Resilience in projects: definition, dimensions, antecedents and consequences

Resilience in projects: definition, dimensions, antecedents and consequences

By

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DEDICATION

I dedicate this thesis to my parents (Mr and Mrs Oppong Banahene) and my husband (Henry Blay).

APPRECIATION

I thank the Almighty God for His grace, mercies and the gift of life in completing my PhD. I also thank my parents (Mr and Mrs Oppong Banahene), my siblings and Henry Blay for their care, support and motivation.

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Abstract

Disruptions can cause projects to fail. Within the project management literature, approaches to managing disruptions consist of uncertainty, risk, opportunity, change, and crisis management. These approaches focus on developing strategies to manage perceived threats and also work towards predicting risk, therefore, reducing vulnerability. This vulnerability-reduction only focus is limiting because it takes the focus away from the development of a general capacity for readiness and for responding to uncertain situations. A resiliency approach enables a simultaneous focus on vulnerability reduction, readiness and response and thus ensures recovery. Given the context and discipline specific nature of the resilience concept, and the little or no attention in projects, this thesis conceptualises resilience in projects. This conceptualisation is to enable the identification of factors to consider and indicators to ensure overall project recovery, through the identification of dimensions and antecedents of resilience respectively. The aim of this study therefore, is to develop a framework to conceptualise resilience in projects.

To achieve this aim, three case studies, namely; building, civil engineering and engineering construction projects were investigated. Within each case study, the critical incident technique was employed to identify disruptions and their management through direct observations of human activities, narration of critical incidents and review of documents on disruption. Following this, a comparative analysis and synthesis of the case studies was carried out and findings revealed definition, dimensions, antecedents and consequences of resilience in projects.

Specifically, resilience in projects is defined as; *the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity.* The dimensions of resilience are; proactivity, coping ability, flexibility and persistence. Proactivity can be defined as an anticipatory capability that the project takes to influence their endeavours whilst coping ability can be defined as the capability to manage and deal with stress caused by disruptions within the projects. Furthermore, flexibility can be defined as the capability of a project to manage disruption by allowing change but ultimately making sure that the aim is maintained and persistence is the capability to continue despite difficult situations.

Several antecedents of these dimensions of resilience are identified. For *proactivity* these include contract, training, monitoring, contingency and experience. For *coping ability* these include the contract, training, contingency and experience. For *flexibility* these include open-mindedness, planning, continual monitoring and continual identification of ideas and for *persistence* these include continual monitoring, planning and negotiation. Also, the consequence of resilience in projects is recovery through response, readiness and vulnerability reduction. This conceptualisation of resilience is then synthesised into a validated framework for resilience in projects.

Theoretically, this research provides definition, dimensions, antecedents and consequence for resilience in projects and a theoretical starting point for the concept of resilience in projects. The significance of this research to practice is the identification and development of a more holistic perspective of managing disruptions in projects through the identified dimensions, antecedents and consequences. These dimensions, antecedents and consequences provide clarity for the roles of project managers and team members in managing disruptions and thus, expand the eleventh knowledge area; project risk management, of the Project Management Book of Knowledge (PMBOK). In addition, the dimensions, antecedents and consequences of resilience in projects contribute to the curriculum development in project management and thus, provide factors and indicators that project managers require in managing disruptions.

Keywords; Disruption, Project, Resilience, Critical Incident Technique (CIT), Recovery

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1- Introduction

1.1 Background

A project can be defined as a Temporary Multidisciplinary Organisation (TMO) which consists of diverse skilled people and or resources working together on a complex or unique endeavour in a competitive and uncertain environment over a limited period of time after which they disperse to their parent organisation upon completion (Stringer, 1967). Major interference within projects can cause failure (Loosemore *et al.*, 2006) due to the interruption and distortion of planned works and procedures. These interferences also known as disruptions are managed through approaches such as uncertainty risk, opportunity, change and crisis management (Ward & Chapman, 2003a; Loosemore *et al.*, 2006). These approaches manage disruptions by focussing on the source of disruptions. For instance, uncertainty, change and crisis management deal with the unknown sources of disruption whereas risk and opportunity management focus on the known sources. The reason these approaches focus on the source is to reduce the level of vulnerability (the state of a project being harmed or transformed when struck with disruption (Zhang, 2007)), given that projects exist in a complex (Pannanen & Koskela, 2005) and drifting environment (Palermo & Mashal, 2012; Kreiner, 1995). As such, the impact of these approaches can be labelled as vulnerability-reduction.

This vulnerability-reduction perspective is limiting because the approaches focus on identifying strategies to implement on disruptions perceived and also work towards predicting threat, without critically developing the general capacity (response and preparedness) for dealing with shock (sudden distress) these disruptions cause. Similar to this limitation, Perminova *et al.* (2008) and McEvoy *et al.* (2016) highlight the lack of capacity development in managing disruptions and recommends, the need for further research to ensure recovery. Recovery can be defined as the process of improving to the same or new set of objectives to ensure a successful completion of project endeavours after or during a disruption (Ponomarov & Holcomb, 2009) and encompasses vulnerability reduction, response and readiness (preparedness) (Haigh *et al.,* 2006). This research therefore presents a resilience approach to disruption management (Seville et al., 2006; Ponomarov & Holcomb, 2009). A resiliency approach provides a holistic perspective to disruption management through a simultaneous focus on vulnerability reduction, readiness and response (Haigh *et al.,* 2006; Ponomarov & Holcomb, 2009) and thus enables recovery.

1.2 Research Problem

There is no clear definition of resilience in projects. This is due to its context specific nature (thus, it depends on where it is being applied). The context specific nature of resilience is identified from the diverse definitions which has emerged from the two foundations of resilience; engineering and ecological resilience. Engineering resilience is defined as the ability to resist force (rigidity) (Alexander, 2013) whereas ecological resilience is defined as the capacity for renewal and reorganisation (Holling, 1973). The focus of engineering resilience is efficiency, stability, predictability and return time to normal functioning (Walker *et al.*, 2004) whereas ecological resilience places emphasis on persistence, flexibility and the dynamic and continual development of systems to sustain higher and better levels of functioning (Gunderson, 2000; Holling, 1973).

Based on these two foundations, numerous conceptualisations of resilience (Oppong Banahene *et al*., 2014) have been developed and makes its definition in projects unclear. For example, following the engineering resilience perspective, authors such as Walker *et al*. (2004) and Rutter (1999), emphasise stability and resistance during disruption and, thus, imply strengthening the organisation against shocks through utilising contingencies. On the other hand, definitions of the resilience construct from an ecological perspective such as Klein *et al*. (1998); Holling (1973); Rice & Sheffi (2005); Bruneau *et al*. (2003) and Coutu (2002) place emphasis on responding flexibly to disruption, thus, aiming at recovering to a better position or state termed as bouncing forward and back, stronger.

Furthermore, much research attention on resilience has also been directed towards investigating the resilience to specific disruptions, including, for example, natural and man-made hazards/disasters (example Bosher, 2014), recessions (example Coutu, 2002), and predation on ecological systems (example Holling, 1973). These define resilience differently as: an ability/ capability ‘the means to do’ (example, Rice & Sheffi, 2005); a capacity ‘the means to receive or contain’(example, Coutu, 2002: Walker *et al*., 2004); a quality ‘an inherent characteristic’ (example, Bosher, 2014) and a process 'steps taken to achieve an end' (example, Rutter (1999)) depending on where it is being employed.

Resilience is therefore a discipline or field specific concept and as such requires a clear conceptualisation in projects. Despite recent research on resilience in permanent organisations, the structural differences and discipline boundaries makes its dimensions, antecedents and consequences a challenge in projects due to the projects' multidisciplinary and temporary nature. For instance, dimensions, antecedents and consequences of organisational resilience are enabled by the organisational culture and established relationship and challenged by transactional relationships. Projects on the other hand, exist within transactional relationships thereby challenging the dimensions, antecedents and consequences of the main stream organisational resilience concept. Thus, a clear conceptualisation of resilience in projects is required. Also, in project-based sectors such as construction, research in resilience largely focuses on physical infrastructure assets and their capacity (or lack thereof) to withstand both natural and human-induced disasters (Boin & McConnell, 2007; Bosher, 2014) with little focus on projects (temporary multidisciplinary organisations). Thus, resilience in projects is conceptualised in this thesis.

1.2.1 Research Question

The lack of research on resilience in projects (temporary multidisciplinary organisations) means there is, as yet, no common agreement on its theoretical definition, dimensions, antecedents and consequences. Therefore, the research questions to be answered are as follows:

- **What is resilience in projects?**

  -What is the definition of resilience in projects?

  -What are the dimensions of resilience in projects?

  -What are the antecedents of resilience in projects?

  -What are the consequences of resilience in projects?

1.3 Aim & Objectives

To develop a framework to conceptualise resilience in projects

The above stated aim will be addressed by the following objectives;

1. Identify the theoretical definitions and the dimensions of resilience in projects,
2. Identify antecedents of resilience in projects,
3. Identify the consequences of resilience in projects, and
4. Develop and validate a framework for resilience in projects.

1.4 Research Justification

Disruptions in projects can cause shock, lead to project vulnerabilities and thus, failure. The ability to effectively manage disruptions in projects is critical to its success. To manage disruption, the approach should ensure recovery which encompasses vulnerability reduction, response and readiness through capabilities (Project Management Solutions, 2011; Haigh *et al.,* 2006; Ponomarov & Holcomb, 2009). However, the management approaches in projects focus on reducing vulnerability (example, Perry & Hayes, 1985; Qazi et al., 2016) with little focus on response and readiness which help manage shock.

The benefit of focussing on recovery rather than vulnerability reduction only is that, recovery provides a broader perspective for the project to utilise its resources in managing disruption. The vulnerability-reduction perspective limits the thinking and the perception in managing disruptions to the identified threats thus, leads to increased shock when disruptions occur on the project. Also, authors such as Seville *et al.,* (2006), Holling (1973) and Raco & Street (2011) have confirmed that, recovery reduces exposure to future threats.

On a holistic perspective, research on resilience in projects will clearly identify the reality on the ground to know how projects actually manage disruptions through the identification of the dimensions (capabilities) and antecedents required to manage disruptions. The findings from this research will contribute to the eleventh knowledge area; project risk management, of the Project Management Book of Knowledge (PMBOK) through the identification of dimensions (capabilities) and antecedents of resilience required to manage disruptions. This will provide clarity for the roles of project managers and team members in managing disruptions. Thus, this research also addresses recommendations made by Atkinson, Crawford & Ward (2006) and Cicmil *et al.* (2006) on the need for further research to reflect the actuality of projects in the midst of complex uncertainty.

1.5 Outline Research Methodology and Methods

In order to develop a framework to conceptualise resilience in projects, a comparative case-study approach was employed. The cases studied varied based on the endeavour being carried out and the contractual agreements. The cases consisted of a building, civil engineering and engineering construction project. Within each case studied, critical incidents were focussed on. Critical incidents were focussed on because they provide the shock required when identifying reactions to disruptions. Flanagan (1954) defines critical incident as an unexpected (uncertain) occurrence which is outside the planned works and causes distress. The identified critical incidents were validated by carrying out credibility and trustworthy tests. The test consisted of three stages deduced from Butterfield et al (2005). Firstly, the transcribed information from the case study was cross-checked with the audio record and then given to some participants to confirm initial categories against content in order to determine the extent to which it reflects their personal experiences. Secondly, critical incidents which did not contain capabilities to manage disruptions and antecedents were removed. Thirdly, the less descriptive and vague incidents despite probing to get details were also removed. As such, the unit of analysis was the project and the sub-unit was critical incidents.

Furthermore, an abductive approach which is a combination of deductive and inductive was employed to address objectives 1 to 4. In defining resilience in projects, critical literature review was carried out to sieve out the definitions and dimensions of the notion in other fields in order to identify its similitude and provide a lens and thus inform the question required within the case-study to identify dimensions, antecedents and consequences of resilience. Furthermore, to identify the dimensions of resilience, a case study approach comprising archival analysis, observations and interviews was employed. Archival analysis was carried out to provide a better understanding on information acquired from observations and semi-structured interviews. Also, an inductive approach comprising observations on each project and semi-structured interviews on critical incidents with key project personnel who work on each project was also carried out. Since these experts have varying experiences, providing them with questions that have restricted answers would have reduced the amount and depth of information being sought. This is because, in depth information is required to identify the dimensions (capabilities) required to manage disruption. The common capabilities identified across case studies were then compared with existing disruption management approaches in projects.

Following the identification of the capabilities, antecedents and consequences of the capabilities were identified from archival analysis, observations and semi-structured interviews. Findings from the cross-case analysis and literature were used in developing a framework to conceptualise resilience within the projects. The developed framework was validated using focus groups.

1.6 Structure of Thesis

The thesis is organised into 9 chapters. Figure 1-1 provides a graphical representation of the relationship between the chapters.

Chapter 2 is the literature review chapter and it is broken down into two parts. The first part is a review of current approaches in managing disruptions in projects and identifies the under-researched areas. Within this review, disruption and its causes are outlined and discussion of the current approaches presented. Also, the need to have a theory which goes beyond the current approaches; resilience, is recommended. The second part captures, an in depth literature review on the definitions and dimensions of the notion of resilience in main stream literature. In addition, the ambiguity and diversity in literature which have emerged from the two main foundations; engineering and ecological resilience is presented in this chapter. Also, challenges of the identified definition, its dimensions, antecedents and consequences of organisational resilience to projects are identified and the need for further research to conceptualise resilience in projects is stated.

Chapter 3 is the research methodology chapter. Within this chapter is the discussion and selection of the research methodology required to conceptualise resilience in projects. It focuses on the philosophies, approaches, strategies, choices and techniques and procedures required for the research. The qualitative approach focussing on case study and critical incidents was employed.

Within-case analysis for Case study Alpha-Building project, Beta-Engineering construction project and Gamma-Civil engineering are presented in Chapters 4, 5 and 6 respectively. These present the background of case study, critical incidents and also the capabilities identified.

Cross-case analysis of chapters 4, 5 and 6 is presented in Chapter 7. This chapter presents the common capabilities identified within projects Alpha, Beta and Gamma in order to conceptualise resilience in projects.

Research findings from the synthesis of common findings from the case studies (Chapters 7), disruption management in projects and resilience literature (Chapter 2) are presented in Chapter 8. Resilience in projects is conceptualised here and this shows how projects responds to, prepares for and reduces vulnerability of disruption. This is then synthesised into a framework for resilience in projects and validated.

Finally, presentation of a conclusion to the research, highlighting the main findings as per Chapter 8 and thus, presents the research contribution to, both theory and practice is in chapter 9. For contribution to theory; (1) Resilience in projects has been conceptualised (as presented in developed and validated framework in chapter 8). For contribution to practice; this conceptualisation of project resilience contributes to project management and project success through the identified area of focus. Thus, the identified dimensions reveals the factors to consider in managing disruptions and the identified antecedents reveal the indicators required for managing disruption in projects to ensure recovery.

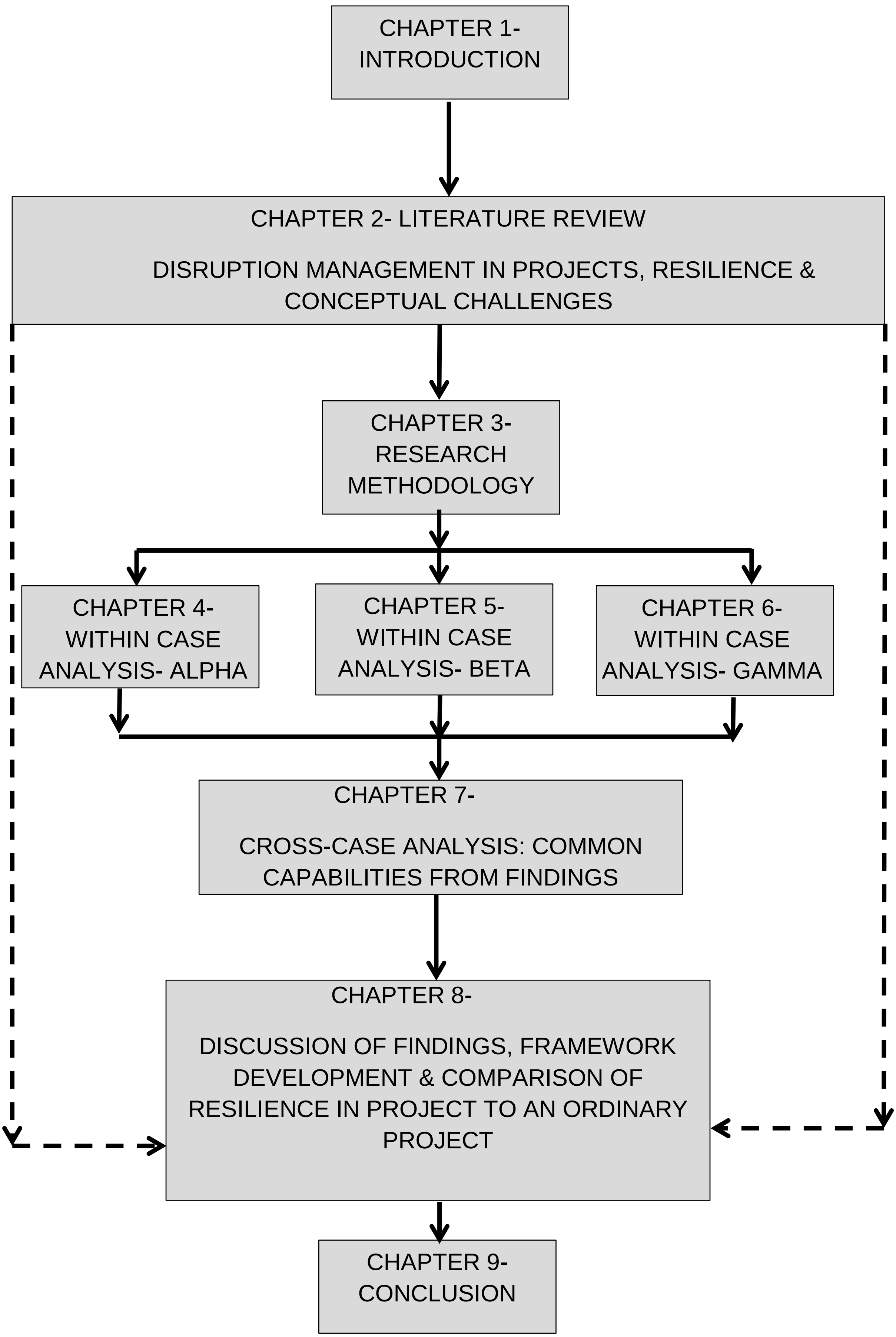


Figure 1-1 Graphical representation of structure of thesis

2- Literature Review

2.1 Introduction

This chapter presents a literature review on disruption management approaches in projects, resilience and the conceptual challenges of employing resilience in projects. It is presented in two parts; Part A and B. Part A reviews current approaches in managing disruptions in projects within the construction sector. This is aimed at identifying limitations and untapped areas. To achieve this, disruption and its causes are outlined and approaches in managing these in projects are presented. Furthermore, the limitation of disruption management approaches emerging from literature review and need to have a theory which goes beyond the current approaches; resilience is recommended.

Part B provides an in depth literature review on the definitions and dimensions of the notion of resilience. This part presents the ambiguity and diversity of resilience which have emerged from the two main foundations; engineering and ecological resilience. Also, the stable organisation application of organisational resilience is reviewed in order to assess its suitability for projects. Also, the need for resilience in projects to be conceptualised in order to ensure recovery is presented.

- **Part A Disruption management in Projects**

Projects are temporary multidisciplinary organisations which consists of a set of diverse skilled people and or resources working together on a complex or unique endeavour in a competitive and uncertain environment over a limited period of time after which they disperse to their parent organisation upon completion (Stringer, 1967). Projects are characterised by the endeavour they undertake and the contractual agreement (Hodgson & Cicmil, 2006). For example, in construction, projects are classified as either building, civil engineering or engineering construction (Office of National Statistics, 2007). Though, projects have been identified as tools for achieving continuous improvement and innovation (Winch, 2014), they are affected by disruptions.

2.2 Disruption in Projects

A disruption is a major interference in a project (Burr, 2016). It causes shock, which increases project vulnerabilities (the state of being harmed or transformed) and thus, failure (Burr, 2016). This is because shock caused by disruptions are upsetting and causes distress (Zhang, 2007). This then leads to delay, over budget, low quality and incomplete scope (due to shock) (Buchanan, 1991).

Furthermore, it was identified by Zhang (2007) that the longer projects are vulnerable to disruptions, the higher the probability to fail. In light of this, approaches to manage disruptions do so by reducing the impact of the disruption and duration of vulnerability through focussing on the cause or source of disruption. Sears *et al.* (2015) adds that, it is essential to identify the causes of disruptions in projects in order to place the management approaches in better perspective therefore, incorporate measures to minimise the entity's exposure duration to the disruption. From a synthesis of literature there are two causes of disruption namely complexity (Pannanen & Koskela, 2005) and drifting environment (Palermo & Mashal, 2012).

2.2.1 Complexity of Projects

Complexity of projects is a composition of many varied interrelated parts (Baccarini, 1996). These interrelated parts comprise processes and resources employed which vary from one project endeavour to the other and interactions of the different workflows (Gidado, 1996). These many varied interrelated parts causes disruptions and also makes projects require exceptional work to maintain focus and prevent disruption. Sources of complexity are diverse and are grouped under known (identified) to unknown (unidentified). The known is the project orientation;(1) individual organisations have their 'homes' before, during and after being involved in the project, hence have different interests (2) of dispersed nature of the team and (3) resource constraint (Hodgson & Cicmil, 2006). The unknowns increase cost, time and affect quality due to lack of prior awareness and are managed as they occur.

Moreover, the management of complexity is essential to the success of projects. Researchers such as Gidado (1996) and Qazi *et al.* (2016) have recommended solutions to manage project complexity. Gidado (1996) recommends that knowing how complexity is managed is essential to achieving project success. This is achieved by understanding the managerial (which involves planning of the various parts of the project) and the operative and technological perspective (which consists of the technical difficulties in work execution). This has been critiqued by the non-identification of factors of project complexity (Wood & Ashton, 2009).

Based on Wood & Ashton (2009) critique, Qazi *et al.* (2016), identifies factors of project complexity such as; inherent complexity, uncertainty, number of technologies, rigidity of sequence, overlap of phases or concurrency and organisational inherent complexity. These researches guide the areas to focus in order to properly manage and deal with complexity. However, the complexity management approaches lack the identification of strategies to manage disruptions complexity causes and thus, require further research.

2.2.2 Drifting environment of projects

Drifting environment on the other hand is a situation where something deviates from its planned course (Kreiner, 1995). Projects drift due to change caused by known and unknown sources. The known sources are grouped into two; internal and external. Internal sources include client requirements, team composition, planned works, aim of the team and resource limitations (Stringer, 1967; Cherns & Bryant, 1984; Kreiner, 1995). External sources include third party stakeholders, weather and terrorism. Changes within any of the internal source (example, composition, requirements, and agreed state) cause projects to deviate from the planned course and thus, drift. The unknown factors vary and they are managed when they occur.

Dubois & Gadde (2002) highlighted that project complexity is influenced by the drifting environment and these breeds uncertainties within projects. Though projects have set out varying approaches to manage disruptions uncertainties cause, projects inevitably drift, thus, introducing more disruptions. To manage the disruptions that the uncertainties cause, there are a number of approaches. These approaches are classified by the source of complexity or environmental drift; thus, known and unknown. These approaches which are deterministic and restrict the ability to manage disruptions are discussed in section 2.3 to identify their limitations.

2.3 Disruption management approaches in Projects

Disruption management approaches are into two groups; the known and unknown sources. The known captures predictable sources of disruptions whereas the unknown are the uncertainties. Under the known source, approaches such as risk and opportunity management are employed. Under the unknown sources, change, uncertainty and crisis management approaches are employed. Figure 2-1 summarises the discussion.

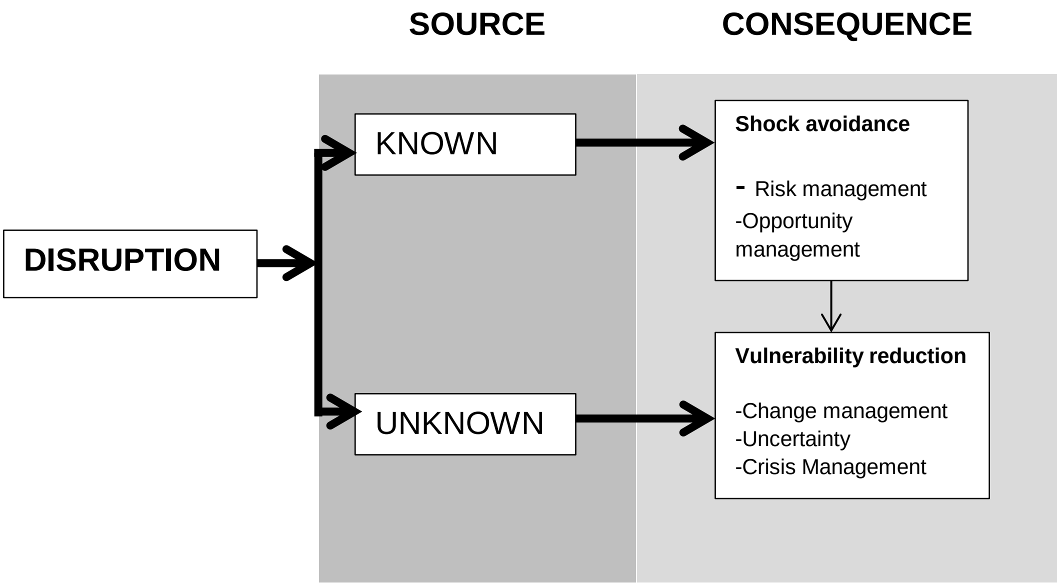


Figure 2-1 Disruption management approaches in construction

2.3.1 Approaches for managing disruptions from known sources

The challenge of the approaches under the known source is the inability to fully manage shock, develop capabilities and ensure overall project recovery. This is because the approaches focus on increasing abilities to predict the threat or opportunity in order to manage them to avoid shock.

2.3.1.1 Risk Management

The management of risk, also known as a threat (Carr & Tah, 2001) or a measurable uncertainty (Hillson, 2003) is by first predicting the occurrence of threat accurately and developing strategies to cater for the identified threat (Perry & Hayes, 1985; Qazi *et al.*, 2016). Following the identification stage, the other stages in managing risk which are risk analysis, response and implementation and monitoring and reviewing (Perry & Hayes, 1985; Qazi *et al.*, 2016) are dependent on the threat identified. For example, risk identification stage categorises and assess the threat associated with a project (Al-Bahar & Crandall, 1991). This is done by extracting or imagining the potential future events that could affect (either negatively of positively) the attainment of defined objectives (Loosemore *et al.*, 2006). These are however, identified to be subjectively influenced based on project personal interest and experiences and thus, challenge risk identification (Loosemore *et al.*, 2006). Thus, any unidentified threat is not catered for and could greatly affect the project through increased shock despite strategies set up to proactively identify risk (example; recruiting people with creative ability, training those without, idea elicitation techniques, forecasting, soft system analysis, brainstorming, electronic brainstorming, influence diagram, fault tree analysis and simulations (Loosemore *et al*., 2006; Sanderson, 2012)).

Also, the risk analysis stage is influenced by the risk identified. This is because, any unidentified risk which has a potential to cause disruption but not quantified in accordance to its tendency and severity of magnitude (that is, its impact) is not covered under this stage (Perry & Hayes, 1985). Similarly approaches to respond to risks such as avoidance, reduction and elimination, transfer and sharing of residual risk (Perry & Hayes, 1985; Serpella *et al.*, 2014) are not planned for the unidentified threat and thus, increases shock to the project when it occurs. This is due to the lack of awareness and thus channelling resources to manage other areas where risk and opportunities have been identified.

Furthermore, unforeseen risks do not have an implementation, monitoring and reviewing plan and thus, disrupts works if they occur. This is because this latter stage in managing risk ensures that parties involved; do as planned and follow response decision chosen (Carr & Tah, 2001; Loosemore *et al.*, 2006; Akintoye & MacLeod, 1997). To date, risk management approaches, either manually (example Perry & Hayes, 1985) or technologically (Dey, Kinch & Ogunlana, 2007) both follow the same fundamental approach (that is, risk analysis, response and implementation and monitoring and reviewing).

2.3.1.2 Opportunity management

Opportunity is a positive perception of risk (Olsson, 2007). The major difference between opportunity and risk management is that opportunity management focuses on positive consequence of the threat instead of negative consequences that risk does (Olsson, 2007). Opportunity management also suffers from the inability to manage shock and develop capabilities. It has similar stages to risk management (outlined in section 2.3.1.1) and these are: opportunity identification, analysis, response, implementation, monitoring and reviewing (Ward & Chapman, 2003b). However, under response, opportunity management differs. Risk management responds by avoiding, transferring, mitigating and accepting. Opportunity management on the other hand responds by exploiting, sharing, enhancing and ignoring (Hillson, 2002). The exploit strategy is to ensure that opportunities definitely happen in order to realise its benefits (Hillson, 2002). Similar to transfer in risk, sharing seeks to partner with the party best able to manage opportunity. Also, contrary to mitigation in risk management, enhancing seeks to increase the impact of the opportunity to acquire maximum benefit (Hillson, 2002).

The limitation of risk and opportunity management which is the inability to manage shock, develop capabilities and manage uncertainties is aimed to be resolved by approaches for managing unknown sources. However, they are not wholly covered but instead minimise the impact of shock.

2.3.2 Approaches for managing disruptions from unknown sources

These manage disruption caused by the unknown sources by setting out measures to be followed prior to the disruption or employ risk management processes to reduce vulnerability.

2.3.2.1 Change management

The management of change, which is a deviation from planned works is by continually renewing the projects direction and structure, to respond to internal and external sources of disruptions (Motawa *et al.*, 2007; Chen *et al.*, 2015). Change is managed by providing a proactive approach in reducing impact of shock but first seeks to forecast possible changes (similar to risk management) (Hayes, 2014).

The difference between the change management approaches and risk opportunity management is the generic processes set out early on the project to manage change. Motawa *et al*. (2007) develops a generic process for change management. This generic process comprise; start up, identify and evaluate, approval and propagation and post stage. At the start-up stage is where a generic definition of proactive requirements needed to manage the change and respond readily is developed (Motawa *et al.*, 2007) prior to the change. This generic process is aimed at minimising shock through the sequential steps it provides (Hayes, 2014) without focussing on developing the capacity of project to absorb shock.

From the above, change management process does minimise the impact of shock first, by utilising the requirements provided at the start up stage. This is successful, provided the processes enable the resolution of disruption. However, the exact requirements are not outlined. In cases where unknown sources of disruption are beyond those perceived or allowed for, change management fails (Ward & Chapman, 2003b; Pritchard & PMP, 2014). Then, uncertainty and crisis management approaches are employed.

2.3.2.2 Uncertainty management

Under uncertainty management, the focus is an event that if occurs, will have an effect on the achievement of the project's objectives (Hillson, 2002). Uncertainty management deals with the unknown sources of disruption. Strategies to manage uncertainties are (1) incorporating strategies to understand uncertainties (Paté-Cornell, 1996; Pritchard & PMP, 2014), (2) ignoring it or (3) reacting to uncertainties as they occur (Paté-Cornell, 1996).

Incorporating strategies to understand uncertainties aims at increasing awareness in order to minimise the shock disruptions cause. This increase in awareness is limited to the potential uncertainties, thus risk. Increase in awareness is enhanced by promoting communication amongst the team (Teller, Kock & Gemünden, 2014). Also, uncertainties are ignored if the impact to the overall project aim is insignificant. Furthermore, reacting to uncertainties as they occur leads to the utilisation of risk, opportunity and change management strategies. The approaches then lead to reducing vulnerability by reacting to it, therefore, ignores developing general capacity and hence does not focus on overall project recovery.

At the initial stage of reacting to uncertainties, projects are vulnerable (Yang *et al.*, 2014). When these available approaches to manage uncertainty fail due to severity of disruptions, projects are disrupted and thus, go into crisis which if not managed swiftly leads to failure.

2.3.2.3 Crisis management

Crisis is an intense difficult state (Boin & McConnell, 2007). Within projects, crisis management focuses on dealing with problems which disrupt the works. This is to prevent the project from further being disrupted. Approaches to managing crisis include utilising pre-developed plan (similar to change management's start-up stage), employing command centre strategy and training (Loosemore, 1999; Kerzner, 2013). The pre-developed plan is issued to the project to act on in order to buy time for the command centre (experts) to develop a strategy and also minimise the initial shocking impact it has on the team. Training techniques in crisis management focus on developing ability to predict the exact consequences of the crisis and its response (Boin & McConnell, 2007).

These crisis management approaches are critiqued because they oversimplify the severity of crisis. Despite the critiques, recent strategies to manage crisis continue to oversimplify its severity, thus making projects more vulnerable (Kerzner, 2013) during crisis. This therefore leaves a significant gap within the management of disruptions for cases where these crisis management strategies do not work (example severe uncertain situation). Also, crisis creates special problems of social adjustment, behavioural instability, information management and conflict management (Loosemore, 1999; Love & Smith, 2016) however, these have been ignored in current crisis management approaches and not catered for in projects. As such, the development of holistic approach in managing disruptions which identifies and develops the functional capacity of projects, resolves problems crisis creates, does not oversimplify crisis and overall project recovery; resilience is required.

2.4The need for resilience

The vulnerability reduction and shock avoidance through process oriented approaches discussed in section 2.3 make projects more vulnerable to disruptions caused by uncertainties. Authors such as Haigh *et al.,* (2006) and Ponomarov & Holcomb (2009) are the few who have also highlighted the need for disruptions in construction to be managed beyond vulnerability reduction and also consider readiness and response to ensure recovery.

2.4.1 Recovery

Recovery is the process of improving to the same or new set of objectives to ensure a successful completion of project endeavours after or during a disruption (Haigh *et al.,* 2006; Seville *et al.,* 2006; Ponomarov & Holcomb, 2009). Response is defined as the reaction to disruptions. It comprises following established processes and utilising capabilities to react to the disruption (Alliger *et al.*, 2003). Readiness is the preparedness of the project to disruptions. However, little has been done in utilising capabilities to respond to disruption and little research has been carried out to identify how preparedness to disruptions can be achieved in projects. This research seeks to carry this out.

The benefit of focussing on recovery rather than vulnerability reduction only is that recovery provides a broader perspective for the project to utilise its resources in managing disruption (Chang *et al.*, 2012). Authors such as Holling (1973) and Raco & Street (2011) have confirmed that recovery reduces exposure to future threats in ecological and economic areas respectively. To ensure recovery, the concept of resilience which has received little attention in projects has been highlighted by Seville *et al. (*2006) and Ponomarov & Holcomb (2009) to enable this. Given that construction projects are identified to follow a different logic (Winch, 1987), Dubois & Gadde (2002) conclude that adopting a management technique from other fields is a mistake. Hence, a conceptualisation of resilience in projects in order to clearly identify how project recovery is achieved in order to better manage disruption is required.

Figure 2-2 shows the limitation under current approaches and the need for a holistic approach to ensure recovery.

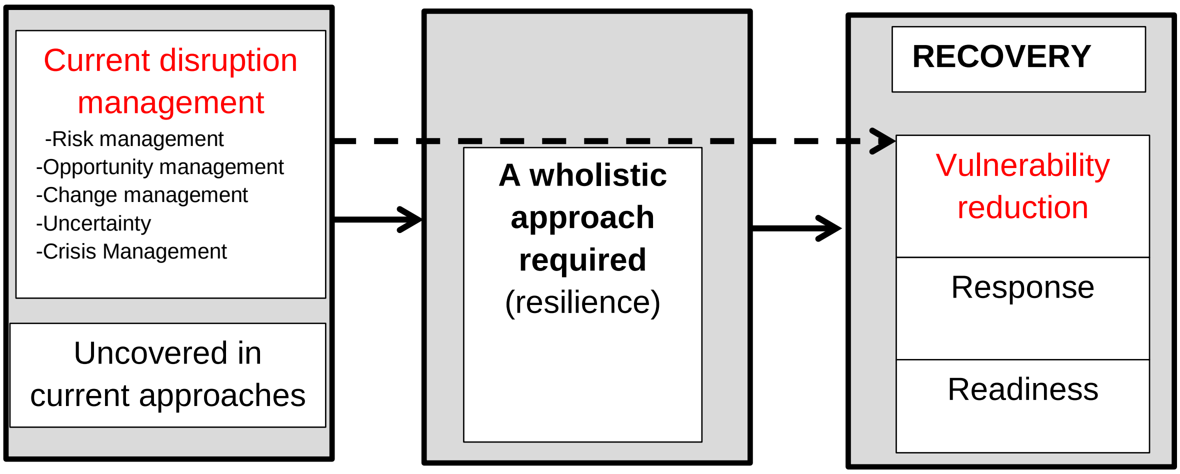


Figure 2-2 Limitation of disruption management approaches

• Part B- Resilience

2.5 Defining Resilience

2.5.1 Foundational definitions of Resilience

There are two foundations of resilience which are engineering and ecological resilience. Engineering resilience is defined as the ability to resist force (rigidity) (Alexander, 2013) whereas ecological resilience is defined as the capacity for renewal, reorganisation and development (Holling, 1973). The focus of engineering resilience is efficiency, stability, predictability and return time to normal functioning (Walker *et al.*, 2004) whereas ecological resilience places emphasis on persistence (ability to continue despite disruptions), flexibility and the dynamic and continual development of systems to sustain higher and better levels of functioning (Gunderson, 2000; Holling, 1973). These foundations of resilience has evolved within the years and led to diverse definitions of resilience.

2.5.1.1 Engineering Resilience

This concept of resilience was first applied in systems in the 1800's by an engineer to describe the strength and ductility of steel beams. This was defined as*; 'a steel member is said to be resilient if it survived the application of a force by resisting it with its strength (rigidity) and absorbing it with deformation (ductility)'* (Alexander, 2013: 1263). This concept is now termed engineering resilience. This concept was then employed in psychology in the 1950's to describe the capacity of a child suffering from schizophrenia to withstand shock (Masten, Best & Garmezy, 1991).

From the above, emerging literature on 'engineering resilience' focusses on efficiency (Hollnagel, Woods & Leveson, 2006), predictability (Folke, 2006) and constancy (Pimm, 1984), as foci of engineering resilience. The 'efficiency' focus, define engineering resilience in terms of the level of performance that reduces the inputs required to restore to original position (Hollnagel, Woods & Leveson, 2006) whereas , the 'predictability' focus define engineering resilience as the degree to which a system is restored to the perceived or original position based on known sources of disruptions (Folke, 2006). Also, the 'constancy' focus, which has been employed by a greater number of authors, defines resilience as *'the stability near an equilibrium steady state of an element, where resistance to disturbance and speed of return to equilibrium are used to measure its property'* (Pimm, 1984). Stability as employed in ’constancy’ is defined as the tendency of a system to retain a balanced condition of an oscillation (Gunderson, 2000). This constancy focus, as stated by Gunderson (2000) and Hollnagel *et al*. (2006) place less emphasis on absorption of disruption due to its ‘resistive nature’ thus, focuses on avoiding disruption.

Due to the ever growing definitions of the engineering resilience construct, there are now conflicting interdependencies and interrelationships amongst the various foci. For instance, ‘stability’ which has been used by a number of authors to describe constancy has had three attributes associated with it in relation to human and nature. These are efficiency, predictability and return time (Walker *et al.*, 2004) which conflict with prior literature. For example, stability used as constancy by Walker *et al.* (2004), highlight that, consideration of return time and predictability were not essential however for the association with human and nature it concludes otherwise.

Also, the application of engineering resilience concept within the management context is presented as a reactive approach. Reactive here is defined as responding to any deviation that occurs within the management process to ensure stability and return to the previous position to meet the organisational goals. McManus (2008) establish that, the reactive nature of this concept hinders the overall resilience of the team. Thus, efficient management and control in the engineering sense will initially lead to success but ultimately to less resilience management systems if disruptions are not managed properly. This is mainly due to the employed predictive (thus identifying potential threats) and resistive nature (ensuring that you return to original position) which hinders the flexibility of adjusting to the ever growing change in the management context (McManus *et al.*, 2008).

Despite the above diverse meanings, engineering resilience assumes the ability to remain stable (Paté-Cornell, 1996; Parry, 1996) and also the assurance of recovery once the disturbance is removed (so long as it does not exceed the elastic limit (Timmerman, 1981). For example, using a stress-strain curve analogy as shown in Figure 2-3, stability is achieved anywhere before the elastic limit of yield point after which failure is caused and cannot be recovered.

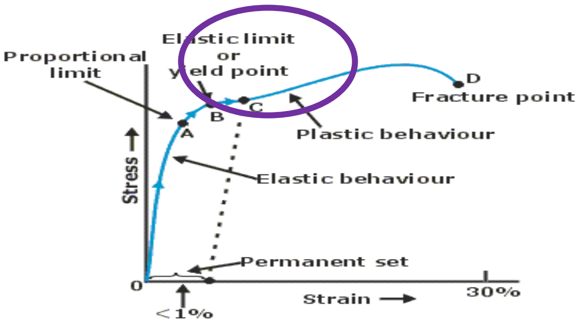


Figure 2-3 Stress strain curve (TutorVista, 2013)

Recovery here is to get the entity to the original position which is any space before the elastic limit and not necessarily the same point as the original (Gallopín, 2006).

From the above review, the engineering resilience perspective is influenced by the area of focus. However a common theme identified is building in resistance to or developing response mechanisms for disruptions (Bruneau *et al.*, 2003; Rice & Sheffi, 2005). In other words, engineering resilience primarily focuses on disruption and usually involves the use of mathematical tools in assessing the likelihood and impact of each disruption (Winkler, 1996; cited in Knight (1921)) and also, the assurance of recovery once disruption is removed (Oppong Banahene *et al.*, 2014).

2.5.1.2 Ecological Resilience

Another concept of resilience, called 'ecological resilience', emerged in ecology in the 1970's, following Holling (1973) seminal paper on the subject. This notion of resilience is defined as the capacity for renewal, re-organisation and development and places emphasis on persistence but also flexibility and the dynamic and continual development of systems to sustain higher and better levels of functioning (Holling, 1973, 1996; Folke, 2006; Gunderson, 2000). Holling (1973:14) defines resilience as *'a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables'*.

Within this context, the persistence (ability to continue despite disruptions) of the system is more important than the constancy because systems are almost always confronted by external unknown and unpredictable factors (Holling, 1973). The persistency is, hereby, enhanced by flexibility (allowing change but ultimately making sure that the aim is maintained) and the introduction of lags and dummies to minimise the impact of the disruption (Holling, 1973). An ecological resilience view also focuses on change and unpredictable situations and highlights that the complexity of a particular situation makes it susceptible to a wide range of change (both welcome and unwelcome) and unpredictability (Holling, 1973; Walker *et al.*, 2004; Folke, 2006).

Holling (1996) points out in explaining the benefit of being flexible to change, that; systems that have fixed rules for achieving constant yields, and independent scale generally lead to gradual loss in resilience and suddenly break down in the face of disturbance which could have been previously absorbed. In ecological resiliency, one important feature is, its integrative approach of working, which include; connectedness and diversity (Holling, 1986). Thus, including all participants in order to ensure disruption management due the communication, commitment and collaboration it provides. Also, this helps define early warning signals of disruptive changes and provides a platform to design self-renewing resource systems (Gallopín, 2006).

Following the above, the ecological resilience perspective is a holistic focus in managing disruption through its emphasis on flexibility and dynamic and continual development of the system to sustain higher and better levels of functioning (Carpenter *et al.,* 2001; Seville *et al*., 2006). It deals with situations where the current state, conditions, outcomes, extents or magnitude of circumstance is unpredictable and unmeasurable. Thus, ecological resilience looks beyond hardening or stability as in engineering resilience, bouncing back (returning to original positions) as per engineering resilience and focusses on persisting to move stronger or recover to a better position therefore; bounce forward. Figure 2-4 depicts how ecological resilience subsumes engineering resilience.

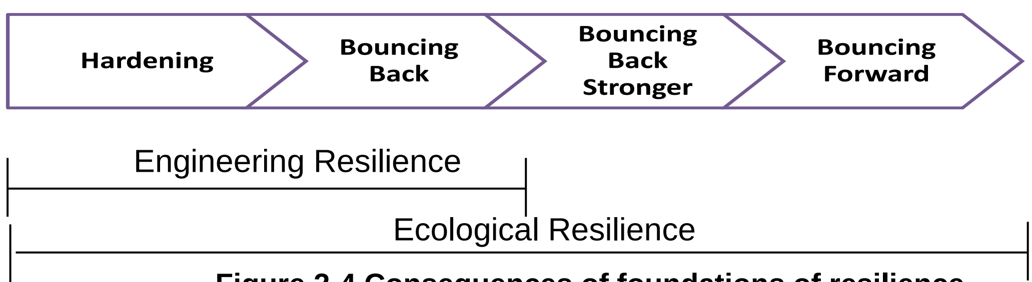


Figure 2-4 Consequences of foundations of resilience

2.5.2 Evolved definitions of Resilience

Building on these two foundations, resilience has been applied in various fields and disciplines and these stand in the way of a unified understanding of the theoretical dimensions, antecedents and outcomes of the concept (Oppong Banahene *et al.,* 2014).

For instance, in defining resilience to a particular disruption, some key words are used in describing the concept, either as process or as an outcome. These include; an ability/ capability ‘the means to do’ (example, Rice & Sheffi, 2005); a capacity ‘the means to receive or contain’(example, Walker *et al*., 2004); a quality ‘an inherent characteristic’ (example, Bosher, 2014) and a process ’steps taken to achieve an end’ (example, Rutter (1999)).

These key words which run through a number of definitions are influenced by the focus for which resilience is developed. For instance, in defining resilience as an ‘ability’ within communities by Bruneau *et al*. (2003), the ability here refers to the means to overcome earthquakes within the communities, carry out measures such as sharing knowledge and making it a habit to allow for redundancy to contain these hazards and carry out recovery activities within the community. This ‘ability’ definition is different from that of Perrings (2006), in relation to ecological system. Here, the ability refers to the means to withstand shocks within the ecological systems during predation. Also, ‘ability’ stated by Cumming *et al*. (2005) in relation to socio-ecological systems, is explained as doing something totally different which nullifies the disruption but making sure that the overall goal of the system remains the same. Within organisations where groups are captured, resilience as an ability is seen as a capability (example Bhamra *et al*., 2011).

Again, in relation to defining resilience as a capacity which is; *‘the means to receive or contain’*, it is generally applied to outcomes of a group of focus. For example in defining resilience as a capacity in societies, Timmerman (1981) describe this capacity as one that enhances absorption and recovery whereas Luthans (2002) explains these capacities as that which enhances stability against change. This shows that within the same focus, the notion of resilience also means different things depending on the author as well.

Also, in describing resilience as an inherent characteristic (quality), these vary. For instance Horne & Orr (1997) defines this *quality* as a means to absorb this change in organisations whereas Keong & Mei (2010) describe this *quality* in relation to small and medium enterprises as an enabler to develop capabilities which will then manage these disruptions.

Despite the diversity, terminologies such as ability/ capability and quality, relate to resilience as a process. Also, these terms lead to capacity (outcome). However, in relation to conceptualising resilience as an outcome, McCubbin (2001) identifies two main outcomes; namely positive outcome or negative outcome. These are however determined by the success or failure of the processes. Thus, resilience as viewed as an outcome is influenced by resilience as viewed as a process. The diversity in the notion is influenced by the 'field' being employed. The definitions of these conflicting meanings of resilience are presented in Table 2-1.

Table 2-1: Definitions of resilience

Author	Focus / Field	Definition of Resilience
Klein *et al*. (1998:40) (2003)	Coast	The *self-organising capacity* of the coast *to preserve* actual and potential functions *under changing* hydraulic and morphological *conditions.*
Bruneau *et al* (2003:735)	Community	*Ability* of social units *to mitigate and contain* hazards *and* also *carry out recovery activities*
Gunderson (2000:426)	Ecological system	*Amount of disturbance* that an ecosystem could *withstand without changing* self-organized processes and structures
Perrings (2006:418)	Ecological system	The *ability of the system to withstand* either market or environmental *shocks without loosing the capacity to allocate resources efficiently*
Holling (1973:14)	Ecological systems	A *measure of the persistence* of systems *and* of their *ability to absorb change* and disturbance *and still maintain* the same relationships between populations or state variables
Coutu May (2002:4)	Individual	The *ability to accept, have a strong belief* that life is meaningful *and* that there is the *need to improvise.*
Masten, Best, & Garmezy (1990:426)	Individual Child	*Process, capacity or outcome of successful adaptation* despite challenges or threatening circumstances . . . . good outcomes despite high risk status, sustained competence under threat and recovery from trauma
Luthar (2003:4)	Individual Child	*Positive adaptation* despite adversity
Richardson, Neiger, Jensen & Kumpfer, (1990:34)	Individual Child	The *process of coping* with disruptive, stressful or challenging life events *in a way that provides* the individual with additional *protective and coping skills* before the disruption results in the event
Rutter, (1999:119); (2000)	Individual Child	A *process of* relative *resistance to psychosocial risk experiences*
Giezen (2013:727)	Megaproject	Reactive resilience is the ability of an entity *to respond* to challenges *by minimizing* the effect these challenges have on it. Active resilience is geared towards *accepting adaptation* as a necessary feature of the planning process *and using it to add value.*
Bhamra *et al*., (2011:5587); (2012)	Organisation	Resilience is the *emergent property* of organisational systems *that relates to* the *inherent and adaptive qualities and capabilities that enables an* organisation's *adaptive capacity* during turbulent periods.
Braes and Brooks (2010:123)	Organisation	Resilience is *a common capacity possessed* by individuals, groups or communities *that enable* them *to prevent, minimise or prevail* through periods of adversity.

