which as populated in order to capture the data from the KCDI reports by marking those red flags which were prevalent in the various reports.

Table 9: Archival Research Template

Project Failure Red Flag description	KCDIs										Comments
	1	2	3	4	5	6	7	8	9	10	
Lack of sponsor support/buy in											
Unclear strategic direction by top management											
Inexperienced project team											
Lack of stakeholder involvement and/or participation											
Low morale of project team											
Subject matter experts are overscheduled											
Lack of documented requirements and/or success criteria											
No change control process											
Ineffective schedule planning and/or management											
Communication breakdown among stakeholders											
Scope creep											
Decision-makers being too imbedded in the project											
Immature technology											
Unclear statements of expected outcomes											
Undefined roles and responsibilities											
Project milestones not met on schedule											
Budget overruns											
Budget cuts											
Inexperienced Project Manager											
Project benefits not clearly defined											

Source: Author

Appendix C: Online Survey Questionnaires

Question 1: The Project Failure Red Flag described is critical for identifying imminent project *failure.*

1 = strongly agree, 2= Agree, 3= Neutral, 2= Disagree, 1 = Strongly Disagree

Table 10: Questionnaire 1 of 2 - Criticality of Project failure Red Flags within Transnet

	Project Failure Red Flag description	**1**	**2**	**3**	**4**	**5**
i.	Lack of sponsor support/buy in					
ii.	Unclear strategic direction by top management					
iii.	Inexperienced project team					
iv.	Lack of stakeholder involvement and/or participation					
v.	Low morale of project team					
vi.	Subject matter experts are overscheduled					
vii.	Lack of documented requirements and/or success criteria					
viii.	No change control process					
ix.	Ineffective schedule planning and/or management					
x.	Communication breakdown among stakeholders					
xi.	Scope creep					
xii.	Decision-makers being too imbedded in the project					
xiii.	Immature technology					
xiv.	Unclear statements of expected outcomes					
xv.	Undefined roles and responsibilities					
xvi.	Project milestones not met on schedule					
xvii.	Budget overruns					
xviii.	Budget cuts					
xix.	Inexperienced Project Manager					
xx.	Project benefits not clearly defined					

Source: Author

Question 2: Please rate the criticality of the Project Failure Red Flags where *1 = most critical and 5= least critical of the "Top 5" most critical Project Failure Red Flags.*

Table 11: Questionnaire 2 of 2 -Rating the criticality of the Project failure Red Flags

	Project Failure Red Flag description	**Criticality Rating (1 – 5)**
i.	Lack of sponsor support/buy in	
ii.	Unclear strategic direction by top management	
iii.	Inexperienced project team	
iv.	Lack of stakeholder involvement and/or participation	
v.	Low morale of project team	
vi.	Subject matter experts are overscheduled	
vii.	Lack of documented requirements and/or success criteria	
viii.	No change control process	
ix.	Ineffective schedule planning and/or management	
x.	Communication breakdown among stakeholders	
xi.	Scope creep	
xii.	Decision-makers being too imbedded in the project	
xiii.	Immature technology	
xiv.	Unclear statements of expected outcomes	
xv.	Undefined roles and responsibilities	
xvi.	Project milestones not met on schedule	
xvii.	Budget overruns	
xviii.	Budget cuts	
xix.	Inexperienced Project Manager	
xx.	Project benefits not clearly defined	

Source: Author

Appendix D: Focus Group Questionnaire

Table 12: Focus Group Questionnaire

Was the research methodology used in the study adequate to come to the conclusions required?Please substantiate where possible and suggest what could have been done better.

Please comment on the final research findings (Slide 16). Do you agree with the findings or feel that the outcome should have been very different? Please substantiate.

Do you feel that the FER Framework adequately addresses the TOP 5 Project Failure Red Flags? Please substantiate.

General Comments

Source: Author

Appendix E: Acronyms List

1PL	1st Party Logistics
2PL	2nd Party Logistics
3PL	3rd Party Logistics
4PL	4th Party Logistics
CATWOE	Customers, Actors, Transformations, Weltanschauung, Owners, Environment
CONOPS	Concept of Operations
EV	Electric Vehicle
FER	Front End Research
ICE	Internal Combustion Engine
IDEF0	Icam Definition for Function Modeling
INCOSE	International Council on Systems Engineering
ISEF	Integrated System Engineering Framework
KCDI	Key Capacity Development Initiatives
KPI	Key Performance Indicator
MODAF	Ministry of Defence Architectural Framework
NASA	National Aeronautics and Space Administration
PLP	Project Lifecycle Process
PM	Project Management
PMI	Project Management Institute
SCOPA	Standing Committee on Public Accounts
SE	System Engineering
SEBoK	Systems Engineering Body of Knowledge
SEM	Systems Engineering Management
SEMP	System Engineering Management Plan
SMART	Specific, Measurable, Assignable, Realistic, Time
SSM	Soft System Methodology
TGC	Transnet Group Capital
VSM	Viable System model