Hamel & Valikangas (2003:2)	Organisation	The *ability to dynamically reinvent* business models and strategies *as circumstances change*
Hollnagel *et al*. (2006:339)	Organisation	The *ability to withstand* the effects of stress and strain *and to recover* from adverse conditions over long periods
Luthans (2002: 702); (2006) p. 32	Organisation	Resilience is the *positive psychological capacity to rebound, to 'bounce back' from* adversity, uncertainty, conflict, failure *or even positive change, progress and increased responsibility*.
MacManus (2008:5)	Organisation	This is a function of an organisation's *situational awareness, identification and management of keystone vulnerabilities and adaptive capacity* in a complex dynamic and interconnected environment
McDonald (2006:157)	Organisation	The *capacity of* an organizational system *to anticipate and manage risk* effectively, *through appropriate adaptation of its actions, systems and processes* so as *to ensure that its core functions* are carried out *in a stable and effective* relationship with the environment
Seville *et al*., (2006:3)	Organisation	Organisations that will *achieve its core objectives* in the face of adversity *and speed to manage* crisis effectively
Vogus and Sutcliffe (2007:3418)	Organisation	The *maintenance of positive adjustment* under challenging conditions *such that* the organization *emerges from* those conditions *strengthened* and *more resourceful.*
Keong and Mei (2010:3)	Small and Medium Enterprise	Resilience is a '*set of qualities'* which provides SME's *with the capacity to sustain* their businesses
Timmerman (1981:21)	Society	The *measure of* a system's or part of a system's *capacity to absorb and recover* from the occurrence of a hazardous event in different countries.
Cumming *et al*. (2005:976)	Socio-ecological system	The *ability* of the system *to maintain* its *identity* in the face of internal change and external shocks and disturbances
Folke (2010:6); (2006:258)	Socio-ecological system	Resilience is *a concept that has advanced in relation to* the *dynamic development of complex adaptive systems* with interactions across temporal and spatial scales.
Gallopin (2006:7)	Socio-ecological system	An *internal property of* a system which *preserves the behaviour* of the system as expressed by its state remaining *within the considered domain of attraction*
Walker et. al (2004:2)	Socio-ecological system	Resilience is *the capacity* of a system *to absorb disturbance* and *reorganize* while *undergoing change* so as *to still retain* essentially *the same function, structure, identity, and feedbacks*
Pimm (1984:322)	Specie	The *speed with which* a system *returns to* its *original state* following a perturbation (based on larger participants).
Rice & Sheffi (2005:41)	Supply chain	*Ability to recover from* disruption *quickly* by *buiding redundancy* and *flexibility* into its supply chain.
Tang (2006:36)	Supply chain	*Ability* of a supply chain strategy *to be robust*
Adger (2000:347)	Workgroup/ community	Social resilience as the *ability* of groups or communities *to cope* with external stresses and disturbances *as a result of* social, political, and environmental *change*.

Definitions of resilience in Table 2-1 following the engineering resilience perspective, such as those by Walker *et al*. (2004) and Rutter (1999), emphasise stability and resistance during disruption and, thus, imply strengthening the organisation against shocks through utilising contingencies. On the other hand, definitions of the resilience construct from an ecological perspective such as Klein *et al*. (1998); Holling (1973); Rice & Sheffi (2005); Bruneau *et al*. (2003) and Coutu (2002) place emphasis on responding flexibly to disruption, thus, aiming at recovering to a better position or state termed as bouncing forward and back, stronger.

Also, the definitions in Table 2-1 show that resilience is dependent on the focus in which it is being employed. For instance, resilience in ecological systems is defined as an ability to absorb shock whereas resilience of individual children focuses on the ability to adjust to changes or shock. Furthermore, resilience in organisations is defined as a competence, capability or capacity to manage disruptions. Resilience in socio-ecological systems defines resilience as the ability to absorb shock through stable or dynamic means whereas resilience in supply chains is defined as the ability to recover through rigidity or flexibility. These definitions clearly show that resilience is a field or discipline specific concept as such before employing it to any discipline, it first need to be conceptualised.

2.5.3 Evolved Dimensions of resilience

Emerging from the definitions of resilience are dimensions. Dimensions here are defined as aspects or features of resilience. Table 2-2 presents the identified dimensions of resilience across the various foci where resilience is employed. Despite the varying definitions, the labelling of the dimensions employed is similar. For example, resilience in ecological system, children, organisations and socio-ecological systems use the adaptive capacity dimensions, however, adaptive capacity is defined differently. For instance, adaptive capacity in ecological systems is defined as an ability of the system to remain in a stability domain (Gunderson, 2000) whereas adaptive capacity in individual children is defined as rigid internal locus of control in the face of uncontrollable devastation (Masten, Best & Garmezy, 1991). Also, adaptive capacity in organisation is defined as a measure of the culture and dynamics of an organization that allow it to make decisions in a timely and appropriate manner (McManus *et al.*, 2008), whereas adaptive capacity in socio-ecological systems is a component of resilience that captures the systems behaviour in cases of disruption (Carpenter *et al.*, 2001). These variations in adaptive capacity is similar to that of other dimensions in resilience. Hence, supporting the fact that resilience is clearly a discipline or field specific construct.

Table 2-2 Dimensions of resilience

Author	Focus /Field	Dimensions
Klein *et al*. (1998:40) (2003)	Coast	-High adaptive capacity, Sustainability, Vulnerability
Bruneau *et al* (2003:735)	Community	-Robustfulness , Redundancy, Resourcefulness , Rapidity
Gunderson (2000:426)	Ecological system	- Stability, Adaptive Capacity
Perrings (2006:418)	Ecological system	-Adaptive capacity, Robustness
Holling (1973:14)	Ecological systems	-High capacity to persist, Stability
Coutu May (2002:4)	Individual	-Optimistic behaviour, Attitude of searching for meaning, Improvising at all times
Masten, Best, & Garmezy (1990:426)	Individual Child	-High adaptive capacity, Recovery
Luthar (2003:4)	Individual Child	-Significant risk to overcome, Adaptability
Richardson, Neiger, Jensen & Kumpfer, (1990:34)	Individual Child	-Ability to bounce back, Process Model
Rutter, (1999:119); (2000)	Individual Child	-Resistive, Level of sensitivity
Giezen (2013:727)	Megaproject	-Adaptability, Inertia
Bhamra *et al*., (2011:5587); (2012)	Organisation	-Adaptability, Coping Ability, Business continuity, Stability
Braes and Brooks (2010:123)	Organisation	- Adaptability, Business continuity strategies, Prepardness, Awareness of situations
Hamel & Valikangas (2003:2)	Organisation	-Rebounding, Renewal, Continual reconstruction
Hollnagel *et al*. (2006:339)	Organisation	-Persist
Luthans (2002: 702); (2006) p. 32	Organisation	-Adaptive capacity
MacManus (2008:5)	Organisation	-Adaptive Capacity, Coping, Vulnerability, Recovery, Business continuity, High Reliability Organisations
McDonald (2006:157)	Organisation	-High adaptive capacity
Seville *et al*., (2006:3)	Organisation	-Adaptive Capacity
Vogus and Sutcliffe (2007:3418)	Organisation	-Coping ability, High reliability organisations
Keong and Mei (2010:3)	Small and Medium Enterprise	-Flexibility, Highly motivated, Perseverance, Optimistic
Timmerman (1981:21)	Society	-Adaptive capacity, Persistence, Vulnerability, Stability
Cumming *et al*. (2005:976)	Socio-ecological system	-Multi-facetet concept, Adjustment, Self-organising
Folke (2010:6); (2006:258)	Socio-ecological system	-Persistence, Sustainability, Adaptability, -Transformation
Gallopin (2006:7)	Socio-ecological system	-Capacity to cope, Vulnerability, Adaptive capacity
Walker et. al (2004:2)	Socio-ecological system	-Adaptive capacity, Resistance, Precariousness Panarchy
Pimm (1984:322)	Specie	-Persistence, Stability, Resistance
Rice & Sheffi (2005:41)	Supply chain	-Flexibility
Tang (2006:36)	Supply chain	-Resistant
Adger (2000:347)	Workgroup/ community	- Persistence, Vulnerability, Sustainability, Stability

2.5.4 Evolved Antecedents of resilience

Antecedents to resilience are things that exist before and enable dimensions of resilience. These largely vary across the different disciplines. For instance, identified antecedents for ecological systems are buffers, whereas that of community is monitoring. Again, antecedent for children is motivation and training whereas organisations are largely contingencies and motivation. These variations clearly show that resilience is a field or discipline specific concept.

Table 2-3 Antecedents of Resilience

Author	Focus / Field	Antecedents
Klein *et al*. (1998:40) (2003)	Coast	Promoting flexibility and enhancing public awareness and preparedness
Bruneau *et al* (2003:735)	Community	Gathering useful information through monitoring, sensing, and other field activities to pre-plan
Gunderson (2000:426)	Ecological system	Buffers/lags and ability to continually learn, develop trust and engage with each other
Perrings (2006:418)	Ecological system	Redundancy
Holling (1973:14)	Ecological systems	Buffer
Coutu May (2002:4)	Individual	X
Masten, Best, & Garmezy (1990:426)	Individual Child	Disciplinary training
Luthar (2003:4)	Individual Child	Convincing
Richardson, Neiger, Jensen & Kumpfer, (1990:34)	Individual Child	Motivation
Rutter, (1999:119); (2000)	Individual Child	Parental training
Giezen (2013:727)	Megaproject	Redundancy of actors and knowledge; Incremental adaptations
Bhamra *et al*., (2011:5587); (2012)	Organisation	Incentives
Braes and Brooks (2010:123)	Organisation	Building redundancy and flexibility
Hamel & Valikangas (2003:2)	Organisation	-Liberating resources, promoting innovation & valuing variety
Hollnagel *et al*. (2006:339)	Organisation	Knowledge about past, future and present situations, and continuous monitoring
Luthans (2002: 702); (2006) p. 32	Organisation	Motivation
MacManus (2008:5)	Organisation	Incentives and promoting feedback systems
McDonald (2006:157)	Organisation	Contingencies
Seville *et al*., (2006:3)	Organisation	Motivation
Vogus and Sutcliffe (2007:3418)	Organisation	Learning from the past, monitoring, treat success lightly, believe they are imperfect and have willingness to learn, promote competence, restore efficacy, encourage growth
Keong and Mei (2010:3)	Small and Medium Enterprise	Incentives
Timmerman (1981:21)	Society	X

Cumming *et al*. (2005:976)	Socio-ecological system	Developing a behaviour to feedback information
Folke (2010:6); (2006:258)	Socio-ecological system	Providing incentives to enhance learning, innovation and feeding back information
Gallopin (2006:7)	Socio-ecological system	X
Walker et. al (2004:2)	Socio-ecological system	X
Pimm (1984:322)	Specie	Speed
Rice & Sheffi (2005:41)	Supply chain	Redundancy and resilient culture
Tang (2006:36)	Supply chain	-Incentives -Contingency plan -Security measures
Adger (2000:347)	Workgroup/ community	Motivating group or community to maintain focus in the face of disturbance

Due to this field dependent nature of resilience, the application of resilience to that of organisations is reviewed in detail because projects are a form of organisation.

2.6 Defining Organisational Resilience

The definition of the notion of resilience in organisations has up to date been employed in various disciplines with varying meanings as well. However, they all follow the engineering resilience perspective. Organisational resilience aims to improve on the organisation's situational awareness, reduce vulnerability and increase adaptive capacity during or after a disruption. It focuses more on bouncing back to organisational objectives. This section reviews major works of organisational resilience from literature. In all, there are four ways in which organisational resilience has been presented; (1) as a positive adjustment to disruption response, (2) as response to disruptions, (3) in terms of its barriers and enablers and (4) defining what organisational resilience is. Across these perspectives, three critical terms which interrelate are revealed namely; competence, capability and capacity. Competence is defined as the state of being functionally adequate or having the know how (Vincent, 2008). Whereas capability is defined by Helfat & Peteraf (2003) as an ability of the organisation to perform coordinated tasks with the use of resources from the organisation for the purpose of achieving a particular goal. Capacity on the other hand is depicted as the power to retain, hold or accommodate and generally capture outcomes (Vincent, 2008).

Conceptualisation of organisational resilience reveals the relationship between these as, the capability of the organisation which is aided by competence together with other organisational assets. Furthermore, capacity captures the outcome or measure of the capability. Thus, organisational resilience though in certain cases is defined as the outcome; capacity, it is enabled by the process; capability. Hence the focus in this research is the capability. These conceptualisations of organisational resilience are based on permanent organisational structures and process and thus, challenging for project which are temporary and have a different set up.

2.6.1 Organisational Resilience; perceived as a positive adjustment to disruption response

Organisational resilience perceived here is based on positive adjustment (outcome: capacity). Thus, it is ascertained when an entity is doing well or better than intended (Sutcliffe & Vogus, 2003). This is based on organisational processes and resources focusing on competence and organisational growth (Sutcliffe & Vogus, 2003). Thus, organisational resilience is likely when employees are adequately motivated and most importantly highly likely when experiences based on past success are encountered. This level of resilience is dependent on the capability to restore success, retain organisational resources and competencies in a flexible, storable, convertible and malleable form, and also the ability to adequately process feedback and share knowledge appropriately to overcome a disruptive event (Sutcliffe & Vogus, 2003). These are achieved by the ability of the organisation to avoid and cope during disruptions. A framework developed by Sutcliffe and Vogus (2003) showing organisational resilience perceived as a positive adjustment to disruption is presented in Figure 2-5;

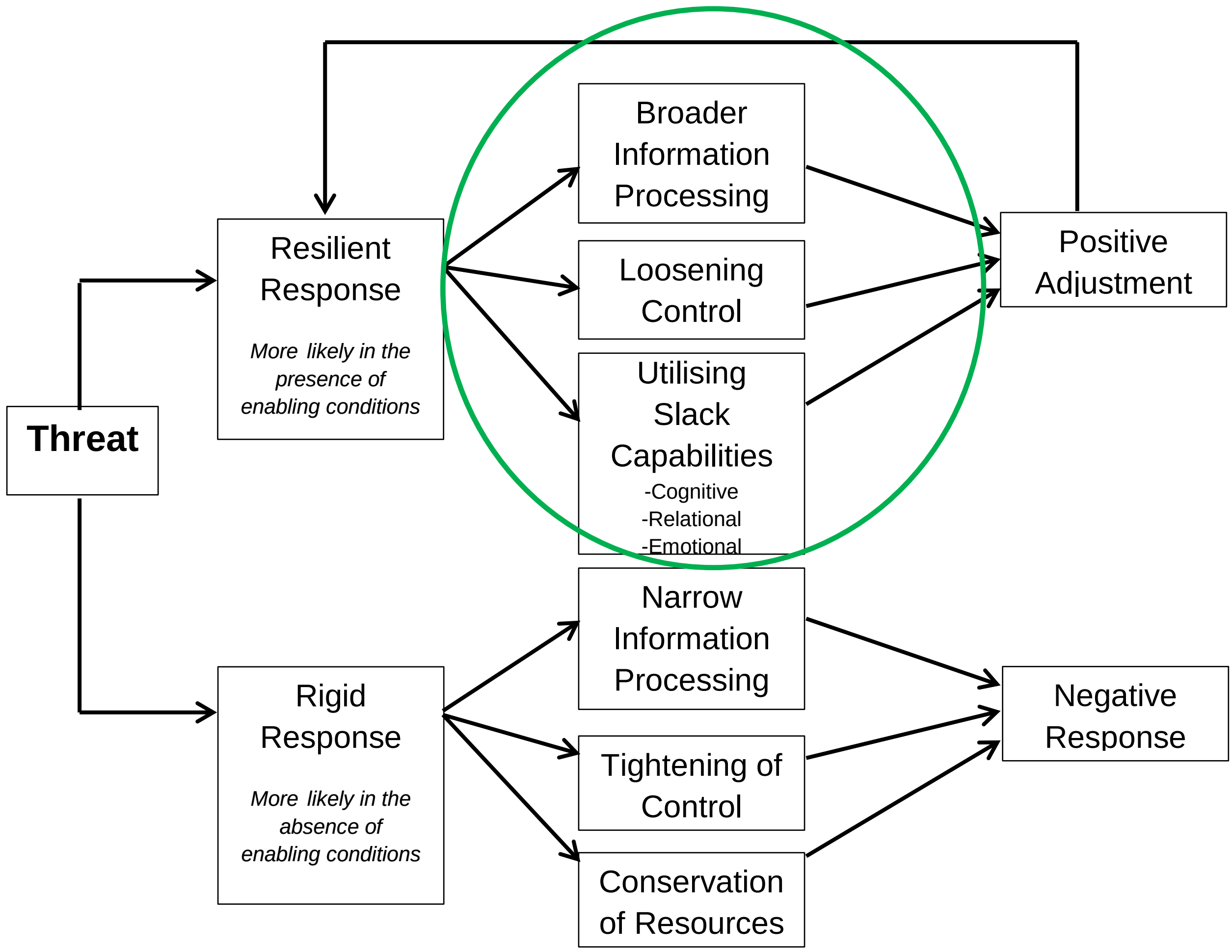


Figure 2-5 Resilient and rigid responses to threat (Sutcliffe & Vogus, 2003)

Focusing on the highlighted area (in the green circle) in Figure 2-5, organisations manage threats or disruptions by providing enabling conditions which help build competencies (state of being functionally adequate) (March, 1991). Also, this nature of organisations captured here is similar to that of High reliability organisations (HRO) which is known to initiate new patterns of activity to manage disruptions while maintaining connection with established organisational competencies (Virany, Tushman & Romanelli, 1992). This is carried out by proactively testing their assumptions about risk and encouraging people to speak out regarding errors to manage disruptions (Vogus & Sutcliffe, 2007). However, the HRO conceptualisation of organisational resilience has been criticised for: oversimplifying accidents, hence underestimating accidents and the vulnerability of an organisation to disruptions through its risk and uncertainty management (McManus, 2008).

In addition, the highlighted area in green focuses on competency development and reveals information sharing (broadening information) as a means to attaining positive response. This is attained by ad-hoc problem solving networks, fluid decisions structures and relationships. Also, loosening of control to attain positive response is achieved by strategic reorientations to provide higher capacity (power to retain) and developing structures that allow flexibility in transferring expertise and resources and also enhance capabilities to quickly process feedback (Sutcliffe & Vogus, 2003).

Furthermore, utilizing slack capabilities which are acquired from ordinary processes such as innovation, strategic decision making and alliances with partner firms are required. Slack is the diversity in organizational members' perspectives about the organization and the willingness to question what is happening rather than feign understanding (Weick, 1993). Slack capabilities is identified to enhance competency by increasing available perspective (Sutcliffe & Vogus, 2003). These are however, enabled by learning (seeking new knowledge) and acting without knowing in advance what one will be called to act upon (Schulman, 1993). The cognitive, emotional and relational dimensions of slack capabilities influences the number of perspective available for identifying the solving of problems and it foster success through the ability to challenge inherited knowledge and appreciate new perspective (Sutcliffe & Vogus, 2003).

2.6.2 Organisational Resilience: perceived as response to disruptions

Organisational Resilience, perceived as response to disruptions, is similar to 2.6.1 and also looks at awareness as the main enabling condition to respond to disruptions in order to reduce vulnerabilities. This conceptualisation establishes that, being aware of a situation is an essential component of resilience and this mainly drives the ability to adapt which relates to the creation of learning and novelty which aids better preparedness for disruptions and thus, enable coping and persistence (Burnard, 2013) in order to reduce vulnerability. Here, the ability to adapt is made up of two stages; detection (enhanced by awareness) and activation (response preparation). These are the essential stages in responding to disruption within an organisation (Fiksel, 2006). This is however, greatly influenced by the organisation's ability to feedback critical information to the appropriate personnel (Fiksel, 2006). Within this conceptualisation, recognizing and interpreting threats is critical for positive adjustment of a system to a disruption. Figure 2-6 presents a graphical representation of how organisations respond to disruptions from Burnard (2013) enabled by awareness.

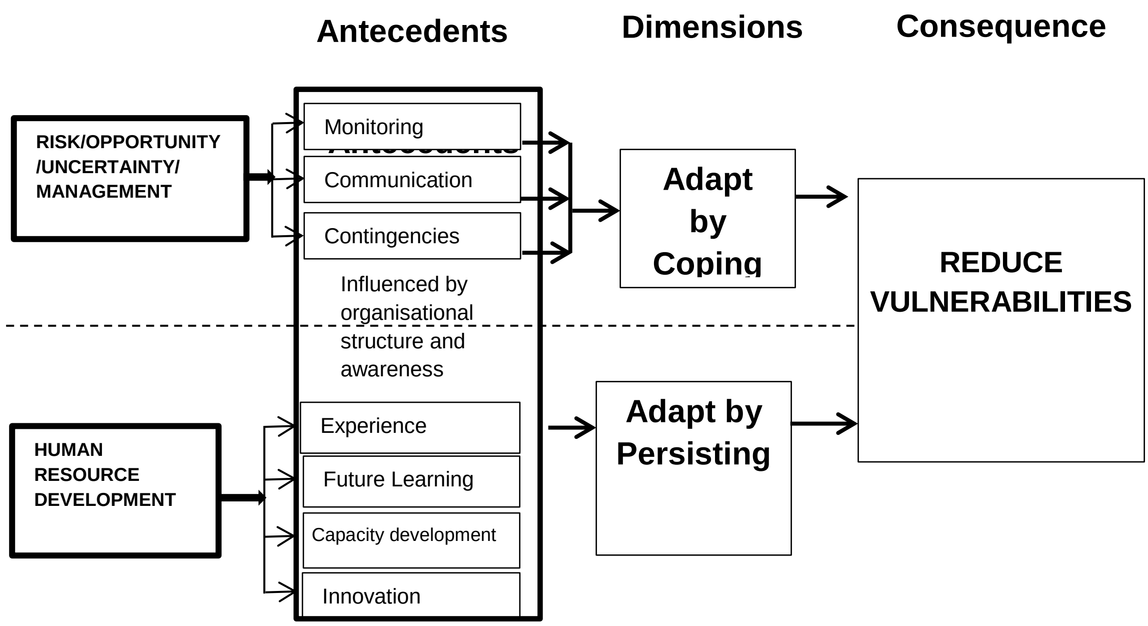


Figure 2-6 Organisational resilience response to disruptions (Inferred from Burnard, 2013)

The capability to cope focuses on dealing with stress in order to return the organisation to the original position whereas persistence enables continuing despite the disruptions (Burnard, 2013).

2.6.3 Organisational resilience: barriers and enablers

This conceptualisation of organisational resilience focuses on the barriers and enablers (McManus, 2008). Enablers were adaptive capacity and situational awareness whereas barriers were anything which increased vulnerabilities. Situational awareness is a measure of the organisations understanding and conception of its entire operational environment, this includes organisations awareness of the resources it has available, minimum operating requirements and expectations, obligations and limitations in relation to both internal and external stakeholders (McManus, 2008). Also, adaptive capacity is a measure of the organisational processes that allows timely and appropriate decisions to be made both in day-to-day business and in crisis as well (McManus, 2008). Vulnerabilities cover those operational and managerial areas of an organisation which have high negative impacts during disruptions (McManus, 2008). Within this are strategies to identify situational awareness, and increase adaptive capacity in order to reduce vulnerabilities of the organisations to possible disruptions. Antecedents of organisational resilience vary and are largely influenced by organisational processes and procedures. These antecedents (enabled by awareness) enable the organisations reduce vulnerabilities by increasing adaptive capacity (coping and persisting) despite the disruptions. Figure 2-7 lists the antecedents to resilience in organisations.

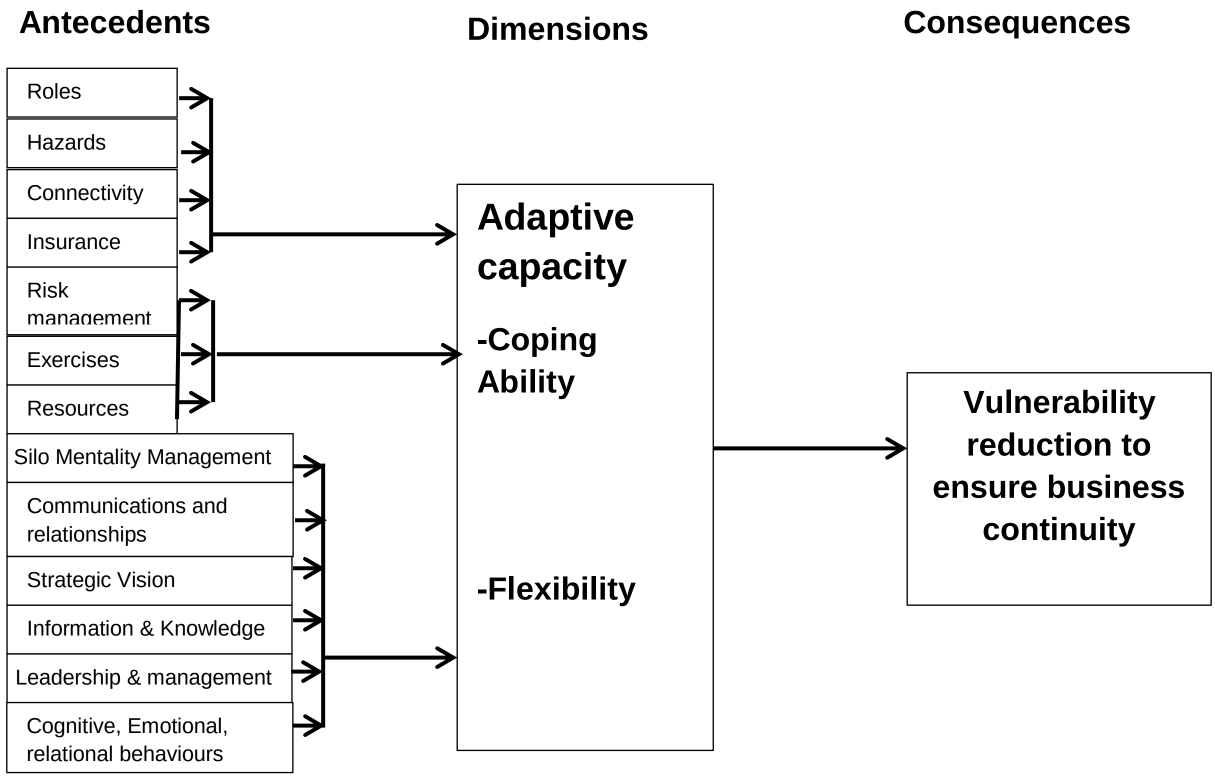


Figure 2-7 Organisational resilience; achieving improved resilience for organisation (Inferred from McManus, 2008)

Also, vulnerability reduction is enabled by a Readiness Exercises and Disaster Simulations (REDS) (McManus, 2008). REDS encourages organisations to identify their vulnerability in a simulated environment to ensure business continuity. Business continuity is defined as the capability of the organization to continue delivery of products or services at acceptable predefined levels following a disruptive incident (ISO 22301:2012). Furthermore, authors such as Braes &Brook (2010:123) who define organisational resilience as '*a common capacity possessed by individuals, groups or communities that enables them to prevent, minimise or prevail through periods of adversity'* and Giezen (2013:727) *as 'the ability of an entity to respond to challenges by minimizing the effect these challenges have on it'* have developed their concepts of organisational resilience around this.

2.6.4 A systems view of defining Organisational Resilience

This is similar to perspectives in 2.6.1-2.6.3 except that, the organisations are dependent of other organisations to function hence the need to consider multi-organisations in organisational resilience. Thus, organisational resilience is explained as an interdependent ability of organisations to respond to a disruption (Seville *et al.*, 2006). Mcmanus *et al*, (in press) defines organisational resilience, as a function of the overall vulnerability, situation awareness and adaptive capacity of an organisation in a complex, dynamic and interdependent system. Based on this definition, access to information characterizing the disruption intensity, location and related damages, as well as the availability of human and physical resources is identified to be essential (Seville *et al.*, 2006).

This notion of organisational resilience highlights vulnerabilities to be reduced and adaptive capacity and awareness to be increased (Seville *et al.*, 2006). Vulnerabilities are reduced by deploying physical and human resources, whereas adaptive capacity is increased by inter-organisation hazard planning and awareness is increased by legal and contractual (agreed relationships and co-ordination) requirement. The means of achieving these is presented in Figure 2-8.

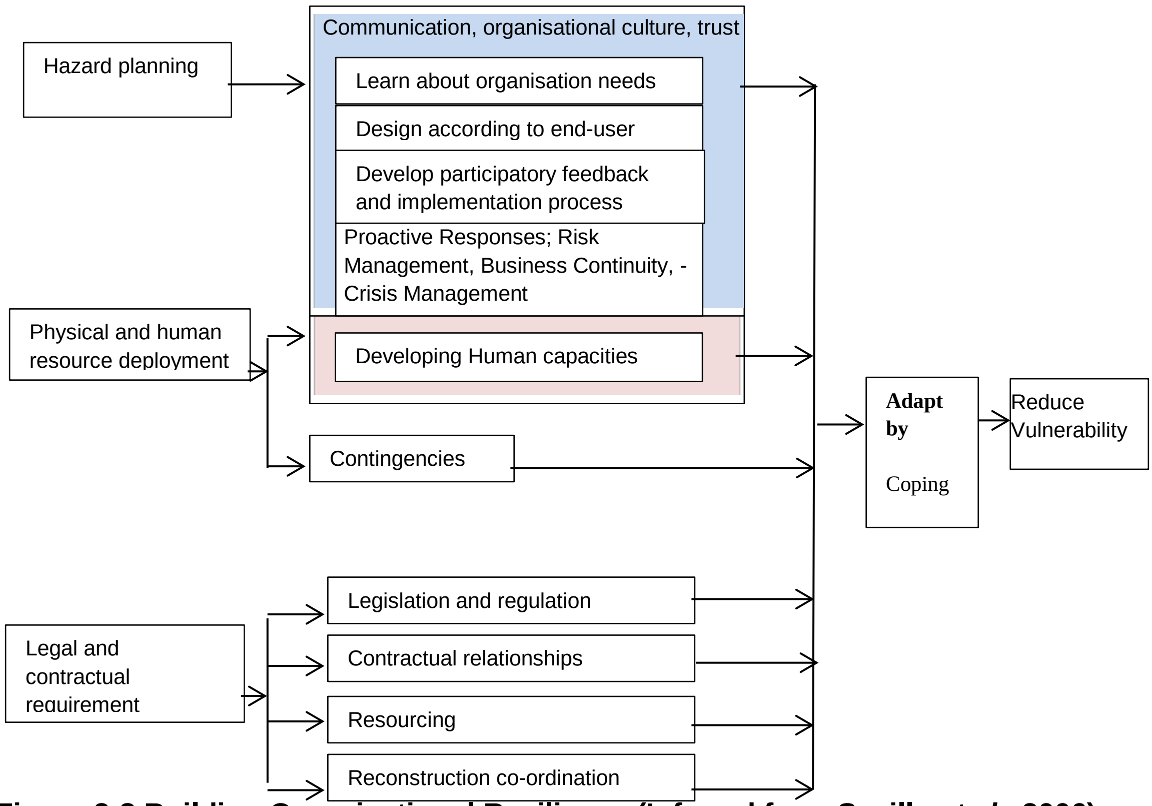


Figure 2-8 Building Organisational Resilience (Inferred from Seville *et al.*, 2006)

2.6.5 Working definition of Organisational Resilience

Following the perspectives in section 2.6.1-2.6.4 a comparison of these key points are highlighted in Table 2-4. Across the definitions, resilience as a capability runs through out as summarized in Table 2-4.

Table 2-4 Comparison of key definition points

Organisational resilience; perceived as a positive adjustment to disruption response	Organisational resilience: perceived as response to disruptions	Organisational resilience: barriers and enablers	Organisational resilience: A systems view approach of defining what organisational resilience is
-*Capability*	-*Capability*	-*Capability*	-*Capability*
-Positive adjustment	-*Respond* to disruption	-Barriers and enablers to ensure *response*	-*Respond and recover* from a disruption
-Utilises *organisational processes and resources* through focusing on *competence* and organisation growth	-*Situational awareness* driven by adaptive capacity which aids better *preparedness*	-*Situational awareness* through managing *vulnerability* and increasing *adaptive capacity*	-Function of the overall *vulnerability, situation awareness and adaptive capacity*
Enabled by *learning* and *acting without knowing in advance what one will be called upon to act*	Enabled *by learning, feedback information to appropriate personnel* and *developing human resource awareness*	Enabled by *awareness of the environment, using resources and organisation culture*	Enabled by human and physical *resources, reduces* vulnerability by motivation, enables adaptive capacity by *experience* and increases awareness by *knowing critical dependencies and function*
Leads to the development of sub-dimensions of adaptive capacity; *coping ability, flexibility and persistence*	Ensures ability to *cope and persist* and these enable *adaptive capacity*	Develops *coping ability* and *flexibility* to ensure business continuity	Ensures ability to *cope*

Table 2-4 shows that across the conceptualization organisation resilience is perceived as a capability. Furthermore, organisational resilience aims to reduce vulnerability by responding to and preparing for disruptions. These are enabled by utlising organisational processes and resources to increase awareness required to adapt by responding to and preparing for disruptions to ensure vulnerability reduction, the definition of organisational resilience in this research is;

“The capability of an organisation to respond to and prepare for disruption”

2.7 Dimension of Organisational Resilience

From summary of definitions captured in section 2.6.5 the main dimension of organisational resilience is adaptive capacity. Capabilities under adaptive capacity within organisational resilience are coping ability, persistence and flexibility.

2.7.1 Adaptive Capacity

Adaptive capacity is a measure of the culture and dynamics of an organization that allow it to make decisions in a timely and appropriate manner (McManus *et al.*, 2008). Adaptive capacity within organisations promotes learning, flexibility to adopt novel solutions and develop general responses to a wide range of challenges (example combine experiences and knowledge and respond to changing drivers) (Burnard & Bhamra, 2011a).

Three essential factors that shape adaptive capacity are cultural, political and economic factors. Folke *et al*. (2010) identified four dimensions of adaptive capacity; learning to live with uncertainty, nurturing diversity for reorganisation and renewal, combining different types of knowledge for learning and creating opportunities for self-organisation.

The driving force of adaptive capacity is consciousness (Knight, 1921) or situational awareness (Seville *et al*., 2006). Consciousness in organisation resilience literature is presented as situational awareness. Consciousness is a person's awareness about something (Solms, 1997). Its' role is to give the organism the 'knowledge' (learning from past) of the future (forward looking). Unlike humans, animals reacts to situations before they materialise (Knight, 1921). As humans, we perceive the world before we react (Knight, 1921). Similarly, situational awareness is defined as a measure of an organization's understanding and perception of its entire operating environment (McManus *et al.*, 2008). The level of awareness of the organisation influences differently the strategies employed (Oloufa, Ikeda & Oda, 2003). Thus, entities or systems with high level of awareness withstand and manage disruptions better because awareness reduces the sensitivity (Smit & Wandel, 2006). The sensitivity reduction in turn reduces vulnerability despite the exposure (Gallopín, 2006). For example, this can be seen in the risk management approaches employed to identify and manage potential threats (hence, reducing vulnerability). The bounce-back, hardened nature and relatively stable environment of organisational resilience makes situational awareness very crucial to its success. This is because most measures employed to ensure readiness, response and recovery through adaptive capacity are influenced by situational awareness.

2.7.1.1 Coping Ability

This capability to manage and deal with stress caused by disruptions has varied definitions in organisational resilience literature. For example, Vogus & Sutcliffe (2007) define coping ability as an ability to adjust to unwelcome change or disruptions. Smit & Wandel (2006) on the other hand define coping ability as an adaptive capacity. Despite the inconsistency in defining this ability to cope, common dimensions, sub-dimensions, antecedents and consequence inferred from literature exist.

Two major domains of coping ability deduced are; psychological and structural. Psychological is enabled by relationship and driven by trust and learning (example; McManus, 2008; Seville *et al*., 2006) whereas structural is enabled by resources and procedures. Trust is the primary antecedent driver for constructing meaning and making challenging choices in difficult situations (Seville *et al*., 2006). Also, learning is the fundamental antecedent to resilience in organisations because organisations perceive that they do not know enough and thus, have a continual learning approach (Vogus & Sutcliffe, 2007).

More importantly, the cognitive, emotional and relational sub-dimensions of the psychological dimension are identified to be organisational culture influenced. For instance, this cognitive sub-dimension is identified as a cohesive sense of the company's beliefs and values. The company values influence these daily behaviours and lead to desirable behaviours like creativity, decisiveness despite uncertainty and conceptualising of appropriate solutions (Lengnick-Hall, Beck & Lengnick-Hall, 2011). Also, the relational sub-dimension is developed amongst the team by enabling more social functions and having more social areas within the organisation to prevent transactional relationship. This main significance of the relational sub-dimension is to ensure the organisational culture and aim is maintained amongst the team and evident in decisions whilst coping to promote communal continual attaining of organisation set goals during disruptions.

Furthermore, for structural coping, the contingencies and ad-hoc problem solving networks sub-dimensions amplifies organisation competence by increasing available alternatives to problem resolution and allow problems to be directed towards experts in the organisations respectively (Sutcliffe & Vogus, 2003). For the slack resources, the permanent nature of these organisations provides the opportunity to tap into additional resources in order to cope with broader interruptions when required. Also, the social capital and relationship development nature of these organisations enable them tap into their networks during disruptions for required assistance and insight (McManus, 2008).

Coping ability identified in organisational resilience literature leads to increasing awareness, reducing vulnerability and increasing adaptive capacity and hence business continuity for the organisation. Business continuity is the uninterrupted availability of key business resources during disruption periods in order to return the organisation to the state before the disruption or a better state (Burnard, 2013).

2.7.1.2 Flexibility

This is a capability which manages disruption by allowing change but making sure that the ultimate aim is maintained. That is, it provides an ability to adjust to change and promotes renewal, re-organisation and development (Starr, Newfrock & Delurey, 2003). Flexibility enables disruption management by focussing and building on the positive strengths of the organisation and uses it for the benefit when managing disruptions (Rice & Sheffi, 2005). In defining this ability, common dimensions, sub-dimensions, antecedents and consequence exist. For instance the two major antecedents of flexibility are accommodation and adaptation. Accommodation is defined as the capacity to withstand disruption by containing. Adaptation is the ability of a system to adjust to change, moderate potential damages and take advantage of opportunities.

Accommodation is enabled by clear roles and responsibilities, contingencies and communication and collaboration. Clear roles and responsibility identified creates the authority required for individuals to take accommodative initiatives and promote taking decisions to resolve issues. McManus (2008) explained the significance of clear roles and responsibility as drivers for strategic orientation in that, it creates the awareness required for re-orientation. Furthermore, resourcing and contingencies also enable flexibility by allowing for unforeseen to be catered for. This intends reduces the vulnerability of the organisation and also aid strategic re-orientation (Sutcliffe & Vogus, 2003). Also, communication and collaboration creates the awareness required to increase adaptive capacity and this enables flexibility (McManus, 2008).

Adaptation on the other hand is enabled through training and learning to develop the capabilities required to manage a disruption. Training courses such as leadership management, exercises and knowledge sharing are identified to provide the understanding required to aid the flexibility so as to reduce vulnerability, increase awareness and increase adaptive capacity (McManus, 2008). This is continually promoted through the feedback process and re-training as a result of building on comments with the utmost aim to ensure business continuity amidst disruptions.

2.7.1.3 Persistence

Persistence is the act of continuing despite difficult situations (Burnard, 2013). Also, persistence is due to the functional capacity of the system to withstand and dynamically reinvent strategies as system encounters disruptions (Janssen *et al*., 2006). Based on these two conceptualisations of persistence, it can be defined as the ability to continue despite difficult situations through withstanding and dynamically reinventing strategies.

Enablers of persistence include striving, persevering and reinventing. Burnard, Bhamra & Young (2012) identify that these are promoted by continual preparation and readiness, and motivation. Striving here is defined as the effort to overcome disruption in order to achieve set goal. Perseverance on the other hand is the ability to complete objective despite difficulty in overcoming disruption and reinventing is the ability to transform the process of attaining a goal due to disruption but maintaining the ultimate goal (Burnard, Bhamra & Young, 2012). Similar to coping ability, persistence is influenced by the level of sensitivity and exposure of the organisation to the disruption.

Therefore, the level of development of persistence is influenced by the trained sensitivity and exposure of the organisation to a disruption. For instance, persistence is identified through the promotion of innovation and utilisation of experience (Bhamra, Dani & Burnard, 2011). Also motivation through incentivising by the leaders is identified to aid persevering and reinventing within the organisation (Burnard, Bhamra & Young, 2012). This is maintained through collective focus in order to meet the objective of the organisation (Burnard, 2013).

2.8 Antecedents of Organisational Resilience

Common antecedents to the dimensions of organisational resilience are incentives, future learning, redundancy, and training. The stable structures available within the organisations enable the efficient employment of these antecedents (Burnard, 2013). These antecedents in themselves enable the development of more than one dimension of resilience.

2.8.1 Incentives

Incentives are measures put in place to motivate in order to achieve an expected outcome (Vogus & Sutcliffe, 2007). Within organisations, incentives are put in place to motivate workers to develop high capabilities so as to manage disruptions adequately (Bhamra *et al*. 2011). The incentives are to enhance the persistence of the system to disruptions. Here, incentives such as rewards and subsidies are put in place to motivate those who persist even when undergoing unwelcome change to attain the set goals (Seville *et al.*, 2006). This is however effective due to the stable and long term nature of these systems and also confirms that one incentive can be used to attain more than one dimension of resilience.

2.8.2 Future learning

Future learning is the process of capturing, developing, sharing and effectively using knowledge from colleagues to enhance knowledge (Burnard, 2013). This is a common antecedent used in organisations to develop dimensions such as persistence, coping ability and flexibility respectively (Vogus & Sutcliffe, 2007; Weick & Sutcliffe, 2001). This antecedent works effectively in stable systems where the longer the duration of managing knowledge, the more dimensions of resilience are developed.

2.8.3 Redundancy / Contingency

Redundancy is the inclusion of extra components or resources which may or may not be needed within a system (Vogus & Sutcliffe, 2007). Within organisations, redundancy is made possible due to the competitive and business continuity nature of organisations, it motivates them to commit more resources (for example; labour and materials) to gain competitive advantage (Hamel & Välikangas, 2003). The commitment of more resources ensures the redundancy required to attain stability (Giezen, 2013) in the face of disruption. This enables dimensions such as coping ability and flexibility.

2.8.4 Training

Training such as team building enables the collaboration from workers to attain a specific goal. Training also comprises ad-hoc solving networks and understanding established roles and responsibilities. It is a common antecedent within the organisational context and aids in developing the adaptive capacity of the organisation especially flexibility.

2.9 Consequences of Organisational Resilience- Vulnerability Reduction

From the working definition of organisational resilience; *the capability of an organisation to respond to and prepare for disruption,* the main consequence of organisational resilience identified here therefore is vulnerability reduction through increase adaptive capacity. Due to the sensitivity and exposure, vulnerability reduction in organisational resilience focusses on utilising capabilities revealed in adaptive capacity to minimise effect of disruption and its occurrence (Burnard, 2013).

For instance, the ability to cope utilises the established relationship within the organisation to reduce vulnerability (Trim & Lee, 2008). This established processes which aids coping (McManus, 2008) reduces the sensitivity and thus exposure. Furthermore, flexibility of the system enables it to move to another stable state within the same basin of attraction and thus reduces the organisations vulnerability. This is enabled by the communication, collaboration, clear roles and responsibility, contingency and training of the organisation (Bhamra, Dani & Burnard, 2011; McManus, 2008). Also, the continual preparation, innovation, experience and motivation which ensures persistence reduces the sensitivity and exposure (McManus, 2008; Seville *et al.*, 2006). This ability to continue despite difficult situations through withstanding and dynamically reinventing strategies reduces vulnerability also.

Vulnerability reduction is enabled by the manifestations of the capabilities which are seen in the organisation’s response. Response lead to learning to live with uncertainty, combining different types of knowledge for learning and creating opportunities for self-organisation (Seville *et al.*, 2006; McManus, 2008).

2.10 Conceptual challenges and the need for further research

Organisational resilience ensures vulnerability reduction similar to the consequence of disruption management approaches in projects (section 2.3). Also, the structural difference of these permanent organisations to projects (Lundin & Soderholm, 1995) challenges the potential to explore the antecedents or dimensions of organisational resilience in projects hence, the need for further research to identify how projects manage disruptions. Detail explanation of these challenges is presented in 2.10.1 and 2.10.2.

2.10.1 Discipline boundaries

Following the review of works on organisational resilience, most of the strategies that are to enhance the overall resiliency of the organisation will in project terms, only redefine an existing aspect of it, that is, risk management (example, McManus, 2008). For example, the concept of organisational resilience perceived as a response to disruption (manufacturing industry) (Burnard, 2013) has similarities in risk management processes in construction. These features of organisational resilience captured from the research include;

1. Invest time and effort in considering events to be focused on,
2. Develop unique solutions in addressing threats,
3. Make decisions within organisational values and beliefs,
4. Recognise limitations within operations, planning and responses,

In addition to the above, a more detailed synthesis of steps identified which are in line with 'the identifying' and 'response' risk stages within construction risk management stages are as follows; internal and external awareness in organisational resilience related to risk identification whilst escalation of response activities, the need to establish organisational linkages and event resolution (Burnard, 2013) relate to response.

Given the relationship between organisational resilience and risk management in projects, and the challenge of risk management identified in section 2.3.1, it will therefore be inappropriate to say that, since the strategies developed in other disciplines depicts risk management in the construction sector, then once a construction company has up to date risk management strategies, then it is resilient. This is because the ever drifting nature of project environment breeds uncertainties and challenges the risk identification, response and review processes. Also, current statistics in the industry show almost a quarter of projects fail due to failed risk management approach (KPMG, 2013, 2015), based on its inability to identify all threats and thus manage disruption. Hence these approaches in managing disruptions, are not enough and this has called for research in both academia (example Winch, 2014; Giezen, 2013) and the government (example Construction 2025, 2013) to meet this call.

In relation to developing capacity of the organisation through utilising capabilities, Burnard (2013) highlights aspects of Human Resource Management (HRM) such as innovation and future learning and these are in line with HRM within construction literature. However within construction, the focus on developing human resource capacities is to enable the execution of planned project works and are aligned in accordance with the overall business strategy and direction of the project but primarily influenced by the parent organisation (Huczynski & Buchanan, 2001; cited in Loosemore, Dainty, & Lingard, 2003). Thus, any other capability which is not required to execute that particular planned work in the project is not considered. Most of these again relate to the risk management stages within projects' specifically identifying, responding and reviewing risk. Therefore research to clearly identify how projects manage disruption is required.

2.10.2 Structural differences

Organisational resilience relies upon the permanent organisational processes, routines, resources (especially human), structures and practices which are developed over a period of time to endure and adjust during unexpected situations (Sutcliffe & Vogus, 2003). These are challenging in projects given the structural differences and the different discipline in which it is applied.

For instance, organisational resilience manages disruptions through utilising organisational procedures and mechanisms such as incentives, future training, contingency and training. These, within organisational terms ensure vulnerability reduction only because; it focuses more on bouncing back to organisational objectives, whereas within projects, this will be different, due to its drifting environment and complexity. As such, a conceptualization of resilience in projects is required to identify the exact antecedents.

2.11 Theoretical definition of resilience in projects

To conceptualise resilience in projects, a theoretical definition is first required. From the theory of resilience (section 2.5-2.9), resilience is a form of capability though manifested differently based on where it is employed. Also, resilience within projects is to ensure recovery through response, readiness and vulnerability reduction. Furthermore, the causes of disruption within projects are complexity and the drifting environment. Based on this synthesis, a theoretical definition of project resilience is;

the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity.

Using this definition, recovery is identified through conceptualising resilience in projects.

2.12 Preliminary Framework for resilience in projects

A preliminary framework comprising of antecedents, dimensions and consequences of current disruption management approaches in projects and organisational resilience is presented in Figure 2-9. This is to provide a theoretical lens to conceptualise resilience in projects.

2.12.1 Antecedents for disruption management in projects and organisational resilience

Common antecedents for both disruption management in projects and organisational resilience are the procedures which consist of risk, uncertainty and change management. However, these are employed differently given the structural differences. Also, in terms of developing capacity to manage disruptions, antecedents in organisational resilience are incentives, future learning and training however, these are not considered in disruption management approaches in projects. Hence, the preliminary framework provides a lens to identify clearly how projects manage disruption by not avoiding shock as it currently does, but manage disruption and the shock it brings to ensure recovery.

2.12.2 Dimensions of organisational resilience

The organisational procedures employed enable them adapt by coping, being flexible and persisting. Given that the exact evolution of these dimensions is not clear in projects due to the structural difference, a conceptualisation to identify the exact dimensions of resilience is required.

2.12.3 Consequences of project resilience

As discussed in section 2.4, the overall consequence of disruption management in projects should be recovery. However, the disruption management approaches and organisational resilience lead to vulnerability reduction in projects. Based on this limitation, further research is to be carried out to develop a framework for resilience in projects to ensure recovery.

This framework is required to comprise the antecedents, dimensions and consequence of resilience. Below in Figure 2-9 is a preliminary framework for resilience in projects which captures a synthesis of disruption management approaches in projects and organisational resilience. It reveals that, current approaches do not cover response and readiness which enables recovery in projects, therefore further research is required.

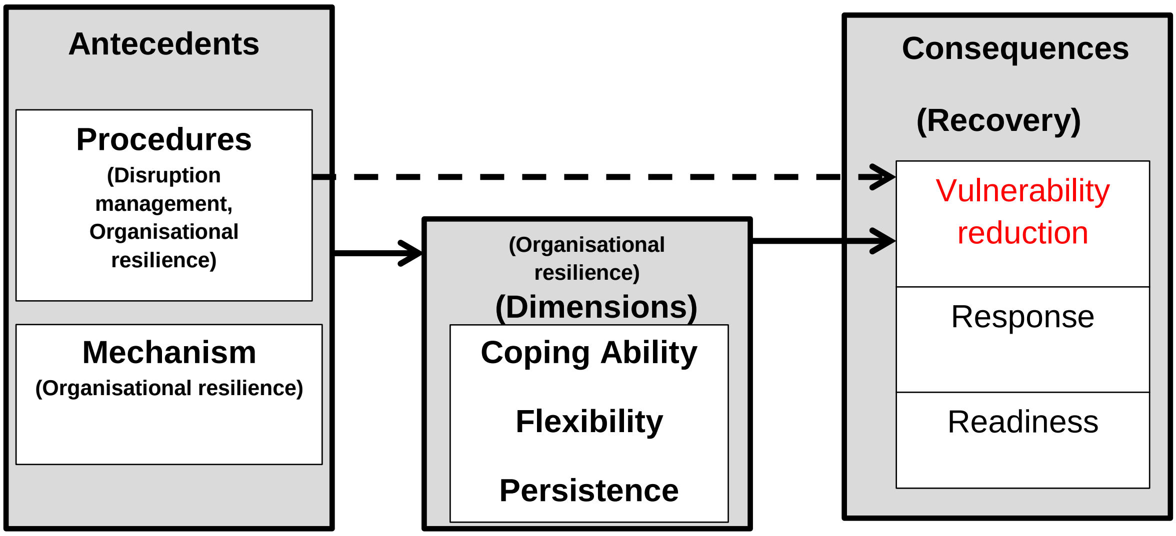


Figure 2-9 Preliminary Framework for resilience in projects

2.13 Chapter Summary

Disruptions in projects can cause shock, and increase the state of being harmed or transformed and thus, failure. The ability to effectively manage disruptions in projects is critical to its success. The management approaches seek to avoid shock and reduce vulnerabilities through predicting disruptions and employing procedures to manage unforeseen disruptions. This is carried out by managing the known and unknown sources of project complexity and drifting environment. These sources place the current approaches to managing disruptions into two groups. Under the known source, approaches such as risk and opportunity management are employed. Under the unknown sources, change, uncertainty and crisis management approaches are employed. These approaches do not wholly manage disruptions to ensure recovery, that is, they focus on vulnerability reduction with no focus on response and readiness. Therefore resilience, which ensures recovery is conceptualised to address these limitations.

Within the conceptualisation, this chapter presents the field dependent nature of resilience. It is identified that resilience evolves from two main foundations; engineering and ecological resilience. The engineering resilience foundation focuses on efficiency, predictability and constancy whilst the ecological resilience perspective implies a holistic focus, and emphasises on flexibility and dynamic and continual development of the system to sustain higher and better levels of functioning. Ecological resilience deals with situations where the current state, conditions, outcomes, extents or magnitude of circumstance is unpredictable and unmeasurable.

Following the identified field dependent and discipline specific nature of resilience, the notion of organisational resilience is reviewed and identified to be inappropriate for projects due to its vulnerability-reduction focus and the structural challenges it has with projects. Hence, the need to conceptualise resilience in projects in order to ensure recovery is required. The conceptualisation, which will provide definition, dimensions and antecedents, will clearly identify the factors (the dimensions) to consider and the indicators (antecedents) to focus on in order for projects to manage disruptions and ensure recovery. To attain this, the research method and data collection approach to be adopted is discussed in the next chapter (chapter 3).

3- Research Methodology and Methods

The aim of this chapter is to present and justify the research method adopted for this study. To do this, layers of the research onion by Saunders, Lewis, & Thornhill (2009) comprising research philosophy, approaches, strategies and data collection methods are reviewed to identify their strengths and weaknesses. Based on the reviewed layers of research onion, the suitable methods which respond to this research aims and objectives are selected. This follows Mckerchar (2008) where it is explained that, if a piece of research is to be meaningfully understood, and assessed by other researchers, the researcher must explicitly state the theoretical tradition and methodological criteria employed.

3.1 Research Philosophy

Research philosophy is the theory or a set of assumptions that direct how research is carried out (Reason & Rowan, 1981; Collis *et al*. 2003). A clear understanding of research philosophies enables the examination of how the world is viewed and thus, informs research methods and practices to be adopted. Saunders et al., (2012) explains research philosophies in two ways namely; ontology and epistemology. The ontological view focusses on the nature of reality whilst the epistemology focusses on acceptable knowledge in a field of study (Saunders et al., 2012; Mckerchar, 2008). Under the epistemological view, knowledge is either created through a positivist or interpretivist perspective. The positivist perspective, is employed when objectivity is sought in explaining the reality and the researcher is generally detached from the subjects under study. Data acquired by this perspective is based on deductive reasoning where the researcher follows a systematic process leading to the identification of causal relationship, drawing conclusions and making predictions (Mckerchar, 2008). The interpretivist perspective however, provides an understanding of reality based on subjectivity (inductive reasoning). The researcher in this case is attached to the subjects being studied.

3.2 Approaches to Research

3.2.1 Deduction

This approach to research moves from general ideas or theories to specific situations (Neville, 2007) and is sometimes referred to as the “top-down” approach. This approach reveals an outcome not previously likely from an examination of the empirical world (Eisenhardt & Graebner, 2007). As such, the employment of a positivist view is essential here to avoid the introduction of bias as a result of interference with subjects being studied (Tuuli, 2009). A theoretical proposition, prior to the study is however required and then, narrowed to a more specific hypothesis (theoretical proposition) which is tested by collecting observations to address the hypothesis (Neville, 2007). Figure 3-1 captures the deduction research process.

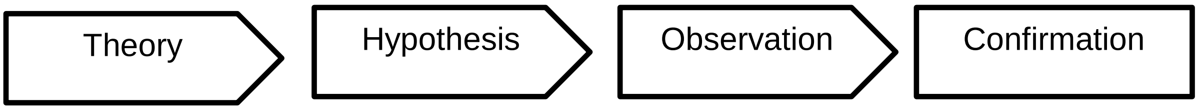


Figure 3-1 Deductive research process (Neville, 2007)

3.2.2 Induction

This is the opposite of deduction approach and also captured as interpretivist approach. It mainly uses qualitative data for the formulation of concepts or theories to explain the observations (Neville, 2007). It takes an outcome and constructs a model from it (Eisenhardt & Graebner, 2007). Inductive approach begins with specific observations and measures, begins to detect patterns, formulate hypothesis and then finally develop the theory as shown in the flow diagram in Figure 3-2 below;

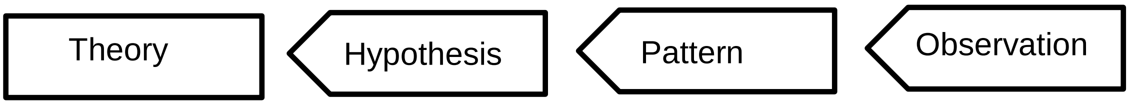


Figure 3-2 Inductive research process (Neville, 2007)

3.2.3 Abduction

Besides moving from theory to confirmation or observation to theory, an alternative is an abductive approach which is a combination of deductive and inductive approaches (Saunders *et al.,* 2012). Abductive approach mainly comprises the process of gaining insights to create new conceptual possibilities (Reichertz, 2007). There are a number of differences between deductive, inductive and abductive. These are grouped under logic, generalisation, use of data and theory and compared in Table 3-1.

Table 3-1 Comparing deduction, induction and abduction (Saunders *et al.,* 2012).

	Deduction	Induction	Abduction
Logic	When premises are true, the conclusion must also be true	Known premises are used to generate untested conclusions	Known premises are used to generate testable conclusions
Generalisation	From general to specific	From specific to general	From interactions between the specific and the general
Use of data	To evaluate propositions or hypotheses related to an existing theory	To explore a phenomenon, identify themes and patterns and create a conceptual framework	To explore a phenomenon, identify themes and patterns, locate these in a conceptual framework work and test this through subsequent data collection
Theory	Theory falsification or verification	Theory generation and building	Theory generalisation or modification; incorporating existing theory where appropriate, to build new theory or modify existing theory

From Table 3-1 logic presents the different reasoning across the three approaches whilst generalisation shows how data is deduced. The use of data compares how deduction, induction and abduction use data whilst theory compares the type of or use of theory emerging from each approach.

3.3 Research Strategies

The research philosophies and approaches discussed above influences the selection of research strategies. These strategies include case study, ethnography, grounded theory, action research and narrative research.

3.3.1 Case Study

A case-study systematically explores an in depth study of the target. It studies a whole by solely focusing on it, and making it a central object of study. Case studies are generally used when the investigator has little power over events, building theories and when conducting organisational and management studies (Yin, 1994). The mode of data collection with case studies can be collective in nature (that is, a group of researchers' collects data and share amongst themselves in order for researchers to extract required patterns of behavior for their individual study). The research methods employed under case study consist of archival data collection, observation and interviews. Further, one technique that can be used in case studies is the Critical Incident Technique (CIT) (Flanagan, 1954).

3.3.1.1 Critical Incident Technique (CIT)

This technique was originally developed in the 1950's in an Aviation Psychology Program in the US by John Flanagan and his colleagues. CIT enables direct observations of human activities or narration of experiences known as "incidents", generally distressing ones to be captured. An incident as defined by Flanagan (1954: 327), is "any observable human activity that is sufficiently complete in itself to permit inferences and predictions to be made about the person performing the act". The CIT technique has been employed in a number of fields with researchers validating this technique (example Butterfield *et al.,* 2005; Andersson & Nilsson, 1964). These researchers have since, confirmed the authenticity of this technique. Though CIT has also suffered dilution of the term, thus others refer to it as Critical Review Technique (CRT) and Critical Outcome Technique (COT) (example Mattson, 2000), the core tenets of the different labels of the concept have been identified to be the same.

3.3.2 Ethnography

Ethnography provides an insider's view of a society in order to understand how people see the world and it is said to provide a more accurate representation of a study (Taylor, 2001). This is a culture-focussed approach and lasts over a long period of time. Under ethnography, data collection methods include observations, focus groups and in depth interviews employed over a long period of time to identify what is actually being done (Creswell, 1994). Observations, focus groups and in depth interviews employed attempt to interpret the findings from a cultural view point and concerned with the development of grounded theory (Mckerchar, 2008). The limitation for the application of theories developed here is its generalisation to other cultures.

3.3.3 Grounded theory

Grounded theory focusses on developing a theory (Creswell, 1994). It is carried out by interviewing participants on the general or abstract theory of a situation (Saunders, Lewis & Thornhill, 2009). A systematic examination of the event under study leads to the theory (Shannak & Aldhmour, 2009). This is through an iterative process between the data and findings. The challenge for a researcher in building a theory is to remain open-minded to listen to and hear what is being said and to interpret it as honestly as possible, always checking and rechecking for other possible interpretations (Creswell, 1994).

3.3.4 Action research

The focus of action research is to systematically monitor and evaluate issues in order to identify and justify any causal relationship (Saunders, Lewis & Thornhill, 2009). A close collaboration between the researcher and the research participants to enable theory and practice to be combined is required. Also, agreement and commitment are central issues of concern because action research seeks to bring about a conscious change within a partially controlled environment (Collis *et al.*, 2003). Action research involves two objectives; solve a problem and contribute to research.

3.3.5 Narrative research

Narrative research involves analyzing, categorising and interpreting materials generally based on retold stories from experiences. It focusses on gaining meanings from the shared experiences and provides new fields of inquiry and solutions to recurrent problems (Squire *et al.,* 2014). Narrative research also enables establishing links such as applying research to policies (Squire *et al.,* 2014). Data collected here is mainly by written account or an in depth interview (Mckerchar, 2008).

3.3.6 Experimental

The experimental approach has two types which differ in relation to the control level the researcher has in determining group criteria of the subjects. A review of these two types of experiments reveal that quasi-experiments achieve higher validity (Fellows & Liu, 2008). The two types of experimental are either true or quasi (Davies, 2007). True experiments are where all important factors that affect the study are controlled. In cases where this is not attainable, quasi is implemented (Davies, 2007).

3.3.7 Survey

Survey on the other hand is when large number of respondents are required within a limited time (Naoum, 2013). It consists of the descriptive survey and the analytical survey. These deal with counting the number of respondents with similar opinions and establishing the association between objects of the questionnaire with the help of correlations (Creswell, 1994). The survey approach is however critiqued to be subject to three main flaws; uncertain aim of the researcher, poor validity measures and poor external validity when biased samples are employed (Tuuli, 2009) due to the large numbers.

3.4 Data Collection Methods

The research strategies discussed above influences the data collection method selected. These methods include interviews, observations, archival analysis, focus group and questionnaire. The nature of the use of data acquired from these methods can be quantitative, qualitative or mixed method. Interviews, observations, archival analysis and focus group are generally classed under qualitative research (Saunders *et al.,* 2012) this is because data acquired is in the form of words whereas questionnaire surveys are classed under quantitative research because data is generally converted to numerical values to address questions that hypothesise relationships amongst variables.

In other cases, the mixed method, which is a combination of qualitative and quantitative, is employed.

3.4.1 Interviews

Interviews are an interactional event which ask respondents to reveal, describe and report on their internal or external world as they perceive it (Fellows & Liu, 2008). These are structured, semi-structured or unstructured interviews. The structured interview, reflects on preconceived theories and as such has little scope for probing the responses and supplementary questions (Fellows & Liu, 2008). These are quick to answer and require specific participants to respond as such little focus on depth of questions is required (Gill *et al.,* 2008). Unstructured interviews on the other hand are based on minimal preconceived theories and are not as organized as the structured interviews (Gill *et al.,* 2008). It may start with questions to share experience on doing an activity. For example, can you share your experience on working at a university? Unstructured interviews last longer than structured due to the lack of control on responses to be acquired. It provides more scope for responses without any interruptions or limitations (Fellows & Liu, 2008). The semi-structured interview is a combination of both structured and unstructured (Green *et al*., 2010). It consists of questions to define area of exploration and enables the interviewer to direct questions to specific areas of interest (Green *et al*., 2010).

3.4.2 Observations

Observation is "the systematic description of events, behaviours, and artefacts in the social setting for a study" (Marshall & Rossman, 1989, p.79). Observations provide the context for developing sampling guides and interview guidelines (Dewalt & Dewalt, 2002). It enables the identification of non-verbal expressions, identifies how subjects interact amongst themselves and also the identification of time duration for different activities (Marshall & Rossman, 1989). Observations provide a holistic view of the subject under study and minimises subjectivity in analysing data (Dewalt & Dewalt, 2002). The main caution for observation is for the observer to avoid intervening or interfering with subjects or situations being observed (Merriam, 1998).

3.4.3 Archival analysis

Archival analysis is the collection of documents and textual material about the entity or subject being studied (Ventresca & Mohr, 2001). It entails past (historical) or non-historical information which have or are influencing the current activities of the entity being studied and helps answer research questions (Green *et al.,* 2010). It seeks to gain insights through a systematic interrogation of the documents or text being studied (Ventresca & Mohr, 2001). Archival analysis in certain studies is used together with observations and interviews and informs data acquired from the other method. Archival analysis is recommended for studies that focus on conceptualisations of theories (Green *et al.,* 2010).

3.4.4 Focus Group

Focus group is 'an informal discussion among selected individuals about specific topics' (Beck*et al*. 1986: 73). The discussion is guided, monitored and recorded by the facilitator (Gill *et al.,* 2008). Focus groups enable information to be generated and collective views acquired. Also, this collective approach helps generate rich information from the understanding, experiences and belief's acquired with the help of the diverse participants generally involved (Gill *et al.,* 2008). Generally a minimum of three participants are advised within a focus group in order to avoid limited discussions from occurring (McLafferty, 2004). In analysing results of focus groups, Creswell (1994) advices that words should be focused on and not numbers (percentage representation).

3.4.5 Questionnaire Surveys

Questionnaire surveys are in the form of standardised questions designed and administered to measure a preferred attribute of a sample taken from a population (Fellows & Liu, 2008). It is made up of direct and indirect questions and it is employed when there is a clear focus of study and the researcher has clearly defined the variables of study (Bryman & Bell, 2015). Similar to interviews, questionnaires are prepared in the structured and non-structured form. The structured and non-structured interviews are either open-ended or close ended surveys (Bryman, 2015). Open ended surveys provide the respondents opportunity to include answers that seem to be appropriate whereas close ended questions do not (Bryman & Bell, 2015).

3.5 Classification of Data Collection Methods

The methods discussed in section 3.4 are classified as either qualitative or quantitative research.

3.5.1 Quantitative Research

Creswell (1994: 2) defines quantitative research as "*an inquiry into a problem, based on testing a hypothesis or a theory composed of variables, measured with numbers and analysed with statistical procedures, in order to determine whether the hypothesis or the theory holds true*". Quantitative research employs an objective approach and mainly theory driven, however the objective here is not to build a theory but rather to test it (deductive) (Naoum, 2013). Two research strategies are common to quantitative research and these are experimental and survey.

3.5.2 Qualitative Research

Qualitative research provides a systematic approach for exploring and gaining knowledge on individual's perspective about certain phenomena (Saunders *et al.,* 2012). It can be used to explore areas where both variables and theoretical foundations are unclear or unknown (Mckerchar, 2008). The nature of qualitative research follows an inductive approach and is generally exploratory in nature (Creswell, 2003). Qualitative research is exploratory due to diagnosing a situation, screening alternatives and discovering new ideas. Qualitative research typically involves collecting data from participants in a non-numerical form. Within qualitative research, a number of strategies and multi-methods exist, namely; case study, ethnography, grounded theory, action research and narrative research.

3.5.3 Mixed Method

This is a combination of methods. Since each method has its strengths and weaknesses, this combination is argued by some authors as complementary (that is, inform, validate or compensate each other) (Mckerchar, 2008). This method may help fill a void but it may not necessarily be better than either qualitative or quantitative only. However, authors such as Yin (2013), argue that, mixed method research allows richer questions to be addressed and investigated. The basic motive behind the mixed method approach is to develop knowledge and better understanding that involves a wider range of interests and perspectives.

Mixed method approach has some challenges also. Some of which include the loss of detail or flexibility that occurs when qualitative data are quantified. Quantifying qualitative data within the mixed method converts them to fixed and one-dimensional data and mainly changes the multi-dimensional meaning and therefore loses its value. Recommendations to mixed method researchers who quantify qualitative data include avoiding focusing on the quantitative dataset to the exclusion of the original qualitative data to avoid this problem (Driscoll *et al.,* 2007). Following the research methods discussed above, a graphical representation of the relationship within these is captured within Figure 3-3.

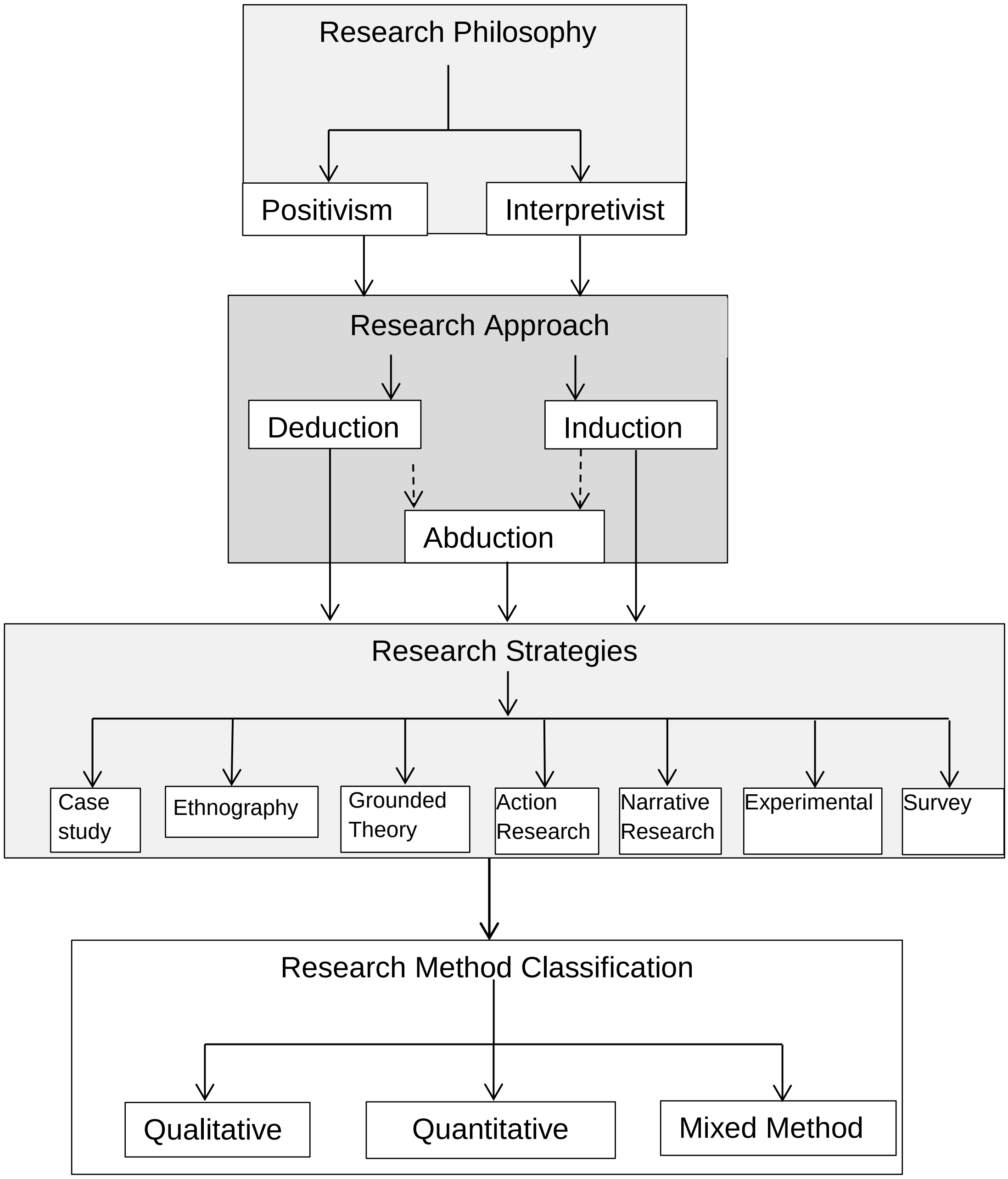


Figure 3-3 Graphical relationship between research Paradigms, Approaches and Methods

3.6 Sampling

Following the above research philosophies, approaches, strategies and methods, sampling is very critical in drawing a representative from the population as a study of the whole population is impractical. Sampling provides a practical means of collection and processing data such that, the sample chosen provides a good representation of the population (Fellows & Liu, 2008). The types of sampling are random and non-random. Random sampling focusses on selecting participants at no specific order, normally employed where the sample is very large (Fellows & Liu, 2008). Non-random sampling on the other hand is used when the sample is not relatively large. This comprise systematic, stratified, cluster, convenience and snow ball sampling (Fellows & Liu, 2008).

Systematic sampling, samples by focusing on every xth number of the population, where x is the interval between them and it is kept constant. Stratified sampling on the other hand is employed in cases where the population occurs in separate groups. Also, cluster sampling is used in situations where populations are divided into groups. With cluster sampling, the total sample is the total members of the clusters (Marshall, 1996). Furthermore, convenience sampling is used in cases when the nature of the research question(s) and the population do not make explicit any particular form of sample hence, the researcher collects data from an easily accessible sample. Finally the snowball is used when the data sought is difficult to access because individual sources of data cannot be readily identified. With the snowball, the researcher may identify a very small number of sources (respondents) and after collecting the data from each one, asks the respondents to identify another potential respondent thereby progressively building a sufficient sample (Fellows & Liu, 2008).

3.6.1 Sampling for Quantitative & Quantitative research

The common approaches used in quantitative researches is the random, or probability sampling (Marshall, 1996). This is further broken down as the stratified and area sampling which enable subgroups to be studied in detail. In random sampling, the nature of the population is defined and all members have equal chance of selection. The sample size, which is generally large, is selected based on the optimum number required to enable a valid deduction about the population to be made (Fellows & Liu, 2008).

The sampling method generally employed for qualitative research is non-random sampling method, due to the relatively small sample size of the population.

3.7 Data Analysis

3.7.1 Quantitative analysis

Quantitative analysis is generally complex in nature. There are two main types of quantitative analysis; descriptive (a statistical analysis dealing with one variable) and inferential (those used to find links between two or more variables) (Naoum, 2013). Descriptive method of analysis, consists of measurement of central tendency, the normal curve and the frequency of distribution whilst inferential statistical method of analysis, includes t-test, chi-square test, Spearman 'rho' ranking correlation and the product-moment correlation coefficient (Gelo *et al.,* 2008; Naoum, 2013). Results of these are graphically represented using various software and technological tools.

3.7.2 Qualitative analysis

The goal of qualitative analysis is to define and identify themes during the process study. These themes are deduced from the responses of open ended questions asked during the study. These themes are either inductive (those that are determined based on the data collected; when the researcher has no idea about how the study is going) or deductive (those that are predefined; the researcher has a fair idea of the work carried out based on a preliminary study) (Davies, 2007).

Data analysis for qualitative research requires in depth preparation because it is time consuming and requires great skill. Information acquired from the data collection and literature are discussed, observations made and conclusions arrived at (Yin, 1994).

3.8 Research Plan for this Study

This section justifies the selection of the research methodology for the study as summarised in Figure 3-8. The aim of this research is to develop a framework to conceptualise resilience in projects. Due to the ambiguity and diversity of the notion of resilience identified within chapter 2, this research avoids using the term 'resilience' in seeking experts' knowledge.

Resilience has been identified to manifest when planned works or programmes are disrupted (example McManus, 2008). Hence, this research focusses on critical incidents and identifies how they are managed within projects. Critical incidents are unexpected occurrence which is outside the planned works and causes distress (Flanagan, 1954). This is to enable antecedents and dimensions of resilience within projects to be extracted with less biasness, ambiguity and misconception introduced in the results. The unit of analysis therefore for this research is the project and the sub-unit of analysis is critical incidents.

Based on the discussion of research methodology and the influences of research design in the previous section, answers to the following four questions provided a clear research plan for this study.

(a) Which research philosophy was employed and why?

This research followed the interpretivist perspective to enable the conceptualisation of resilience. This is because, interpretivist provides an understanding of reality based on subjectivity (inductive reasoning) given that, multiple realities of resilience concept exist. Again, the interpretivist view was employed because of the complexity of the resilience construct. A true conceptualisation of the construct can only be captured if the researcher is attached to the subjects being studied which interpretivist permits.

(b) Which approach was adopted and why?

An abductive approach was employed within this research. This is because abduction helps gain insights to create the conceptualisation. Also, since the results attained from this research are to challenge disruption management approaches, abduction affords this theory building process. The final deliverable for this study is a framework which conceptualises resilience in project. As such, abductive approach enabled themes to be identified together with patterns in order to facilitate the development and testing of this framework (Saunders, Lewis & Thornhill, 2012).

(c) Which research strategy was employed and why?

The interpretivist and abductive approaches proposed for this research favours a qualitative approach. Under qualitative approach, a case study method employing critical incident technique was used. Case studies comprising observations, archival analysis and semi-structured interviews were employed to address the aim of the study.

(i) Observation

Observations within the case study focussed on a critical incident and its evolution within the project. These observations were carried out on each project and synthesised with information from archival analysis and responses from the interview to gain findings.

(ii) Archival Analysis

Archival analysis of information about the project and relating to the critical incident and how it was managed, focussing on measures put in place, were carried out. Both observations and archival analysis did better inform the researcher during the interview process. Hence, these two compositions of the case study were carried out before interview took place.

(iii) Semi-structured Interviews

This research employed semi-structured interviews where prepared questions together with some probing questions were asked.

(d) Which sampling method was employed and why?

Non-random sampling method was employed. At the project-selection stage of the case-study, the stratified sampling method was employed to select the projects to study. Following this, the easily accessible projects within each of these classes (example, building, civil engineering or engineering construction) were selected thus, employing convenience sampling technique. At the interview level within the projects, the snowball sampling method was used to gain access to all the lead personnel on the project. Lead personnel (example lead architect, quantity surveyor, structural engineer, project manager, and contractor) were targeted because, they are likely to have information about critical incidents on the project. Snowball sampling method was used at the leader-target-level in order to gain valuable experiences on how disruption had been managed on the particular project.

3.9 Relating Approaches and Strategies to Research Objectives

Following the research plan for this study, a link between the selected research plan and the objectives of this study is outlined in this section. Across the research objectives, an abductive approach which is a combination of deductive and inductive was employed.

For instance, in defining resilience in projects, critical literature review was carried out to sieve out the definitions and dimensions of the notion in other fields in order to identify its similitude and provide a lens and thus inform the question required within the case-study to identify dimensions, antecedents and consequences of resilience. Furthermore, to identify the dimensions of resilience, a case study approach comprising archival analysis, observations and interviews was employed. Archival analysis was carried out to provide a better understanding on information acquired from observations and semi-structured interviews. Also, an inductive approach comprising observations on each project and semi-structured interviews on critical incidents with key project personnel who work on each project was also carried out. Since these experts have varying experiences, providing them with questions that have restricted answers would have reduced the amount and depth of information being sought. This is because, in depth information is required to identify the dimensions (capabilities) required to manage disruption. The common capabilities identified across case studies were then compared with existing disruption management approaches in projects.

Following the identification of the capabilities, antecedents and consequences of the capabilities were identified from archival analysis, observations and semi-structured interviews. Findings from the cross-case analysis and literature were used in developing a framework to conceptualise resilience within the projects. The developed framework was validated using focus groups.

3.10 Data Collection and Handling Procedures

The aim of data collection stage was to identify capabilities, antecedents and their impacts during or after critical incidents. As such, the Critical Incident Technique (CIT) was employed to collect data within the case studies. This section discusses and justifies the data collection and handling process employed in the study.

3.10.1 Critical Incident Technique (CIT)

The data collection and handling procedures employed in the research followed Flanagan (1954) who captures CIT under five main headings. The five headings are; general aims, plans and specification, data collection, analysis of data and, interpreting and reporting data.

3.10.1.1 General aim, plans and specifications

The aim for using CIT was to acquire information and shared experiences from leaders and managers in the particular project in relation to critical incidents and how these were managed. This was to acquire information on capabilities manifested in the project from shared experiences in order to conceptualise resilience in projects. Leaders and managers were targeted because they are the responsibility takers and decision makers and thus, drive the projects. Also, the leaders and managers are assumed to know the measures employed to manage disruptions holistically and thus, are able to explain it with little or no ambiguity.

In relation to the plans and specification for the study, this research studies critical incidents which can be defined as unexpected occurrence which is outside the planned works and causes distress. This is because critical incidents provide the areas of focus in order to ask exact questions about disruptions and how it is managed to gain understanding of the measures put in place and compare with current approaches to managing disruption. This is to provide knowledge on the actuality of how projects recover from disruptions. In order to place information acquired from in chapter 2 and findings from the case study into better perspective, the researcher was the observer and collected data on experiences of managing/dealing with critical incidents.

3.10.1.2 Selecting the cases

Following the employment of a case study approach (as highlighted in section 3.8), three case studies comprising a building, civil engineering and engineering construction projects were selected. Projects that met all the criteria below were selected and studied. These criteria were outlined following Meyer (2001) recommendation on selecting case studies which highlighted that cases should be a representation of the sample and therefore, define the generalisation of results. The criteria were as follows, the case study should be;

1. A Construction project,
2. One of the following; a building, civil or engineering construction project,
3. A complex project and a representation of a typical project,
4. Located in England,
5. A project that allows free access to documents, meetings, offices and team members,
6. One that has encountered a make or break event.

A construction project defined as a Temporary Multidisciplinary Organisation (TMO) which consists of diverse skilled people and or resources working together on a complex or unique endeavour in a competitive and uncertain environment over a limited period of time after which they disperse to their parent organisation upon completion (Stringer, 1967) was the focus. This is because this research seeks to conceptualise resilience within the project context in order to identify the dimensions, antecedents and consequences. Given that construction projects are classified either as building, engineering construction and civil engineering projects (Office of National Statistics, 2007) one of each type of project is required. Also, since these embody important contrasts; such as, the endeavour being carried out and the contractual agreements, a comparison amongst these case studies will enable common capabilities manifested across these to be identified and thus labelled as dimensions of resilience whilst the enablers of these dimensions labelled as antecedents to resilience. Also, since a conceptualisation is required, a complex project of each of these classifications of projects is targeted to source expert's knowledge in this comparative study. Following this, there were a number of complex projects within each classification hence; complex projects that were easily accessible were selected. This led to having one project in each category. Complex project was targeted because they require extra management processes such as planning and monitoring (Wood & Ashton, 2009) and thus provide a worst case scenario with increase potential for disruptions.

Findings from the case studies were targeted to be used across England thus, one project each, from the northern, southern and central parts of England was selected. This was also to gain a vast range of critical incident experience given that different geographical locations affects how works are executed (Flyvbjerg *et al.,* 2004). Also, case studies that allow free access to documents, meetings, offices and team members were studied. In order to attain this level of access, directors on the project were targeted to gain access into the project. This is because directors are usually the gate keepers in projects and if their approval was obtained access to the project becomes easier. Most importantly, projects that are or had experience with make or break events or critical incidents were the targets. Critical incident was therefore being used as a proxy for examining resilience, its dimensions, and antecedents. The unit of analysis therefore for this research is the project and the sub-unit of analysis is critical incident.

(I) Crafting instruments and protocols

General information on project such as, key deliverables, key drivers and specifically information on critical incidents and how they are managed within the project context were sought to enable the conceptualisation of resilience with less bias, ambiguity and misconception introduced in the results. Data was collected by observing the actual manifestation of the incident and interviewing (semi-structured) people to recall their critical incident experiences. It was essential that recent events were focussed on to ensure that incidents are true representatives of real happenings (Flanagan, 1954). The case study protocol adapted is the template proposed by Brereton & Kitchenham (2008). In Table 3-2 below, a mapping Table capturing the objectives of this study and the methods to be employed in addressing these objectives are outlined.

Table 3-2 Mapping of Research Focus (Questions, Aim and Objectives) to Data Collection and Analyses Techniques

Overall Aim: *To develop a framework to conceptualise resilience in projects*

Problem/Issue/ Rationale	Research Questions	Aim	Research Objectives	Data/Information Required to Address Objective or Question	Source(s) of Data/information	Research Method(s) for Data Collection	Data Analyses Techniques
-The current definition and dimensions of the notion of resilience is ambiguous and unclear and little/ no work of what resilience means in project is done.	What is resilience in projects?	*To develop a framework to conceptualise resilience in projects*	Identify the theoretical definitions and dimensions of resilience in projects	+Literature on resilience in various disciplines. + Literature on the Definition, Dimensions, Antecedents and Consequences of Organisational Resilience +Manifestations of critical incidents on project and its dimensions	-Journal papers and reports -Conference Proceedings -Books -Documented Case studies -Press releases -Project Documentations -Project events -Experience of lead personnel on project	-Systematic and critical review of literature -Case study	Information from Literature reviewed is synthesised by highlighting key words and identifying commonalities and critical points within the definitions, dimensions, antecedents and consequence to have a working foci of what organisational resilience means. This foci (capability) is used to analyse data from case study using Nvivo 10 -Data from case study is analysed by focussing on the 'what' the capabilities are -Analysis is by triangulating information from observation, document analysis and interviews. -Observation, document analysis together with interview material which are recorded, digitised, transcribed verbatim are analysed using qualitative data analysis software NVivo10 to analyse; - Within-Case Analysis -Cross-Case Analysis
-The characteristic difference in the notion of organisational resilience challenges its employment in projects	What are the antecedents of resilience in projects?		Identify antecedents of resilience in projects	+Project Information; -Definition of the project -Key deliverables -Project Priorities -Key Drivers -Project Risk/Opportunity/ Uncertainty -Evolution of project -Measures incorporated in project to manage it to time, cost and quality + Critical incidents; -Critical incidents that have occurred on the project -Measures used to resolve it	-Project Definition Documentation -Contract Documents -Minutes from meeting -Email correspondence -Extranet for project -Meeting/ Workshops -Live Project -Experience of lead personnel on Project	Case study	-Data from case study is analysed by focussing on the 'how' the capabilities are enabled -Analysis is by triangulating information from observation, document analysis and interviews. -Observation, document analysis together with interview material which are recorded, digitised, transcribed verbatim are analysed using qualitative data analysis software NVivo10 to analyse; - Within-Case Analysis -Cross-Case Analysis
The lack of literature on resilience in projects makes its exact consequence unclear	What are the consequences of resilience in projects?		Identify the consequences of resilience in projects	-Project Information + critical incidents; -Impact of critical incidents on the project -Impact of the measures used in overcoming change on the project	-Minutes from meeting -Email correspondence -Extranet for project -Meeting/ Workshops -Live Project -Experience of lead personnel on Project	Case study	-Data from case study is analysed by focussing on the 'the effect' of the capabilities -Analysis is by triangulating information from observation, document analysis and interviews. -Observation, document analysis together with interview material which are recorded, digitised, transcribed verbatim are analysed using qualitative data analysis software NVivo10 to analyse; - Within-Case Analysis -Cross-Case Analysis
-There is currently no clear understanding of resilience and how it manages disruptions in projects	*How is resilience revealed in projects?*		Develop and validate a framework for resilience in projects.	+ Synthesis of all information above; -Definition and Dimension of resilience in projects -Antecedents of resilience in projects -Consequences of resilience in projects	- Data from objectives 1,2 and 3	Systematic and critical review of literature and Case Study	Conclusion from discussed data from Cross-Case Analysis and literature

(II) Entering the field

The case studies commenced with archival data analysis and observations which continued till the end of the case studies. When enough rapport was established with key project participants and good understanding of the project and key issues identified through archival analysis and observations, interviews were conducted. As shown in Table 3-2 above, the case study approach was employed to collect information on critical incidents. This allowed for a cross comparison of evidence.

Included in the case study protocol, is the interview protocol (Appendix D) which enabled shared experiences from the managerial level to be acquired. The interview protocol comprised of three main sections which captured; 1) personal details, 2) project detail and 3) critical incidents experience on the project. A pilot interview was carried out with three project managers in England but not members of the cases studied in order to gain an independent view on the interview protocol.

i) Personal detail

The personal details covered professional information about the respondent in order to inform the researcher during the analysis stage and aid in placing responses in a better perspective (that is, based on their experiences).

ii) Project detail

The project detail focusses on project information in order to place the critical incidents into better perspective and thus compare findings. These include key issues/ deliverables on the project. This enabled the objectives such as identifying antecedents and dimensions to be met.

iii) Critical incident experience

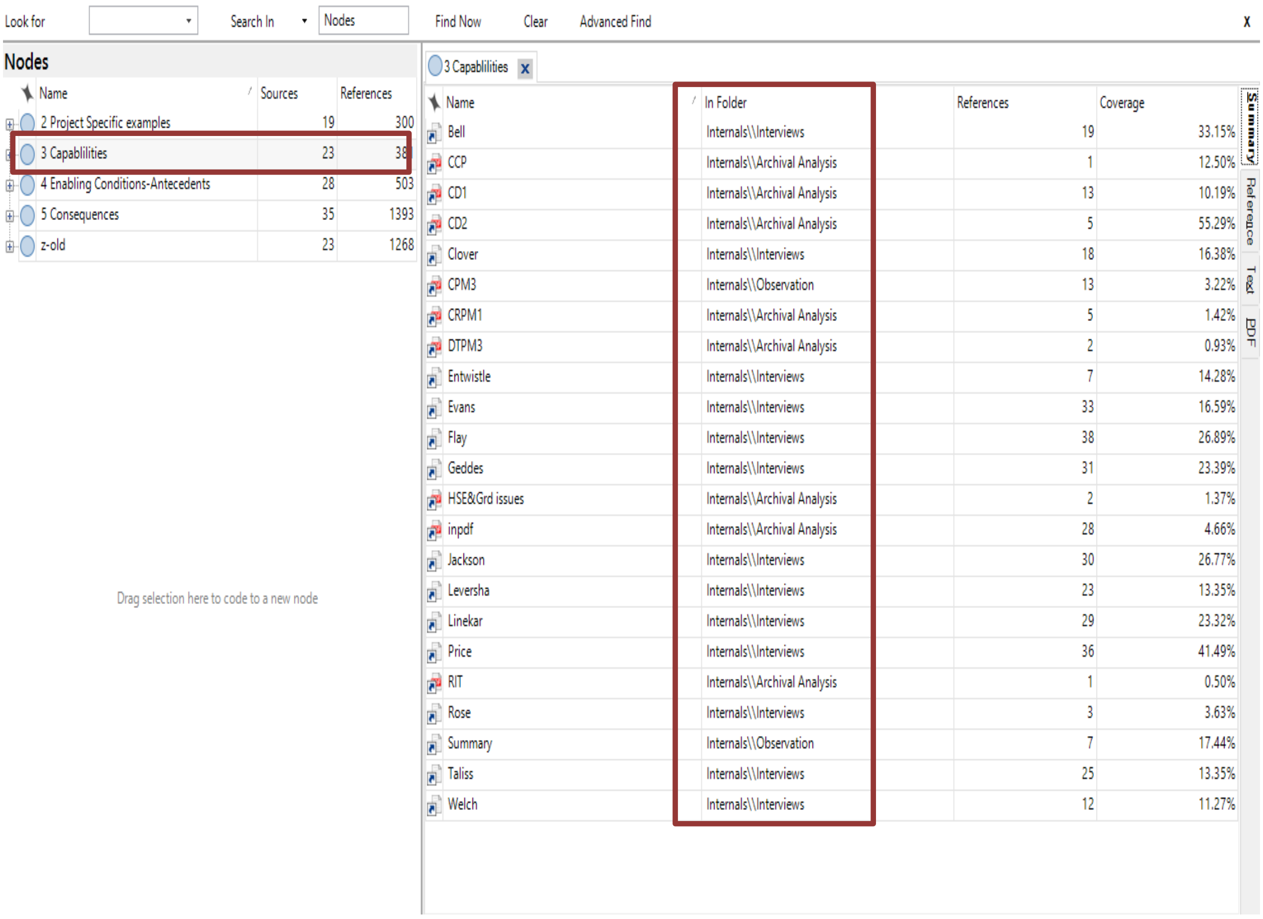
These were asked in order to identify the dimensions and antecedents of resilience in projects. This section of the protocol covered; 1) critical incident, 2) its impact on the project, 3) measure that were employed to manage disruptions, 4) responsibility of the respondent and required skills if available and 5) measures to overcome future similar change. Questions on impact were to justify the need for recovery whilst questions on measures were to identify the capabilities and antecedents in managing disruptions.

3.10.1.3 Data analysis

Data analysis went through three primary stages; (1) determining the frame of reference which emerged from utilisation of the data (2) formulating categories and (3) determining the level of generalising data, either broad or specific generalisation (Butterfield *et al.*, 2005).

In relation to determining the frame of reference, themes from responses were mainly grouped in accordance to dimensions-capabilities of resilience. With formulating categories, headings such as Personal details, Project Details, Dimensions of resilience- Capabilities were selected. Finally, determining the level of specificity or generality to be used in reporting the data was dependent on responses acquired from the study.

Data acquired from observations, archival analysis and interviews were synthesised and coded under each node. For example Figure 3-4 shows the sources from documents, interviews and observations coded under the capabilities node.



Name	Sources	References
2 Project Specific examples	19	300
3 Capablilities	23	38
4 Enabling Conditions-Antecedents	28	503
5 Consequences	35	1393
z-old	23	1268

Name	In Folder	References	Coverage
Bell	Internals\\Interviews	19	33.15%
CCP	Internals\\Archival Analysis	1	12.50%
CD1	Internals\\Archival Analysis	13	10.19%
CD2	Internals\\Archival Analysis	5	55.29%
Clover	Internals\\Interviews	18	16.38%
CPM3	Internals\\Observation	13	3.22%
CRPM1	Internals\\Archival Analysis	5	1.42%
DTPM3	Internals\\Archival Analysis	2	0.93%
Entwistle	Internals\\Interviews	7	14.28%
Evans	Internals\\Interviews	33	16.59%
Flay	Internals\\Interviews	38	26.89%
Geddes	Internals\\Interviews	31	23.39%
HSE&Grd issues	Internals\\Archival Analysis	2	1.37%
inpdf	Internals\\Archival Analysis	28	4.66%
Jackson	Internals\\Interviews	30	26.77%
Leversha	Internals\\Interviews	23	13.35%
Linekar	Internals\\Interviews	29	23.32%
Price	Internals\\Interviews	36	41.49%
RIT	Internals\\Archival Analysis	1	0.50%
Rose	Internals\\Interviews	3	3.63%
Summary	Internals\\Observation	7	17.44%
Taliss	Internals\\Interviews	25	13.35%
Welch	Internals\\Interviews	12	11.27%

Figure 3-4 Sources for coding nodes

Data acquired were coded under two major headings namely; (1) background of project and critical incident and (2) capabilities with their antecedents and consequences using Nvivo 10 software as shown in Figures 3-5,3-6 and 3-7.

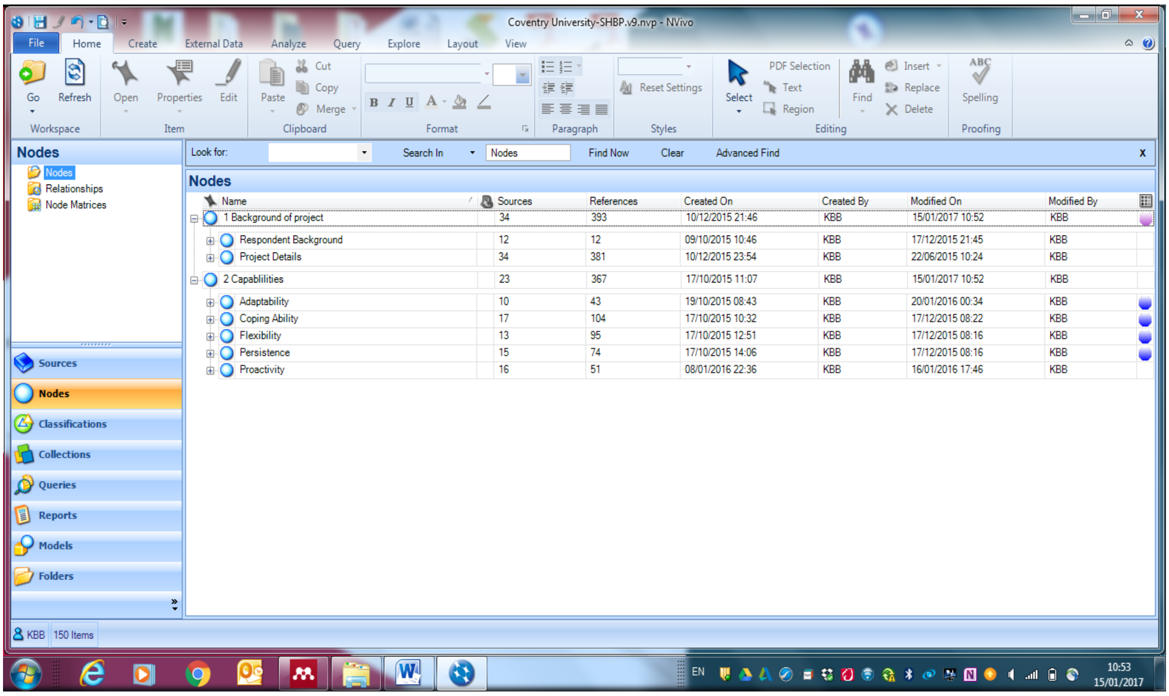


Figure 3-5 Case study Alpha Data Analysis Screen Shots from Nvivo 10

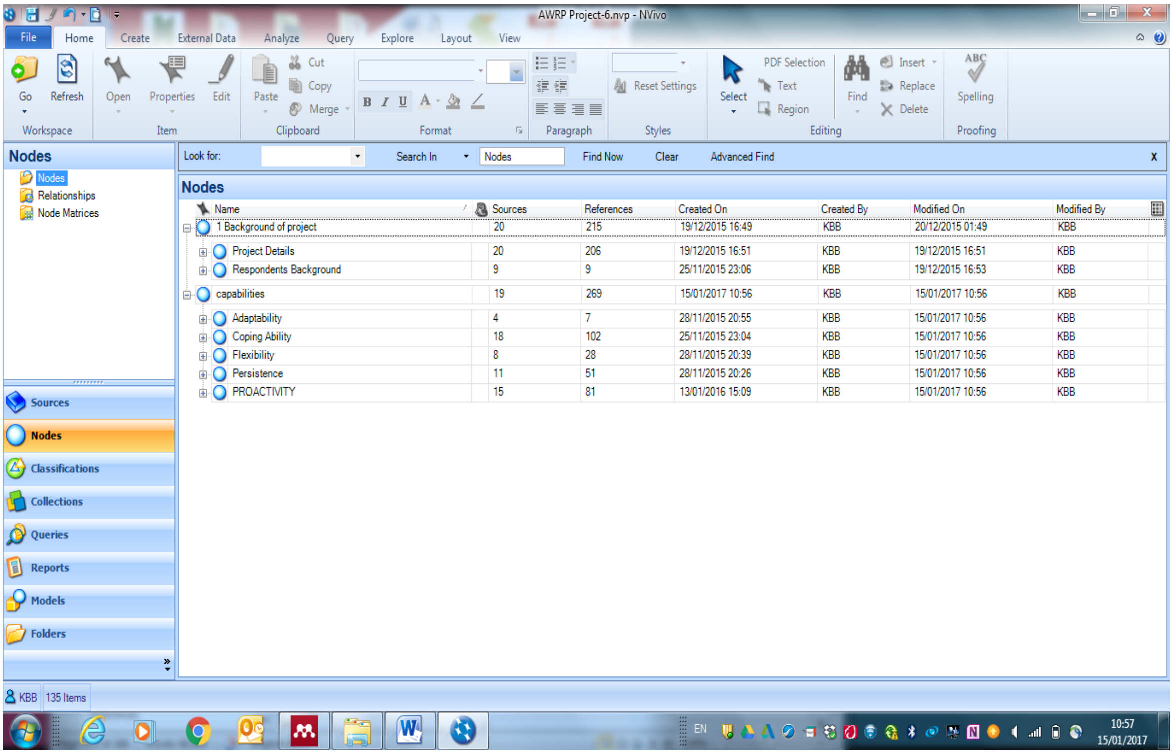


Figure 3-6 Case study Beta Data Analysis Screen Shots from Nvivo 10

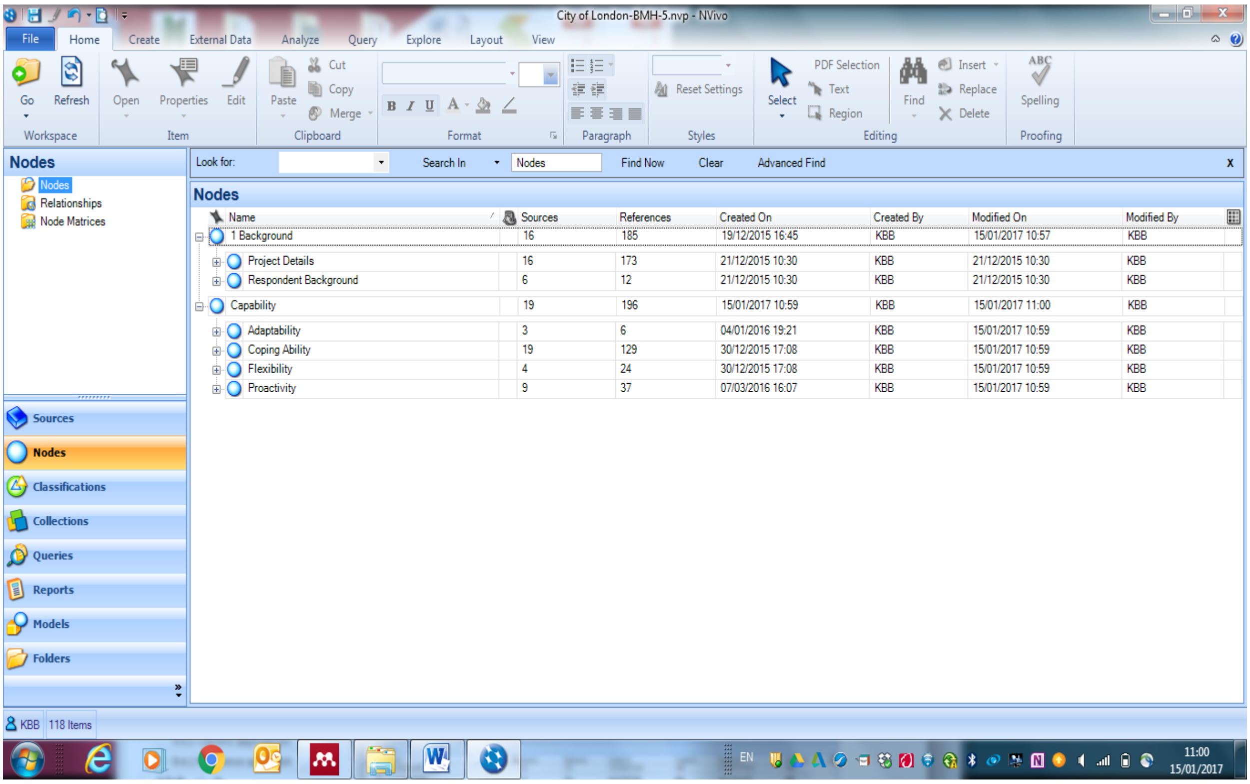


Figure 3-7 Case study Gamma Data Analysis Screen Shots from Nvivo 10

The codes in Figures 3-5,3-6 and 3-7 were arrived at after iterative process of moving between data collected and literature. Coding began with open codes from results of the case study. Following this, higher order themes were identified after three rounds of coding, meaning theoretical saturation for data had been achieved (Strauss & Corbin, 1998). After this, axial coding which involved grouping open codes was done specifically for the capabilities.

3.10.1.4 Interpreting and reporting data

At this stage the soundness of the methods was examined. This was carried out to identify bias and decisions made at these areas (Butterfield *et al.*, 2005). The ultimate responsibility was to point out limitations, point out degree of credibility and determine the value of the final result obtained.

3.10.2 Validation

Validation is seeking the authenticity and confidence in the results attained in the research (Fellows & Liu, 2008). Validation in this research was in two stages; employing the credibility and trustworthiness checks on the critical incidents and validation of findings.

3.10.2.1 Validation of critical incidents- Credibility and Trustworthiness checks

Critical incidents identified in this research were screened in accordance to the basic requirement outlined by Butterfield et al (2005). Overall 31 critical incidents were identified and 4 were removed for failing at least one of the tests below. The test consisted on three stages deduced from Butterfield et al (2005).

Firstly, the transcribed information from the case study was cross-checked with the audio record and then given to some participants to confirm initial categories against content in order to determine the extent to which it reflects their personal experiences as recommended by Alfonso (1997) and Butterfield et al (2005). Secondly, critical incidents which did not contain capabilities manifested and antecedents were removed. Thirdly, the less descriptive and vague incidents despite probing to get details were also removed. Following this, the capabilities which were identified across the case studies were identified.

3.10.2.2 Validation of findings

Validation of findings was done using focus groups. This was to validate the framework. Focus group was used because views about the developed concept was required (Fellows & Liu, 2008). This rigorous technique aims at eliciting and exploring in-depth opinions, judgements and evaluations expressed by respondents (Fellows & Liu, 2008). A homogeneous group was used (Beck*et al*. 1986) with a minimum of three participants (McLafferty, 2004). The focus group was analysed under the following themes; overall assessment, logic of the framework, completeness of framework, adequacy of framework, and adaptability of framework.

3.10.3 Ethical Considerations

Access to projects, participants and documentary information involves ethical issues which require ethical clearance (Loughborough University, 2016). All research carried out within Loughborough University goes through ethical clearance to ensure that these researches, especially in this case where human participants are involved, adhere to the state of the art ethical standards.

This research received ethical approval (see appendix H) before contact with any expert in the field was made. Directors of the projects were contacted by email to gain access (see appendix A). In addition, an adult participation information sheet was sent to explain the purpose of the study, who was doing the research, what they will be asked to do, the non-compulsory nature of the study, how long the study will take and other information (see appendix B). Also, an informed consent form was given to participants to sign (see appendix C) and confidentiality of data acquired from the study was assured by anonymising the project.

A graphical representation of the research plan for this study is presented in Figure 3-8.

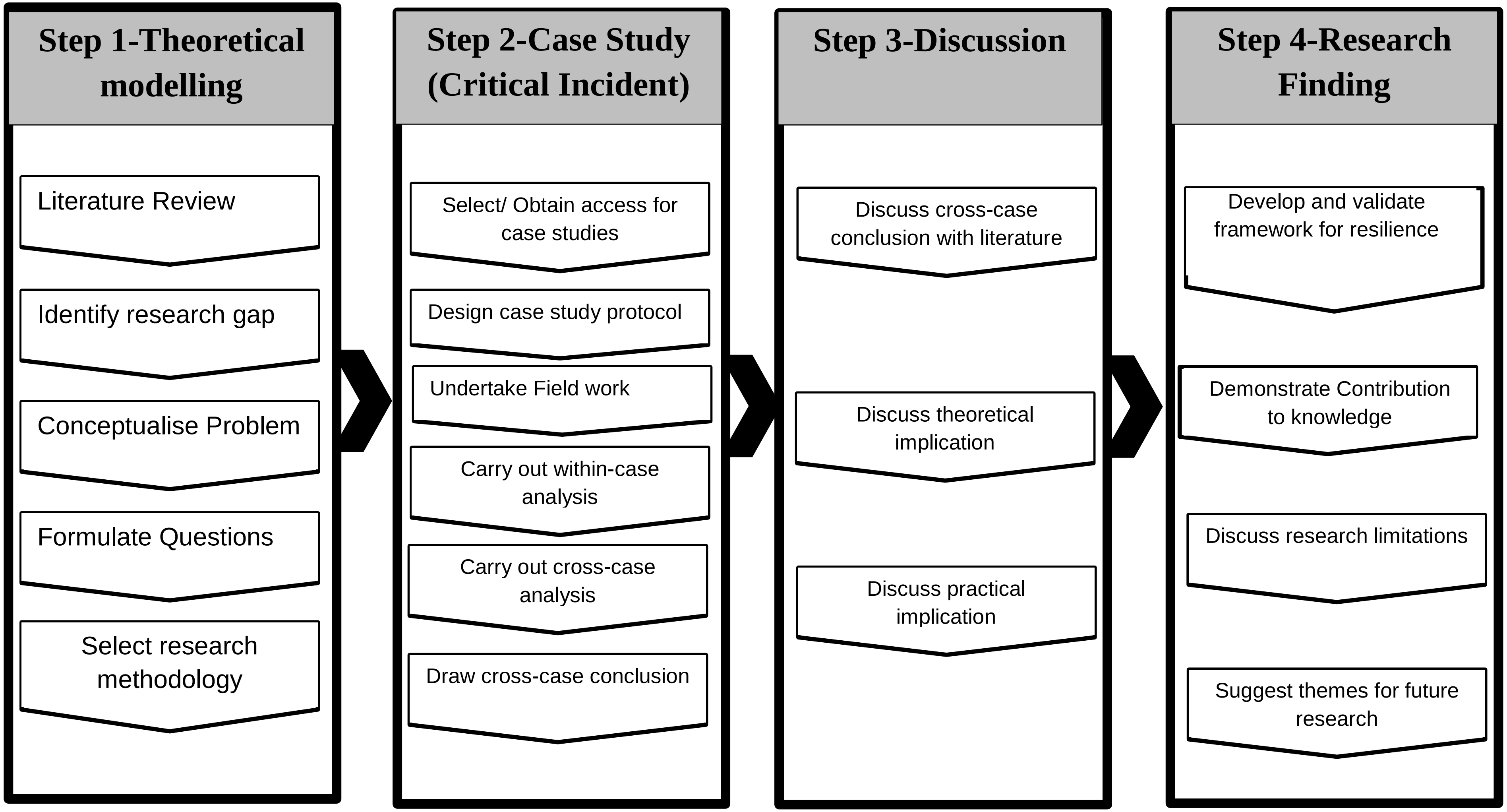


Figure 3-8 Research Plan

3.11 Chapter Summary

The research philosophy, approach, strategy and data collection methods adopted for this study has been presented in this chapter. The research philosophical view and approach adopted were the interpretivist view and an abductive approach respectively. The interpretivist and abductive approach employed favour a qualitative approach. Under qualitative research, a case study approach comprising archival analysis, observations and interviews focussing on critical incident was employed. Critical incident was used as a proxy for examining resilience, its dimensions, and antecedents.

At the project-selection stage of the case-study, the stratified and convenience sample method were employed to select the projects to study and the snowball sampling method was used at the interview level to gain access to all the lead personnel on the project. The case studies selected consist of a building, engineering construction and civil engineering project labelled projects alpha, beta and gamma respectively. Data from the case studies were validated using the credibility and trustworthy checks whilst findings were validated using focus groups.

The next three chapters (4, 5 and 6) present the analysis of data from the three case studies.

4- Within case analysis of Project Alpha

4.1 Introduction

Analysis of data from Project Alpha is presented in this chapter. Data consists of interview responses, documents on the project and observations. Respondents were identified to be members of at least one professional association. The leadership-target focus of respondent influenced the high level of experience captured. In all thirteen (13) respondents were identified. Below in Table 4-1 is a summary of attributes of the respondents.

Table 4-1 Attributes of respondents in Project Alpha

Respondent code	Respondent/ Role on project	Gender	Team	Position in Organisation	Years of experience in current role	Years of experience in construction	Professional Associations
E001	Lead client monitoring advisor	M	Client	Associate architect	6 Months	14 years	Architectural Retraction Board (ARB), Forum for the built environment (FBE)
R002	Director for Architecture	M	Client	Major shareholder	27 years	27 years	Architectural Retraction Board (ARB), Royal Institute of British Architects (RIBA), Building and Construction Authority (BCA)
C003	Quantity Surveyor/ Cost manager	F	Client	Senior Associate	7 years	9 years	Royal Institute of Charted Surveyors (RICS)
J004	Project Manager	F	Client	Project Manager	6 months	6 years	Association of Project Managers- APM, Assessment for Professional Competence- RICS
W005	CDM coordinator	M	Client	CDM coordinator	14 years	17 years	CIOB- Charted Institute of Builders, Association of Project Safety-APS and COSHH
F006	Employers' agent and project manager	F	Client	Senior Project Manager	14 months	7 years	Royal Institute of Charted Surveyors (RICS)
E007	Lead Mechanical Engineer	M	Client	Senior Mechanical Engineer	2 years and 9 months	10 years	Charted Institute of Building Service Engineers- CIBSE
B008	Project manager for the construction side	M	Contractor	Project Manager	12 years	25 years	MCIOB and ILM level 5
T009	Client and also manage Client team	M	Client	Director of Estate	18 months	35 years	RICS
L010	Project Director in Civil works- ensure delivery on civil works and work by BH	M	Client	Project Director	5 years	18 years	Institute of Structural Engineer
L011	Operations Manager	M	Contractor	Operations Manager	6 months	20 years	Associate at the Association of Project Managers
P012	Project Surveyor- Procurement of sub-contractors	F	Contractor	Project Surveyor	11 years	11 years	CIOB- Charted Institute of Builders,
G013	Project Design Manager -Key point of contact for the design team	M	Contractor	Project Design Manager	12-15 years	40 years	Construction Technician Institute

Documents revealed in this case study were high level strategic documents, comprising of hard copy versions of contract documents, risk and opportunity management documents, change management documents and drawings and soft copy versions of Building Information Modelling (BIM) and COBie Data drops. Most respondents during the interview referred to one or more of these documents showing how they played a role during the critical incident. Managerial level meetings such as the client meetings and workshops were observed during the case study. Also observed were presentations for the way forward following a critical incident. Information from these interviews, observation and documents were together used in coding the capabilities on Project Alpha.

Capabilities were the focus of the study because, resilience, is defined as a capability. The critical incident lens used to capture these capabilities led to the identification of four main capabilities within Project Alpha namely; proactivity, coping ability, flexibility and persistence.

This chapter is presented in the two major parts. The first part provides background to the case study (comprising project detail and risk, uncertainty and opportunity management process) and discusses the critical incidents. The second part captures the capabilities revealed in the project to ensure recovery. Figure 4-1 shows a graphical representation of the background to the case study and capabilities identified together with the relationship between them.

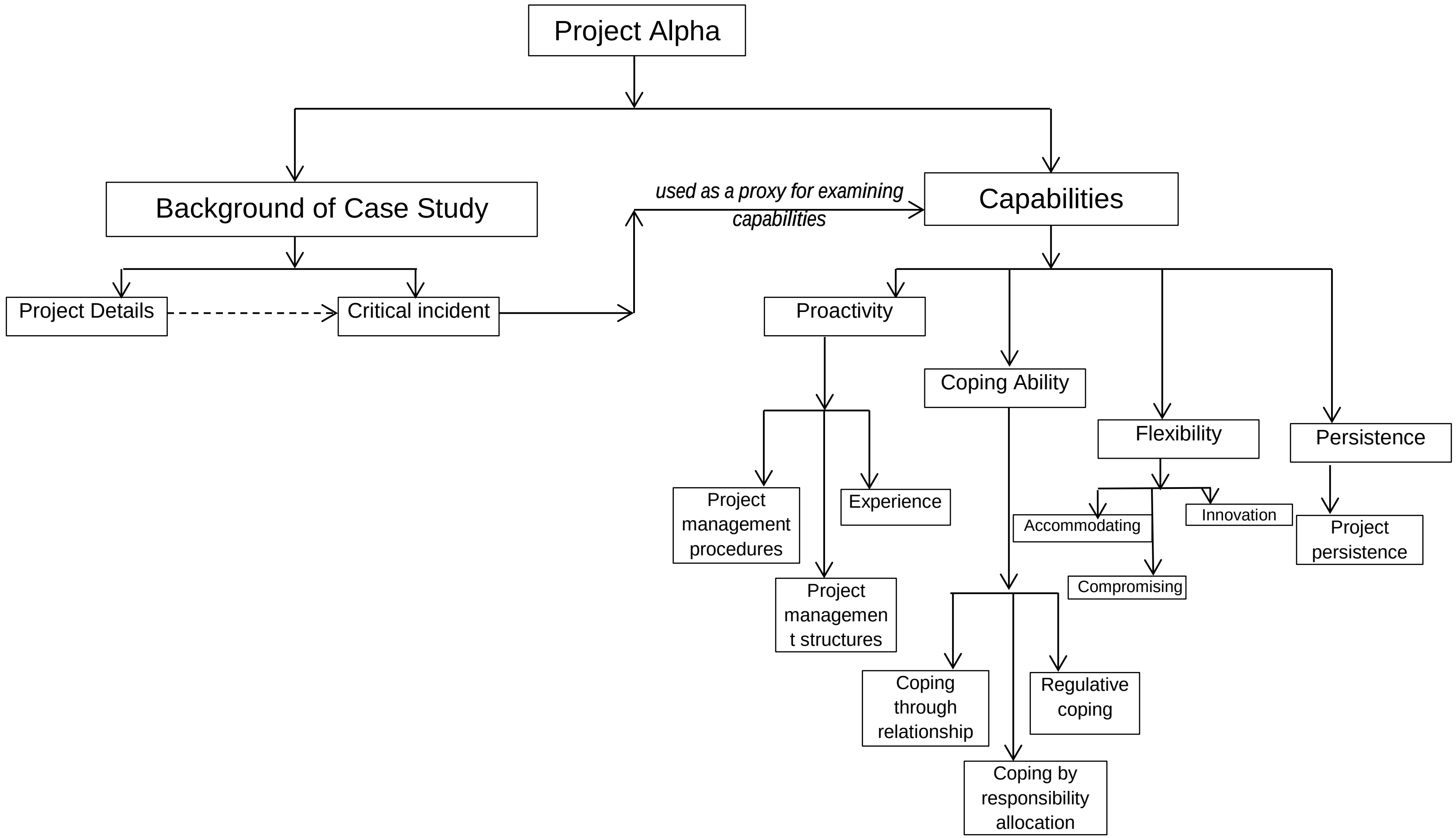


Figure 4-1Graphical Representation of analysis of Project Alpha

PART A- Background of Case study Alpha

4.2 Project Details

4.2.1 About Project Alpha

Project Alpha constructed a state-of-the-art flagship building. The building is an educational facility comprised of a new state of the art science laboratory and associated teaching space, plus external public realm areas and an energy centre. The Project was located in the West Midlands of England in an area that was greatly affected by the World War II and thus known for high possibility of archaeological findings.

The start date for main works was 16th February, 2015 and proposed completion date was 16th December, 2016. The proposed contract sum is £37,401,701.25 and the anticipated final account is £37,453,541.73. The main objective of the project for the client was to produce a state of the art educational facility with an ultra-modern (first of its kind in terms of size) super lab within United Kingdom in order to promote collaboration among the health sciences courses. However, the objective of the contractor team was to mainly get repetitive contracts from the client and win awards. Ultimately the client's objective drove the project and captures quality as the main priority on the project. These quality requirement were to meet the ISO 9001, ISO 14001 and ISO 18001 standards with minimal or no snag during handover.

Due to disruptions, the project had not evolved as planned. This affected the signing of the contract for almost a year and led to the contractor working under letter of intent until resolved. Despite the disruptions within the project, a number of procedures have been employed and measures are being put in place to enable project recover;

> *" Nothing ever goes as planned, it's just managing it……".*
>
> (Employers' agent, client).

The procurement route for this project was design and build with JCT standard form of contract. However, this project employs an innovative procurement route known as '*The Chinese wall'*. This Chinese wall route was based on the client's requirements to promote collaboration amongst the project team. With this Chinese wall approach, the architectural and structural/civil disciplines on both the client and the contractor's team were from the same parent organisation. Each team on either the contractor or client side were required to stick to the contractual agreement, thus work to attain the goals of the team one belonged to and have little informal communication with the other team though this was not necessarily the case due to stronger ties with parent organisations.

4.2.2 Key risk and opportunity identified on the project

4.2.2.1 Risk management

Identified risks on the project were; planning, design team and frame design and asbestos removal within plant room.

The planning issue had been managed by altering the floor plans and having workshops with the council in order to gain approval. The design team and frame design risk were being managed by continual communication with the design and contractor team and utilising contingencies allowed for. This risk was being monitored as well since it was still ongoing. Furthermore, the asbestos removal risk was managed by transferring the risk to experts to manage it.

4.2.2.2 Opportunity management

Opportunities identified include drainage, concrete frame and pre-case finishing. Organised workshops led to the development of an action plan for these identified opportunities.

For instance, concrete frame workshop was carried out because the initial steel frame for the project had been changed to concrete frame due to its benefits. Example of benefits identified were better quality, reduced cost, quicker delivery and relative long lasting nature of the concrete frame to be used. Also, in order to manage the opportunity and the innovation it brings with it, an innovation register was available within the project and reviewed monthly at client meetings.

Other opportunities were arrived at as a result of innovation and value management introduced in managing risks. For instance, due to the employment of 'BIM Lite' for drainage, a significant saving of over £2,000,000 (estimated) on the overall project is targeted. 'BIM Lite' enabled this due to its collaboration and early identification of clashes it provided.

4.3 Critical incident- Project Alpha

The critical incidents within the projects are discussed under these headings;

- Availability and manifestation of critical incident,
- Expectation of critical incident,
- Effect on delivery and success on project, and
- Measures to manage critical incident.

Overall six (6) critical incidents lenses were identified namely; room data sheet, archaeological findings, energy centre, lift specification, petrol tanks and piling issues. These critical incidents have mostly been resolved now with the help of project capabilities.

4.3.1 Room Data Sheet (RDS)

Room Data Sheet (RDS) gives detail descriptions of all finishes, fixtures, mechanical and electrical requirement for each room.

4.3.1.1 Availability and manifestation of RDS

From the case study findings, five respondents, two observations of clients meetings and four documents revealed RDS as a critical incident on the project. An overlook of the accuracy and consistency of the RDS detail at the tender stage due to rushed work by the design team led to issues that disrupted the project.

This critical incident was first identified during a workshop when the contractor and the design team were reviewing detail of works. Spot checks were being carried out in key and general rooms and these together with their impact on other elements of the building were identified. It was during that time that it was realised information available was not clear and it raised a number of requests for information (RFI's). These led to questions and clarification seeking and it also came to light at the client meeting that it was quite expensive with these evolving queries.

4.3.1.2 Expectation of RDS

RDS was an unexpected event. Out of the sources which identified RDS as a critical incident, only one mentioned it was expected but concluded that they did not appreciate the extent to which it escalated to and the knock on effect it had had on the project.

4.3.1.3 Effect on delivery and success on project

RDS affected the project in diverse ways such as; increase in cost, prevented contract from being signed and delay in overall programme.

With regards to cost increase, RDS led to the rework of room data (G values, air changes, temperature and cooling values, temperature set points), the option to change the ventilation type from natural to mechanical, increase in total cost by 0.27%, and a week's delay in completion. Thus, it caused the works to cost £350,000 more which then made the current contractors not the lowest tenders anymore. Furthermore, misunderstandings as a result of increased cost led to a blame game process amongst the project parties. This was identified to have effect on the team. It caused sleepless nights and led to the reduction of trust amongst some team members as highlighted;

> "*Few sleepless nights,..saw a team which was very strong at the start tear apart*"

(Lead client monitoring advisor, client).

Furthermore, the prevention of contract signing by RDS led to the contractor working under letter of intent for a considerable time within the project. This is because the contractor required the RDS event to be resolved before signing the contract, given that this project is a design and build and they take up most of the risk after contract is signed.

More so, RDS delayed the projects by stopping the works and causing other works such as laboratory design and u-values to be re-done.

RDS challenged the project priority which is quality. For example, the change in air temperatures and difference in glass materials reduced the required air quality for the labs. This would have affected the client requirement for the lab and make the lab unfit for purpose.

4.3.1.4 Measures to manage RDS

Measures to manage RDS include; effective communication, adjudication, effective document management, training, motivation, contingencies and logical analysis.

- ***Effective communication-*** The common means of communication identified were teleconferencing, meetings, intranets and focussed workshops. Effective communication was identified to enable the continuation and execution of works within the project despite 'side' issues that arose such as lack of trust and disappointment amongst the teams. Also, this established procedure in most cases enabled the team understand where the risk were and what was not going to plan so that they tackled that straight away, thus thinking ahead. Furthermore, effective communication was identified to enhance motivation amongst the team during the critical incident as highlighted;

> "…*communication amongst the team helps keep the motivation going. It motivates by learning from peoples experiences and taking advice from colleagues ..*"

(Employers agent, client).

- ***Adjudication-*** This measure was employed due to the loss of trust within the team at a point in time. Experienced independent personnel was employed to listen to both sides to resolve the issues and this enabled the project team to contractually come together though there was evidence of no or little trust. Though the team could not have the same level of trust for each other as before, adjudication led to the identification of the responsible party and the role they had to play to resolve the issues.

- ***Effective document management-***The systematic approach of managing document enabled the ease in tracking the source of the room data sheet issue. This effective document management enabled everyone to understand what who had done, when and how. The systematic identification of the issue enabled a resolution to be agreed on and also who to incur the cost involved so the project could move on smoothly. This is was highlighted in;

> *"We currently have a systematic, proper documentation and a clear approach in processing information. This helps track information and provides a clear understanding of works. This helped during the RDS resolution in identifying culprit"*

(Employers agent, client).

- ***Training***- A lesson-learnt training workshop was carried out to enable the client see things from the perspective of the different teams and build a better team relationship during the RDS issue. Further, the contract-understanding training promoted clarity and understanding of the clauses and responsibilities of the team within the project as commented by one respondent;

> *"The training organised to help understand the contract helped us know what we were or not responsible for. This training sped the resolution of the room data sheet and eased the clear identification of whose fault it was and who was to incur the cost caused"*
>
> (Project Surveyor, contractor).

- ***Motivation-*** Continual motivation by the mangers was evident in project procedures described and also responses of measures to manage event. For example the project manager ensured continual motivation by providing necessary resources on time to enable the contractor team work whilst resolving the RDS issue. Other incentives to enable motivation were provided. For instance the operations manager for the contractor team shared;

> *"One of the guys worked late one night because we had the air change issue and I bought him a pack of beer as a thank you so its little things like that, that actually mean a lot".*

Furthermore, motivating by making team feel a sense of belonging through getting interested in personal life during the resolution of incidents was identified to lead to a communal contribution and participation by team members during the RDS resolution.

- ***Contingencies-***Contingencies provided the lee way the project has in terms of time. This enabled the utilisation of the add-on time when required for RDS resolution. Also, extra staff was employed. For example, new information technology expert was employed solely to focus on the project and help resolve the RDS issue.

- ***Logical Analysis***- *T*he loss of trust amongst the team, and the confusion of who was speaking the truth led to a logical analysis. This was carried out by the key parties in the project to review documents from tender to the construction stage reached. This was to identify the source of the issue. Though identified as the most painful situation, it was agreed that this was the only way out at that stage. Thus;

> *"…..going through work and every bit and aspect of it logically was the major way that RDS resolution could have been approached…."*
>
> (Lead mechanical engineer, client).

4.3.2 Archaeological findings (AF)

Archaeological finding is the body of physical evidence about the past that is not written.

4.3.2.1 Availability and manifestation of AF

From the case study findings, four respondents and one document (change document) revealed AF as a critical incident on the project. Within the Project Alpha, archaeological findings were identified during the foundation excavation. AF was identified at the early stages of the programme before the contractors came in. However, the larger portion of the archaeological findings was identified during excavation.

Whilst AF was being assessed, the project team had a little bit of debate with the local authority on ranking the quality of the findings. At one point the council almost suggested it was national interest which would have stopped the project because it would have had to get archaeologist out to really interrogate the AF. As it was, it was deemed of local interest but of national significance, so the works could go on. Furthermore, this finding could have reduced the levels of the project from three storeys to a two storey building. These have been overcome and the foundations are almost complete.

4.3.2.2 Expectation of AF

Respondents and documents which identified AF as a critical incident revealed that it was mainly unexpected. Only one respondent mentioned it was identified, but concluded that they did not appreciate the extent to which it escalated to and the knock on effect it had had on the project.

4.3.2.3 Effect on delivery and success on project

AF affected the project by increasing cost and stopping the works, hence causing delay. The delay was caused by the need to redesign the foundations to prevent interference with the archaeological findings which the council agreed that it should be buried as identified.

Also, re-strategising of certain aspects of the project led to increase in cost. For example, the change in foundation design led to a further look at options in the change control processes but led to cost increase.

4.3.2.4 Measures to manage AF

Measures to manage AF include; robust change control process, Chinese wall, method statement and employing specialists.

- ***Robust Change Control Process***-The early introduction of robust change control process on the project made all parties aware and well abreast with the process to follow when a change is encountered. This team acceptance of the process led to all parties meeting during the archaeological finding issues to raise the change request form and discussed the best option moving forward (example, strategic re-orientation). Thus, enabling team coordination and collaboration required to resolve the issue faster.

- ***Chinese Wall-*** The Chinese wall approach aided in collaboration to resolve the AF issue. For example, during the AF issue, since both teams mainly had the same aim to meet the client's objectives and to their respective organisational targets a collective team effort was experienced. This was through the in-house discussions that were carried out (though not allowed). This collaboration led to the resolution of issues earlier because of the prior communication and collaborative approach Chinese wall provides. Thus;

> *"…the Chinese wall promoted working together. It aided prior communication in-house and clarifications before attending client meeting so we got to agree and resolve issues faster especially during the archaeological issue where cost was increased…".*

(Lead client monitoring advisor, client).

- ***Method statement-***This systematic approach of carrying out certain works was further altered to suit the requirements provided to bury the archaeological findings in the ground by the archaeology department. This enabled the project to be continued. The method statement was edited from the original 5 stage to the 16 stage process it currently is.

- ***Specialist-***Specialists (archaeologist) were employed to resolve issues like the archaeological findings and the audio visual issues. Archaeologist from London museum were contracted to provide advice on the way forward for the archaeological findings on the site

4.3.3 Energy Centre (EC)

4.3.3.1 Availability and manifestation of EC

From the case study findings, two out of the thirteen respondents and one document reviewed revealed EC as a critical incident. The Energy centre is a brand new building to accommodate a plant which is meant to provide power to the quadrant of the campus. The aim is to generate all energy required for other buildings from this central plant rather than the individual plants which currently exist. A change from in-situ as recommended by the client to pre-fabricated by the contractor was agreed and this impacted positively on programme and BREEAM but mostly negative on cost and safety. This change was recommended after the tender process when contractor had been selected and thus, were left in shock. Again the project team members were hesitant due to the increased risk and uncertainties this change brought.

4.3.3.2 Expectation of EC

The respondents and document which identified EC as a critical incident revealed that it was unexpected. Furthermore, this critical incident was identified mid-way in the incident and thus, made managing it challenging.

4.3.3.3 Effect on delivery and success on project

EC caused a change in programme, cost, safety and BREEAM. It called for a complete new maintenance schedule in accessing the plant from previous plan and thus, more works to be re-done by the service team and also affected the planning permission.

4.3.3.4 Measures to manage EC

The main measure to manage EC was communication and collaboration.

- ***Communication****- C*onference calls and emails to promote communication and ensure everyone understood what was being done was focused on. These coordinated meetings promoted knowledge sharing because people were spread out and those who were not available at that point got involved through conference calls in order to provide information. Also, email follow up was done to ensure that all parties were on the same page.

- ***Collaboration-*** Collaboration through site meetings, workshops and informal social activities were carried out. Within site meetings and workshops collaboration was by the sharing of information on the issues with the pre-fabrication of EC and the agreement amongst parties to clarify any misunderstandings and gain communal approval.

4.3.4 Lift Specification (LS)

This is the standard required for the vertical transportation on the building.

4.3.4.1 Availability and manifestation of critical incident

From the case study findings; one respondent and two documents revealed lift specification as a critical incident. This issue was due to the provision of wrong foundation excavation depth which was spotted at the early stages of the procurement packages from drawings. This was identified when enquiries for quotations sent out by the project quantity surveyor were coming back with varying sizes. These varying loading and the size from drawings required clarification from the client. The client revealed that the higher size was required and thus, increased it from the current 1400m to 1900m.

4.3.4.2 Expectation of LS

The respondent and the two documents which identified lift specification as a critical incident revealed that it was unexpected. Furthermore, this critical incident was identified at the end of the design phase and thus, made managing it a challenge.

4.3.4.3 Effect on delivery and success on project

The lift specification issue affected the programme and cost through re-designing of works and a new specified lift. The programme was delayed by 2 weeks. Also, cost increase of £80,000 was incurred due to mistake caused by experts employed by client. The contractor was then employed to resolve the error. As per procurement and contractual agreement, the client took up the risk. Works re-done included digging deeper pits and changes to piles.

4.3.4.4 Measure to manage LS

The main measure to manage lift specification issue was sub-contractor database.

- ***Database of sub-contractors-*** Within the resolution of the lift issues, utilisation of a sub-contractor on the data base list a bit earlier on the project enabled a quick response to the issue. This database as stated by Project Surveyor (contractor) is known as a Procurement Excellence Program (PEP). It enabled the identification and employment of a competent sub-contractor (based on working relationship) to resolve the lift issue.

4.3.5 Petrol Tanks (PT)

4.3.5.1 Availability and manifestation of critical incident

From the case study findings, one respondent, one observation (design team meeting) and one document (change document) revealed petrol tanks in ground as a critical incident. The site for project Alpha was formerly a car park prior to its allocation for construction of the works. This was not identified by surveys carried out on the site prior to contractor selection but during the foundation excavation. From the contractual agreement on the project, the contractor is to take the risk of anything found in the ground.

This material was then tested and when it was identified and seen not to be harmful. It was arranged for removal. Whilst this was being investigated some frustrations amongst the team set in. This was because, there were uncertainties as to the volume of the petrol available and it led to identification of more services which were not captured in the drawings. Also, this uncertainty called for a much more detail investigation such as more trial pits than earlier required and inclusion of radar detections.

4.3.5.2 Expectation of PT

The respondent, observation and document which identified petrol tanks as a critical incident revealed that is was unexpected. Further PT was identified at the end of the incident and thus made managing it very challenging.

4.3.5.3 Effect on delivery and success on project

PT caused works to be stopped briefly for the tanks to be investigated and removed. The team experienced some frustrations during this incident but overcame it and worked to make up for the lost time.

4.3.5.4 Measures to manage critical incident

Measures used to manage the petrol tank issue includes; Chinese wall, empowerment and risk tracker.

- ***Chinese wall***- The Chinese wall enabled the clear information coordination amongst the team which resorted to the swift resolution of the petrol tank issue by updating the whole team in time and receiving contributions on the best way forward and agreement by all parties.

- ***Empowerment***- During the critical incident, tools to resolve issue such as brainstorming and lesson learnt workshops were provided the team to utilise in resolving the incidents. Further empowering the team by providing them with only required information and taking out those that will cause further harm to the team was identified. Empowerment enabled the project team gain the confidence required in solving the issue. For example

  > *"take the information, take the unnecessary ones out, and give them the fact, this surprisingly empowered the team and made them confident".*
  >
  > (Project manager, contractor).

- ***Risk tracker-*** Risk tracker enabled the project regulate the consequence PT caused and help absorb the shock in bred. It was through following the established steps in the risk mitigation process. This was also used in identifying extra potential risk during the petrol tank identification. This live document helped pre-identify the risk PT caused and provided measures to resolve it.

4.3.6 Piling Issues (PI)

Pile is a post like foundation member. The process of installing the piles is piling.

4.3.6.1 Availability and manifestation of PI

From the case study findings, one respondent and one document (change document) revealed piling as a critical incident. During piling, pools of water were found in the ground which required further investigation and re-design of works.

4.3.6.2 Expectation of critical incident

The respondent and the document which identified piling as a critical incident revealed that it was unexpected. Further, this critical incident was identified mid-way during foundation section of the works thus made managing a bit challenging.

4.3.6.3 Effect on delivery and success on project

This required foundation re-designs in order to reposition piles and carry out a test to show the client that all test passed. The piling issue caused the works to stop for a couple of days for further investigations to be carried out and increased design cost. The change in programme caused by this affected the design manager who was then undergoing personal problems but revealed it was resolved by managing it.

4.3.6.4 Measures to manage PI

Measure used to manage the piling issue includes; buffers/ contingency and risk absorption by client

- ***Buffers/ contingency-***The contingency allowed within the project was resorted to for re-positioning and redesigning original piles. This design development fund enabled the structural designers and civil engineers to come together to redesign and come up with a solution to resolve this piling issue. The success of this measure was successful due to the quick release of funds by the contractor and the commitment by the team in general. Other contingencies resorted to was the time contingency within this project which led to the re-sequencing of works was during PI issue.

- ***Risk absorption by Client-***The allocation of risk for this design and build project is mainly to the contractor. However, with this project, it is only in exceptional cases where the contractor proves that they have used the best endeavours and are unable to resolve the issue that the client takes up the risk. In this PI incident, misinformation during the tender stage led to the client taking up the risk to prevent further project delay and thus extra cost during this issue.

From the critical incidents discussed, the measures to manage disruptions which portrayed capabilities were coded under the respective capability. For example, Figure 4-2 shows the measures which were evident of proactivity.

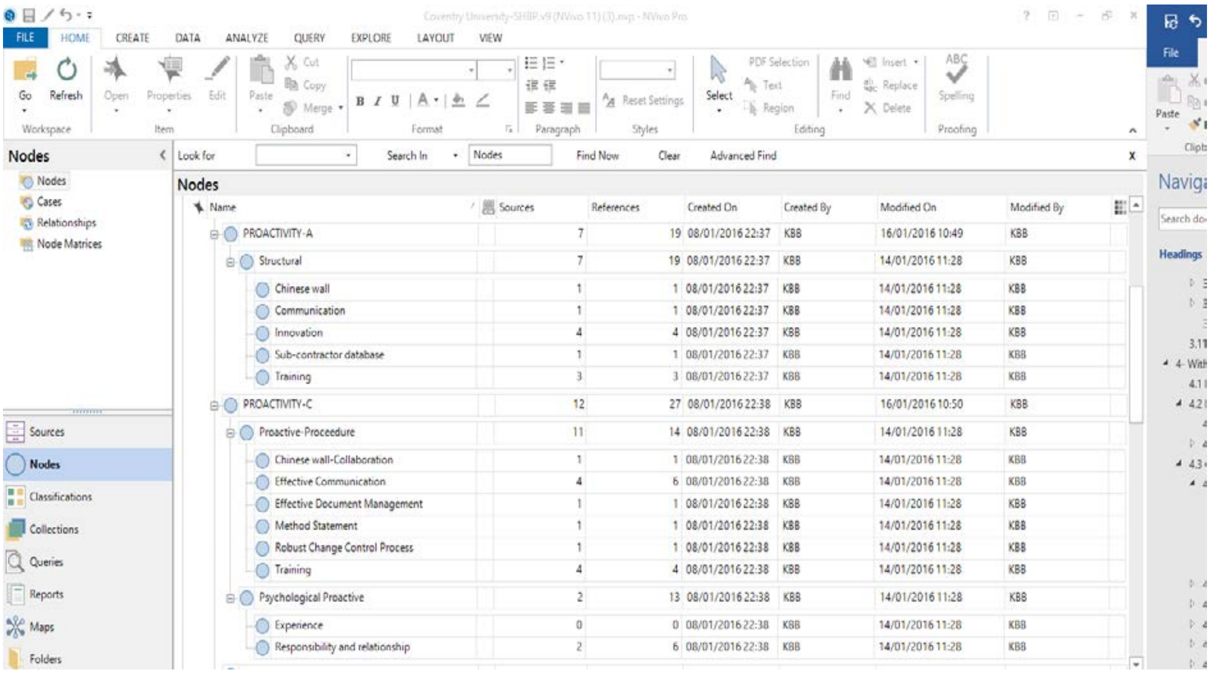


Figure 4-2 Evidence of capability (proactivity)

PART B- Capabilities for Project Alpha

Capability is an ability to perform coordinated tasks with the use of resources for the purpose of achieving a particular goal (Helfat & Peteraf, 2003). This section discusses capabilities identified within Project Alpha in managing disruptions caused by the critical incidents. These capabilities were deduced from the measures employed to manage disruptions in section 4.3. Capabilities identified include; Proactivity, Coping Ability, Adaptability, Flexibility and Persistence. These capabilities enabled the project respond, prepare for and reduce vulnerabilities.

<u>4.4 Proactivity</u>

Proactivity is defined as an anticipatory capability that the project takes to influence their endeavours. Within Project Alpha, this future-focussed capability is aided through project management procedures, mechanisms and experience employed during the critical incident.

Proactivity in project Alpha led to readiness of the project, reduction in vulnerability and aided response during the critical incident. Readiness is defined as the preparedness of the project to disruption whereas reduction in vulnerability is minimisation of the impact of the disruption on the project through procedures, mechanisms and experience within the project. Response is the reaction to the disruption using project capabilities.

4.4.1 Project Management Procedures

Project management procedures are the established ways of executing works. The procedures manifested during the disruptions to aid proactivity were; the robust change control process, Chinese wall, effective document management, training, roles and responsibility, motivation, planning and communication.

4.4.1.1 Robust change control process

The robust change control process provided the coordination and collaboration required resolving the disruption faster. For instance, the early introduction of robust change control process on the project made all parties aware and well abreast with the process to follow when a change is encountered. This team acceptance of the process led to all parties meeting during the disruption to raise the change request form and discussed the best option moving forward. Thus;

> *"the change control process aids the fast resolution of issues. We did have a lot of collaborated meetings and discussion groups to ensure that change encountered is understood by all and keep information flow"*

(Employers agent, client).

4.4.1.2 Chinese Wall

The Chinese wall enabled the clear information coordination amongst the team which resorted to the swift resolution of disruption. This was done by updating the whole team in time and receiving contributions on the best way forward and agreement by all parties due to factors such as the same parent organisation ties. Also, during the disruption, since both teams had the same aim to meet the client's objectives and to their respective parent organisational targets, a collective team effort was experienced. This was stated as;

"we worked collaboratively because as earlier mentioned we are from the same organisations though working on the client and contractor team. Our aim is to meet the clients requirements and get more contracts….we sit down with the project director on a monthly basis just to go through and make sure things are going as they should be and information is clearly communicated"

(CDM coordinator, client).

Also team effort was captured with the help of JCT clauses 1.6 and 1.7 and also confirmed by the collaborative approach these clauses drove as mentioned in responses such as;

"…I think everyone took up that challenge and we did not have any one storm off and say I'm leaving I don't want to be part. We have all been through changes from what we ultimately want is the deliverable. Our contractual responsibilities also guide us through times as these"

(Lead client monitoring advisor, client).

Another major reason for the employment of the Chinese wall approach was for effective communication and this was enabled by clause 1.7 in the JCT contract. This is identified to manifest both in the formal and informal perspective. Common identified communication modes during the disruption were teleconferencing, weekly meetings, intranets (Live link), discussion groups and focussed workshops. This was explained as;

"the Chinese wall guides us to ensure that we have regular discussions, weekly meetings with the contracting team through personal and virtual means so that we can tackle issues especially during swift changes straight away"

(Employers agent, client).

Also, effective communication was identified to enable the continuation and execution of works within the project despite the misunderstandings that arose like trust and disappointment amongst the teams. This established procedure in most cases also enabled the team understand what emerging risk were and manage it immediately, thus thinking ahead. Furthermore, effective communication was identified to enhance motivation amongst the team during the critical incident. For example,

> "…*communication aids motivation and help keep the team going.."*

(Employers agent, client).

Furthermore, clear responsibility allocation through the Chinese wall/contract enabled the identification of responsible party. This led to acceptance of the need to resolve issue quickly.

4.4.1.3 Effective document management

Proactivity is also evident in the effective document management identified in the project which enabled everyone to understand what who had done, when and how. This systematic approach of managing document enabled the ease in tracking the source of the room data sheet issue. The discrepancy in the room data sheet issue led to a couple of weeks delay in the project and the delay in signing the contract. Again, the systematic identification of the issue through document management enabled a verdict to be agreed upon and also identified who to incur the cost involved so the project could move on smoothly. This was stated as;

> *"the systematic identification through document management eased the adjudication process and also the acceptance of responsibility by party who made the mistake".*

(Project Design Manager, contractor).

4.4.1.4 Training

Proactivity in the project was evident in training. Training consisted of lesson learnt workshop and a contract-understanding course. The lesson learnt workshop was carried out to enable the client see things from the perspective of the different teams and build a better team relationship. Further, the contract-understanding training promoted clarity and understanding of the clauses and responsibilities of the team within the project. This training enabled the resolution of the disruption by easing the clear identification of whose fault it was and who was to incur the cost caused and empowering the team to absorb shocks.

The impact of these training was evident in the role respondents played and their behaviours during the disruption. Roles such as being an anchor, motivator and coordinator were revealed by the design manager during the disruption. This was revealed through the guiding of the design team, assuring them of their potential to overcome the disruption encountered and providing incentives to motivate the team.

4.4.1.5 Motivation

Continual motivation by the mangers was evident prior and during the disruption. For example, the project manager ensured continual motivation even during disruption by providing necessary resources on time to enable the contractor team work whilst resolving disruption. Other incentives to enable motivation were provided. For example;

> *"One of the guys worked late one night because we had the air change issue and I bought him a pack of beer as a thank you so its little things like that, that actually mean a lot"*
>
> (Operations Manager, contractor).

Furthermore, motivating by making team feel a sense of belonging through getting interested in personal life during the resolution of incidents was identified to lead to a communal contribution and participation by team members during the disruption.

More so, the project director in civil works motivated his team during the disruption when his team was accused of doing rushed work and hence are the culprits who caused this issue. He motivated them by defending them in their presence during client meetings and providing incentives such as money and drinks for them. Also, during the disruption, the project surveyor researched and provided advice for the team in order to prevent any panic and frustrations.

4.4.1.6 Planning

The planning nature of this project is evident in the document management, change processes, method statement, communication processes, the Chinese wall approach and the database of sub-contractors employed during the critical incident. This future-thinking nature of projects influenced how documents were managed and enabled the easy identification of the incident and resolution when it occurred. Also procedures such as the change process and the systematic outlining of methods in which works are carried out enabled disruptions to be resolved without incurring extra cost and also at a shorter time possible. This was achieved by releasing of change request form.

4.4.1.7 Communication

Communication and the contractual structural relationship established through the Chinese wall also depict proactivity. These ensured the clarity and trust required to resolve the incident. During disruptions, regular communication both in-person and virtual ones were carried out to resolve the issues mainly going through the contractual communication route. The set-up of the Chinese wall where parties from both the client and contractors side were from the same organisation promoted informal communication as well and thus minimised ‘redoing’ of planned decisions and this eased the incident resolution process.

4.4.2 Project management mechanisms

Project management mechanisms are structures put in place to enable project execution. Those manifested to manage the disruption include; method statement, contingencies and database sub-contractors

4.4.2.1 Method Statement

The existing method statement, (the systematic approach of carrying out certain works within this project) was used in managing a critical incident by providing steps for project to follow. For example, the method statement for archaeological findings presented in the risk register was further altered to suit the requirements given to bury the archaeological findings in the ground by the archaeology department to be able to continue the project. This method statement was edited from the original 5 stage to the 16 stage process.

4.4.2.2 Contingencies

Contingencies allowed provided the extra time and cost during the incident. During the disruptions, the time and cost contingencies were utilised to prevent delay in the project. For instance extra staff was employed solely to focus on the issue the disruption had caused;

> *“Getting someone to come in to resolve this issue sped up the programme... Financial contingencies allowed in the project were used to cater for this”*

(CDM coordinator, client).

4.4.2.3 Sub-contractor database

The database sub-contractors promoted the employment of competent personnel to manage disruption. This enabled a quick response to the issue. This database thus, promoted working with known expertise and reduces the tendency of employed sub-contractors going into administration.

4.4.3 Experience

Besides the procedures discussed above, some psychological traits which were mainly noted to be influenced by experience were identified. These included; open-mindedness, curiosity and innovativeness. These established traits were identified to influence how the project manager coped during the critical incident (Source; Discovery document on psychological capabilities of project manager from case study). For instance during the room data sheet issue;

> "*his innovative ability led to the unveiling of options which influenced the re-sequencing of the programme and thus minimise time loss on the project*"
>
> (Lead client monitoring advisor, client)

Also, roles and responsibilities were given to those best able to manage it based on their strengths and skills. This was deduced from a framework known as Insight which profiles individuals on the team. The employment of the Insight framework for which skills deduced from the personality theory by Juung's (1921) are used by the contractor team to provide roles to each member of the team. The contractor project manager believes that you cannot change someone but you can build on their strengths to maximize the way they work. This theoretical framework influenced the roles each member played during the disruption. These traits are said to be able to drive the team through disruptions.

To arrive at these roles, each member of the construction team answered a set of questions and based on the responses to these questions different roles were given them. Figure 4-3 is an Insight wheel which draws one to a specific role based on the responses provided. Thus, depending on the responses provided, each person falls into a particular wheel and hence given that role.

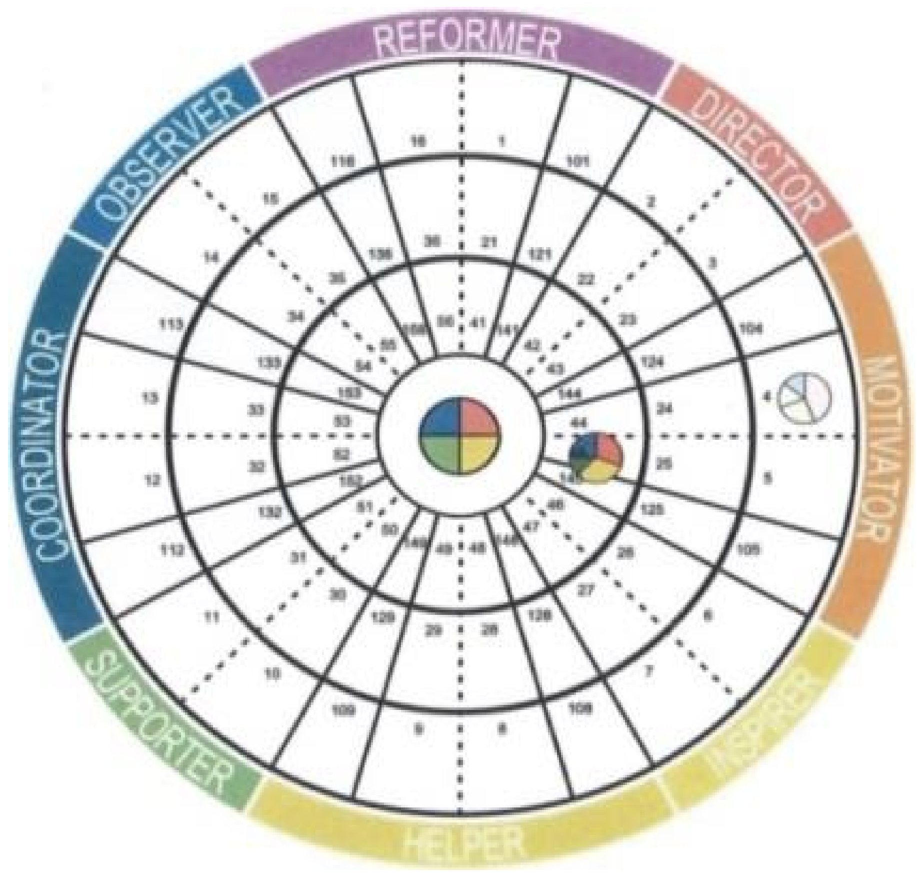


Figure 4-3 Insight Discovery Wheel (Insight, 2015)

4.4.4 Summary of antecedents and consequence of Proactivity

From the manifestations of the proactivity discussed above, a summary of identified antecedents and the consequence emerged from sections 4.4.1-4.4.3 is captured in the Table 4-2.

Table 4-2 Antecedents and consequence of Proactivity

Project Alpha		
Antecedent	Consequence	
Change process and systematic outline of methods	Resolution of archaeological findings without incurring extra cost and at the minimal time possible	Readiness, Reduction
Planning- Effective document management and method statement	Enable issue to be easily identified and informs way forward	Readiness
Clear responsibility allocation	Accepted adjudication verdict and allow contingencies to cater for unknowns	Readiness
Training-Psychological development	Drive team through critical incidents, ensure project team are equipped and enables team accommodation	Readiness, Reduction
Communication and contractual structural relationship	Clarity, Trust, Coordination and also Planning	Readiness
Chinese wall	Promoted informal communication, prevented redoing of	Readiness, Reduction

	planned works and eased incident resolution process, easily agree and adapt to situations	
Sub-contractor database	Ensure reliably sound organisations is employed	Readiness
Innovation	Minimise time and quality loss	Reduction
Motivation	Unveil hidden traits required to manage critical incident	Readiness
Contingencies	Re-design of works	Readiness
Experience	Cope	Readiness, Reduction

4.5 Coping Ability

The manifestation of this capability to manage and deal with shock caused by disruptions within Project Alpha was evident in proactive measures and the manifestation of reactive measures. Coping ability enabled the project respond, reduce vulnerability and prepare for disruptions. Within project Alpha, this ability to manage and deal with shock caused by the disruption was by; coping through relationship established by the Chinese wall approach and change control process; coping by responsibility allocation set out in contract and coping through regulating which were evident in experience and contingencies and coping by reacting which was by training.

4.5.1 Coping through relationship

The Chinese wall provided the relationship required to manage and deal with the shock. This was through the clear information coordination amongst the team and thus provided the trust required during the disruption. This then also led to the swift resolution of the issue by updating the whole team in time and receiving contributions on the best way forward.

The Chinese wall promoted collaboration through the awareness of roles, clear information coordination and thus enabled coping. Re-emphasis on roles and project processes (example change process) was made during regular discussions and weekly meetings. These created the awareness which is required to enable the project manage the shock and hence cope during the incident. The Chinese wall approach is identified to be one that promotes collaboration;

> *"Chinese wall promotes team involvement and thus makes everyone feel and sense of belonging*"

(Employer's Agent, client).

Chinese wall enables endurance by the overall team which is required to cope. More so, the early introduction of the change control process enabled the project to manage and deal with the stress. This step by step procedure outlined in the process was followed to buy time and tolerate the incident as other stringent measures were being discussed to manage the incident. This also contractually promoted trust given that they had a process required to follow irrespective of risen issues and thus maintained relationship.

> *"Each time we went through issues we raise the change request form and meet and discuss the best option moving forward. We did this even during times where trust was lowered due to blaming and issues raised"*

(Client)

4.5.2 Coping by Responsibility Allocation

This was revealed in responsibility set out for project leaders, adjudicator and client.

4.5.2.1 Contractual responsibility set out for project leaders

Contractual responsibility set out restored trust and enabled project Alpha manage and deal with disruption when trust was lost. This enabled the project leaders drive the rest of the team through motivation, continual emphasis on the aim of the objective and empathise with them in order to manage and deal with the incident. Also, these responsibilities are identified to be greatly influenced by experience of project leaders. Based on experience, the project design manager shared how difficult or easy certain aspects of design were and these influenced how he reacted to the team while playing his role in managing and dealing with the disruption.

Also, experience from past similar projects by the project leaders influenced how they absorbed shock. For example, the project director in charge of civils on the client's team added;

> *"we therefore assess based on experience as to what may or may not happen in order to prepare and minds and make us ready….."*

Again, with the contractual responsibility set out, each party was assigned definite roles which stated what they had to do and also influenced how they reacted to the shock. For example, in the room data sheet issue, the role of the project manager was to understand the issue by bringing relevant parties together to identify the key issues in a special way and identify resolution and ensure the resolution does not affect the project objective.

Furthermore, the clear roles and responsibilities within the project enabled the team know who they listened to, the person responsible and also how to communicate with the team based on training. These training teach the leaders to know how to present bad news to the team and know what information to provide and what not to. This depends on the level of tolerance of the team to ensure that the logical and collective understanding required of the team to respond to the issue is attained. Also the Lead client monitoring advisor mentioned that;

> *"too much information for the team was not good and could cause unnecessary panic to the team and thus minimise the effect responses will provide"*

(Lead client monitoring advisor, client).

Also, the Lead mechanical engineer accepted the responsibility to identify source of issue based on contractual requirements. This was carried out through logical analysis by a systematic review of the issue by the Lead mechanical engineer in order to attain effective response. He concluded;

> *"In relation to RDS I looked at the thing logically and did not panic too much in that situation because I think a lot of matters that had been raised through the contractors and the sub-contractors were right because, for example, with the labs where they gave options, they went for the most expensive option to cover themselves before they went into contract so what they put forward was not wrong"*

(Lead mechanical engineer, client).

Based on experience from similar project, the step-by-step analysis revealed that the discrepancy caused was not their fault and thus provided the mechanical team and the project in total to attain effective response and hence identify whose fault it was to resolve the issue.

Also, effective document management carried out by Quantity surveyor promoted trust and provided the understanding required especially during the room data sheet issue.

> *"I was the guardian of ensuring documents were managed effectively so I guess I was there to manage and confirm exactly what had gone on in the tender and what had gone out in the addendum and the chronology is quite important so that everyone could understand what who had done what, when and how"*

(Quantity surveyor, client).

This provided the platform for which the project tolerated the critical incident and thus managed and dealt with it based on the awareness the effective document created for the project.

4.5.2.2 Contractual responsibility set out for adjudicator

The clear responsibility and role allocation aided the adjudication process. The senior members who were involved to adjudicate the escalation of the room data sheet issue and manage the tension amongst the team had their works eased by the established job specification allocation in the project definition document which aided the trust required. Within the contract, everyone knew what they had to do and it was clear that everyone's aim was to attain the common objective of this project which was to produce the state of the art facility to serve the educational sector and be the first of its kind in the United Kingdom and Europe at large. The quantity surveyor confirmed;

> *"it just needed that slightly independent party to come in and do the high level rattle based on the responsibilities set out for them in the contract"*

(Quantity surveyor, client).

4.5.2.3 Contractual responsibility set out for client

More so, the clear responsibility in the contract aided the risk during the lift issue to be absorbed by the best person possible. Here the risk was absorbed by the client despite the fact that the contract was a design and build contract. Certain clauses within the unsigned contract stated which risk was to be borne by the contractor and those outside their jurisdiction of which the situation within the lift issue fell outside his jurisdiction. Thus;

> *"the contractor has to do it prove that they have used their best endeavours and are unable to resolve it and then the client takes up the risk as a result of this, of which they did"*

(Project surveyor, contractor).

Again within this disruption, changes to the roof were required due to the wrong specification provided and this required going back to planning. It is in light of this that the client decided to absorb the risk after the contractor has proven to use the best of their endeavours to manage the issue.

4.5.3 Coping by regulating the impact of the incident

This is defined as controlling ones feeling and attitude towards a disruption. Experience from past similar projects influenced how they coped. For instance, because a similar design had been carried out on another project, the mechanical team knew the mistake was not from their side and thus minimised the frustration that would have been experienced.

The high level experience exhibited by the project, influenced how they adjusted to the disruption with little panicking during the incident;

> *"most of us did not panic; I think everyone is working enthusiastically for the end goal by focussing on the goal, being forthcoming and not focussing on problems being raised"*

(Lead client monitoring advisor, client).

> *"Each time we went through issues we raise the change request form and meet and discuss the best option moving forward"*

(client).

Again, experience made the project regulate the impact of the disruption not only with established processes but also personal attributes such as open mindedness and being insightful.

Furthermore, contingencies were also used in absorbing shocks. These contingencies and their percentages allowed were resorted to during the disruption. For example;

> *" we put money (design development fund) based on experience in the pot to deal will ground problems so the client pays for it so if we don't find any problem we take it. It was about calling on the structural designers and civil engineers and literally calling an emergency meeting to come up with a solution to resolve it. It was our risk because we are taking responsibility for the ground works.. and the contingency allowed made the solution possible"*

(Project manager, contractor).

Also, Project Alpha absorbed shocks through training (within project and external). Within the project, lessons learnt workshop through project comparison activities were carried out. This was to share experiences from past similar project amongst the team to increase awareness and ensure that the ultimate goal for this project was well known to all. Externally, training such as leadership courses capturing how project leaders should behave were identified to enable the project leaders manage and deal with shock.

4.5.4 Summary of Antecedents and Consequence of Coping Ability

From the manifestations of the coping ability discussed above, a summary of identified antecedents and the consequence emerged from sections 4.5.1-4.5.3 is captured in the Table 4-3 below.

Table 4-3 Antecedents and consequence of Coping Ability

Project Alpha		
Antecedent	Consequence	
Coping through Relationship		
Chinese wall	Enabled the clear information coordination amongst the team, promotes team involvement and thus makes everyone feel and sense of belonging, thereby enabling endurance by the overall team	Readiness, Reduction
Change control process	Tolerate and adjust	Response, Reduction
Coping through Responsibility allocation		
Contractual responsibility set out for Leaders	Drive the rest of the team through motivation, enable the project leaders manage and deal with stress. Enable project team tolerate	Response
Contractual responsibility set out for Adjudicator	Enabled the identification of the party to incur cost and allowed contract to be signed for works to carry on as scheduled	Response
Contractual responsibility set out for client	Allocate risk to responsible party	Response
Coping through Regulating		
Experience	No panicking, open minded-ness	Readiness
Contingency (money)	Re-design of foundation	Response

Training	Share experiences from past similar project amongst the team to ensure that the ultimate goal for this project was well known to all, know how to deliver bad news	Readiness, Reduction

4.6 Flexibility

This is a capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained. Within Project Alpha, evidence of this is identified in the accommodating, willingness to compromise and innovative nature of the project. These manifestations of flexibility reveal the antecedent and consequence.

4.6.1 Accommodating

Accommodating was manifested by the client and the project team. Within this project, though identified that quality is a major priority, the flexible nature of the client was revealed when materials required for the section of the project, run short (extinct) and hence was allowed to be changed. Thus;

> *"the client was understanding and we said can we use this other stone instead.. though it was not as high quality as the former"*

(Project surveyor, contractor).

Accommodating also led to allowing change and its implementation. This began from the tender stage and was revealed through the free-will and communication allowed. In terms of free-will, the client provided the contractor with the freedom of selecting which organisations to be part of their team. The Chinese wall procurement route aided the promotion of in house hand-over and again promoted flexibility through communication and collaboration during the disruptions. The free-will provided at this first instance ensured that the client's goals and their overall parent organisation goals were not compromised.

Furthermore, accommodating manifested through the free-will promoted the identification of early warning in the project to help early resolution, clarification and explanations within the project. For example;

> *"Early warnings helped early clarification and explanations in which case it did during the archaeological findings"*

(Client).

Also besides accommodating to allow for change, the flexible capability by the project to accommodate how different people work and respond to issue was identified. Efforts by the project to accommodate everyone was seen to be promoted both at the project and the parent organisation level. Within the project, this was being promoted by making everyone feel valued and showing gratitude and appreciation for works carried out by the project. One main driver of accommodating identified by the client was that as a project, one has to able to look at different scenarios and options and think laterally to an extent;

> *"it is important to be flexible by being able to look at different scenarios and options, thinking laterally to an extent, knowing your client and how they will feel and respond to swift changes"*

(Client).

On the other hand, accommodating also enabled the change in time and cost contingencies allowed on the project. The acknowledgement that within projects, things do not go as planned by the project design manager revealed the continual allowance of exact and excess contingencies, where excess contingencies were acquired from value engineering. For example, the Project Director of civil works revealed example of value engineered works which provided contingency for resolving a disruption;

> *"So like the energy centre is now a prefabricated building instead of in-situ to reduce time on site and this is through contingencies or from the value engineering and the understanding from meetings"*

(Project Director of civil works, client).

More so, flexibility through accommodating within the project to ensure that the ultimate goal was achieved led to the employment of new staff during the disruptions. In addition to the new staff employment, specialist input was accommodated though not in original project plan also. This acceptance of input by the specialist aided in resolving the archaeological findings and the room data issue and thus contract signing.

4.6.2 Willingness to Compromise

Evidence of compromising which depict flexibility was identified. The project leaders revealed the need to accommodate inputs and recommendations from the team even if it implied shifting from the original plan but maintaining the ultimate aim of the project. These helped during the management of disruptions. For instance, a strategic re-orientation by the client team was carried out when the contractor presented alternative solutions for specified works during archaeological findings. The project manager emphasised the need for the project to compromise when required and the importance for the team to be empowered to come out with more innovative ideas such as these and present to the team.

4.6.3 Innovation

The promotion of innovative ideas during the critical incident showed the level of flexibility of the project. The Project Manager for the construction side added that during meetings, they urged the team to suggest ideas that will enhance the project and once it is approved, the project considers it. Innovative ideas considered include;

> "*introducing beams into the foundation to enable the archaeological findings to be buried*"

(Client).

> "*converting part of the project which was not originally in the planned works to prefabrication to regain time loss*".

(Project manager, contractor).

Also, innovation was identified during the lift specification issue. Here, cost was saved by having sub-contractor packages which cater for labour and plant only and not material in order to avoid paying double the client's profit and overhead. Thus;

> *"we had an all-inclusive package that is labour, plant and material based but when you think about it you are paying for the labour and over head of profit, plant and overhead and profit and materials plus overhead and profit so what we are doing now is procuring the materials direct so that we don't have to pay sub-contractor overhead and profit"*

(Project surveyor, contractor).

4.6.4 Summary of antecedents and consequence of Flexibility

From the manifestations of the flexibility discussed above, a summary of identified antecedents and the consequence emerged from sections 4.6.1-4.6.4 is captured in the Table 4-4 below.

Table 4-4 Antecedents and consequence of Flexibility

Project Alpha		
Antecedent	Consequence	
Accommodating	Promote early warnings, allowing extra resources for contingencies	Readiness
	Foundation re-design, additional staff and specialist employment, Change in materials	Readiness, Response
Compromising	Adopting alternative unplanned solutions	Response
Innovation	Convert part of the project to prefabrication	Response

4.7 Persistence

Persistence within this research is defined as the capability to continue despite disruptions. This is due to the functional capacity of the project which aids it to withstand and dynamically reinvent strategies as the project encounters disruptions. Within Project Alpha, evidence of these was identified. Evidence of persistence was identified in the project through continual contractual relationship, communication, the planned programme driven nature, continual monitoring and negotiation.

4.7.1 Project persistence

4.7.1.1 Contractual relationship

The maintenance of contractual relationship despite disruption revealed persistence. This was mainly driven by the contractual procedures set out in the contract and the clear responsibilities stated. Communication processes such as workshops highlighted the good and bad issues that had arisen during the disruption and agreed solutions for the bad ones. Also, lesson learnt workshops were carried out to create awareness for the project in order to learn from other people's experience and therefore moderate the effect the incident had impacted on them and thus enable them carry on with the project. For instance, the employer's agent on the client's team shared;

> *"it was a very open and frank lessons learnt workshop between parties and we told them things we were not happy about, discussed what was running the project and what the main aim was so that we remain focus and strive through despite the incident"*

Within Project Alpha, relationship development and maintenance of trust was the key driver employed to ensure persistence. During the room data sheet incident which led to a blame game, there was loss of trust and thus the Lead client monitoring advisor decided to put measure in place to restore the trust that was lost. This was carried out by introducing informal communication, developing inter-personal skills and making sure that overall, team members were on the same page in addition to those set out in the contract.

Again, evidence of continual collaboration and communication despite the incidents revealed persistence. These were carried out to moderate the effect disruption had had on the project.

4.7.1.2 Continual monitoring

Persistence was evident through the continual monitoring of other risks despite the disruptions. This captures the re-inventing and continual moderation ability of the project. For example;

> *"Risks are also measured in a risk register and are monitored by monthly reviews and brings out actions and make sure the guys are closing them. These were continually done even during the make or break incidents"*

(Project Director in Civil works, client).

In addition, a design tracker was also continually utilised to manage the risks identified during the design stage even during room data sheet issue. For example,

> *"we have a design tracker, to highlight what the risks are and who the owner is and we do this continually on the project even in times when we encounter disruption so that no new disruptions are introduced"*

(CDM coordinator, client).

These were being carried out to moderate the effect the disruption would have on other aspects of the project and also prevent other risk and uncertainties from manifesting.

4.7.1.3 Programme

The end-goal driven nature of the project and the aim to maintain client relationship revealed persistence. This was enabled by, the project being forthcoming and not focussing on the problems being raised. Despite disruptions which led to delay in contract being signed, project persistence was evident by contractor agreeing to continually work under the letter of intent to ensure that the project is delivered on time. Also, strict processes were identified to prevent discrepancies and further disruptions thus;

> *"we tend to go through a strict process to get works done to prevent any discrepancy or further issues and get things to work together to meet the programme time line"*

(Project Director in Civil works, client).

4.7.1.4 Negotiation

Negotiation was also identified during the adjudication process of the room data sheet issue in order to gain the understanding and identify the party required to incur the cost so that the project could be continued. Negotiation reduced cost instalment by the parties involved during the room data issue so as to enable projects carry on. The initial instalments would have rendered the responsible party to go into administration. Also, negotiations through continual collaboration and communication despite loss of trust were carried out during disruptions.

4.7.2 Summary of antecedents and consequence of Persistence

From the manifestations of the persistence discussed above, a summary of identified antecedents and the consequence emerged from above section is captured in Table 4-5 below.

Table 4-5 Antecedents and consequence of Persistence

Project Alpha		
Antecedent	Consequence	
Project Persistence		
Contract	Continual collaboration and communication	Readiness
Programme	Maintain client relationship and work under letter of intent	Readiness
Risk register	Continual monitoring to manage uncertainties	Readiness, Reduction
Design tracker	Continual monitoring to manage design	Readiness, Reduction
Negotiation	Cost instalment reduction	Reduction

4.8 Interrelationship amongst Capabilities

Proactivity within this Project Alpha is identified as an overarching capability enabling aspects of coping ability, flexibility and persistence whereas, coping enable flexibility and persistence. These are discussed in sections 4.8.11-4.8.3.

4.8.1 Proactivity Enabling Coping Ability

This anticipatory capability influences the ability to manage and deal with stress caused by disruptions; coping ability. Identified procedure manifested here includes Chinese wall, effective communication, effective document management, method statement, robust change control process and training aided in relationship coping, responsibility coping and regulative coping. Table 4-6 captures how these procedures enable coping ability.

Table 4-6 Proactivity enabling coping ability

Identified Procedure	How procedure enabled project cope
Chinese wall	clear responsibility allocation to the parties and this provided trust
Effective communication	coordination and clarity
Effective document management	provide information required to make further decision and implement respectively
Sub-contractor database	ensure that reliable personnel and financially sound sub-contractors based on ranking from past experience are employed on the project
Robust change control process	enabled the project follow through and manage the changes

4.8.2 Proactivity enabling flexibility and persistence

Proactivity enables flexibility and this is evident in aspects such as Chinese wall, contingencies and training. Table 4-7 captures how these procedures enable coping ability.

Table 4-7 Proactivity enabling flexibility

Identified Procedure	How procedure enabled flexibility
Chinese wall	Enabled innovation, relationship, comfortable environment, honesty
Contingencies	re-design of the foundation, promoted value engineering
Training	educated the team to tolerate and understand from different perspectives

Project persistence was enabled by contract through the continual relationship, communication and planned programme it drives. Further, the contract aids in the development and maintenance of trust which was the key driver employed to ensure persistence.

4.8.3 Coping ability enabling flexibility and persistence

The capability of a project which manages a disruption by allowing change is enabled by the ability of the project to manage and deal with shock. For instance, coping through responsibility allocated led to accommodating changes despite the manifestation of the critical incident.

Also, the ability to continue despite difficult situations is also enabled by the ability of the project to manage and deal with shock. For instance, coping through responsibility allocated promoted continual collaboration and communication and this created awareness and continual update risk register despite the manifestations of disruptions.

4.9 Chapter Summary

This case study revealed capabilities such as proactivity, coping ability, flexibility and persistence in managing the disruptions. Antecedents for proactivity include project management procedures and mechanism and experience. Coping ability was enabled by antecedents of proactivity and manifested during the incident. The project coped through; (1) relationship established by the Chinese wall approach and change control process; (2) responsibility allocation set out in contract and (3) regulating which were evident in experience, training and contingencies. Furthermore, coping ability also enabled persistence and flexibility. Flexibility was identified in the accommodation, willingness to compromise and innovative nature of the project whilst persistence was identified in the project through the contractual relationship, planned programme driven nature, negotiation and continual monitoring.

The next chapter (chapter 5) presents the within case analysis of Project Beta.

5- Within case analysis of Project Beta

5.1 Introduction

Data from Project Beta is presented in this chapter. These consist of interview responses, documents on the project and observations. In all nine (9) respondents were identified with most respondents having at least one professional affiliations. Below in Table 6-1 is a summary of attributes of the respondents.

Table 5-1 Experience of respondents in Project Beta

Respondent/Code	Respondent/Role on project	Gender	Team	Position in Organisation	Years of experience in current role	Years of experience in construction	Professional Associations
AG01	Project Manager	M	Client	Principle Consultant	9	15	Charted Engineer and member of Energy Institute
AL02	Senior commercial manager- Commercial and contractual matters	M	V-Contractor	Senior Commercial Manager	5	35	Charted institute of civil engineers surveyors
BA03	Contract Manager	M	V-Contractor	Senior Project Manager	10	27	None
BE04	Project Director for the structural engineers	M	V-Contractor	Regional Director	15	38	FISE, FICE and Associate member of the Charted institute of Arbitrators and a member of the Charted Engineers
HU05	Senior design and engineer manager	M	V-Contractor	Senior design manager	15	30+	Institute of civil engineers
TH06	Planning control manager	M	V-Contractor	Planning and controls manager	0.5	20	Charted institute of building
TR07	Process activities Manager	M	V-Contractor	Project Director	4	20	None
TU08	Engineering Manager- Responsible for the furnace, turbine and the technical part	M	V-Contractor	Engineering Manager	5	9	None
W09	Project Coordinator- Coordinate activities	M	O-Contractor	Project Director	7	17	CIOB

Documents reviewed in this case study were high level strategic documents, comprising of hard and soft copy versions of project execution plan documents, risk and opportunity management documents, change management documents and drawings. More so, most respondents during the interview referred to one or more of these documents showing how information in there played a role during the critical incident.

Meetings at managerial level, design team training and project evolution were observed to identify how disruptions were managed. Also, observed were emergency meetings to resolve critical incidents. Information from interviews, observation and documents were together used in coding the capabilities on Project Beta.

The critical incident lens used to capture these capabilities has led to the identification of four main capabilities within Project Beta namely; proactivity, coping ability, flexibility and persistence.

This chapter is presented in the two major parts. The first part provides background to the case study (comprising project detail and risk, uncertainty and opportunity management process) and discusses the critical incidents. The second part captures the capabilities revealed in the project to ensure recovery. Figure 5-1 shows a graphical representation of the background to the case study and capabilities identified together with the relationship between them.

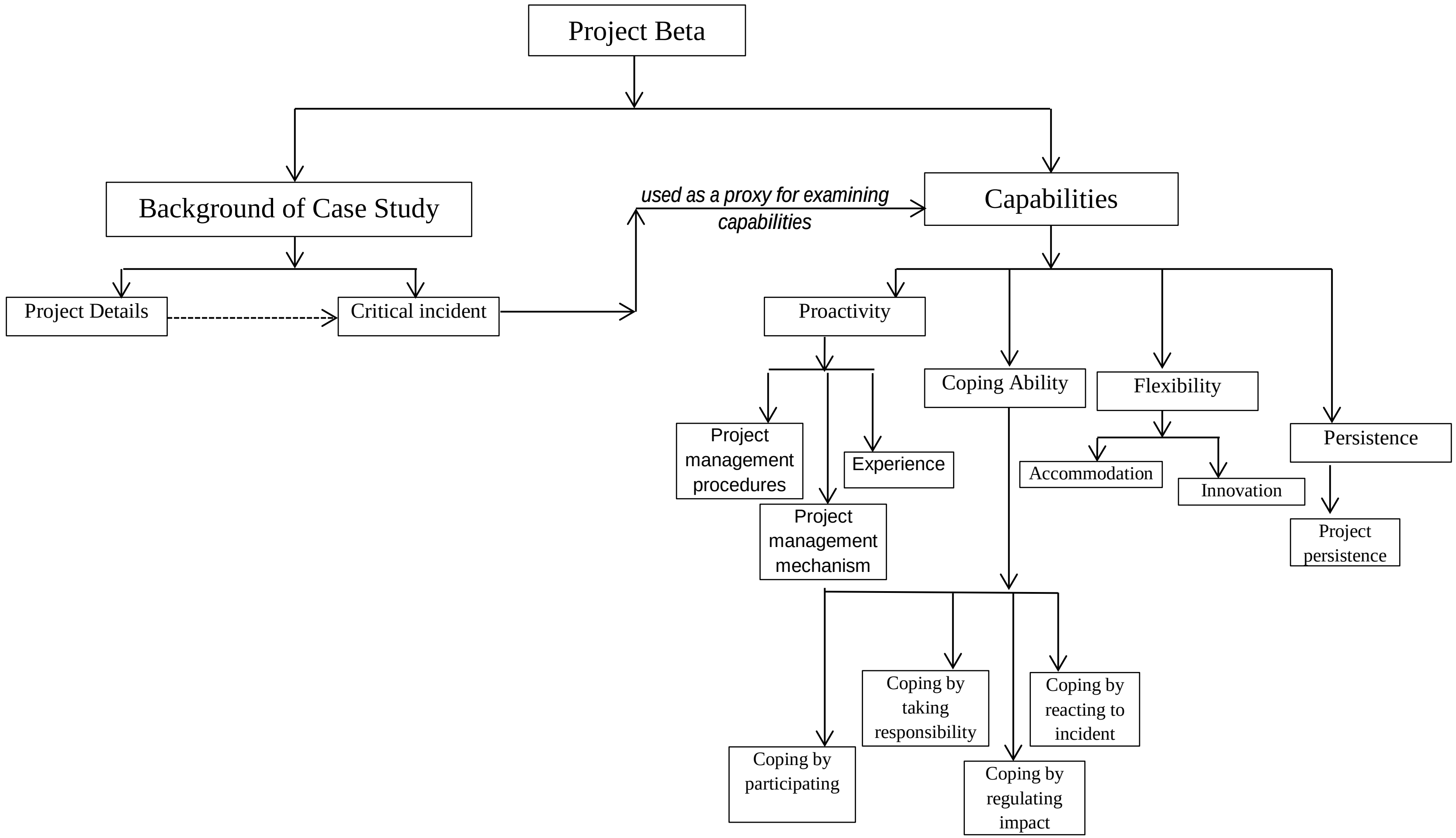


Figure 5-1 Graphical Representation of analysis of Project Beta

PART A- Background of Project Beta

5.2 Project Details

5.2.1 About Project Beta

Project Beta focussed on the execution of a waste-to-energy facility in the northern part of England. It is mainly an engineering construction project. This reasonably sized project has the processing plant (engineering construction section) costing over £170 million and the civils works costing £15 million.

The project started in October 2014 and it is for 37 months. The client objective for this project is to provide a 25year waste disposal facility for 350,000 tonnes per annum domestic and commercial waste. However, that of the contractor differs, which is to make more profit and win more projects with the clients. The ultimate priority for this project in terms of cost, time, safety and quality is quality, time, safety and cost in order or significance. Quality-wise the aim was to make sure that the plant functions as required.

Project Beta has faced many disruptions since its initial commencement in 2003. For instance, due to planning approval challenges, a delay of seven (7) years was experienced on the project. Upon commencement, the project has also encountered design development challenges due to a non-allowance for design time (that is, the 6 months before construction) and moving straight into construction. Due to lack of time for the design development stage, other uncertainties like foundation change have been encountered. The project is currently one month behind schedule and has thus, led to weekend working hours being introduced to make up for time lost.

Multiple procurement route and contracts exist on this project. Project Beta has three design and build contracts running on the IChemE redbook and one design and build contract under the NEC3 option A contract. NEC3 is being employed on the civil works whilst IChemE is being used on the process plant section of the works because it has a better structure for process plant and for testing and commissioning. With process plant, the contract has to include rigorous mechanism for testing and accepting the plants. Financially, the project is a PFI (Publicly funded initiative) which is the contract between the contractor and the client.

This design and build project has parties comprising one major contractor, with two other main sub-contractors and then other subcontractors and most importantly the client as the main parties. Due to the size and complexity of the projects, most of the works are sub-contracted to specialist. In relation to the major contractor, there is a joint venture between the civil sector of the company from United Kingdom and the engineering construction sector located in France.

5.2.2 Key risk and opportunity on the project

5.2.2.1 Risk Management

The identified risks on project Beta were; design growth, nesting of birds on the excavated surfaces and weather conditions.

The design risk has been managed by weekly meetings between the contractor and the design team to ensure the drawings are on time for construction and it is buildable. The nesting of birds which have prevented works on that section has been managed by ensuring that all slanted surfaces from excavations are avoided. Also, most works have been planned for the summer to manage the weather condition issues.

5.2.2.2 Opportunity Management

Opportunities from disruptions identified include re-sequencing of works, maximising space on site, prefabrication of certain element and drainage opportunities. Some float times identified in the programme was utilised in re-sequencing certain works to make up of time loss on the project. Also, due to the time loss, the initial programme which required certain contractors finishing their part of their works before others has been altered by working simultaneously. Opportunity for extra space on site has been identified and this has led to having more than one contractor on the site at a point in time to promote simultaneous working on the project. Finally an opportunity such as prevention of deep excavation during drainage was pointed out;

> *"we recovered a detail or drainage design, these are small things but they all add up. So we also prevented some deep excavations and used alternatives and that saved some money as well. We constantly review value engineering"*

(Senior commercial manager, contractor)

In addition to above discussed opportunities, others through value engineering (VE) have been identified. VE has emerged due to the current delay on this project, not to gain profit but to recover time loss. VE is carried out by constantly reviewing works and meeting to ensure that resources are maximized.

5.3 Critical incident- Project Beta

The critical incidents manifested within the projects are discussed under these headings;

- Availability and manifestation of critical incident,
- Expectation of critical incident,
- Effect on delivery and success on project, and
- Measures to manage critical incident.

Overall, three (3) critical incidents lenses were identified namely; foundation change, late payment and concrete pour. All these critical incidents have now been resolved with the help of capabilities.

5.3.1 Foundation Change

Foundations are the lowest load bearing parts of a structure.

5.3.1.1 Availability and manifestation of critical incident

From the case study findings, seven respondents, two observations and two documents revealed foundation change as a critical incident on the project.

Within project beta, a misinterpretation of provided loading information generated by a United State company and interpreted by an European company led to a foundation change from pad to raft foundation. The difference was with the writing style, thus using commas to separate hundreds instead of a full stop which is common in Europe. This incident was identified during the first phase of the engineering and after contract award.

Also, the clear communication of the requirement of the foundation was not provided. The engineers for the processing plant failed to inform the contractors that foundations being constructed required differential settlement across the building. Also, this miscommunication of foundation loading led to a blame game within the project as the responsible culprit was meant to incur the cost of the consequence of the foundation change. This was emphasised by the senior commercial manager;

“They gave us the load that they expected the plants and equipment to carry on our foundations but these increased and the thing they didn't tell us is that this required differential settlement across the building which was far tighter than normal designs will allow for and as a result of the increased load and differential settlement we have had to change the foundation philosophy so as far as we are concerned it is entirely their fault and their cost.”

(Senior commercial manager, contractor).

Furthermore, the project director for the structural engineers added that due to the disruptions experienced at the start of the project; when planning permission was not granted, demotivated any one to carry out further investigations which could have prevented this issue. He added;

“we should have undertaken more detail geotechnical investigations on site”

(Project director for the structural engineers, contractor).

Again, in addition to lack of commitment at the start of the project, the planning control manager added;

“It was a case that we had a design which was done with not a great amount of payment gone to the designers because they wanted to go with us and wanted to do a job of this scale with us and as a project team including the designers did not fully appreciate the ground conditions for loads that might be required and from the back of that we had to change from a pad foundation to a raft foundation which has got a knock on impact so we are trying to see various areas”

(Planning control manager, contractor).

5.3.1.2 Expectation of critical incident

All respondents, observation and documents which identified foundation change as a critical incident revealed that is was unexpected. Further, this critical incident was identified after the contract award period; during the foundation excavation and design stages.

5.3.1.3 Effect on delivery and success on project

The foundation change affected the project in terms of time and cost. For instance, the discrepancy in the foundation design and the delay in payment have caused a month's delay on the project. Again the foundation led to a blame game amongst the client, contractor parties from the UK and France branch. The blame game amongst contractors was because the change in foundation increased the project cost by about a million pound and the party whose fault it was, was required to incur that cost. This continuous blame game also in itself contributed to the delay.

The senior commercial manager summarized this. Thus;

> *"There is always a question as to whether the tender design was adequate. Therefore it could potentially be a design deficiency. But the main line of thought at the moment is that it's an issue with the requirements of our joint venture partner company Vinci Environment per se who have increased the loading requirement for the equipment and also required differential settlement which our tender requirement could have coped with. At the moment it does not create good environment because we have a Joint Venture partner who is asking us to pay this amount of a million pounds but they owe us a best part of a million pounds"*
>
> (Senior commercial manager, contractor).

Also a requirement to change the foundation due to the discrepancy did put a lot of pressure on the designers as they had little time to turn the new designs around to the team. Again the error caused designers to do double the planned works and thus inducing more pressure.

The senior commercial manager added;

> "*It has put a lot of pressure of the designers and the design resources which have been stretched which means the designs are being delivered late"*
>
> (Senior commercial manager, contractor).

Furthermore, the inadequate communication and inexperience portrayed by the engineer increased the cost.

5.3.1.4 Measures to manage critical incident

These comprised, high level meetings, building ahead of design approval, contingencies (employment of extra staff) and re-sequencing of works. These measures are highlighted in the following quotes respectively;

> *"We have weekly site meetings and monthly design meetings and if things cannot be resolved then they are escalated to the monthly progress meetings where we resolve them. But the intent is to resolve design and site issues at the schedule meetings and the progress meeting focus on the overall progress of the project where there is the project director, client, construction head and commercial head and also project directors for the contractors"*
>
> (Project manager, client)

> *"We are actually building far in advance before we get approval from the designs. So we are building at risk we are ordering larger quantities of reinforcement on the assumption that the design we have been given will be approved"*
>
> (Senior Commercial manager, contractor).

> *"So our acceleration measure is not that we finish on time but also to get more float times so that if we have problems in future, we have something to fall back on. So not just planning to recover time lost but also get us extra free time to take care of loss in the future"*
>
> (Senior Commercial manager, contractor).

> *"We ended up employing additional staff to help recover the programme that we lost in terms of the design delivery. On the structural side, we are conscious of the fact that everybody had to do their design before we could start doing ours because we need fairly fixed information to do our detailed design. Our services side underestimated the amount of design work for the project and they also fall behind so that has been a source of frustration for everybody as well. They have put in lots of efforts to recover their positions as well and are now back up to speed"*
>
> (Project Director for the structural engineers, contractor).

5.3.2 Late payment

This is a delay in payment from the client to the contractor.

5.3.2.1 Availability and manifestation of critical incident

From the case study findings, one respondent and two documents revealed late payment as a critical incident.

Late payment caused a delay in the project. This was as a result of client not releasing funds on time and thus affected the ordering of parts of the process plant required for installation. This late payment was bred from the foundation change issue that was being settled and thus made the commercial manager lose track of the certificates sent for payment.

5.3.2.2 Expectation of critical incident

The respondent and the two documents which identified the late payment as a critical incident revealed that it was unexpected. Further, this critical incident was identified during the latter part of the design stage.

5.3.2.3 Effect on delivery and success on project

This led to a delay in ordering materials required for the project and thus delayed the planned works.

5.3.2.4 Measures to manage critical incident

Extension of time was allowed the contractor to compensate for late payment and time loss. Also, meetings to promote innovation to make up for time loss were employed. For instance,

> *"We had an extension of time because they didn't pay us on time so they gave us a grace time that if we are late they won't apply LAD's for the second event there is an ongoing claim. Also we did have some meeting to see the impact and develop innovative ways to move forward"*
>
> (Project coordinator, contractor).

5.3.3 Concrete Pour

5.3.3.1 Availability and manifestation of critical incident

From the case study findings, one respondent and one document revealed concrete pour as a critical incident.

During the design stage, the process activities manager identified an issue with the concrete pour. The method in which the concrete was poured was not in accordance with what was specified in the method statement. This therefore caused a crack in the concrete because it was not continuously done as recommended. Though the process activities manager confirmed that the client had knowledge about this instance from the start, it led to a stage where the client started blaming the process contractor and behaved like they were unaware of the developments. A respondent added;

> *"The client was saying we didn't manage our project early and that we should have done it in a different manner and when I discussed it with the project manager he told us that this concrete pour was really bad on us because we had to demolish a slab and it had an effect on the programme"*
>
> (Process activities manager, contractor).

5.3.3.2 Expectation of critical incident

The respondent and the document which identified the concrete pour as a critical incident revealed that it was unexpected. Further this critical incident was identified during the design stage.

5.3.3.3 Effect on delivery and success on project

The concrete pour issue delayed the works and demoralised the process team.

> *"It affected us a lot, because the client was saying we didn't manage our project early and that we should have done it in a different manner and when I discussed it with the project manager he told us that this concrete pour was really bad on us because we had to demolish a slab and it had an effect on the programme. So in all it caused delay and cost effect"*
>
> (Process activities manager, contractor).

5.3.3.4 Measures to manage critical incident

A demolishing and re-construction of the element were carried out. This was catered for by contingency allowed for by the contractor. Prior to this reconstruction in-depth communication was carried out to identify who was required to own the cost and ensure that the works did not affect other parts of the works;

> *"A lot of emails and weekly meetings were required to identify who owned the cost and ensure that the works did not affect other parts of the works"*
>
> (Process activities manager, contractor).

From the critical incidents discussed, the measures to manage disruptions which portrayed capabilities were coded under the respective capability. For example, Figure 5-2 shows the measures which were evident of proactivity.

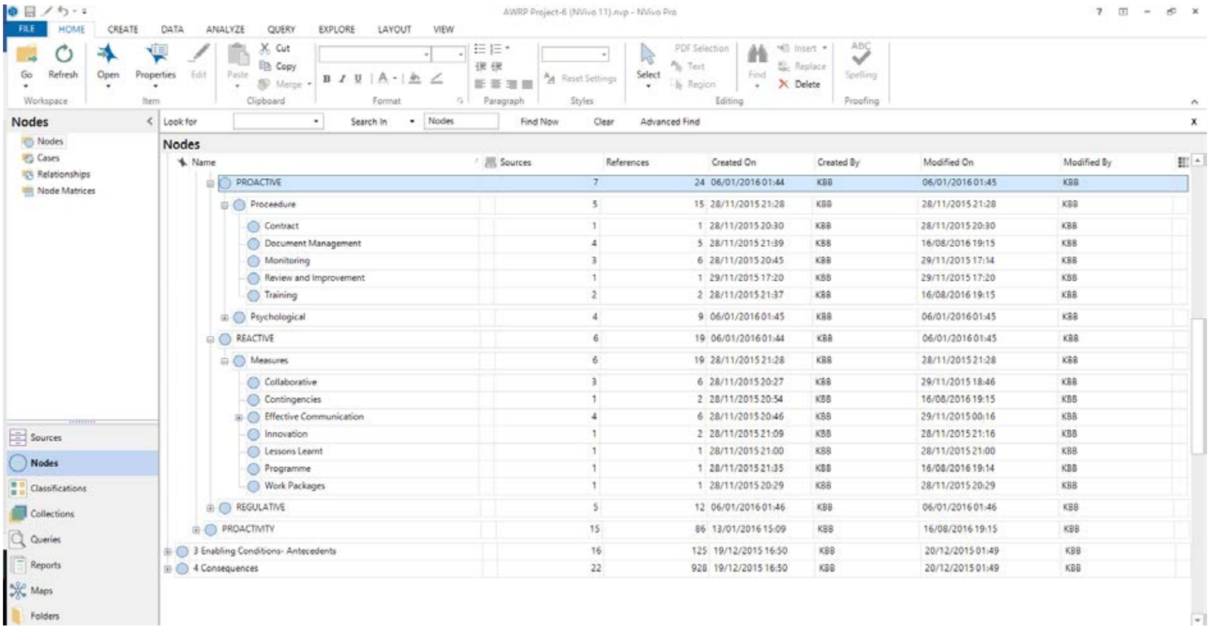


Figure 5-2 Evidence of capability (proactivity)

PART B- Capabilities for Project Beta

This section discusses identified capabilities revealed within Project Beta in managing disruptions caused by the critical incidents. Capabilities identified include proactivity, coping ability, adaptability, flexibility and persistence. These capabilities enabled the project respond, prepare for and reduce vulnerabilities.

5.4 Proactivity

Within Project Beta, this future-focussed capability is identified through the project management procedures, project management mechanism (contingency) and experience. Proactivity in project Beta led to readiness of the project, reduction in vulnerability and aided response during the critical incident.

5.4.1 Project Management Procedures

The procedures manifested during the disruptions to aid proactivity were; contract, effective document management, training, monitoring and learning lessons.

5.4.1.1 Contract

The contracts set up within the project provided collaboration and the platform for effective communication during the disruption.

In terms of collaboration, the Public Finance Initiative (PFI) tender process enabled the early involvement of the construction team with the client and thus provided an early relationship and a basis for collaborating from the start of the project and to maintain a common team goal. This was highlighted by the senior commercial manager on the contractor's team;

> *"We were involved in 2009, quite early I think 2009/2010 we had an agreement that if they were successful then they will use us in the bid in the design and construction element. Our relationship began from here. The client was awarded the contract in 2011 and we then signed the pre-engineering contract with the client in 2011 and that contract was novated to 2014 last year"*

This established relationship enabled the client to trust the contractor during the foundational issues and provided them with a specific date to resolve issue. Also, within the contractor's joint venture, the existing contract enabled them collaborate and share the risk of the incurred cost of foundation change. This collaboration was still attained despite the blame game. In this blame game; Joint Venture (JV) parties within the UK branch were blaming the French for providing wrong loadings and the French blaming the UK for proving wrong ground conditions.

Also clauses in the NEC3 and IChemE such as clauses 2.6 and 11.7 provided the collaboration platform for the Joint Venture contractors to look at opportunities in selecting the best foundation option moving forward. This was made possible due the liabilities the JV held based on the contract and the need for the issue to be resolved with the best endeavours possible and within the shortest possible time. This led to a systematic review process by the parties that helped resolve the issue as stated below thus;

> *"We had a number of reviews with our process plant partner to show the problems and the potential solution and to gain agreements to the technical capabilities and that the results with be satisfying for the process plant*

equipment. In parallel with that we did look at opportunities of going to pile foundations or raft foundations and the consequences of both technically and commercially. So we explored those 2 options but those two went back to the original pad foundation scheme. So we examined both technical, cost and programme implications of this change and internally within the UK branch and shared with the French branch in terms of process and we agreed the raft is what we will go for and that's what we took into design"

(Senior Commercial Manager, contractor).

Furthermore, the contract outlined communication requirement and information release schedule. This ensured the information was meeting the right requirements and managed and released appropriately during the foundation issue. This contractual communication requirement maintained relationship and brought the parties together to integrate the programme and decide on the best way to recoup time loss as a result of the incident. This led to solutions such as working over weekends and pre-fabricating aspects of the works to recover lost time.

The contract was also adjusted according to the legal requirement which had changed based on technological evolution since the contract was signed seven years ago. This adjustment minimised the impact the foundation change would have had on the project.

5.4.1.2 Effective document management

The JV confirmed to have an effective document manage and exchange system which provided the project with the right information during the evolution of the foundation change issue. It is identified to clearly show whose fault it was that caused the foundation change and thus incurred the cost accordingly. Also, this document exchange system provided the information required for the JV to learn lessons from mistakes and move on.

Lessons learnt shared on the document exchange system was used when error in concrete pour was experienced. This enabled a strict supervision and ensuring that the method statement was followed by the team when concrete on other section of the work was being carried out.

5.4.1.3 Training

Training such as understanding the contract and outlining responsibilities were carried out. The client went through the clauses in IChemE contract with the team to ensure the reason for adopting the contract was known to the team prior to the foundation issue. The reason being;

> "*it has a better structure for process plant and for testing and commissioning and clearly outlines responsibilities and explains what is required*"
>
> (Project manager, client).

Also, training process to highlight responsibilities amongst parties and revealed liable parties were carries out. Internal training amongst team from their parent organisations were identified to influence how change was managed and the empowerment it provided them to enable them work through it. For instance, the teams highlighted that these training courses had given them confidence. Again in-house change management training procedure was carried out in the project to ensure that all parties were aware of the change processes and this saw the team through during the onset of the foundation change which brought shock to the team. The change process provided parties with something to fall on whilst the issue was being resolved.

5.4.1.4 Monitoring

Continuous monitoring through the programme, risk, opportunity and uncertainty register and health and safety responsibility were identified.

Programme assessment was carried out continuously to ensure co-operation between contracts as per contractual requirements. This comprised of meetings to review events and share new knowledge. These and other reasons were captured in the Project Execution Plan as summarised below;

> *"The meetings will also provide an ideal forum for the reviewing of assessments, objectives and strategy, along with the brainstorming of initiatives etc. These matters, in addition to other relevant issues, are also discussed at the site safety committee meeting which includes members of the workforce. The requirement to instigate and manage the Health and Safety Committee is part of the UK Contractors Group Strategy which applies where the Company is the Principal Contractor and there are more than 25*

persons employed on the site"

(Project execution plan, document).

The continuous programme assessment helped control the disruption caused by foundation change. This was by identifying opportunities and highlighting the potential of the risk of further delay caused by the event.

Following the foundation change, the existing coordinated programme between the civil (UK) and the process engineers (France), enabled the Project Manager manage the two separate teams by considering the issues within the programme. This was by incorporating, editing and re-sequencing activities to ensure that both parties were happy and that it had little impact on the project. This called for a weekly meeting to ensure continual monitoring of events;

> *"we had weekly meeting to ensure continual monitoring of events. It probably leads to a very solid program that we are happy with and that everyone understands and buys into because we have to know if we are not producing what we have to its more of tracking the volume of whatever we are producing and making sure we keep our eye on the programme and what's the critical path"*

(Contract Manager, contractor).

More so, the same risk and opportunity register were employed for continuous monitoring of works for both NEC3 and IChemE contracts. Continual identification of risk were carried out on a monthly basis during the disruptions and managed with contingencies allowed.

With risk management, when early warnings were prompted, quick measures were introduced to resolve matters. To ensure continuity, the risk management process had a cycle called the risk management cycle and comprised of monthly reviews which focus on specific Monthly Risk Review Bid Teams, Pre-tender HSE Risk Register, Project/Contract Risk Assessment and HSE Risk Control Schedule: Project Plan. Again in managing risk during the disruption, a systematic monitoring and agreeing of suggestions by the project controls team was carried out to enable the project spot things before they occur and with understanding. This was highlighted by the project manager for the client;

"On this projects it's more on experience and ok'ing things to understand things to spot things especially risk before they happen and warn them and get things examined"

More importantly, health and safety responsibility within the project despite the disruption was maintained through monitoring. All parties were required to ensure old and new works were to be carried out in accordance with the projects health and safety standards. This continual monitoring of the responsibility push was to prevent further disruptions and thus maximize the limited time available.

5.4.1.5 Learning lessons

Evidence of continual lesson learnt is evidence of the anticipatory capability by the project. This was pointed out by the senior commercial manager;

"We will learn from our lessons so when we tender for our next project with a JV partner. We will ask them what their loading requirements are and what their differential settlement requirements are. So yes we will learn from our mistakes but it won't stop a different thing from happening. We will always have something new coming but that's the nature of construction. You just have to do your best to limit it and learn from your mistakes. Change in civil engineering and engineering projects is more common than in building projects which you get the problems in the ground only but in civil and engineering it's all through and a lot more complicated with a lot more risk."

(Senior commercial manager, contractor)

Also, from the above information, the awareness of the complexity and change prone nature of these projects provides a continuous platform for the project to learn from every disruption and move on.

5.4.2 Project Management Mechanism

Project management mechanisms are structures put in place to enable project execution. The mechanism utilised during disruption was contingency.

5.4.2.1 Contingencies

Contingencies allowed on the project enabled the project manage disruption in cases where planned active procedures where insufficient. This comprised extending working hours and employing new staff to resolve these. Thus;

"We ended up employing additional staff to help recover the programme that we lost in terms of the design delivery…….They have put in lots of efforts to recover their positions as well and are now back up to speed"

(Project Director for the structural engineers, contractor).

5.4.3 Experience

Experience from past similar project enabled readiness. This enabled the team manage the disruption without allowing its impact such as lack of trust to further disrupt it. The experience enabled agreeing of solutions such as contingencies and extra resources to enable it move forward.

5.4.4 Summary of antecedents and consequence of Proactivity

Table 5-2 presents a summary of the identified antecedents and the consequence of proactivity that emerged from sections 5.4.1-5.4.3.

Table 5-2 Antecedents and consequence of Proactivity

Project Beta		
Antecedent	Consequence	
Contract- NEC3 and IChemE	Collaboration and effective communication, trust	Readiness
Effective document management	Identified whose fault it was and thus incurred cost	Response
Training	Clearly outlined responsibilities and understand the change process	Readiness, Response
Continuous monitoring	Emergent risk identification and update Risk and opportunity register, early warning	Reduction
Communication	Review and improvement	Readiness, Reduction
Lessons learn workshop	Avoid repeating mistakes	Reduction
Contingency	Extend working hours	Reduction, Response
Experience	Readiness	Readiness

<u>5.5 Coping Ability</u>

The manifestation of this capability to manage and deal with shock caused by disruptions within Project Beta was evident in taking responsibility of the incident, regulating the impact of the incident and by reacting to the incident. These are further discussed below.

5.5.1 Coping by participating

This ability to manage and deal with shock was identified by the high level of experience and efficiency of the team. The project manager explained that everyone on the project had handled past similar events so they all got involved and were able to deal with the shock. He added;

> *"luckily, we had people with the right mind and the right experiences to be able to overcome these challenges and absorb the shocks"*

(Project Manager, client).

Also, the project manager also shared how he coped by participating during the foundation change. This was through staying positive and working with the rest of the team. He also added being a problem solver and enjoying the challenges that came with it based on the experience he had acquired. More so, coping was identified as a result of 'common sense', the project manager added. Thus;

> *"Nearly all the things I do boils down to common sense, so whether it is administering the contract or trying to resolve differences, between employer and contractor with high degree of common sense between what is right and wrong. Generally is it difficult to keep everyone in agreement but as long as you set it in a common sense way, everyone can see and understand it"*

(Project Manager, client).

This common sense platform enabled the rest of the project team participate when recommendation to resolve the concrete pour issue was provided. It provided the understanding required for the team.

5.5.2 Coping by taking responsibility of the incident

Contractually, the responsibilities allocated to parties drove the project to manage and deal with stress through responsibility acceptance. For instance effect of the late payment issue caused by the client was resolved by the project commercial manager taking up the responsibility to advice on the cost benefits and supplier selection in order to get the materials required and move on with the project without further delay.

Also, the senior commercial manager added that engineers are built for taking up responsibilities such as these as such they do not see taking responsibility as a job or a challenge but as part of their day to day works.

> *"Engineers are built better to overcome these and that's why we enjoy it. We see every day as a challenge. It's a good thing"*

(Senior commercial manager, contractor)

In addition;

“Most engineers are self-motivated to perform”

(Project director for structural engineering)

Further, the contract manager shared how he ended up as a mediator between the construction and design team due to the foundation design team which required new drawings and this put pressure on the design team and created impatience for the contractor team. He stated that;

> *“I ended up being a mediator between the construction guys who were fed and just wanted to get on with the works and the design guys who are struggling and having their issues and frustrated that it’s not getting turned up and then they client they wanted us to hurry up and accelerate as quick as possible and we said we are not quite there yet so they is no need rushing to get it done”*

(Contract manager, contractor).

His mediator role ensured that both parties understood what was going on and came to the decision that drawings be handed out to construction team at earlier phases rather than waiting for entire completion before construction in order to keep works on site going.

Based on the complexity of the project, and its various contractual parties, responsibility acceptance was experienced both from parties on site and those who work virtually. This was explained as;

> *“I was responsible for getting additional geotechnical inputs and managing the production of the information and I was doing that remotely by my staff in Leeds”*

(Project director for structural engineering, contractor)

These geotechnical inputs provided the ground conditions required to redesign the foundation.

5.5.3 Coping by regulating the impact of the incident

This is defined as controlling ones feeling and attitude towards a disruption. Experience, contingency and lesson learnt influenced how they coped. Experience and contingency enabled them adjust by not panicking during the loss of trust amongst the team and blame game caused by the disruption. The experience thus led to agreeing of solutions such as contingencies and extra resources to be introduced on the project to enable it move forward.

Also, the promotion of communication to help resolve issue faster regulated the impact disruption. Communication enabled clarification and minimised the impact of the disruption through the understanding it brings.

> *“We have been there talked a little about it and hopefully try and understand where people have been before”*
>
> (Contract Manager, contractor).

Contingencies such as extending working hours, employing new people to work during these hours and also allowing of extra resources aided in controlling feelings. Furthermore, an extension of time awarded the process engineering team due to the late payment by the client team also enabled controlling the impact of shock.

> *“We had an extension of time because they didn't pay us on time so they gave us a grace time that if we are late they won’t apply LAD’s for the second event there is an ongoing claim which is instructive at the moment”*
>
> (Process activities manager, contractor).

More so, coping through regulating the incidents was enabled by lessons learnt from past projects. This provided shared lessons from experience and thus informed how they regulated shock. These were seen in responses such as enabling design team release packages of construction at closer interval stages rather that at the end of the whole design phase. This reaction decision was learnt from a similar project, thus;

> *“We have another energy to waste project which is still ongoing so we learn things such as these from there”*
>
> (Senior design and engineer manager, contractor).

5.5.4 Coping by reacting to the incident.

The impact the delay caused by the disruption was adjusted by identifying opportunities. These were through innovation.

Project Beta sought to identify opportunities from the incident in reacting to the impact it had had on them in order to aid adjusting. This innovative ideas identified and employed to react to the incident include increasing the size of the site to provide more space for the new employees to work on the site and faster and re-programme the way the plants are commissioned so that they align more closely and minimise the disruption caused by foundation change.

> *"We have identified opportunities to increase the size of the site, and provide more space to the contractor which hopefully is helpful for them. We have also found an opportunity to simplify the grid connection which is vital because it is required to come in on time to allow commissioning to start. So we have found a solution to simplify the level of interface which will hopefully help 3 parties and we also have found an opportunity to re-programme the way the plants are commissioned so that they align more closely and minimise the disruption that would have been caused in the original design sequence"*

(Project Manager, client).

Also opportunities such as prefabricating certain areas of the work separating drainage system from ground water level in order to reduce the drains required by the new foundation and thus save the project about £100,000 pounds were taken.

> *"So that will save about £100 thousand and the rest of the opportunities are lower between £5000 and £15,000".*

(Planning control manager, contractor)

5.5.5 Summary of antecedents and consequence of Coping Ability

From the manifestations of the proactivity discussed above, a summary of identified antecedents and the consequence emerged from sections 5.5.1-5.5.4 is captured in the Table 5-3.

Table 5-3 Antecedents and consequence of Coping Ability

Project Beta		
Antecedent	Consequence	
Coping by participating		
Experienced team membership formation	Communal participation and promotion of positive attitude	Response
Coping by taking responsibility		
Contractual responsibility	Ensure late payment issue was resolved and enjoy role	Response
Mediation by contract manager	Kept parties updated with works	Readiness
Coping by regulating impact		
Experience	Not panicking, maintain trust and agreeing on contingencies	Readiness, Reduction
Extending working hours, new	Working Efficiently	Response, Reduction

staff		
Training- Lesson learnt	Minimised impact on team and enabled quick team collaborative resolution	Reduction
Coping by reacting to the incident		
Innovation	Increase size of site, cost saving of £100,000	Readiness, Response

5.6 Flexibility

This is a capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained. Within Project Beta, evidence of this is identified in the accommodation and innovation ability of the project. These manifestations of flexibility reveal the exact antecedent and consequence.

5.6.1 Accommodation

Flexibility was manifested by the accommodating nature. Accommodating enabled different sections of the project to appreciate each other's work and thus influence the flexible decisions made during foundation change.

Accommodating provided the empathy required to arrive at considerate decisions so that each party experienced minimal pressure caused by the critical incident. The senior design and engineering manager shared how accommodating of the different teams influenced the decision made;

> *"Our programme team have better idea on the time scheme and our commercial on cost but each of us has a broad understanding of each ones needs. So even though we thought pad was the cheapest, the situation was not viably justified and quality wise as well. So each of us has to have an understanding to a reasonable degree on all those aspects and not in isolation"*

(Senior design and engineer manager, contractor).

Accommodating provided the collaboration required to resolve the foundation issue with no clashes after decisions were made and ensured smooth running of the foundation works. Also, accommodating enabled design changes to be contractually agreed. Thus agreement led to the foundation;

> *"That originally was sat on pad foundation and it's now a raft foundation …this is due to understanding we as a team had.."*

(Contract Manager, contractor).

The awareness of potential issues enhanced the accommodating during the re-designing period required during the foundation change despite the short turn in time allowed. Accommodating was also enabled by open-mindedness.

5.6.1.1 Open-mindedness

The open-minded nature of the team enabled the overall accommodating required to re-consider decisions made. Though decisions by some project leaders were made on behalf of the team, inputs from them were welcomed and suggestions to the impact of the decisions from these parties were considered. For instance, some suggestions which were seen to provide immediate positive impact were revealed by the rest of the project team to have negative consequence in the long run.

> *"You always have to have an open mind for those things and very weary of. there might be some things like I have changed the design and I could save 1 cube of concrete and others but it might cost you a month in time to do it and in changing something you want to make sure that you rather not lose time on it so you need to be weary of what opportunities you might to take and the team helped a lot especially during the foundation issue"*

(Contract Manager, contractor).

5.6.1.2 Planning

Flexibility through planning was enabled by the accommodating nature of the project. The foundation change was accommodated by re-sequencing of works in the most economical way possible. This was enabled by planning the works such that extra-hours and days (contingencies) were included in order to complete the works within the expected time since time on this project was fixed. This flexibility in planning also called for extra resources to be incorporated to aid the planning changes.

> *"We have done a lot of re-sequencing and there are better ways to do it and the end result is we have seen we need to work over the weekend which is 6 days a week which is not great for every body's personal life. So this is where at my level we are looking to put things together like get extra staff and do a rota so that some people aren't working weekends all the time."*

(Contract Manager, contractor).

Again, planning was edited to accommodate decision made by the design team to rush through low risk designs in order to create more time to meet strict deadline, Contract manager added;

> *"So we have got on with the stuff that we thought was low risk and we are happy to rush through with design without waiting for approval and that how we were able to start off early and overlap with the design."*
>
> (Contract Manager, contractor).

5.6.2 Innovation

On the other hand, innovation which manifested flexibility was evident in cost-effective re-programming, material recommendation and design solution.

Firstly, the cost-effective re-programming was arrived at due to opportunities identified by the design team such as pre-fabricating aspects of the works sped up the works. The consequence of this;

> *"opportunities identified by the design team such as pre-fabricating aspects of the works sped up the works"*
>
> (Project Manager, client).

This innovative idea also enabled the accommodation of the programmes of the various parties within this multi-contract project to synchronise despite delays by late payment and concrete pour issue. More so, the material recommendation from hardening concrete to rapid hardening concrete based on concrete pour issue was provided. This innovative idea led to the reduction of the cost the contractor bore. Lastly, the design solution through shared innovative ideas by the project leaders led to incorporation of new designs in the best way possible to ensure minimal further disruption during the works. For instance the structural engineer shared;

> *"We then had to work out how to incorporate these on the design we had originally and the best way of manipulating the design so that we can manage the differential settlement in the most economic manner because the original foundation was no more appropriate for what has now been asked*"
>
> (Project Director for the structural engineers, contractor)

5.6.3 Summary of antecedents and consequence of Flexibility

From the manifestations of the proactivity discussed above, a summary of identified antecedents and the consequence emerged from sections 5.6.1-5.6.2 is captured in the Table 5-4.

Table 5-4 Antecedents and consequence of Flexibility

Project Beta		
Antecedent	Consequence	
Accommodation	Empathy so that each party experienced minimal pressure and promoted collaboration, accommodate	Response
Open-mindedness	Provided understanding required to re-consider decisions made and allow for change in contingency allowed, accommodate	Response
Planning	Allowed contingencies and re-sequencing of works, accommodate	Response
Innovation	Cost saving (material change and design changes)	Reduction

5.7 Persistence

Persistence within this research is defined as the capability to continue despite disruptions. This is due to the functional capacity of the system which aids it to withstand and dynamically reinvent strategies as the system encounters disruptions. Within Project Beta, evidence of these was identified. These were through the contract, project monitoring, contingencies, innovation and continual planning.

5.7.1 Project Persistence

5.7.1.1 Contract

The contract enabled project persistence. The IChemE contract used provided the justification needed to continue despite the disruption caused as a result of the incident. The IChemE contract includes the rigorous clauses required to accept plants and the works. Also the responsibilities set out within both contracts do not allow the individuals to stop works until their respective responsibilities have been completed and this drove individuals and hence the rest of the team through the works especially during the disruptions to persevere.

5.7.1.2 Contingency

Evidence of project persistence was identified in the introduction of extra resources and working hours in order for the project to make up time loss caused by the disruption during its evolution. This was seen through responses such as;

> *"So currently to make up for time loss, we have different people coming in over the weekends to work even though we are still resolving the issue. The sub-contractors have been advised to have extra resources also which will enable these weekend workers to have"*

(Senior Commercial Manager, contractor).

5.7.1.3 Continual monitoring

Again, continual monitoring of risk and uncertainties despite disruptions experienced showed the persistence nature of the project. This called for extra monthly meetings despite the meetings which were being held to resolve the concrete pour and foundation change issue. Example;

> *"As uncertainties or risk are identified once the project is ongoing in the risk register and then the risk register is managed on monthly basis to make sure that the issues are added and taken off as appropriate and also progressed in a sensible time frame"*

(Project Manager, contractor).

Also, despite the frustration being experienced by the team, continual monitoring (responsibility of the project manager set out in contract) was being carried out on the projects whilst the issues were being resolved simultaneously.

5.7.1.4 Continual planning

Continual planning to maximize the programme were being carried out whilst the foundation change issue was being resolved. This was also being done despite the frustration of the team at the time due to the blame game that had arisen within the project. This ability to continue work on the programme to maximize its output despite the issue enabled the team accelerate and save a cost £30,000 prior to the final foundation resolution decision.

More so, the work packages of the project drove the team to strive for works to be completed.

> *"That's getting the necessary designs completed in good time through planning continuously so they can construct and procure the right equipment's for the right design in the right time scale…."*

(Project Manager, client)

The end-goal focus through continual planning helped the project through the disruption and thus ensured that successive works were completed in time prior to their dependent works. This also prevented any further delay.

Again, continual planning promoted innovation in the midst of the disruption. This was highlighted by the project manager and showed how determined the project was. Thus;

> *"We are challenged to constantly review value engineering and suggest innovative ideas regardless of what we are going through especially during the foundation change issue"*

(Project Manager, client).

5.7.1.5 Negotiations

Negotiations enabled continual collaboration and communication amidst disruptions. This was through meetings (example emergency meetings) despite loss of trust. For example;

> *"we had to negotiate to maintain the collaboration though the issues had caused mistrust amongst us"*

(Project Manager, client).

Negotiation was eased by the strict collaboration rules set out in the contract. These helped the project resolve issues quicker and toughen the project team, the project manager revealed. Also, continual negotiation was carried out with the joint venture partner in terms of foundation changes in order to share extra cost which had been incurred in order for the project to continue because this had delayed the project.

5.7.2 Summary of antecedents and consequence of Persistence

From the manifestations of the persistence discussed above, a summary of identified antecedents and the exact consequence emerged from sections 5.7.1 is captured in Table 5-5.

Table 5-5 Antecedents and consequence of Persistence

Project Beta		
Antecedent	Consequence	
Contract	Prevents individuals to stop works until their respective responsibilities have been completed	Reduction, Readiness
Contingencies	Made up for time loss	Reduction
Continuous monitoring	Risk and uncertainty identification	Reduction and Response
Programme	Enabled the team accelerate and save a cost £30,000, Drove the team to strive for works to be completed, ensure that successive works were completed in time for their dependent works	Reduction, Readiness
Negotiations	Cost reduction, Collaboration and communication	Readiness, Reduction

5.8 Interrelationship amongst capabilities

Proactivity is identified as an overarching capability enabling aspects of coping ability and flexibility. Whereas, coping ability enables flexibility and persistence.

5.8.1 Proactivity enabling coping ability

This anticipatory capability influences the ability to manage and deal with shock caused by disruptions; coping ability. Identified procedures which enable coping ability vary. For instance, under coping-by-participating, project management procedures identified include continual monitoring and programme. For coping-by taking-responsibility it was through the contract and under coping-by-reacting, it was through the contingencies and opportunities. Table 5-6 captures how these procedures enable coping ability

Table 5-6 Proactivity enabling coping ability

Identified Procedure	How procedure enabled project cope
Continual Monitoring	It drove the design team to work collectively and get involved in order to prevent any further design risk which would hinder the project
Programme	Saving cost and team to accelerate faster
Contract	Enabled the team maintain their roles despite the critical incident and thus work collaboratively to resolve the incident.
Contingency	By reacting to the incident in cases where planned active procedures where insufficient.

5.8.2 Proactivity enabling flexibility

Proactivity enables flexibility and this is evident in aspects such as contract and planning as shown in Table 5-7.

Table 5-7 Proactivity enabling Flexibility

Identified Procedure	How procedure enabled flexibility
Contract	Enabled extra funds to be made available in order to be relaxed. promotes open minded nature also promotes communication and the free-will to share innovative ideas
Planning	Enabled the project accommodate and thus minimise the impact the foundation change

5.8.3 Proactivity enabling persistence

Proactivity enabled this ability to continue despite the difficulties. In relation to the project it was through contract, continual monitoring and programme as shown in Table 5-8.

Table 5-8 Proactivity enabling Persistence

Identified Procedure	How procedure enabled Persistence
Contract	Responsibilities set out within both contracts do not allow the individuals to stop works until their respective responsibilities have been completed and this drove the rest of the team through the works
Continual monitoring	Drove the team to work despite disruption
Programme	Cost saving

5.8.4 Coping ability enabling flexibility and persistence

The capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained is enabled by the ability of the project to manage and deal with shock. The ability to cope by participating influenced the understanding ability manifested in flexibility. Also, the taking responsibility ability enabled the re-design ability manifesting flexibility. On the other hand, coping by regulating the impact and reacting to the incident enabled the open-mindedness within flexibility.

The ability to continue despite difficult situations is also enabled by the ability of the project to manage and deal with shock. Coping by participating and taking responsibility is identified to drive mainly the individual persistence through the non-panicking ability experience from coping provides.

5.9 Chapter Summary

This case study revealed capabilities such as proactivity, coping ability, flexibility and persistence in managing the disruptions caused during the critical incidents. Antecedents for proactivity include project management procedures and mechanism and experience. Coping ability was enabled by antecedents of proactivity and manifested during the incident by coping through participating, taking responsibility of the incident, regulating the impact of the incident and by reacting to the incident. Furthermore, coping ability also enabled persistence and flexibility which both occurred during the and at the end of the disruptions caused by the incident. Flexibility was identified in the accommodation and innovation ability of the project. On the other hand, persistence was identified in the project persistence with the help of procedures such as contract, continual monitoring, continual planning, contingencies and negotiations.

6- Within case analysis of Project Gamma

6.1 Introduction

Data from Project Gamma is presented in this chapter. These consist of interview responses, documents on the project and observations. In all, eight (8) respondents were identified. Respondents were identified to be members of at least one professional association. Below in Table 6-1 is a summary of attributes of the respondents.

Table 6-1 Experience of respondents in Project Gamma

Respondent	Role on project	Gender	Team	Position in Organisation	Years of experience in current role	Years of experience in construction	Professional Associations
BE01	Client	F	Client	Senior principle project manager	2.5	35	FPM, FPMI, FRIA, MAP
BO02	Client side-QS	F	Client	Senior Quantity Surveyor	8	8	RICS
CR03	Operations manager	M	Contractor	Operations manager	3	18	MCIOB
FO04	Quantity Surveyor	F	Contractor	Senior Quantity Surveyor	7	7	None
LE05	Lead Engineer	M	Contractor	Associate	2 months	11	Institution of structural engineer
SC06	Lead Project Manager	F	Client	Senior project manager	26	8	Certified member of British Institute of Facility mangers (BIFM) and a member of APM
DP07	Project Architect	M	Contractor	Project Architect	2	10	AIA Fellow
NR08	Director	M	Client	Director	11	27.5	RIBA

Documents reviewed during the archival analysis were strategic ranging from soft and hard copy versions of project key information, design briefs, change control processes and minutes of client meetings.

Again, most respondents during the interview referred to one or more of these documents showing how information in there played key roles during the critical incident. Managerial level meetings like the client meetings, workshops and an emergency change meeting were observed. Information from these interviews, observation and documents were used in coding the capabilities on Project Gamma.

The critical incident lens used to capture these capabilities has led to the identification of four main capabilities within Project Alpha namely; Proactivity, Coping Ability, Flexibility and Persistence.

This chapter is presented in two major parts. The first part provides background to the case study (comprising project detail and risk, uncertainty and opportunity management process) and discusses the critical incidents. The second part captures the capabilities in the project to ensure recovery. Figure 6-1 shows a graphical representation of the background to the case study and capabilities identified together with the relationship between them.

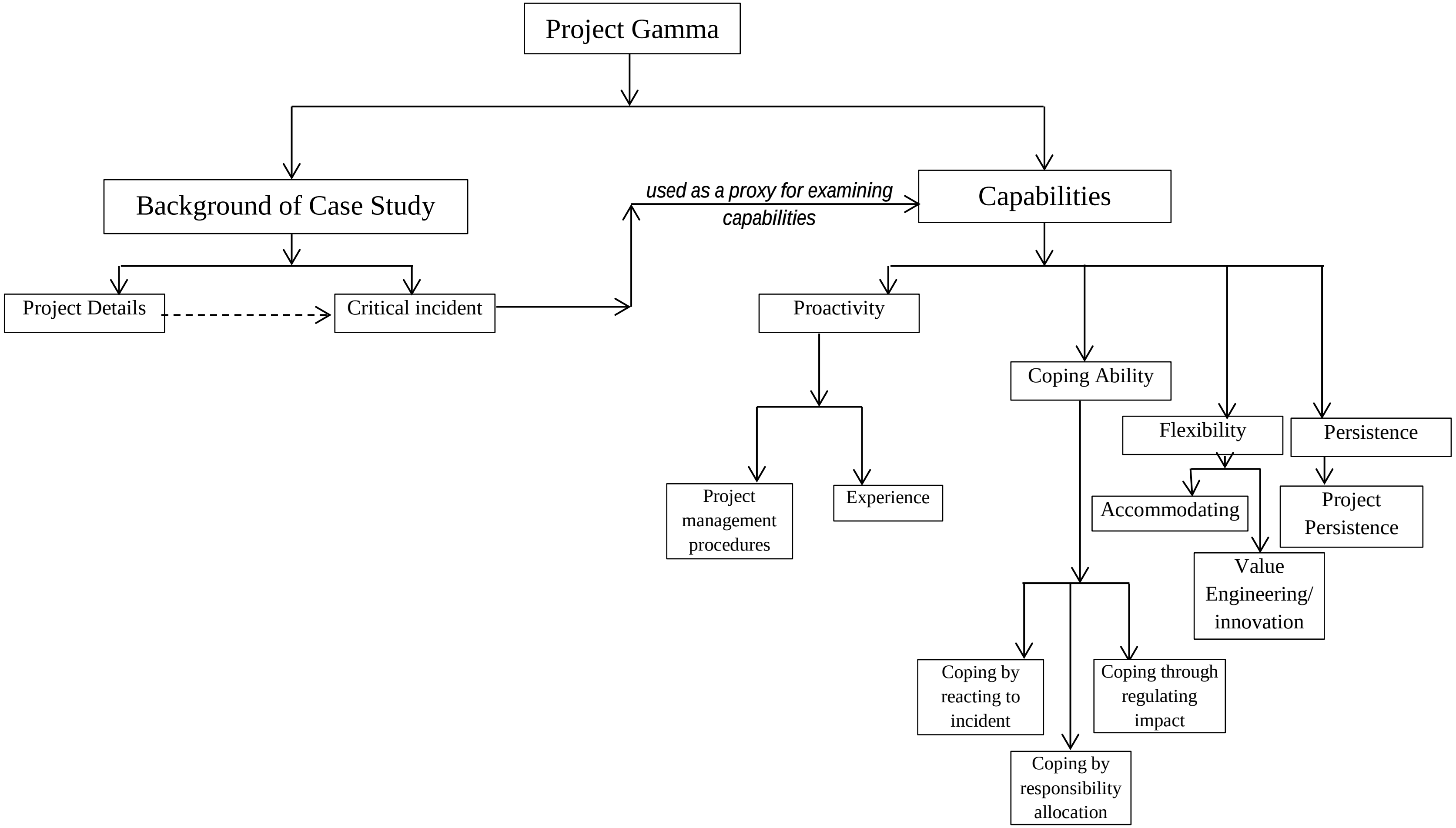


Figure 6-1 Graphical Representation of analysis of Project Gamma

PART A- Background of Project Gamma

6.2 Project Details

6.2.1 About Project Gamma

Project Gamma focussed on the execution of a new build structural extension to a bridge. It is planned to be completed in 55 weeks. The client's objective was to create new commercial spaces and new restaurants in the wingwall of the bridge. For the contractor, their objective is to make sure that the client gets the best service. They aim to resolve any issues that crop up, deliver the works on time and to budget.

However, due to the Grade 2 listed nature of the endeavour, it has encountered many challenges because of the many approvals required from different stakeholders before changes in the original plan is given a go ahead. Moreover, the Grade 2 listed nature hindered the contractor from stripping parts of the bridge off before commencing actual construction and this has caused some disruptions as the works evolved. Besides these internal factors which have caused delays, an external factor which is the adjoining property has also posed major challenges to the project in relation to logistics and also building into the Gamma site where the steel extension was to be placed. All but one of the respondents agreed that the project is delayed due to disruptions.

The main priority on this project is cost. Cost is a priority on this project because of the constraints funders have put on the amounts provided. This made availability of funds a challenge.

The Procurement route employed on this project is SCAPE. SCAPE is a framework agreement in which the contractor wins a number of works summing up to a certain amount. It is a negotiated two stage tender which means that all information is provided; feasibility and the rest of the things needed are provided as well. Works carried out by the contractor include the programme; pricing, budgets and the different gateway to get to a final pre-Figure are gone through. Ultimately SCAPE is an NEC 3 option A with lump and it passes all the risk to the contractor. Some advantages of SCAPE are it encourages collaboration and encourages everyone to be open and honest. In light of this, there is a spreadsheet that everyone on the team can see and share information.

SCAPE also makes the project more defined and tighter so you have more control from beginning to end. The current project life cycle stage is RIBA stage K which is the construction stage and as per the SCAPE gateways routes, it's currently the stage after gateway 4. Gate way 4 is the stage before construction where cost and design coordination are looked at.

6.2.2 Key Risk on the project

From the case study results, identified risks include water ingress, logistics and funding risk.

6.2.2.1 Risk Management

Water ingress has been managed by introducing sealants at the lower parts of the bridge to enable extensions be completed. These sealants were being monitored to ensure that it was able to prevent water from coming in.

The inability to get materials to the site during the daytime led to supplying materials at dawn through a walkway beneath the main road. This is because the works is located in the central part of London and has limited access points.

The risk of having insufficient fund from the charities sponsoring the projects was managed by communication. This was through organising workshops to explain to the sponsors the need for extra funds and the benefits of the changes for which the funds are required.

6.3 Critical incident- Project Gamma

The critical incidents manifested within the projects are discussed under these headings;

- Availability and manifestation of critical incident,
- Expectation of critical incident,
- Effect on delivery and success on project, and
- Measures to manage critical incident.

Overall, five (5) critical incidents lenses were identified namely; access confirmation through adjoining site, adjoining site building into gamma site, mechanical and electrical installations, budget and design development and planning approval.

6.3.1 Access confirmation through adjoining site

6.3.1.1 Availability and manifestation of critical incident

From the case study findings, two respondents and two documents revealed access confirmation through adjoining site as a critical incident. This was experienced early on, in the project.

The adjacent site is a housing and commercial development. In January 2015 sections of this development was meant to be completed in order for works in project Gamma to start. However, this was not completed and thus impacted on the overall programme of project Gamma.

6.3.1.2 Expectation of critical incident

The adjoining site issue as a critical incident was unexpected. This incident was identified earlier on in the incident and thus made managing it less challenging due to availability of resources.

6.3.1.3 Effect on delivery and success on project

Based on this critical incident, the project was delayed and extra cost was incurred. In terms of time, it affected the start date;

> "*access through adjoining site affected our start date and through we tried to look at other options in gaining access that was our only means…"*
>
> (Client).

More so, this incident affected the team in diverse ways. For example the client revealed:

> " *it was very very irritating because the contractor had appointed a team and they were all packed and ready to start and wanted to place orders and get the mobilisation done and everything. Although we were in the position to place the actual purchase order we couldn't complete the contract because dates had to go in there so it has actually taken far longer on this one to get the contract document to signature stage than it would normally take.. it did cause some frustrations amongst the team"*
>
> (Client).

Also, within the team it led to loss of trust and parties blaming themselves;

"*Loss of trust and emergence of blame game which I had to motivate my team to keep going and focus on the client goals"*

(Project Architect, contractor).

6.3.1.4 Measures to manage critical incident

The first measure employed was negotiation of access amongst the parties and moving start date until when access was confirmed.

> *"We negotiated access with adjoin site and pre-informed them on our progress ahead of time so we could coordinate activities and avoid more time loss"*

(Project Architect, contractor).

Furthermore, a time risk allowance of four weeks which was meant to be for the completion date was utilised at this stage.

Also, workshops to prepare the team were carried out to reduce the impact of the disruption on them. These workshops also motivated team to carry out works beforehand in order to be ready when access was granted.

6.3.2 Adjoining site building into gamma site

6.3.2.1 Availability and manifestation of critical incident

From the case study findings, three respondents, one observation and two documents revealed this as a critical incident.

The adjoining site built onto Gamma site and thus affected the structural works to be constructed. This was identified when electrical works were being systematically checked at a client's meeting.

6.3.2.2 Expectation of critical incident

The respondents, observation and documents which identified the adjoining site building into Gamma site as a critical incident revealed that it was unexpected. Further this critical incident was identified mid-way in the execution of the works (over a month into construction).

6.3.2.3 Effect on delivery and success on project

This created shock in the project based on the cost of redesigning. This cost was not catered for within the project and thus required utilising all contingencies allowed which were insufficient at the time.

This disruption has led to an unsigned contract.

6.3.2.4 Measures to manage critical incident

Monitoring of progress in order to mitigate and maximize available opportunities was carried out. In order to achieve this, the works was placed on hold for a couple of days. Monitoring was achieved by continuous communication and motivation amongst the team. Despite the availability of motivation by the project leaders, the Grade 2 listed nature (prestigious nature of structure) of the works motivating the parties was evident.

Furthermore, collaboration and re-sequencing of works were employed. These measures helped absorb the shocks the disruptions had created through participating. For instance;

> *"We did need to engage our architects and engineers when we saw that we can't do it ourselves because we don't have the solution. So we went on site, measured it two or three times and we agreed how to change the frame to fit in the space we have because we are not going to knock the lift down so we just had a few meetings to let the engineers and architect to redraw all the bits and move everything around and then we had to get the steel fabricated and then update their drawings to accommodate the changes and then give the manufacture"*

(Operations manager, contractor).

6.3.3 Mechanical and electrical installations

6.3.3.1 Availability and manifestation of critical incident

From the case study findings, one respondent, one observation and one document revealed mechanical and electrical installations as a critical incident.

The mechanical and electrical installation during a meeting with stakeholders and end-users was identified to be missing in the contract. This revealed that parties from both the client and contractor side had been negligent in their works. This was pointed out by these stakeholders and hence required re-working of major sections of the works.

6.3.3.2 Expectation of critical incident

The respondent, observation and document which identified mechanical and electrical installations as a critical incident revealed that it was unexpected. Further this critical incident was identified very later on in the project (after a stakeholders meeting) and thus made managing it very challenging.

6.3.3.3 Effect on delivery and measures to manage critical incident

This caused a change in programme and shock to the client. The client shared;

> *"I must say I could see shock of people's faces during the meeting and some including myself was distressed considering the strict financiers we have"*

Quotations for the client were provided for these unforeseen works. These quotations were covered by the unutilised contingencies allowed by the client. Also, the client employed experts who are trained to cater for disruptions such as these.

6.3.4 Budget and Design development

6.3.4.1 Availability and manifestation of critical incident

From the case study findings, one respondent revealed budget and design development as a critical incident.

At Royal Institute of British Architect (RIBA) stage 4 the project had a meeting with the client who were told that they had to reduce cost to the barest minimum possible in order for the works to go on considering the financial restraints being imposed them. Furthermore, the existing time constraint on the project due to access by the adjoining site caused more challenges. This made continuing with works almost impossible.

> *"it could only be done whilst the adjoining site was being constructed because after that had been constructed there will be no access to the rear of Gamma to carry out any work down that facade so basically we had to make sure we sat within their time frame but also provided a project that was cost effective to the client but these required more funds".*

(Lead Engineer, contractor)

6.3.4.2 Expectation and effect of critical incident

The respondent who identified budget and design development as a critical incident revealed that is was unexpected. Further this critical incident was identified mid-way in the project (at RIBA stage 4) and thus made managing it very challenging. This issue affected the resolution of other critical incidents.

6.3.4.3 Measures to manage critical incident

Value engineering, self-motivation of the team, cost cutting and re-engineering were the main measures employed. These are presented in the following quotes respectively;

> "*Obviously it took us more time to refine the design that we had provided, so we had to check the steel works and how effectively it is. So we have 3D analysis software for our steel frame and it was physically going through that passage to see if we would save some money. Like I said it was hard more than anything else. With the structure what works is generally that the limited amount of structure can impact on VE because it will generally be designed to what it needs to be and may require very little scope to produce that structure back. So we had to be quite clever with what we suggested to try and keep the cost down"*

(Lead Engineer, contractor).

> *"Motivation for the team was to have it over the line and get it built on site and as I said before it is one of those projects where for various reasons we are not going to make loads of money on it. But it is one of those projects that you are proud to have worked on so that should be the only motivation that you need"*

(Lead Engineer, contractor).

> *"The new architect cut cost significantly by changing a few architectural details and which meant there was a bit of re-engineering required but it made every body's life a lot easier and a lot cheaper than before. So for example the glazed roof over the restaurant area next to the bridge itself, that had a glazing standing which was an interesting concept and the new architect omitted that and came up with a lot more simple system which made it a lot more less bespoke so it cut the cost out in that respect which is good and helps pinning the project down"*

(Lead Engineer, contractor).

6.3.5 Planning approval

6.3.5.1 Availability and manifestation of critical incident

From case study findings, one respondent revealed planning approval as a critical incident. The resolutions of this, is through manifested capabilities. Furthermore, the planning approval for this project was critical considering the project was Grade 2 listed. This is because a number of different stakeholders were required to approve the works. Also, considering the security threat this project posed, more critical measures were to be considered prior approval. This manifested in an iterative process which eventually enabled the project gain approval.

6.3.5.2 Expectation and effects of critical incident

The respondent who identified planning approval as a critical incident revealed that is was unexpected. Further, this critical incident was identified earlier on in the project and thus made managing it less challenging. The planning approval issue led to the delay in contract being signed.

6.3.5.3 Measures to manage critical incident

Communication, collaboration and continual monitoring of drawings, involvement of planning team and self-motivation were measures employed. This was highlighted in the client’s statement;

> *“Open communication through regular parties and regular programme reviews so we know week to week if there are any delays happening in advance so we can plan and sort of flag out any risk that will come in, things that may affect the programme…………As a team we were motivated to recover as much time and this was through continuous communication between the team and contractor specifically to try and reduce the delay”*

(Client).

From the critical incidents discussed, the measures to manage disruptions which portrayed capabilities were coded under the respective capability. For example, Figure 6-2 shows the measures which were evident of proactivity.

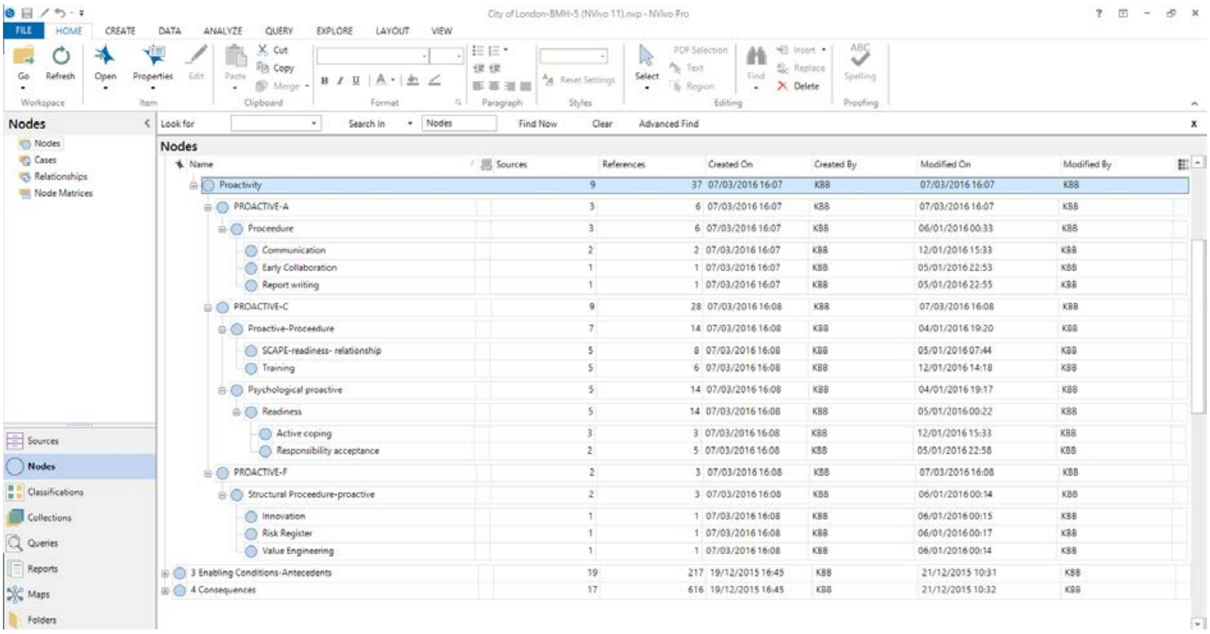


Figure 6-2 Evidence of capability (proactivity)

PART B- Capabilities for project Gamma

This section discusses identified capabilities revealed within Project Gamma in managing disruptions caused by the critical incidents. Capabilities identified include Proactivity, Coping Ability, Adaptability, Flexibility and Persistence. These capabilities enabled the project respond, prepare for and reduce vulnerabilities.

<u>6.4 Proactivity</u>

Within Project Gamma, this future-focussed capability is identified through measures employed during the critical incident. Proactivity in project Gamma led to readiness of the project, reduction in vulnerability and aided response during the critical incident.

6.4.1 Project Management Procedures

Evidence of proactivity within the anticipated and planned procedures was identified by the procurement route employed-SCAPE, training provided, risk register and value engineering.

6.4.1.1 Procurement route employed-SCAPE

The rapidly deployed, performance managed and collaborative approach of SCAPE is identified to deliver value for money and quality buildings while stimulating local growth and community benefits. This design and build framework provided the early collaboration and communication required to resolve the adjoining site issue of building into the site. This was through the relationship SCAPE provides. Thus;

> *"SCAPE is more focussed on relationships and being open"*
>
> (Quantity Surveyor, contractor).

This relationship enhanced the trust the client had in the team to resolve the issue and prevented any panic. The Operations manager explained;

> *"If it wasn't for SCAPE I'm sure the client would be acting more nervous and cautious where they know they can do certain things because we have relationship with SCAPE and they know SCAPE wants to do the right thing"*
>
> (Operations Manager, contractor).

SCAPE promoted control over the project from inception to completion and the clarity during the lift issue. This was achieved by utilising a continually updated spreadsheet which was made available to all parties to ensure that every one had the latest version and contributed to the decisions moving forward to meet the project needs. This was stated as;

> *"With SCAPE it encourages collaboration and encourages everyone to be open and honest so there is a spreadsheet that there won't be any reason that anyone in the team can't see it. SCAPE also makes the project more defined and tighter so you have more control from beginning to end"*
>
> (Lead Project Manager, client).

The NEC 3 Option A with lump sum nature of this framework allowed quantifications to be provided at the start of the project and these contingencies were utilised in situations where disruptions occurred. For instance, cost contingencies were used during the lift issue caused by adjoining site to redesign structural works and time contingencies based on clauses in NEC 3. These were notified to the client and utilised upon agreement to enable the project continue. The operations manager explained this as;

> *"So if there will be a delay we need to write a letter quoting the clauses and sections to let them know there is a delay or going to be. In any point we let them know they are going to put in extension of time we will let them know the cost accordingly. With NEC even if it's your problem, they want you to notify them for approval. For example the lift that was in the wrong place, we didn't*

know it was in the wrong place. So we went out there we got the survey out and we got an engineer and we went Christ that will clash with our steel frame and we should be worried so we raised an early warning"

(Operations Manager, contractor).

The clear responsibility allocated by SCAPE ensured that the team took responsibility by continual working to overcome anticipated events. In light of this, the responsibility of the operations manager was to identify problems, focus on it and solve it. Based on the established relationship with the contractor, the client trusted in the contractor to carry out responsibilities set out for them. He highlighted;

"If it wasn't for SCAPE I'm sure the client would be acting more nervous and cautious where they know they can do certain things because we have relationship with SCAPE and they know SCAPE wants to do the right thing and get more customers so I think from the client's point of view we should identify all the risk on the job and give them more certainty that at the end of the projects it's going to be good"

(Operations Manager, contractor).

The established trust drove the contractor team to continually set up procedures to ensure project effectiveness and bounce forward after overcoming disruptions.

6.4.1.2 Training provided

Parent organisation training was identified in the project and influenced the calmness manifested by the project team. For instance, the quantity surveyor revealed that in-house training courses such as working in other disciplines aside the person's expertise field enabled them gain understanding of the other party's works. This enabled them to tolerate and thus keep calm especially during the re-designing of structural works caused by the life issue.

Also, training from previous organisations where project parties had worked played a role. For instance, the lead project manager shared the utilisations of skills acquired from past training courses such as empowering (giving authority) and how to motivate the team. This enabled him drive the team through during the disruption.

6.4.1.3 Report writing

The anticipatory capability to manage disruptions led to the writing of monthly report in an agreed format to the client by all parties. This report provided continual updates from each section and was a way of checking that all parties understood the project and are striving for the common goal. Aspects such as commercial, time and quality implication were highlighted in the report to provide an overview for the client.

This report was also reviewed alongside information of the dashboard provided on the project. The client used these procedures to curb out a potential uncertainty before they actually occur. More so, learning from issues raised during the omission of mechanical and electrical works, the client urged the users of the building to also provide a report to ensure that the civil works being carried out are fit for purpose.

6.4.1.4 Risk register

The continual update, monitoring and managing of the risk register enabled resources such as monies allowed to reallocated to other highly impact risks. During the mechanical and electrical installation issue, monetary contingency allowed to cater for certain risks were re-channelled and used for these. Also the continuous update of risks enabled the design development and planning issues to be quickly identified and the allocation of cost resource accordingly to help resolve the issue. For example;

> *"there is also a risk register, which is the client's risk register and they also have moneys allowed to manage which risk has been identified. So for example, planners, we might not have planning signed off before we go into contract, at which point the client might ask you to put a different glass or something which may be £3000 more expensive. We may be qualified as the job is but may not have time to get planning sorted so the client has her risk and has 20,000 pounds there so if they say that's all ok. She doesn't have to spend all the 20,000 so then she keeps it, but if she need to spend it, she can instruct that. Unused risk moneys are used elsewhere for example in the mechanical installation issue"*

(Operations Manager, contractor).

6.4.1.5 Value engineering

The promotion of value engineering on this project reduced the cost of redesigning the steel by almost a quarter. This also changed some planned works on the project to further cut cost mainly in terms of material change. For instance the lead engineer shared on changing concrete at the rear extension to timber;

> *"From concrete to timber to reduce any wet trades on site because it's an awkward site to get to and it's not easy to get timber joist up there and joist it all up"*

(Lead Engineer, contractor).

Furthermore, the client provided incentives for the contractor team in further identifying areas to reduce cost during the budget reduction issue. This therefore drove the parties to be more innovative and thus ensure cost was reduced and made available budget to be workable. This also stretched the project to make things that seem impossible and challenging possible. For example the lead engineer added;

> *"We were told we had to make the new things and details to work so myself and one other colleague did the redesign of that and amended everything to get it all to work though challenging"*

(Lead Engineer, contractor)

6.4.2 Project management mechanisms

6.4.2.1 Contingency

The project allowed contingency through the contract. Contingency enabled the project absorb shock from unforeseen cost increase and ensure the works were in line with the planned programme. The project manager highlighted;

> *"As I say as soon as you get an issue on site it doesn't mean stop. We make use of contingencies. The first thing we do is right what can we do what can be joggled and that gets moved…."*

(Lead Project Manager, client).

6.4.3 Experience

Despite the unexpected nature of the critical incidents, the project exhibited readiness during the incident and afterwards. For instance, readiness during the incident was identified in responses such as;

> *"We kind of knew what the solution needs to be but we did need to engage our architects and engineers so when we saw that we can't do it ourselves because we don't have the solution. So we went on site, measured it two or three times and we agreed how to change the frame to fit in the space we have because we are not going to knock the lift down so we just had a few meetings to let the engineers and architect to redraw all the bits and move everything around and then we had to get the steel fabricated and then update their drawings to accommodate the changes and then give the manufacture. So it does feel part of our job because that's what we do so when you say you manage something that's the sort of this you do all the time"*
>
> (Operations Manager, contractor).

Also during the incident, readiness was identified to be enabled by instincts;

> *"With this issue I was acting on a feeling and that's what we generally do. If I take a drawing experience tells me what to do. You can sit in a room with people and I act on a feeling and instinct that something was not right and I tell where the problems are so if I look on a drawings I see these things based on experience and you just know, based on instinct and if I could put a measure in place I will make sure everyone tells the truth only"*
>
> (Operations Manager, contractor).

More so, after the incident, continual readiness by the team on issues such as these was evident in continual monitoring. In addition to this the self-motivated ability of designers and civil engineers were confirmed in responses such as;

> *"designers are built for changes such as these so I think most people were self-motivated"* and *"With the standard of projects we have here, and the standard of consultants, everybody here is just up for the challenge"* respectively.

(Lead Project manager, client).

6.4.4 Summary of antecedents and consequence of Proactivity

From the manifestations of the proactivity discussed above, a summary of identified antecedents and the exact consequence emerged from sections 6.5.1-6.5.3 is captured in the Table 6-2.

Table 6-2 Antecedents and consequence of Proactivity

Project Gamma		
Antecedent	Consequence	
Procurement route-SCAPE	Deliver value for money and quality. Enable earlier collaboration, communication and trust. Promote project control and clear responsibility allocation	Readiness
NEC 3	Allowed for contingencies used to re-design works	Readiness
Training	Enable tolerance	Readiness
Report writing	Provide clear awareness to Project	Readiness
Financial risk register	Manage risk identified by allowing for monies to resolve these	Response
Value engineering	Minimised redesign cost and promote innovation	Readiness, Reduction
Contingency	Absorb extra cost	Readiness
Experience	Readiness	Readiness

6.5 Coping Ability

The manifestation of this capability to manage and deal with shock caused by disruptions within Project Gamma was by accepting responsibility, reacting to incident and regulating the impact of the incident. These are discussed below.

6.5.1 Coping through responsibility allocation- Responsibility Acceptance

The SCAPE framework laid responsibilities on the project parties and thus saw them taking up the works to resolve the issue. The evidence of coping through responsibility acceptance was revealed in responses by the Operations manager which explained how they coped during the lift issue. This was through ensuring that opportunities were created from the incident and taken advantage in addition to taking responsibility. This was explained by the operations manager as;

> *"During the lift issue we made sure the incident was resolved by everyone taking up the responsibility and supporting others where required. Also as contractors we aim for the best service that we could possibly provide and make sure we give them all the answers and help them and if they have a problem we try and solve them to make sure we do the best we can for them and deliver on time or sooner, to deliver on budget or cheaper and to stand out from the crowd we aim to find opportunities from problems as we did for*

the lift issue. We also have a social responsibility, we want to do things, go out do community engagement so that we don't look external but like normal people"

(Operations Manager, contractor).

Again during the lift issue, the contractor engaged all other parties based on their responsibilities to enable the project adjust in statements such as;

"We kind of knew what the solution needs to be but we did need to engage our architects and engineers so when we saw that we can't do it ourselves because we don't have the solution. So we went on site, measured it two or three times and we agreed how to change the frame to fit in the space we have because we are not going to knock the lift down so we just had a few meetings to let the engineers and architect to redraw all the bits and move everything around and then we had to get the steel fabricated and then update their drawings to accommodate the changes and then give the manufacture. So it does feel part of our job because that's what we do so when you say you manage something that's the sort of this you do all the time"

(Operations Manager, contractor).

This enabled the project cope during the lift issue where the client told the contractor team to make the things and details work. The tolerance ability by the contractor team saw them through the redesign and the amending of all the works, the Lead engineer shared. Also, the Lead Project manager mentioned the tolerance level of the contractor enabled them deal with and manage stress during the disruption where all parties were blaming adjoining site and vice versa. The project manager added that, in the heat of the issues, the contractor team showed 100% focus on the works with the help of tolerating the parties blaming them and also accepted any changes recommended by the client or as a result of the change. This was driven by within-contractor team meetings and motivation from their team leaders. For example the Lead project manager explained;

"If the contractor tells you straight away what they were doing then you know they are 100% focussed and know what they are doing. We knew they were having additional meeting we knew there was additional structural meeting on site, drawings, reviews, quite a few extra meetings on the subject and feeding

> *that back to us in meetings and they feeding that back to us and this did not make us worry because they seem to accept changes recommended and sail through".*
>
> (Lead Project Manager, client)

Also, the acceptance of responsibility to deal with and manage stress, by tolerating was driven by instincts. This helped the early identification of the lift issue and this instinct also lead to the need to develop measures such as re-designing in order to resolve the issue and prevent further delay. The Operations manager explained;

> *"With this issue I was acting on a feeling and that's what we generally do. If I take a drawing experience tells me what to do. You can sit in a room with people and I act on a feeling and instinct that something was not right and I tell where the problems are so if I look on a drawings I see these things based on experience and you just know, based on instinct and if I could put a measure in place I will make sure everyone tells the truth only"*
>
> (Operations Manager, contractor).

More so, on responsibility acceptance to cope, civil engineering projects are identified to be problem prone and hence prior to the manifestation of the incidents all parties are self-empowered to take up the responsibility to resolve any issues. This provided them with the professionalism and taught process required to manage the incident by taking responsibility and learning from these.

6.5.2 Coping by reacting to incident

This was achieved by tolerating the event and managing the expectation.

6.5.2.1 Managing expectation

Expectations were managed by not panicking, focussing on facts and not sharing all information to all parties because not everyone on the project has the capacity to absorb first hand shock and may get demotivated through the early awareness. Details as shared are captured below;

> *"with incidents, review it, golden rule never panic just look at the facts look at the options keep it calm and contained within the project team till you have reviewed and assessed and make your decision on your way forward, then you are in control then you report it and give truthful facts with the solution*

and then you are ok. It's just keeping it contained. And if have any new not good don't say it, contain it so they are not demotivated when they hear it and manage it when it happens as you go along so we have the awareness. And also if I keep them going I won't necessarily push them so far because there is all the ambiguity over here so again its assessing the information you have just got, determining on who needs to know and who doesn't and by what point and knowing your teams and knowing how they react and it's the react development which is the most important bit and it's that bit that you need to work on"

(Lead Project Manager, client).

6.5.3 Coping by regulating the impact of the incident

This is defined as controlling ones feeling and attitude during the disruption. This was enabled by experience and relationship amongst the parties.

6.5.3.1 Experience

Experience-wise, the project showed that though the manifestations of these incidents were unexpected and caused shock at the initial stage, their experience and the shared experiences helped them manage and deal with the shock. For instance, during the access confirmation issue;

"From experience, I have been a contractor (planner and project manager) in charge of programmes so I can read a contractors programme and actually know what it means. Also, I have been a consultant before joining the city, I have been a consultant for 15 years so I have got the tract record of actually sitting between the contractor and the client so now I am sitting in the client role, I know the other two roles backwards and that's the reason why I know what's like to sit in the other people's shoes. So I know what they need, what their requirement are and what they need in order to be able to do their jobs properly which is good and sound decision making and decisions made at the right time and not delayed to the point that they can no longer benefit from the project. So it's about having the knowledge, the insight and the capability and the tract record that people know that you have done it before and are therefore capable of doing that and that's what I bring to the project. This helped moderate impact on me and by sharing to the team, the team as well when the access gate was almost impossible"

(Intelligent Client, client).

More so, experience influenced the feeling of the Operations manager;

> *"With this issue I was acting on a feeling and that's what we generally do. If I take a drawing experience tells me what to do. You can sit in a room with people and I act on a feeling and instinct that something was not right and I tell where the problems are so if I look on a drawings I see these things based on experience and you just know, based on instinct and if I could put a measure in place I will make sure everyone tells the truth only. These measures included contingencies and motivation"*

(Operations Manager, contractor).

The above manifestations enabled the project deal and manage shock by incorporating measure such as utilisation of contingencies and team motivation during the lift issues the Operations Manager further reviewed.

Again, experience was seen to provide common sense and also created the identification of issues yet to arise which helped regulate the impact of the issues. The project manager shared;

> *"A lot of it is just common sense, a lot of it is what you learn over the years but every time you go to a different company, they want to get their different processes and it's just going to be hard to get old habits changed and swing over to a new way of doing things*……*the contractor and his team have been good at pre-empting what's going to happen in the future because they don't want everyone turning up and wanting other things because it will be disappointing and you know you have to keep them close otherwise you are going to end up with problems"*

(Lead Project Manager, client).

Furthermore, experience was gained through lesson learnt workshops and communication and this influenced how the project managed expectation. For instance, during the lift issues, workshops were carried out to explain to the parties the impact of the issues and enabled parties share experiences from past project to highlight that some had overcome worse issues than the current. Also, the need for parties to remain calm and resolve issues through collaboration, which in the end contributed to resolution of the issue, was promoted. Continual monitoring through the dash board, early warning and the risk register also enabled the project manage the expectation of the team. This is because these created the awareness and thus reduced the shock and ripple effects the critical incident would have caused.

6.5.3.2 Relationship

In terms of regulating the impact of the incident, personal relationships amongst project parties especially the project leaders and their subordinates enabled them deal and manage the shock. This was through motivation from the project leaders during the budget issue raised in order to get them committed to complete the works and the belief the project leaders showed in the junior members in order to equip them to carry out the works and not be affected by the issues being manifested. The operations manager went on to share the benefit of having a good relationship with project members and the need to trust the team when sharing the manifestation of issues;

> *"People and trust makes things easy and difficult. If you don't trust each other than the change is very very difficult and whatever you tell people they don't believe you and you have to prove it and it takes time and it weighs you down then you say you will just carry on and do things. But you say if we want to be nice and trust each other we have to discuss things and do things sensibly. The client is very good in that respect, she won't like what she hears sometimes but she will listen, take it on board and go and do what she has to do, the project manager is good as well she listens goes to have a look and comes back and there is no argument or things like that whereas its different for other projects. If you manage the people you manage the process"*

(Operations Manager, contractor).

6.5.4 Summary of antecedents and consequence of Coping Ability

From the manifestations of the coping ability discussed above, a summary of identified antecedents and the consequence emerged from sections 6.5.1-6.5.3 is captured in the Table 6-3.

Table 6-3 Antecedents and consequence of Coping Ability

Project Gamma		
Antecedent	Consequence	
Coping through responsibility allocation		
Contractual responsibility set out for contractor	Provide best service despite disruptions. for example deliver works sooner despite critical incident	Readiness,
Responsibility acceptance	Early identification and resolution of critical incidents	Readiness, Response
Self-empowered	Professionalism and taught process required to manage the incident	Readiness, Response
Coping by reacting to incident		
Managing expectation	Provide capacity to withstand first hand shock, Calmness, Tolerance	Response, Reduction
Continual monitoring	Manage team expectation	Readiness, Reduction
Coping through regulating		
Experience	Work ahead of time	Readiness
Contingency	Re-do works	Response, Reduction
Relationship	Gain commitment to complete the works, motivation	Readiness
Workshops and communication	Shared Lessons learnt to manage the incident	Response, Reduction

6.6 Flexibility

This is a capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained. Within Project Gamma, evidence of this is identified in the accommodating nature, through the risk register and value engineering/ innovation.

6.6.1 Accommodation

Accommodating was identified in the open-minded nature and influenced planning and contingency. Within Project Gamma, despite the planned and structural works set out by the client, financiers and the contractor, a level of understanding in order to accommodate changes were manifested. This was identified during the lift issue. Here, the critical incident led to the team editing planned works and resorting to new ideas which were beneficial to the project. More so, the accommodating nature was identified to be aided by the relaxed and non-panicking nature of the project. This was because most parties had gone through more challenging situations and also had early communication which created the awareness of the impact of the situation which they realised had the potential to be managed.

Open-mindedness led to the provision of ideas such as reinforcing current lift and building around it and this reduced the amount of re-design which was not initially in the planned works. Open-mindedness reduced the impact trust issues had had on the project. The need for being more open-minded on the project and its ability to enable trust was emphasised;

> *"You have to have a quite open mind and let them still have the control and learn from them and work with them and be accommodative and work to gain their trust so that once you get their trust you can now be a bit more controlling"*

(Lead Project Manager, client).

6.6.1.1 Planning

Flexibility within the continual planning despite the disruption was manifested. Delay caused by adjoining site saw continual planning being flexibly carried out to accommodate the disruption. This was through a day to day systematic scrutiny of the programme to maximize it where possible. Further, this continual planning guided the client in reallocating funds in order to accommodate the changes. The flexible nature of the client and the SCAPE contractors due to established relationship led to the agreement of changes to the plan and reallocating funds in order to recoup time loss on the project. The Lead project manager shared the benefit of this;

> *"continual planning aids the smooth running of the project with the team having and best minimal impact possible"*

(Lead Project Manager, client).

6.6.1.2 Contingency

Accommodation enabled contingencies allowed to be relocated to enable the project absorb the other unforeseen cost and ensure the works were to programme. This was explained as;

> *"as it happened we managed to redesign the foundation with relocated monies allowed to work around the archives we found. We have been asked to hide the archaeological findings, build our structure on top but maintain the integrity of the findings. So the archaeological findings is still in the ground"*

(Lead client monitoring advisor, client).

6.6.2 Value engineering/ Innovation

Flexibility through the value engineering was identified when the structural design change as a result of the lift issue escalated the project cost. This value engineering led to the change in flooring from concrete to timber. This reduced the cost by about 0.2% and also revealed the benefit of this change which was;

> *"To reduce wet trades on site because it's an awkward site and had a lot of restrictions, which could have cost Health and safety issues"*
>
> (Lead Project Manager, client).

Flexibility through the utilisation of allowed contingencies and relocating unused contingencies was identified within the lift issue. This contingencies helped the project accommodate the cost of changing the lift material to a more robust material which in tend reduced the overall cost of redesigning the structural part of the works.

6.6.3 Summary of antecedents and consequence of Flexibility

From the manifestations of the flexibility discussed above, a summary of identified antecedents and the consequence emerged from sections 6.6.1-6.6.2 is captured in the Table 6-4.

Table 6-4 Antecedents and consequence of Flexibility

Project Gamma		
Antecedent	Consequence	
Open-mindedness	Reduction of re-design works, maintenance of trust	Readiness
Accommodating through communication	Create awareness	Readiness
Innovation	Budget reduction	Response
Value engineering	Cost reduction	Readiness, Response
Continual planning	Maximize time available	Readiness

6.7 Persistence

Persistence within this research is defined as the capability to continue despite disruptions. This is due to the functional capacity of the system which aids it to withstand and dynamically reinvent strategies as the system encounters disruptions. Within Project Gamma, evidence of this was identified at varying times during the manifestations of the incidents. Evidence of persistence was identified mainly with the help of proactive procedures such as continual monitoring, planning, training and negotiation.

6.7.1 Project Persistence

6.7.1.1 Continual monitoring

Evidence of persistence was identified in the project during the access confirmation issue and the planning approval. The project continued monitoring by carrying out meetings and storming whilst working to ensure that the access and planning approval was gained.

> *"So we have had to have a project launch and do all the forming, norming, storming etc. as a new team over the period, especially to identify how we can gain access considering the window of opportunity keeps closes as we go along"*
>
> *(Client).*

6.7.1.2 Planning

Continuous planning despite the disruptions enabled the project persist from inception to completion during the disruption. During the logistic issue, the project re-scheduled activities in order to minimise the shock the issue had on the project. The SCAPE framework used is identified to enable this;

> *'SCAPE also makes the project more defined and tighter so you have more control from beginning to end…. It also provided us with information required to continually plan despite the disruptions..'*
>
> (Project Manager, client).

6.7.1.3 Training

Training such as risk workshop and promotion of communication (example report writing) aided the management of disruption. This enabled all parties to be updated with the developments and enabled collective effort;

> *'We knew they were having additional meeting we knew there was additional structural meeting on site, drawings, reviews, quite a few extra meetings on the subject and feeding that back to us in meetings and they feeding that back to us. We do have ad hoc catch ups in between or whether in will be on the phone or something be put up on Sypro to flag up the problem as early warning. These meetings and risk workshops helped communication amongst us '*

(Project Manager, client).

Furthermore, despite the delay is signing the contract due to the critical incidents, training courses were continually being carried out to empower all parties to resolve issues so the contract could be signed.

6.7.1.4 Negotiation

Though the window to gain access was almost closed, the project continually negotiated gaining access through continual communication and editing the programme to ensure this was possible. This was explained as;

> *"Two things had to be done, first of all we had to negotiate that the access date would keep moving at the same time as the start date moved and because we didn't know when that start date was going to be, we couldn't say at any time until we reached that start date what that end date was going to be so I sneakily added a couple of weeks when no one was looking that's number one. Number 2, maybe sneaky but I let the contractor may be two weeks less than that so I got extra 4 week window, it's what I call my time risk allowance. The contractor has their time risk allowance but it's not related to the access date its related to the completion date but the access date is equally important but in programming I have got 4 weeks until the access window slam shuts so that's a real potential show stopper. I mean from a legal point of view if you had not been able to negotiate the extension of the access, there would not have been time to build in accordance with the agreement and therefore the agreement would have fallen down and we would have been in trouble"*

(Client).

In addition the project manager stated that;

> *'It was just those little conversations and those little phone calls and keeping that rapport and not leaving it for the next month. You learn to judge the amount of time you put in things depending on the people'.*

(Project Manager, client)

6.7.2 Summary of antecedents and consequence of Persistence

From the manifestations of the persistence discussed above, a summary of identified antecedents and the consequence emerged from section 6.7.1 are captured in Table 6-5.

Table 6-5 Antecedents and consequence of Persistence

Project Persistence		
Antecedent	consequence	
Continual monitoring	Ensure access and planning approval	Readiness
Planning	More control and reschedule of works	Readiness
Training	Empower all parties to resolve issues so the contract could be signed, collaboration and communication	Readiness
Negotiation	To gain access and make up for time loss	Response, Reduction

6.8 Interrelationship amongst capabilities

Proactivity within this Project Gamma is identified as an overarching capability enabling aspects of coping ability and flexibility whereas coping enable flexibility.

6.8.1 Proactivity enabling coping ability

This anticipatory capability influences the ability to manage and deal with shock caused by disruptions; coping ability. Coping through responsibility allocation and regulating was enabled by SCAPE. In coping by reacting, it was enabled by value engineering and training. The Table 6-6 presents how these procedures enable coping ability.

Table 6-6 Proactivity enabling coping ability

Identified Procedure	How procedure enabled project cope
SCAPE	Ensured that parties took up their responsibilities and carried out their works in the midst of the critical incidents. Prevented the client team from acting nervous because it's a route which promotes one to have control from inception to completion.
Value Engineering	Managing clients expectations where risks were eminent
Training	Provided motivation which ensured calmness and aided the project tolerate

6.8.2 Proactivity enabling flexibility

This anticipatory capability influences the capability to manage a disruption by allowing change. This is enabled by risk register and value engineering as shown in Table 6-7.

Table 6-7 Proactivity enabling flexibility

Identified Procedure	How procedure enabled flexibility
Risk Register	Identified areas for relocating of unused monies to cater for these uncertainties and other risk which had arose as a result of these two incidents

Value Engineering	revealed the benefit of this change which was reduction of wet trades to reduce health and safety issues

6.8.3 Proactivity enabling persistence

Project persistence was enabled by proactivity through SCAPE and training. SCAPE enabled the project thrive through the disruption by the training and programme it provided. Training empowered all parties to resolve issues so the contract could be signed and also to continually collaborate and communicate.

6.8.4 Coping ability enabling flexibility and persistence

The capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained is enabled by the ability of the project to manage and deal with stress. Experience from the ability to cope by regulating the impact enabled flexibility. Experience influenced the level of understanding which was required to accommodate the changes caused by the critical incident. Also, experience enlightened the project in carrying out value engineering and allowing contingencies to continually plan for the works amidst the critical incidents.

Persistence is enabled by the ability of the project to manage and deal with shock. Coping by taking responsibility, reacting to the incident and regulating its impact are identified to drive the project persistence through managing and moderating of the impact of the incident respectively.

6.9 Chapter Summary

This case study reveals capabilities such as proactivity, coping ability, flexibility and persistence in managing disruptions. Antecedents for proactivity include project management procedures and mechanism and experience. Coping ability was enabled by antecedents of proactivity and manifested during the incident by coping through accepting responsibility, reacting to incident through accepting and managing expectation and regulating the impact of the incident.

Further, coping ability also enabled persistence and flexibility which both occurred during and at the end of the disruptions caused by the incident. Flexibility was identified in the accommodating nature, through the risk register and value engineering/ innovation. On the other hand, persistence was identified mainly by project persistence with the help of proactive procedures such as such as continual monitoring, planning, training and negotiation.

7- Cross-Case Analysis

7.1 Introduction

This chapter discusses the findings across case studies Alpha, Beta and Gamma to enable the identification of capabilities manifested within projects during the critical incidents and thus, conceptualise resilience in projects.

The cross-case analysis is presented in two parts to enable the definition, dimensions, antecedent and consequence of resilience in projects emerge. The first part cross-analyses the backgrounds of projects studied focussing on; level of awareness of the project and critical incidents (availability, expectation, effect on delivery and success on project and measures to manage). The second part captures the identified capabilities namely; Proactivity, Coping Ability, Flexibility and Persistence and their interrelationships across the three case studies.

PART A-Background of Projects

7.2 Level of awareness

Projects Alpha, Beta and Gamma are Building Construction, Engineering construction and Civil Engineering projects respectively. Despite the high level of awareness by these three projects of its environmental drift, they were all vulnerable to the critical incident.

The high environmental awareness influenced the risk, opportunity, uncertainty and change management processes set out prior to the disruptions. For instance, project alpha identified risk such as planning issues, design team and frame design, room numbering changes and asbestos removal within plant room. Also, uncertainties identified include the technology of the super lab, archaeological remains and oil in ground. On the other hand, opportunities such as drainage, concrete frame and pre-case finishing were identified as a result of innovation and value management promoted on the project. Project beta identified design risk as its major risk due to the unavailability of the 6 months design period at the start of the works. Other identified risks were the delivery of materials and the output for the process plant, nesting of birds on the excavated surfaces. In all, risks in project beta was classified into 6 main areas: Health, Safety, Environment, Cost, Time and Quality but were more concerned with cost risk. In addition, to risk, uncertainties identified on this project include design coordination, ground conditions, weather conditions, environmental problems (because the project is in an ex-quarry). Opportunities identified here include re-sequencing of some works, maximising space on site, prefabrication of certain element and drainage opportunities. Lastly, project gamma identified risks such as security issues, water ingress, logistics, terrorism, and financial risk. Due to the renovation section included and the fact that the building is Grade 2 listed, several unknowns were identified in addition to the construction of a lift by the adjoining property on the site.

7.3 Vulnerability of Projects

Despite these above deterministic strategies employed by the projects, vulnerability was identified in responses. Thus, it was identified that these unexpected incidents had a great impact on the project prior to the answering of subsequent questions. Almost half of the interviewees showed a lot of distress whilst answering to the expectation of the incidents even though it was expected to some (but not the extent) and not expected to others.

Further, for the expectation of the incident, the period of awareness of the critical incident varied. This ranged from before the incident, early in the incident, mid-way in the incident and after the incident had occurred. The times in which an incident was identified influenced the impact and how it is managed.

7.4 Critical Incidents

The manifestation of critical incidents varied across the case studies. Tables 7-1 captures the critical incidents, their effects and measures to manage them for projects alpha, beta and gamma respectively.

Table 7-1 Critical incident, effects and measures within project alpha, beta and gamma

Project	Critical incidents	Effect of the incidents	Measures to manage incident
Alpha	-room data sheet -archaeological findings -energy centre -lift specification -petrol tanks -piling issues	Stopping the works for a while, Re-doing of certain aspects of the project, Prevented the contract from being signed, Delay in programme Cost implications £350,000 Sleepless nights Reduction of trust amongst members Prevented the contract	Proactive measures-Procurement route (Chinese wall), Robust Change Control Process, Method Statement and Specialist involvement, subcontractor database, Risk tracker
			Reactive Measures-Effective Communication,

		from being signed Challenged quality Change programme Affected BREEAM rating	collaboration, Adjudication, Logical Analysis, Effective Document Management, Training, Motivation, Contingencies and Logical Analysis, Empowerment, Risk Absorption by Client
Beta	-Foundation change - late payment -concrete pour	Delay in programme Cost increase of about £1 million Put a lot of pressure on the designers as they had little time Demoralised the process team	Proactive measures-High level meetings, collaboration, building ahead of design approval, more contingencies available for future use.
			Reactive measures-Extension of time was allowed the contractor to compensate for late payment and time loss, re-construction, employment of extra staff and re-sequencing of works
Gamma	-access confirmation through adjoining site - B-home not completing works on site early - B-home building into the civil engineering project site - mechanical and electrical installations -budget and design development -planning approval	Delayed start date Increased cost of works Loss of trust and parties blaming themselves Affected the design of steel design Prevented contract from being signed Change in programme	Proactive measures-SCAPE framework, time risk allowance, monitoring
			Reactive measures-Negotiation, re-sequencing of works, communication, collaboration, contingency, Self-motivation of the team, cost cutting and re-engineering

All three projects largely reveal that the critical incident was not expected. For instance, within project gamma, eleven (11) of respondents attested to the fact that the critical incidents were unexpected. However, the remaining two who mentioned it was expected agreed that though it was, they did not appreciate the extent to which it escalated to and the knock-on effect it had had on the project. Within project beta and gamma, all respondents confirmed that the critical incidents were not expected and not even the extent to which it developed to. The lack of prior awareness of all projects to the critical incidents increases sensitivity and thus, vulnerability (Gallopín, 2006).

However, the awareness of the potential for these critical incidents saw the employment of proactive, reactive and regulative measures to resolve these and thus, recover. The measures employed are recovery focussed. Recovery identified here is not to return to the original objective but rather to an objective that will help the project bounce forward. Furthermore, the emergence of critical incident, though were not expected, were managed by the proactive procedures which also enabled reactive measures because of the high level of awareness projects portrayed to ensure recovery. The common capabilities which manifested across the case studies were; Proactivity which enabled Coping Ability, Flexibility and Persistence.

PART B- Capabilities

7.5 Proactivity

Within Projects Alpha, Beta and Gamma, this future-focussed capability was identified through measures employed during the critical incident. Proactivity revealed the role that procedures put in place before the critical incident occurred played during the manifestation of the incident. From the three case studies, proactivity was manifested through the project management procedures, project management mechanisms and experience of the project teams. Project management procedures are the established ways of executing works whilst project management mechanisms are structures put in place to enable project execution. Experience on the other hand is, the practical contact that project has in terms of managing disruptions.

7.5.1 Project management procedures

Projects alpha, beta and gamma employed project management procedures such as contract, training and monitoring. The contract positively influenced collaboration and relationship during the manifestation of the critical incident. In terms of training, both within-project training and parent organisation training were identified across the projects. Also, continual monitoring despite disruptions was evident across case studies.

7.5.1.1 Contract

The contracts within the three case studies differed and were coined to suit each project type and enable collaboration. For instance, within projects alpha, beta and gamma, the Chinese wall (JCT), Joint venture (IChemE and NEC3) and SCAPE (NEC 3) were employed respectively.

Collaboration was maintained through the continual communication promoted in the clauses 1.7 of JCT contract and clause 2.6, 11.7 of the IChemE contract within project alpha and beta respectively. This provided team effort which saw the project through during the critical incident. Also, the roles and responsibilities set out in the contract enabled the team effort. For instance, despite the loss of trust and disappointment amongst the team, collaboration through the Chinese wall and joint venture enabled the resolution and saw the project bounce forward.

For example, project alpha revealed a collective team effort with the help of the JCT clauses 1.6 and 1.7 during the critical incident. Also, project beta, worked collaboratively and shared knowledge despite the foundation change issue and the mistrust that had arisen.

> *"we had to get all the parties involved through meetings, sharing ideas and clarification to incorporate the foundation change issues. Despite the loss of trust at the time, we were contractually bound by the JV to get works done as it was our responsibility"*

(Senior design and engineer manager, contractor)

Also, besides the contract clauses 1.6 and 1.7 of JCT contract and clause 2.6, 11.7 of the IChemE aiding collaboration, a physical collaboration based on the contract was also observed. This is through the responsibilities allocated to the parties in the contract. From observation, both the client and the contractor were located on the same floor space at the construction site offices in order to further drive collaboration and communication stated in the contracts.

Furthermore, project gamma was a design and build framework agreement and therefore experienced early collaboration and communication required to resolve the

B-home issue. The framework agreement known as SCAPE is one in which the contractor wins projects summing up to a certain amount. It is a negotiated two stage tender which means that all information is provided; feasibility and the strategic information needed are provided as well. Works carried out by the contractor include the programme; pricing, budgets and the different gateway to get to a final pre-figure are gone through. Ultimately, SCAPE was an NEC 3 option A with lump and it passed all the risk to the contractor. Some advantages of SCAPE were that, it encouraged collaboration and encourages everyone to be open and honest. In the light of this, there was a spreadsheet that everyone on the team could access. SCAPE also made the project more defined and tighter so that the parties had more control from beginning to end.

Further to collaboration, clauses in the JCT, NEC3 and IChemE contract provided a relationship amongst the parties and restored trust when it was lost during the evolution of the critical incidents across all the three projects. For example, the project beta revealed; established contractual relationship also helped parties collaborate despite the foundation change issue and the mistrust that had arisen. This was achieved by working collaboratively using procedural tools and sharing knowledge based on experiences to resolve the issue.
Also, within project gamma, clause 10.1 in the NEC3 contract enabled the relationship and thus enhanced the trust the client had in the team to resolve the issue and prevented any panic.

> *"If it wasn't for SCAPE I'm sure the client would be acting more nervous and cautious where they know they can do certain things because we have relationship with SCAPE and they know SCAPE wants to do the right thing"*
>
> (Operations Manager, contractor)

7.5.1.2 Training

Across the three projects, training which aided the anticipatory ability differed but was all aimed at providing understanding to the project team. Within project alpha, the ongoing and continuous training was first captured in a lesson learnt workshop, a contract-understanding course and parent organisation training.

> *"understanding the contract really plays a part in the change because if you understand it, it helps you know what you are or not responsible for".*

(Project surveyor, contractor)

This enabled the resolution of the room data sheet issue and minimised the shock impact during the manifestation of the incident. More so, most of these team members had received trainings from parent organisations such as leadership courses, management training courses, graduate development course and software training courses. Within project beta, change management contract training was provided. The client went through the clauses in IChemE contract with the team to ensure that the reason why that contract was adopted was known to the team prior to the foundation issue. This was so that issues are clearly resolved given the clear identification of responsibility and explanation the clauses in the contract provides.

> *"the client wanted back to back conditions for other clauses"* (Process activities manager) which IChemE provided because "*it has a better structure for process plant and for testing and commissioning"*

(Project manager, client)

Further, project gamma revealed past project trainings and parent organisation training, and this influenced the calmness manifested by the project team. For instance, the quantity surveyor revealed that in-house trainings from parent organisations such as working in other disciplines in the project aside the person's expertise field so as to have a feel and gain understanding of what the other parties do provided the understanding required to tolerate and thus keep calm especially during the re-designing of structural works caused by the lift issue.

7.5.1.3 Monitoring

Project beta capture continuous monitoring through the programme, risk, opportunity and uncertainty register and health and safety responsibility. Whereas, project alpha capture monitoring under continuous planning and project gamma, under continual risk register update.

In project beta, programme assessment was carried out continuously to ensure co-operation between contracts as per contractual requirements. This consists of meetings to review events and share new knowledge. These and other reasons were captured in the Project Execution Plan and enabled the resolution of the foundation change issue.

In addition, risk and opportunity register were employed for continuous monitoring of works for both Nec3 and IChemE contracts. Continual identification of risks was carried out monthly during the manifestation of the critical incidents.

With risk management, when early warnings were prompted, quick measures were put in place to resolve matters. More importantly, health and safety responsibility within the project despite the critical incident was maintained. All parties were required to ensure that despite the manifestations of the critical incidents, old and new works were to be carried out in accordance to the projects health and safety standards.

Following project beta, there were broad monitoring techniques, however, with project gamma, monitoring was mainly risk identification and management focussed. The risk register for this project gamma was mainly money based.

> *“So there is also a risk register, which is the client’s risk register and they also have moneys allowed to manage which risk has been identified. So for example, planners, we might not have planning signed off before we go into contract, at which point the client might ask you to put a different glass or something which may be £3000 more expensive. We may be qualified as the job is but may not have time to get planning sorted so the client has her risk and has 20,000 pounds there so if they say that's all ok. She doesn't have to spend all the 20,000 so then she keeps it, but if she need to spend it, she can instruct that. Unused risk moneys are used elsewhere”*

(Operations Manager, contractor)

The continual update, monitoring and managing of the risk register enabled resources like monies allowed to be relocated to other highly impact risks.

7.5.1.4 Other uncommon evidence of project management procedures in case studies

The different evidence includes robust change control, inclusion and motivation and planning for project alpha; review and improvement and learning lessons for project beta and report writing and value engineering for project gamma. These are summarised in Figure 7-2.

Project Alpha

- Robust change control; The robust change control process provided the coordination and collaboration required to resolve the issue faster during the manifestation of the incident. For instance, the early introduction of robust change control process on the project made all parties aware and well abreast with the process to follow when a change is encountered. This team acceptance of the process led to all parties meeting during the lift and archaeological finding issues to raise the change request form and discussed the best option moving forward.
- Inclusion and Motivation; Continual motivation by the mangers was evident in project procedures described and also responses of measures to manage event. For example the project design manager described that the contractor is motivated to go on by providing necessary resources to enable them work, that is; "generally we try to think of what we can do to keep the contractor going on site and that's what as a design manager I do by propping ideas to see how we can release information quicker, also we make everone feel valued and respected" (Project design manager, contractor).
- Planning; The planning nature of this project is evident in the document management, change processes, method statement, communication processes, the Chinese wall approach and the database of subcontractors employed during the critical incident. The future-thinking nature influenced how documents were managed in this project and enable the easy identification of the incident and resolution thereof when it occurred. Also procedures such as the change process and the systematic outlining of methods in which works are carried out enabled the archaeological findings to be resolved without incurring extra cost and also at the minimal time possible. This was achieved by, "each time we went through issues we raise the change request form (CRF) and meet and discuss the best option moving forward"(Client)

Project Beta

- Review and Improvement; These reviews mainly revealed the salient problems and recommended solutions in order to assess if capabilities required to manage these were available. These aided to swift resolution and maintenance of solution during the foundation change issue. Again, these continual reviews were enabled by communication amongst the JV partners and highlighted some technical issues which also arose during the critical incident. This called for more meetings to be scheduled to resolve the issue quickly. "We also have some technical issues with the civils contractor but we have meetings every week because the drawing Vinci make have to comply with our process drawings so we make clash reviews to see if it fits to make corrections" (Engineering manager, contractor)
- Lesson learnt; Following the foundation change incident, evidence of continual lesson learnt show continuous proactivity by the project. Also from the above information, the awareness of the complexity and change prone nature of these projects provides a continuous platform for the project to learn from every disruption and move on in the project..

Project Gamma

- Report writing; The anticipatory ability to manage disruptions led to the writing of monthly report in an agreed format to the client by all parties. This report provides continual updates from each section and is a way of checking that all parties understand the project and are striving for the common goal. Aspects such as commercial, time and quality implication are highlighted in the report to provide an overview for the client.
- Value engineering; The promotion of value engineering on this project reduced the cost of redesigning the steel due to the lift issue by almost a quarter. This also changed some planned works on the project to further cut cost mainly in terms of material change.

Figure 7-1 Evidence of other project management procedures in case studies alpha, beta and gamma

7.5.2 Project management mechanisms

The project management structures identified include contingency, method statement and sub-contractor database.

Contingencies allowed on project alpha provided the time and cost buffers during the incident. During the room data sheet and archaeological findings, the time and cost contingencies were utilised respectively. For instance, the room data sheet issue led to delay in the project which required extension of time. Contingency allowed on the project was utilised here. Also, the method statement for archaeological findings captured in the risk register was further altered to suit the requirements given to bury the archaeology found in the ground to be able to continue the works. This method statement was edited from the original 5 stage to the 16 stage process, as revealed in document ‘change document 1’ (CD1). Also, the database sub-contractors promoted the employment of competent personnel to manage anticipated incidents. This database thus, promotes working with known expertise and reduces the tendency of employed sub-contractors going into administration. Within the lift issues, utilisation of a sub-contractor on the data base list a bit earlier on the project enabled a quick response to the issue. Contingencies were also allowed for in project beta and gamma in the, risk opportunity and uncertainty register, and health and safety responsibility.

7.5.3 Experience

Experience was another common evidence of proactivity. Within the project alpha, experience was identified in the open-mindedness, curiosity and innovativeness. The open-mindedness and curiosity of experience was also identified to influence the roles and responsibilities given to the project team. This was deduced from a framework known as Insight which profiles individuals on the team. The employment of the Insight framework for which skills deduced from the personality theory by Juung’s (1921) were used by the contractor team to provide roles to each member of the team. The contractor project manager believed that you cannot change someone, but you can build on their strengths to maximize the way they work. These traits are said to be able to drive the team through critical periods. However, within the project gamma, experience enabled them to be ready and provided them with fore knowledge on solutions in certain cases.

"Based on experience, we kind of knew what the solution needs to be but we did need to engage our architects and engineers"

(Operations Manager, contractor)

In addition, the self-motivated ability of designers and civil engineers based on experience also manifested proactivity. These were confirmed in responses such as;

> *"designers are built for changes such as these so I think most people were self-motivated"* and *"With the standard of projects we have here, and the standard of consultants, everybody here is just up for the challenge"* respectively.

(Director, client) and (Lead Project manager, client)

Innovativeness, here based on experience is identified to minimise time and quality.

7.5.4 Common antecedents and consequence of Proactivity

Following on from the evidence of proactivity, the antecedents and consequences of proactivity from the discussion are tabulated below;

Table 7-2 Antecedents and consequence of Proactivity

Antecedent		**Consequence**	
Project management Procedures	-Contract	-Collaboration -Relationship	Readiness
	-Training	-Empower teams -Collaborative Understanding -Calmness	Readiness
	-Monitoring	-Risk, uncertainty and opportunity identification -Early warning identification -Continual co-operation -Carry out work in accordance with the projects health and safety standards -A realistic and updated plan	Response Reduction
Project management mechanisms	-Contingency	-Redesign of works -Guidance and informs way forward -Employment of reliable sub-contractor organisation	Response Readiness
Experience	-Open-mindedness -Curiosity -Self-motivation	-Managerial responsibility allocation -Fore knowledge of solutions -Readiness	Readiness
	-Innovation	- Minimise time and quality loss	Reduction

7.6 Coping ability

Across case studies, coping ability was evident in regulating the impact of the incident and responsibility taking. These were enabled by contractual relationship and responsibility set out in the contract, trust enabled by the contract, training, the effective communication procedure, change control process, innovation and experience.

7.6.1 Regulative coping

This ability to cope by as controlling ones feeling and attitude towards a critical incident was enabled by training, experience and change control.

Internal and external trainings influenced the ability to control impact of incident on the project. For instance, internally within the project, communication skill training, lessons learnt workshop through project comparison activities was carried out. This was to share experiences from past similar project amongst the team and ensure that the goal for this project was well known to all and thus, there was the need for the incident on the ground to be managed thus, through enduring to ensure project aim is met. Further, external training such as leadership courses which was aimed at capturing how project leaders should behave, were identified to enable the project leaders to adjust and endure.

Further, experience impacted on controlling impact of the critical incident also. For instance, within project alpha, because a similar design had been carried out before on another project, the mechanical team knew the mistake was not from their side and thus minimised the frustration that would have been experienced (The lead mechanical engineer revealed). Again, with project gamma, experience with critical incidents in past similar project and the shared experiences helped them adjust and work ahead of time, (for example, during the access confirmation issue). Also, with project beta, it was revealed that experience enabled them to adjust to this change by not panicking;

> *“its knowing how to react to these problems and not panicking”*
>
> (Senior commercial manager, contractor)

Besides self-experience, experience was shared from training (internal and external) in which lessons learnt were shared and experiences derived from them.

Further, the early introduction of the change control process enabled the project to adjust. This step by step procedure outlined in the change control process was followed to buy time and tolerate the incident as other stringent measures were being discussed to manage the incident. This also contractually promoted trust given that they had a process required to follow irrespective of risen issues.

> *"Each time we went through issues we raise the change request form and meet and discuss the best option moving forward"*

(Client)

7.6.2 Responsibility Coping

Across the projects, responsibility coping is enabled in three ways, thus responsibility allocated, responsibility taking and accepting responsibilities. Though responsibility coping is captured differently, all three case studies reveal responsibility as set up in the contract and manifestation through the allocation, taking and acceptance of responsibility by project leads and its ability to drive the team through the critical incident.

The JCT, NEC3and IChemE clearly allocates responsibilities for the parties on the projects and based on this the parties are to execute their parts, maintain trust and thus, enable the project cope. For instance, with the project, responsibility coping through contractual responsibility allocation enabled the project leaders to drive the rest of the team through motivation, continual emphasis on the aim of the objective and empathise with them to adjust to the incident. Also, these responsibilities were identified to be greatly influenced by experience of project leads. In relation to the project beta, the contractual responsibility allocated to parties drove the project to adjust through responsibility acceptance.

Responsibility taking and acceptance by the team also showed how they coped. All respondents shared how they coped as a team with the help of carrying out their respective roles. For example, contractual responsibility set out for adjudicator enabled the identification of the party to incur cost and allowed contract to be signed for works to carry on as scheduled during project alpha. Also, effect of the late payment issue caused by the client was resolved by the project commercial manager taking up the responsibility to advice on the cost benefits and supplier selection to get the materials required and move on with the project without a further delay impact. Finally, with project gamma, the SCAPE framework laid responsibilities on the project parties and thus, saw them taking up the works to resolve the issue. The evidence of coping through responsibility acceptance was revealed in responses by the Operations manager which explained how they coped during the lift issue in not just taking the responsibility to resolve the issue but also ensure that some opportunities are created from the incident and taken advantage of accordingly. In addition to employing responsibility laid down by SCAPE framework, the acceptance of responsibility to adjust was also evident and driven by instincts based on experience. This helped the early identification of the lift issue and led to the need to develop measures such as re-designing to resolve the issue and prevent further delay.

7.6.3 Other uncommon evidence of coping ability in case studies

Figure 7-2 captures other evidence of coping ability not common across case studies

Project Alpha

- **Relationship;** The Chinese wall provided the relationship required to cope. This was through the clear information coordination amongst the team and thus provided the trust required during the petrol tank issue in the building project. This then also led to the swift resolution of the issue by updating the whole team in time and receiving contributions on the best way forward and agreement by the project and thus adjusted.The Chinese wall promoted collaboration through the awareness of roles, clear information coordination and thus enabled coping. Re-emphasis on roles and project processes (example change process) was made during regular discussions and weekly meetings. These created the awareness which is required to enable the project adjust and hence cope during the incident and emphasise on relationship. The Chinese wall approach is identified to be one that "promotes team involvement and thus makes everyone feel and sense of belonging", (Employer's Agent, client)

Project Beta

- **Participatory coping;** The Engineer manager explained that in getting the team together, members with high level of experience and efficiency are identified and brought together. This is to enable everyone get involved with the works because they have handled past similar events before. This team formation led to everyone within the project participating during the foundation design issue, especially members of the design team. "as a PM its mainly having people with the right mind and the right experiences to be able to overcome these challenges"(Project Manager, client).Also, the Project manager also shared how he coped by participating during the foundation change. He added how he stayed positive and worked with the rest of the team and also based on experience has gotten used to being a problem solver and enjoying the challenges that come with this.

Figure 7-2 Other evidence of coping ability

7.6.4 Common antecedents and consequence of coping ability

Following on from the evidence of coping ability, the antecedents and consequences of coping ability from the discussion are tabulated below;

Table 7-3 Antecedents and consequence of coping ability

Dimension of coping ability	Antecedent	Consequence	
Regulative coping	Contingency	-Redesign of works -extending working hours to work	Response, Reduction

		efficiently	
	Experience	-Minimised impact of incident on project -work ahead of time	Readiness, Reduction
	Training (communication, motivation, Lesson Learnt)	-Ensure that the goal for this project was well known to all - Know how to deliver bad news -Develop behaviour of project leaders -Minimise impact on team and enable the collaborative resolution -Share lessons learnt to manage incident -Provide capacity to withstand first hand shock, Calmness, Tolerance	Response, Reduction, Readiness
Responsibility coping	Responsibility allocated through contract	-Drive the rest of the team through motivation, enable the project leaders to adjust and endure. -Enable project team to tolerate -Trust	Readiness, Response
	Responsibility taking and acceptance	-Resolve issue	Readiness, Response

7.7 Flexibility

Flexibility within three case studies was through accommodation and the innovative approaches on the projects.

7.7.1 Accommodation

This was shown by allowing changes to the planned and agreed works to enable the project to continue during the critical incident through open-mindedness, contingencies and planning.

Within project alpha, an effort by the project to understand everyone was seen to be promoted both at the project and the parent organisation level. Within the project, this was being promoted by making everyone feel valued and showing gratitude and appreciation for works carried out by the project. For project beta, accommodation enabled different sections of the project to appreciate each other's work and thus influence the decisions made during foundation change. This was manifested by the empathy shown during the foundation change which ensured that each party experienced minimal pressure caused by the foundation change.

Also, the accommodative nature was identified to be aided by the relaxed and non-panicking nature of the project based on experience and deduced from responses such as;

“Here people don't panic when things go wrong, that is generally through lack of experience, you learn through what goes wrong and you take that to your next project and used for life. You never know when it will come up again but because you have tackled it and seen it, it makes you stronger and knowledgeable”.

(Lead Project Manager, client)

7.7.1.1 Open-minded
The open-minded nature of the team enabled the overall accommodation required to re-consider decisions made. For instance, in project beta, though decisions by some project leaders were made on behalf of the team, inputs from them were welcomed and suggestions to the impact of the decisions from these parties were considered. Again, the multi-contract nature of this project drove the open-minded nature of the client to accommodate all parties on the project. This was evident in money allocations of the contract to ensure that both parties on the NEC 3 and IChemE contract had sufficient funds to carry out works given the delay foundation change had caused and the need to recoup time loss by the team. Also in project gamma, it was seen through the provision of ideas such as reinforcing current lift and building around it and this reduced the amount of re-design, which was not initially in the planned works. The need for open-mindedness on the project and its ability to enable trust was emphasised;

“You have to have a quite open mind and let them still have the control and learn from them and work with them and be accommodative and work to gain their trust so that once you get their trust you can now be a bit more controlling”.

(Lead Project Manager, client)

7.7.1.2 Contingency
Within the projects accommodation was identified when the critical incident led to the team editing planned works and resorting to new ideas which were beneficial to the project. For instance, within project gamma, these were enabled by utilising contingencies allowed for under risk management in the NEC3 contract employed on the project.

"As I say as soon as you get an issue on site it doesn't mean stop. Having contingency available in mind, the first thing we do is right what can we do what can be joggled and that gets moved so that's it really that and they do that seamlessly without being told to do that".

(Lead Project Manager, client)

Contingencies allowed within the project include time and cost contingencies. Both these contingencies were identified to be used. Example, in project alpha during the archaeological findings where the re-design of the foundation was required.

"As it happened we managed to redesign the foundation with monies allowed to work around the archives we found. We have been asked to hide the archaeology, build our structure on top but maintain the integrity of the archaeology. So the archaeology is still in the ground".

(Lead client monitoring advisor, client)

Also, the acknowledgement that within projects, things do not go as planned by the project design manager revealed the continual allowance of contingencies was essential. Where excess resources were got from value engineering, these moneys were used for uncertainties. Further, flexibility within the project to ensure that the goal is achieved led to the employment of new staff during the room data sheet issue.

7.7.1.3 Planning

Again, accommodation enabled the re-sequencing of works such that extra- hours and days were included to complete the works within the expected time since time on this project was fixed. This flexibility in planning also called for extra resources to be incorporated to aid the planning changes.

"We have done a lot of re-sequencing and there are better ways to do it and the result is we have seen we need to work over the weekend which is 6 days a week which is not great for every body's personal life. So, this is where at my level we are looking to put things together like get extra staff and do a rota so that some people aren't working weekends all the time."

(Contract Manager, contractor)

In terms of agreed works, within project alpha, though identified that quality was a major priority, the client was flexible enough to allow for material change when some materials for the project run short and were hard to come by.

> *"the client was understanding, and we said can we use this other stone instead".*

(Project surveyor, contractor)

Furthermore, flexibility within the continual planning despite the critical incident was manifested. Delay caused by B-Home in completion of their works saw continual planning being flexibly carried out to accommodate the disruption the incident caused. This was through a day to day systematic scrutiny of the programme to maximize it where possible. Further, this continual planning guided the client in relocating funds to accommodate the changes. The flexible nature of the client and the SCAPE contractors due to established relationship led to the agreement of changes to the plan and relocating funds to recoup time loss on the project.

7.7.2 Innovation

Continual innovation through continuous monitoring, identification of innovativeness and acceptance of innovative ideas by projects was identified. This flexible approach in managing project manifested across the case studies during the critical incidents.

For instance, within the project alpha, the team was continually urged to suggest ideas that will enhance the project and once it is approved, the project considers it. Innovative ideas considered include;

"*introducing beams into the foundation to enable the archaeology finding be buried* (Client)

and

converting part of the project which were not originally in the planned works to prefabrication" to regain time loss.

(Project manager, contractor).

Also, flexibility through cost saving was identified. Cost was saved by having subcontractor packages which cater for labour and plant only and not material as normally done to avoid paying double the client's profit and overhead.

In the project beta innovation which manifested flexibility was evident in cost-effective re-programming, material recommendation and design solution. Firstly, the cost-effective re-programming which has been arrived at due to opportunities identified by the design team such as pre-fabricating aspects of the works sped up the works. The consequence of this;

> *"so that they align more closely and minimise the disruption that would have been caused in the original design sequence"*

(Project Manager, client)

This innovative idea also enabled the accommodation of the programmes of the various parties within this multi-contract project to synchronise despite delays by late payment and concrete pour issue. Again, the material recommendation from the normal hardening concrete to rapid hardening concrete based on concrete pour issue was provided. This innovative idea led to the reduction of the cost the contractor bore. Lastly, the design solution through shared innovation ideas by the project leads led to incorporation of new designs in the best way possible to ensure minimal further disruption during the works.

Project gamma captured innovation through continual value engineering during the structural design change critical incident because of the cost escalation the incident had caused. This continuous value engineering on the project reduced the project cost by about 0.2%.

7.7.3 Other uncommon evidence of flexibility in case studies

Figure 7-3 captures other evidence of flexibility not common across case studies

Project Alpha

- **Training;** Flexibility through the training educating them to tolerate and understand from different perspectives during the room data sheet issue. Internally within the project, training such as lesson learnt workshop and understanding the contract were carried out. We have had a course in understanding the contract so we had a lady come in to explain the contract due to the less clarity and understanding of the clauses and our responsibilities within it"(Project surveyor, contractor) These training processes provided the understanding required to accommodate within the project especially during the manifestation of the RDS. Thus, the understanding of the contract and the responsibility thereof enabled the responsible party accommodate the cost. Communication through workshops, meetings and focus groups to provide awareness and understanding required for the team to accommodate the critical incident were identified.

Project Gamma

- **Risk management;** Further flexibility through the management of the risk register was identified during the lift and access to site issue. This was manifested by the relocating of unused monies to cater for these uncertainties and other risk which had arose as a result of these two incidents. This saw the client having to go justify the diversion of some funds to the financial board of the project and gaining approval to cater for these risk and uncertainties the intelligent client revealed.More so, flexibility through innovation was promoted and identified when the budget for the project was being cut."We were told we had to make the new things and details to work so myself and one other colleague did the redesign of that and amended everything to get it all to work" (Lead Engineer, contractor)

Figure 7-3 Other evidence of flexibility

7.7.4 Common antecedents and consequence of flexibility

Following on from the evidence of flexibility, the antecedents and consequences of flexibility from the discussion are in Table 7-4.

Table 7-4 Antecedents and exact consequence of flexibility

Antecedent		**Consequence**	
Accommodation	Open-mindedness	Empathy, trust	Response, Readiness
	Planning	-Re-sequence of work -Change in materials -Accommodate changes	Response, Readiness
Innovativeness	Continual monitoring	Contingency allowed	Readiness
	Continual identification of innovative ideas	-Cost saving -Time saving -Quality enhancement	Reduction, Response

7.8 Persistence

Evidence of persistence was identified across the case studies. This was through continual monitoring (as per risk management and innovativeness), continual planning and negotiations.

7.8.1 Continual monitoring

Within project alpha, persistence was evident through the continual monitoring of other risks within the risk register and design tracker despite the management of the critical incident. On the other hand, in project beta, persistence was evident with the help of contingencies, project monitoring, programme, work packages, promotion of innovation and collaboration to persevere and strive.

Continual monitoring was being carried out in project alpha to moderate the effect the room data sheet would have on other aspects of the project and prevent other risk and uncertainties from manifesting. Also, in project beta, evidence of continual monitoring of risk and uncertainties despite disruptions, and frustrations showed the persistence nature of the project. This called for extra monthly meetings despite the meetings which were being held to resolve the critical incidents.

Further, project gamma persisted through continual monitoring. Here, the project continued monitoring by carrying out meetings and storming whilst working to ensure that the access and planning approval was gained.

> *'So we have had to have a project launch and do all the forming, norming, storming etc. as a new team over the period, especially to identify how we can gain access considering the window of opportunity keeps closes as we go along'*
>
> (Client)

7.8.2 Continual planning

Continual planning to enable persistence was identified. For instance, within project alpha, its end-goal driven nature and its aim to maintain client relationship revealed persistence through its striving nature. This was identified to be enabled by, the project being forthcoming and not focussing on the problems being raised. On the other hand, the end-goal driven enabler of project beta helped the project through the midst of disruption and thus ensured that successive works were completed in time for their dependent works were due. This also prevented any further delay the critical incidents would have caused. Also, the end goal driven nature of project gamma had the project carrying out trainings to continually identify risk and motivate the team through the critical incident manifestations. Within project gamma, despite the strict budget allowed on this project, the continual allowance of contingencies to enable the critical incidents identified be managed was promoted. These contingencies were secured from the client board by informing them of the benefits the contingency being allowed will bring to the project and elaborating on these to get money released.

Again, the promotion of innovation (during planning) during the critical incidents by the project manager in project beta showed how determined the project was.

> *"we are challenged to constantly review value engineering and suggest innovative ideas regardless of what we are going through when planning"*
>
> (Project Manager, client)

7.8.3 Negotiations

The projects persisted through negotiations in diverse ways. Project alpha went thought an adjudication process through the room data sheet issue to gain the understanding and identify the party required to incur the cost so that the project could be continued. Project beta also continually negotiated with the joint venture partner in terms of foundation changes to share extra cost which had been incurred for the project to continue because it had delayed the project and led to mistrust in the team.

Also, project gamma persisted to gain access to the site despite it being almost impossible. This was through a continual contractual negotiation by the project through continual communication and editing the programme to ensure this was possible.

> *'Two things had to be done, first of all we had to negotiate that the access date would keep moving at the same time as the start date moved and because we didn't know when that start date was going to be, we couldn't say at any time until we reached that start date what that end date was going to be so I sneakily added a couple of weeks when no one was looking that's number one. Number 2, maybe sneaky but I tell the contractor may be two weeks less than that, so I got extra 4-week window, it's what I call my time risk allowance. The contractor has their time risk allowance, but it's not related to the access date its related to the completion date, but the access date is equally important but in programming I have got 4 weeks until the access*

window slam shuts so that's a real potential show stopper. I mean from a legal point of view if you had not been able to negotiate the extension of the access, there would not have been time to build in accordance with the agreement and therefore the agreement would have fallen down and we would have been in trouble'.

(Client)

7.8.4 Common antecedents and consequence of persistence

Following on from the evidence of persistence, the antecedents and consequences of persistence from the discussion are tabulated in Table 7-5.

Table 7-5 Antecedents and exact consequence of persistence

Persistence		
Antecedent	**Consequence**	
Continual monitoring	Risk management	Readiness, Reduction and Response
Continual planning	Motivation	Readiness
	Innovation	Readiness, Reduction
Negotiation	Cost & Time reduction	Reduction

7.9 Interrelationship amongst capabilities

This section presents a detailed interrelationship between capabilities across the case studies. Proactivity is identified as an overarching capability enabling aspects of coping ability, flexibility and persistence with coping ability also influencing flexibility and persistence. Across the case studies evidence of proactivity was identified before, during and after disruption whilst the projects coping ability and flexibility was during disruptions (as shown in Figure 7-4). All projects showed evidence of persistence during and after disruption.

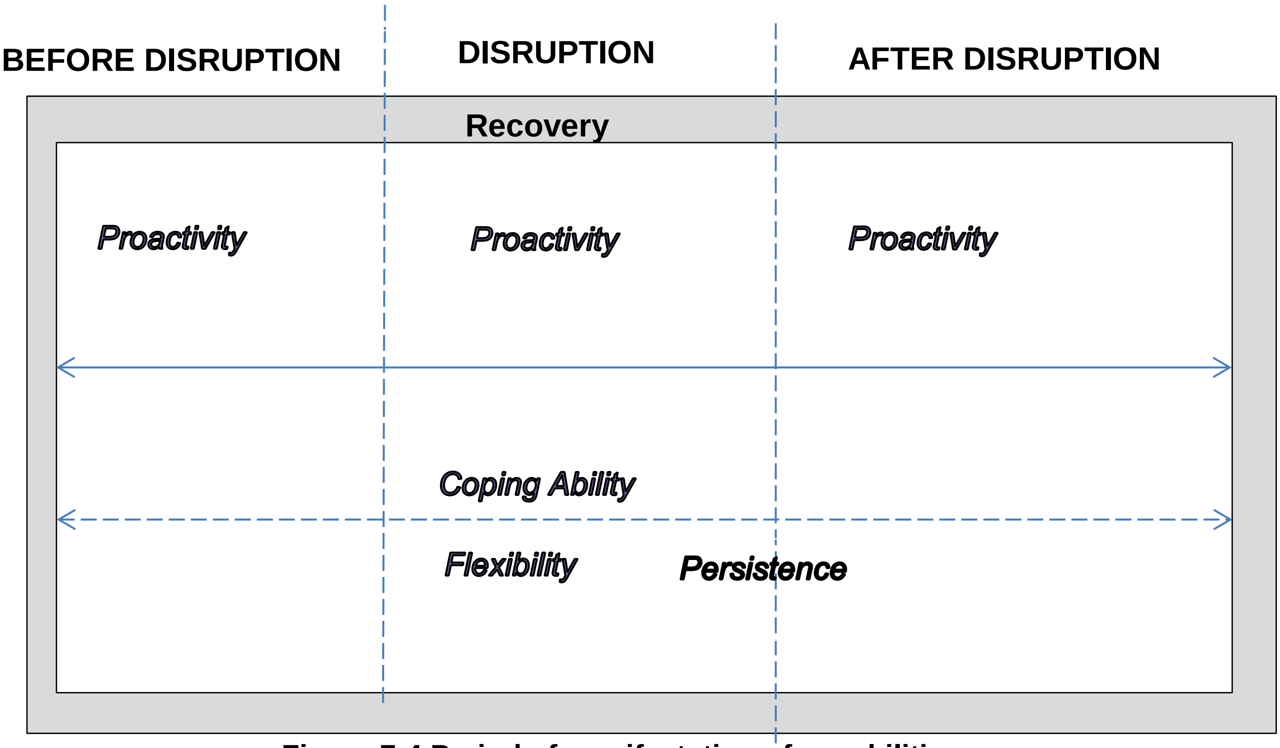


Figure 7-4 Period of manifestation of capabilities

7.9.1 Proactivity enabling coping ability

This anticipatory capability influences the ability to manage and deal with stress whilst experiencing disruptions; coping ability. Across the case studies, proactivity enabled coping ability through the contract as captured in Table 7-6.

Table 7-6 Proactivity enabling coping ability across case studies

Identified Procedure		**How procedure enabled project cope**
Contract	Project Alpha	Clear responsibility allocation to the parties and this provided trust
	Project Beta	Enabled the team maintain their roles despite the critical incident and thus work collaboratively to resolve the incident.
	Project Gamma	Ensured that parties took up their responsibilities and carried out their works in the midst of the critical incidents. Prevented the client team from acting nervous because it's a route which promotes one to have control from inception to completion.

7.9.2 Proactivity enabling flexibility

Flexibility is enabled by proactivity through contingency, programme, risk register and value as presented in Table 7-7.

Table 7-7 Proactivity enabling flexibility across case studies

Identified mechanism	**Procedure/**	**How procedure enabled flexibility**
Planning	Contingency	Re-design of the foundation, promoted value engineering
	Programme	enabled the project accommodates and thus minimise the impact the foundation change
	Risk register	Identified areas for relocating of unused monies to cater for these uncertainties and other risk which had arose as a result of these two incidents
	Value	revealed the benefit of this change which was reduction of wet

	engineering	trades to reduce health and safety issues

7.9.3 Proactivity enabling persistence

Project persistence was enabled by proactivity through the contracts as captured in Table 7-8.

Table 7-8 Proactivity enabling Persistence

Identified Procedure		**How procedure enabled Persistence**
Contract	Project Gamma	Responsibilities set out within both contracts do not allow the individuals to stop works until their respective responsibilities have been completed and this drove the rest of the team through the works
	Project Alpha	Through the continual collaboration and communication it enabled
	Project Beta	Enabled the project thrive through the critical incidents and enabled motivation, more control and experience

7.9.4 Coping ability enabling flexibility and persistence

Coping through responsibility allocated enabled the accommodation manifested in flexibility and the drive manifested in persistence. Also, the responsibility taking enabled the re-designing and accommodation changes which manifest flexibility.

Further, coping by participating and taking responsibility was identified to drive individual persistence through the non-panicking ability it provides. It also managed and moderated the impact of the incident and promoted continual collaboration and communication.

7.10 Chapter Summary

The cross-case analysis identified capabilities such as proactivity, coping ability, flexibility and persistence in managing the disruptions. Overall, antecedents for proactivity existed before, during and after the disruption but, manifested during the disruption. From the three case studies, proactivity was ensured through the project management procedures (contract, training and monitoring), project management mechanism (contingency) and experience.

Coping ability was enabled by antecedents of proactivity and manifested during the incident by coping through regulating the impact of the incident, allocating responsibility, taking responsibility and accepting responsibilities and reacting in order to manage and deal with stress. These were enabled by contingency, experience, contract, training, and managing expectation.

Furthermore, coping ability also enabled the manifestation of persistence and flexibility which both occurred during the and at the end of the disruptions caused by the incident. Flexibility within the three cases studies was through accommodation and the innovative approach on the projects. On the other hand, persistence here was identified through continual monitoring, continual planning and negotiations.

8- Discussion of findings and framework development

8.1 Introduction

This chapter conceptualises resilience in projects. To achieve this, a discussion of the main findings from the case studies (chapters 7) together with disruption management and resilience literature (chapter 2) is carried out. The chapter is presented in four parts; (1) definition of resilience in projects, (2) dimensions of resilience and its antecedents and consequence, (3) a framework for resilience in projects and (4) comparison between resilience in projects and current approaches in managing disruptions. Summary of key characteristics of organisational resilience (chapter 2) and findings from cross-case analysis of resilience in projects (chapter 7) is presented in Table 8-1. These will be further discussed in this chapter.

Table 8-1 Summary of key characteristics of organisational resilience and resilience in projects

	Key Characteristics	
	Organisational resilience (OR)	Project Resilience (PR)
Definition	Follows Engineering resilience definition	Follows Ecological resilience definition
	Standard/ Static objective; Initial organisation objective influences how works are carried out and thus makes it situational awareness focussed	Dynamic objective; Emergent issues changes objectives and thus how works are carried out
Dimension	Increasing Adaptive capacity; Focus on developing adaptive capacity using capabilities; coping ability, flexibility and persistence which are achieved by organisational culture (resources and processes) to ensure readiness, response and recovery	Increasing Proactivity; Focus on enhancing proactivity due to its awareness of its drifting environment. Proactivity enables coping ability, flexibility and persistence through the utilising of project management procedures, mechanisms ('best practice') and experience to manage critical incident
	Coping ability; Coping ability utilised here is mainly focussed on adjusting through relationships existing/ created in the organisation aided by the organisation culture to ensure readiness, response, recovery and reduction	Coping ability; Coping ability revealed here is mainly focussed on adjusting through responsibility allocated (responsibility coping) and regulatory coping. These are enabled by using experience and project management procedures and mechanisms (specifically contingency, training and contract). Coping ability here ensures recovery through response, reduction and readiness
	Flexibility; Due to the stable environment of the organisation, flexibility is identified by the relaxing of the organisations stringent procedures comprising relaxing roles and responsibilities, communication lines, set out collaboration rules, contingency allowed and learning required together with the training provided. These enable organisation to respond, recover, be ready and reduce the impact of critical incidents	Flexibility; Flexibility captured here is mainly through 'accommodation' and innovation due to the ever dynamic nature of projects. Flexibility within projects aids in recovery through response, reduction and readiness.

	Persistence; Persistence here is focussed on continual preparation to ensure that the intended/ initial objective of the organisation is achieved despite the disruption to enable response and recovery. It is mainly promoted by motivation	Persistence; Persistence focusses on the entire project's working ability to ensure that the project is completed irrespective of intermittent objective met, once it works towards meeting the ultimate goal. It is promoted by continual monitoring, planning and negotiation. Persistence within projects aids in recovery through response, reduction and readiness.
Consequence	Reducing Vulnerability; Focus on vulnerability because of the ease in identification of its risk and uncertainties due to its stable environment. Thus resilient organisations work towards reducing areas of identified vulnerabilities using capabilities; coping ability, flexibility and persistence	Recovery; The ever vulnerable nature of projects makes it focus more on recovery rather than reduction of vulnerability as captured in permanent organisations with the help of capabilities together with utilising proactive procedures and measures.

8.1.1 Definition of resilience in projects

To confirm the definition of resilience in projects (stated in section 2.11), the level of awareness, vulnerability of projects, and capabilities identified from the cross-case analysis (Chapter 7) are discussed in line with organisational resilience under two sections; structural differences confirmed from case study and disciplinary boundaries. The structural difference focusses on the characteristics of projects and organisations and its impact on the capabilities manifested. The disciplinary boundary focuses on the difference in meaning of terminologies employed.

8.1.1.1 Structural differences

The capabilities from the case studies portray the ecological resilience definition. This is because of the dynamic project behaviour and changes in processes in addressing disruptions. Holling (1973:14) defines ecological resilience as 'a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables'. This is different from the definition of organisational resilience as; *the capability of an organisation to respond to and prepare for disruption.* This is because organisations have a routine based approach of working through a set of objectives to address the aim or same priority (Seville *et al.*, 2006). This routine based approach generates a familiar environment and therefore efforts to enhance awareness of the situation in order to respond to disruption quicker through reducing vulnerability is ultimate (Burnard, 2013).

Within the cases studied, all projects had a fixed or proposed start date and a proposed completion date within which to complete the objective of the project. They also existed within a drifting environment and were complex in nature (due to the interrelatedness). Unlike organisations which are identified to have a same priority (Seville *et al.*, 2006) in delivering service, the priority for projects differ and it is influenced mainly by client requirement and challenges encountered; therefore, the dynamism in project orientation. This makes projects focus on proactive and quick-to-recover measures. For instance, priority change as a result of client requirement was identified in two (alpha and beta) projects. Here, quality was identified as the main priority whereas project gamma had cost as its priority. This was because for projects alpha and beta, the client requirement was (1) to produce a state of the art educational facility with an ultra-modern (first of its kind in terms of size) super lab within United Kingdom and (2) to provide a 25year waste disposal facility for 350,000 tonnes per annum domestic and commercial waste respectively. Project gamma on the other hand had cost as a priority because of the financial sources and constraints the client-funders had put on the amounts provided. In cases where disruptions were encountered changes were made. For example, in the project alpha, the client had to alter his level of quality by allowing a change in material when a disruption was encountered. This contingency material was already allowed for by the contractor before the issue arose. This flexibility to enable the project move forward is not identified in organisational resilience. Within organisational resilience, measures considered are focussed on responding to the disruption by adapting through coping during the disruption but ultimately ensuring the planned objective and aim is maintained (example (Burnard & Bhamra, 2011a).

Again, the client requirement and resources available influenced the procurement route employed unlike organisations which have fixed organisational processes influenced by organisational culture; organisational process and human resource management structures (Burnard, 2013; McManus, 2008). For instance, project alpha employed a design and build method using JCT but used a Chinese wall approach where parties from the same organisations are mirrored to the client and contractor side. Project beta also employed a design and build route and had two contracts IChemE and NEC3 which met the needs of the project. Project gamma employed a framework known as SCAPE, which is an agreement in which the contractor wins a number of projects summing up to a certain amount. It is a negotiated two stage tender which means that all information is provided; feasibility and the rest of the things needed are provided as well. Ultimately SCAPE is an NEC 3 option A with lump and it passes all the risk to the contractor. These alterations in the original approach of design and build employment prior to the start of the works was to ensure that the potential challenges will be resolved easier.

8.1.1.2 Disciplinary boundaries

Key compositional difference identified between organisational resilience and project resilience is situational awareness in adaptive capacity versus situational awareness in proactivity.

(I) Situational awareness in organisations versus situational awareness in projects

Capabilities in organisations are manifested based on situational awareness. Within organisational resilience, is it identified by Mcmanus (2008) and Burnard (2013) that, the higher the level of awareness of the environment, the better the organisation manages disruptions. This is because awareness reduces sensitivity (Smit & Wandel, 2006), and sensitivity reduction in turn reduces vulnerability despite the exposure (Gallopín, 2006).

Situational awareness in project resilience on the other hand differs. From the findings, projects had a high level of awareness of its drifting environment and incorporated continual measures to respond to it through continual identification of risks and training to ensure readiness. Despite being vulnerable to disruptions they managed it efficiently by employing proactive measures in order to recover. Across the three case studies, the increase in level of awareness was enhanced by continual monitoring of processes and communication. Thus, situational awareness which is defined in organisational resilience as a measure of an organization's understanding and perception of its entire operating environment (McManus *et al.*, 2008), in project, is defined in this research as *'the knowledge of the drifting environment of the project and the readiness to employ proactive measures to enable the project recover from disruption'*

Furthermore, the prior knowledge of complexity in projects makes it have a higher level of awareness. This is due to continual employment of measures such as motivation, monitoring (risk management and workshops) in projects to ensure awareness in order to reduce the negative impact complexity may breed. This follows the complexity theory by Baccarini (1996) which emphasise that complexity influences procedures and measures in projects. This is similar to awareness in organisational resilience where risk management procedures are (Burnard, 2013) aimed at getting the organisation back and reducing vulnerability, thus, portraying elements of engineering resilience in projects. However, from findings, the awareness aims to ensure recovery. Thus, not necessarily getting the project back to original position (as organisational resilience) but instead, to the best possible solutions which will enable the project continue.

(II) Adaptive capacity of organisations versus proactivity in projects

Capabilities manifested in organisational resilience are enabled by the organisation's adaptive capacity. Adaptive capacity is a measure of the culture and dynamics of an organization that allow it to make decisions in a timely and appropriate manner (McManus *et al.*, 2008). This builds on the situational awareness of the organisation to react to disruption and thus, reduce vulnerability. Therefore, without prior awareness adaptive capacity is a challenge.

From the findings, capabilities manifested within the projects go beyond the normal reacting to the disruption based on awareness but responds to disruption and shows readiness and vulnerability reduction to ensure recovery. This is mainly through proactivity.

Proactivity subsumes capabilities (coping ability, flexibility and persistence) and enables readiness, response and reduction with the help of project management mechanisms, procedures and experience. Recovery in projects utilises situational awareness from proactivity together with other measures, the reason being that, proactivity builds on project understanding.

From findings, readiness is the preparedness of the project to the disruption through roles and responsibilities, communication and contract. Response is the reaction to the disruption through training, contingency and contract. Reduction is the minimisation of the level of vulnerability or the impact of the disruption through contingency, contract, innovation and continuous monitoring. Unlike recovery in permanent organisations which aims to respond to initial organisational objective, project recovery differs. This is because of the drifting environment and complexity of projects. This environment makes projects drift to varying or new set of objectives within the project evolution.

Capabilities in organisations to ensure resilience will in project terms enable vulnerability reduction. From the structural and disciplinary discussions of organisational resilience and capabilities identified from findings, the definition of resilience in section 2.11 remains. Thus resilience in projects is;

the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity.

Further, dimensions of project resilience identified from findings are proactivity, coping ability, flexibility and persistence.

8.2 Proactivity-Definition, Antecedents and Consequence

8.2.1 Definition and manifestation

Proactivity for this research is an anticipatory capability that the project takes to influence their endeavours. Projects focus on enhancing proactivity due to its awareness of its drifting environment. Within the projects, this future-focussed capability is identified through the role the manifested procedures, mechanisms and experience played during the critical incident. From the findings, proactivity enables coping ability, flexibility and persistence.

From the theory of proactivity, five dimensions exist, thus; form, intended target of impact, frequency, timing and tactics (Grant & Ashford, 2008). In terms of form, proactivity varies in the behaviour carried out (Grant & Ashford, 2008). With regards to target of impact, proactivity is identified to affect three main targets, the self, other people and the organisation (Vandyne, Cummings & Parks, 1995). Frequency on the other hand focuses on the likelihood that the proactive behaviour will occur and how often it occurs and then timings is the degree to which behaviour occurs (Grant & Ashford, 2008). Lastly, tactic is similar to form but captures the behaviour strategy and methods that employees use to carry it out, mainly focusses on the how.

Evidence of proactivity within the projects are discussed in line with dimensions of proactivity; form, intended target of impact, frequency, timing and tactics (Grant & Ashford, 2008). Form is identified in three main groups, thus the project management procedures, project management mechanisms and experience. For all forms, the intended target here was mainly the project with focus on the client in certain cases. Also, all forms reveal that proactivity occurred and it was mainly during the resolution of the critical incidents. However, the timings and the tactics varied for all forms. These variations of manifestations in projects is similar to Green, Larsen, & Kao (2008) who capture dynamism in the capabilities revealed by construction companies in responding to its changing environment, therefore confirming that study.

8.2.1.1 Project Management Procedures

The timings for the project management procedures were mainly prior to the start of the critical incident but manifested during the incident and also the tactic varied. The main project management procedures identified which revealed proactivity had tactics such as the contract, training and monitoring.

The contract for the projects enabled tactics like collaboration and that of project gamma provided relationship. From the findings, the contract was available prior to the start of the critical incident whereas the training was prior to the start and during the critical incident. Training, which aided the anticipatory capability differed but was all aimed at providing understanding to the project team. Common training courses identified are lesson learnt workshop, a contract-understanding course, parent organisation training, change management and past project training courses. These influenced the calmness manifested by the project team.

Monitoring was mainly prior, during and after the critical incident but was presented differently across the three case studies. Monitoring comprised mainly of risk, uncertainty and opportunity management. Also, planning aided this anticipatory capability which aided risk, uncertainty and opportunity identification, early warning identification, continual co-operation, continual work execution in accordance with the projects health and safety standards identified across the projects. These tactics were all utilised and impacted positively during the manifestation of the critical incident and enabled by continual monitoring.

8.2.1.2 Project management mechanism

The timings for the project management mechanism was mainly prior to the start but manifested during the critical incident also. The mechanism identified across the projects was contingency. This also enabled other project management mechanisms identified such as the method statement presented in the risk register to be further altered with the help of time and cost contingency. Also, contingency allowed the sub-contractor database to be created and utilised. The database for sub-contractors promoted the employment of competent personnel to manage anticipated incidents. This database thus, promotes working with known expertise and reduces the tendency of employed sub-contractors going into administration.

8.2.1.3 Experience

Experience, though common amongst the projects also varied in terms of tactic. This mainly manifested during the critical incident but existed prior to it. For example, experience was identified through the open-mindedness, curiosity and innovativeness. Open-mindedness and curiosity were also seen to influence the roles and responsibilities given to the project. More so, experience enabled the project to be ready and provided them with fore knowledge on solutions in certain cases. In addition, the self-motivated ability of the team based on experience also portrayed proactivity.

8.2.2 Antecedent and consequence of proactivity

8.2.2.1 Antecedent

From Grant & Ashford (2008) antecedents of proactivity include accountability, ambiguity and autonomy. Where accountability is a circumstance in which employees are expected to justify actions. Ambiguity is likely to occur in uncertain situations and autonomy occurs in a situation where freedom abounds. Following on from the different tactic of proactivity discussed above, antecedents and consequences of these through their manifestations are presented below.

All antecedents were in line with ambiguity such that, they were likely to occur in uncertain situations. Table 8-2 captures the antecedents of proactivity deduced from the case studies and its relation to the theory of proactivity.

Table 8-2 Antecedent of proactivity

Antecedent		Antecedent from literature	
Project management Procedures	-Contract		
	-Training		
	-Monitoring		
Project management mechanism	-Contingency	Autonomy	Ambiguity
Experience	-Open-mindedness -Curiosity -Self-motivation		
	-Innovation	Autonomy	

8.2.2.2 Consequence of proactivity

The consequence of antecedents identified in Table 8-2 all seek to, in diverse ways, ensure readiness, enable response and reduction of vulnerability. Overall, the consequence of proactivity from case studies is mapped in Table 8-3.

Table 8-3 Consequence of proactivity

Antecedent		Consequence	
Project management Procedures	-Contract	-Collaboration -Relationship	Readiness
	-Training	-Empower teams -Collaborative Understanding -Calmness	Readiness
	-Monitoring	-Risk, uncertainty and opportunity identification -Early warning identification -Continual co-operation -Carry out work in accordance with the projects health and safety standards -A realistic and updated plan	Response Reduction
Project management mechanisms	-Contingency	-Redesign of works -Guidance and informs way forward -Employment of reliable sub-contractor organisation	Response Readiness
Experience	-Open-mindedness -Curiosity -Self-motivation	-Managerial responsibility allocation -Fore knowledge of solutions -Empowered	Readiness
	-Innovation	- Minimise time and quality loss	Reduction

The common consequence; readiness from Table 8-3 above shows the high level of situational awareness of projects prior to the manifestation of the critical incident. Also, the manifestation of these also revealed a continuity of proactivity during the evolution of and after the critical incidents. Parker *et al*., (2006) points out that, continuity of proactivity is essential to the success of proactivity. Here, this continuous proactivity was seen in the planning, psychological development and maintenance of relationship. This is manifested when procedures, psychological development of the team and responsibility allocation to ensure readiness is available (Armenakis, Harris & Mossholder, 1993) and thus, reduce vulnerability. Proactivity within projects does not focus in bouncing back to the original position but instead to any position which leads to project recovery.

8.3 Coping ability- Definition, Antecedents and Consequence

The manifestation of this capability to manage and deal with stress caused by disruptions within the projects was evident. Similar to organisational resilience, psychological coping is identified in projects. However, within organisational resilience the psychological domains mainly comprises of organisational culture driven development which enables relationship coping (McManus, 2008). Resilience in projects on the other hand, manage and deal with stress through responsibility coping and regulative coping instead of the relationship coping within permanent organisations. Coping ability ensures response, reduction and readiness. Findings show that, the manifestation of this ability to manage and deal with stress whilst experiencing disruptions within the projects was enabled by contingency, training, experience and contract. Psychological coping utilises resources and procedures of the project which in other research is separately captured as structural coping.

8.3.1 Psychological Coping domain

The cognitive, emotional and relational sub-dimensions of organisational resilience are identified as a cohesive sense of the company's beliefs and values. These company values influence daily behaviours and lead to desirable behaviours like creativity, decisiveness despite disruption and conceptualising of appropriate solutions (Lengnick-Hall, Beck & Lengnick-Hall, 2011). Also, the relational sub-dimension is developed amongst the organisation by enabling more social functions and having more social areas within the organisation to prevent transactional relationship. This main identified significance of the relational sub-dimension is to ensure the organisational culture and aim is maintained amongst the team and evidence in decisions whilst coping to promote the communal continual attaining of organisation set goals during disruptions. However in projects transactional relationships exist (Haynes & Love, 2004) hence, the manifestation of responsibility and regulative coping identified from the findings.

8.3.1.1 Responsibility coping

Responsibility coping is defined as a role driven approach of coping whereby one accepts responsibility in placing things right (Haynes & Love, 2004). From the findings, responsibility coping is presented in three different ways; responsibility allocation, responsibility taking and responsibility acceptance. Though responsibility coping is represented differently, findings reveal responsibility as set up in the contract and manifested through the acceptance of responsibility by project leaders and also its ability to drive the team through the critical incident. The JCT, NEC3 and IChemE clearly allocate responsibilities for the parties on the projects and based on this, the parties are to execute their parts, maintain trust and thus, enable the project manage and deal with stress. Findings showed that the project coped by carrying out their respective roles.

8.3.1.2 Regulative coping

This ability to cope by controlling ones feeling and attitude towards a critical incident (Haynes & Love, 2004) was enabled by training, experience and contingency. Internal and external training courses influenced the ability to control the impact of incident on the project. For instance, internally within the project, lessons learnt workshop through project comparison activities was carried out. This was to share experiences from past similar project amongst the team and ensure that the ultimate goal for this project was well known to all. Also, the need for the incident on the ground to be managed, through enduring to ensure project aim is met was identified. Furthermore, external training such as leadership courses which was aimed at capturing how project leaders should behave, enabled the project manage and deal with stress.

Also, experience impacted on controlling the critical incident. Besides self-experience, experience were shared from training (internal and external) in which lessons were learnt and awareness derived from them. Contingency helps regulate the impact of the incidents and it is captured under structural coping within permanent organisations (McManus, 2008). Structural coping, enable the utilisation of slack resources and provide the opportunity to tap into additional resources in order to cope with broader interruptions when needs be. Also, the social capital and relationship development nature of organisations enable them tap into their networks during disruptions for required assistance and insight (McManus, 2008). Though projects are temporary, sufficient contingency was allowed across the three projects. Contingencies allowed for in the contract were used during the critical incidents. This enabled the extra cost incurred to redo works to be taken care of and thus regulated the impact on the project.

Deduced antecedents identified from regulative coping and responsibility coping are further discussed below.

8.3.2 Antecedent and consequence of coping ability

8.3.2.1 Antecedent of coping ability

Contingency is the common antecedent in organisations and projects in terms of coping ability. Organisational resilience antecedents for coping are trust, learning, contingency, ad-hoc solving networks (McManus, 2008; Burnard *et al.*, 2012). Whereas within projects the contract, contingency, training and experience enabled the projects cope through responsibility and regulating impact.

In terms of experience, projects are experience-based type of organisation due to its nature and complexity. These experiences impacted the project such as preventing panic and enabling open-mindedness in the projects. Findings from case studies show how project personnel are built to manage challenging situations due to the dynamic nature of projects. These project mechanisms and procedures are constituents listed in the theorisation of projects by Packendorff (1995) and Stringer (1967) and its benefit should be pointed when managing disruptions. Table 8-4 summarises the exact antecedents of coping ability deduced from the case studies.

Table 8-4 Antecedent of coping ability

Dimension of coping ability		Antecedent
Psychological	Regulative coping	Training
		Experience
		Contingency
	Responsibility coping	Responsibility allocated through contract
		Responsibility taking and acceptance

8.3.2.2 Consequence of coping ability

The consequence of antecedents identified in Table 8-4 all seek to, in diverse ways, ensure readiness, and enable response and reduction of vulnerability. Overall, the consequence of coping ability from case studies is mapped in Table 8-5.

Table 8-5 Antecedents and consequence of coping ability

Dimension of coping ability	Antecedent	Consequence	
Regulative coping	Contingency	-Redesign of works -extending working hours to work efficiently	Response, Reduction
	Experience	-Minimised impact of incident on project -work ahead of time	Readiness, Reduction
	Training (communication, motivation, Lesson Learnt)	-Ensure that the ultimate goal for this project was well known to all - Know how to deliver bad news -Develop behaviour of project leaders -Minimise impact on team and enable the collaborative resolution -Share lessons learnt to manage incident -Provide capacity to withstand first hand shock, Calmness, Tolerance	Response, Reduction, Readiness
Responsibility coping	Responsibility allocated through contract	-Drive the rest of the team through motivation, enable the project leaders adjust and endure. -Enable project team tolerate -Trust	Readiness, Response
	Responsibility taking and acceptance	-Resolve issue	Readiness, Response

8.4 Flexibility- Definition, Antecedents and Consequence

This research defines flexibility as a capability of a project to manage disruption by allowing change but ultimately ensures that the aim is maintained. That is, it provides an ability to adjust to change and promotes renewal, re-organisation and development (Starr, Newfrock & Delurey, 2003). Within organisational resilience, disruption is managed by focussing and building on the positive strengths or capabilities of the organisation and uses it for the benefit when managing disruptions (Rice & Sheffi, 2005), making sure that the identified vulnerability of the organisation is overcome.

Flexibility is manifested by accommodating (Keong & Mei, 2010) through communication and collaboration (Burnard & Bhamra, 2011a) and adapting (McManus, 2008) through training, to develop the capacity required to manage a disruption (Rice & Sheffi, 2005). Due to the relative stable environment of organisations, flexibility is identified by the relaxing of the organisations stringent procedures comprising relaxing roles and responsibilities, communication lines, set out collaboration rules, contingency allowed and learning required together with the training provided. These enable organisations to respond, recover, be ready and reduce the impact of critical incidents.

Within projects, flexibility is mainly manifested through accommodation and promotion of innovation. This is through the drifting environment in which they exist.

8.4.1 Accommodation & Innovation

Accommodation can be defined as the ability of the project to allow changes to the planned works and success factors of the project to enable the project continue. This was manifested during the critical incident through open-mindedness, contingencies and planning. Also, the accommodating nature was identified to be aided by the relaxed and non-panicking nature of the project based on experience.

The open-minded nature of the team enabled the overall accommodation required to re-consider decisions made. For instance, across the project, though decisions were made by project leaders on behalf of the team, inputs from the team were welcomed and suggestions to the impact of the decisions from these parties were considered. Again, the contract of the projects drove the open-minded nature of the client in order to accommodate all parties on the project. This was evident in money allocated within the contract to ensure parties had sufficient funds to carry out works given the delay caused by the critical incidents in most cases. The need for continual open-mindedness on the project and its ability to enable trust was identified.

Also, accommodation was identified when the critical incident led to the team editing planned works and resorting to new ideas which were beneficial to the project. This enabled the re-sequencing of works such that extra- hours and days were included in order to complete the works within the expected time since time on the projects was fixed. This flexibility in planning also called for extra resources to be incorporated to aid the planning changes. Furthermore, flexibility within the continual planning despite the critical incident was manifested. In addition, continual innovation through continuous monitoring, identification of innovativeness and acceptance of innovative ideas across all projects during the critical incidents was identified.

8.4.2 Antecedent and consequence of flexibility

Following the accommodative and innovative manifestations of flexibility, a summary of identified antecedents and consequences are presented in Table 8-6. The consequence of antecedents identified from Table 8-6 all seek to, in diverse ways, ensure readiness, and enable response and reduction of vulnerability.

Table 8-6 Consequence of flexibility

Dimension of flexibility	Antecedent	Consequence	
Accommodation	Open-mindedness	Empathy, trust	Response, Readiness
	Planning	-Re-sequence of work -Change in materials -Accommodate changes	Response, Readiness
Innovativeness	Continual monitoring	Contingency allowed	Readiness
	Continual identification of innovative ideas	-Cost saving -Time saving -Quality enhancement	Reduction, Response

8.5 Persistence

Persistence is defined as the capability to continue despite difficult situations. This is due to the functional capacity of the system which aids it to withstand and dynamically reinvent strategies as the system encounters disruptions. From organisational resilience literature perspective, persistence is enabled by striving (Burnard & Bhamra, 2011b), persevering (Burnard, Bhamra & Young, 2012) and reinventing (Hamel & Välikangas, 2003) driven by trust. Persistence in organisations is focussed on continual preparation to ensure that the intended/ initial objective of the organisation is achieved despite the disruption to enable vulnerability reduction.

Persistence focusses on the entire project's working ability to ensure that the endeavour is completed irrespective of objective met, once it works towards meeting the ultimate goal. It is promoted by continual monitoring (as per risk management and innovativeness), continual planning and negotiations.

8.5.1 Continual monitoring

Persistence was evident through the continual monitoring of other risks despite the disruptions. This captures the re-inventing and continual moderation ability of the project. In addition, a design tracker was also continually utilised to manage risks. These were being carried out to moderate the effect the disruption would have on other aspects of the project and also prevent other risk and uncertainties from manifesting. Again, continual monitoring of risk and uncertainties despite disruptions experienced showed the persistence nature of the project. This called for extra monthly meetings despite the meetings which were being held to resolve the issue.

Also, despite the frustration being experienced by the team, continual monitoring (responsibility of the project manager set out in contract) was being carried out on the projects whilst the issues were being resolved simultaneously.

8.5.2 Continual planning

The end-goal driven nature of the project and the aim to maintain client relationship revealed persistence. This was enabled by the project being forthcoming and not focussing on the problems being encountered. Despite disruptions which led to delay in contract being signed, project persistence was evident by contractor agreeing to continually work under the letter of intent to ensure that the project is delivered on time. Also, strict processes were identified to prevent discrepancies and further disruptions. Continual planning to maximize the programme were being carried out whilst the disruption was being resolved. For instance, on the projects, despite the frustrations that had arisen within the project, continual planning was being carried out. This ability to continue work on the programme to maximize its output despite the issue enabled the team accelerate and saved cost during the disruption. The end-goal driven drive for continual planning helped the project through the midst of disruption and thus ensured that successive works were completed in time before their dependent works were due. This also prevented any further delay. Again, continual planning promoted innovation in the midst of the disruption by the project manager showed how determined the project was.

8.5.3 Negotiations

Negotiations were identified during the disruption. Negotiation reduced cost implication of the disruption and enabled projects carry on. Also, negotiations through continual collaboration and communication despite loss of trust were carried out during disruptions to manage it. Furthermore, negotiations enabled continual collaboration and communication during the disruptions. This was through meetings (example emergency meetings) despite loss of trust. Negotiation was eased by the strict collaboration rules set out in the contract. From the findings, these helped the project resolve issues quicker and toughen the project team.

8.5.4 Antecedents and consequence of persistence

Following on from the evidence of persistence, the antecedents and consequences of persistence from the discussion are presented in Table 8-7. Also the antecedents identified from Table 8-7 all seek to, in diverse ways, ensure readiness, and enable response and reduction of vulnerability.

Table 8-7 Antecedents and consequence of persistence

Project Persistence		
Antecedent		Consequence
Continual monitoring	Risk management	Readiness, Reduction and Response
Continual planning	Motivation	Readiness
	Innovation	Readiness, Reduction
Negotiation	Cost & Time reduction	Reduction

8.6 Overall Consequence of Project Resilience- Recovery

The main consequence of resilience in projects is identified as recovery. The ever vulnerable nature of projects makes it focus more on recovery rather than reduction of vulnerability only as captured in permanent organisations with the help of capabilities together with utilising proactive procedures and measures. Permanent organisations focus on vulnerability reduction only because of the ease in identification of its risk and uncertainties due to its relative stable environment. Thus, resilient organisations work towards reducing areas of identified vulnerabilities using capabilities; coping ability, flexibility and persistence. Also, recovery in permanent organisations is captured differently. It presents recovery as the organisations' ability to return to initial objective using organisational processes and resources (Sutcliffe & Vogus, 2003).

Furthermore, the identified consequence in projects from the discussion which are readiness, response and reduction all work towards recovery. Thus, in projects, the consequence of proactivity, coping ability, flexibility and persistence all lead to recovery. For instance, for proactivity, readiness was the significant consequence. The project management procedures and mechanism all seek to, in diverse ways, ensure readiness and enable response and reduction of vulnerability for all projects in order of significance. Readiness was mainly identified as the recovery means within the contract and training project management procedures. Monitoring focussed in response and reduction to ensure recovery. The project management mechanisms ensured response and readiness. Experience on the other hand ensures readiness and reduction during and after the manifestation of the critical incident to enable recovery.

Coping ability had readiness and response as its main recovery within all projects. Regulative coping led to reduction first then to response and then readiness. Responsibility coping on the other hand led to readiness and response to ensure recovery. Also, flexibility had response and readiness as its main recovery. Persistence within the projects led to readiness mainly and then to reduction and response.

Resilience in projects reveal the actual consequence of projects in term of managing disruptions following the theory of projects (Rose, 2013) instead of the vulnerability reduction only consequence current strategies; risk/ uncertainty/ crisis and change management presents.

8.7 Framework for resilience in projects

Following the discussion in sections 8-1 to 8-6, the antecedents, dimensions of resilience and consequence are presented in the framework in Figure 8-1. This is an updated version of the preliminary framework in 2-9. This section provides a description of the developed framework.

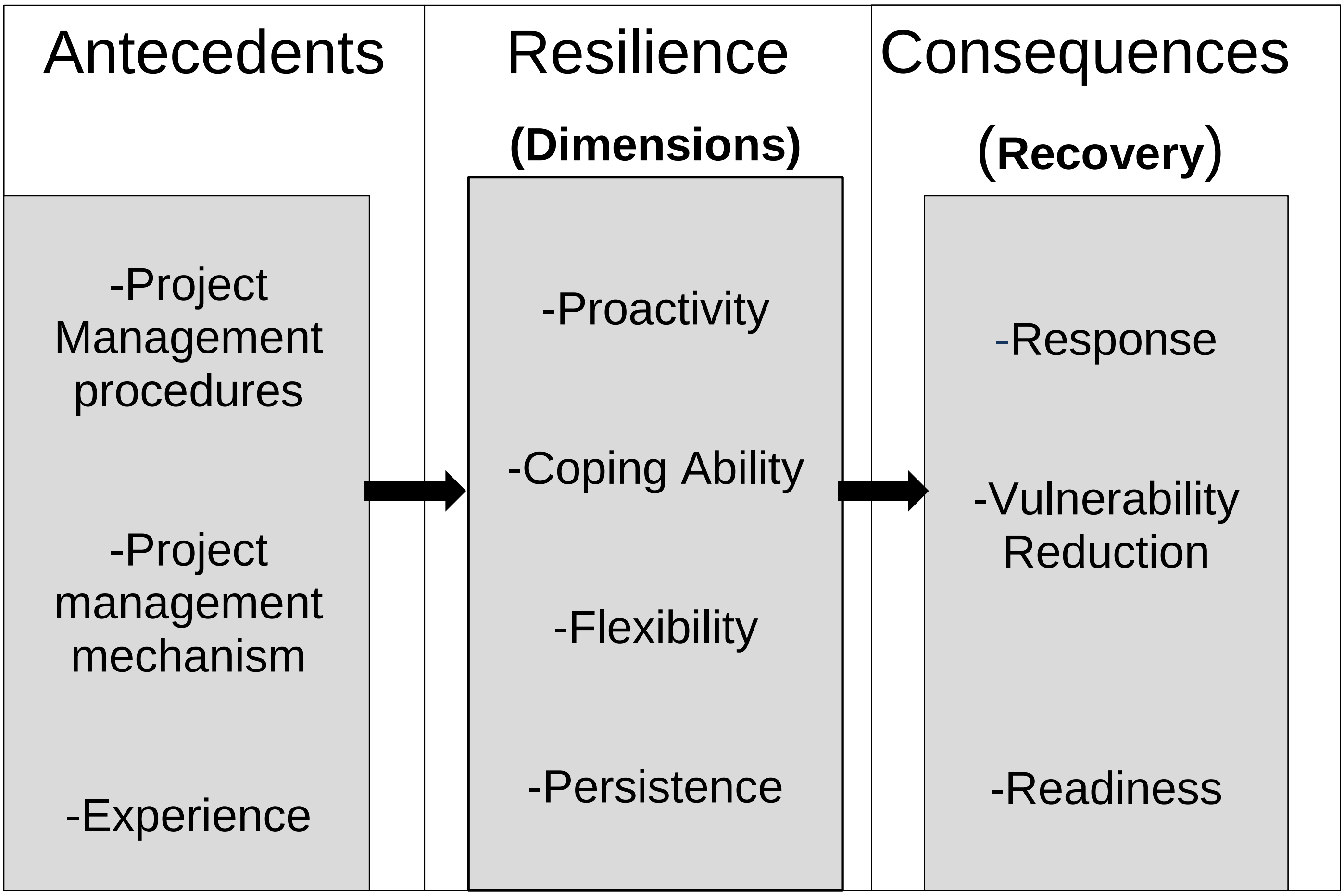


Figure 8-1 Framework for resilience in project

8.7.1 Description of framework

The framework was developed by carrying out case studies on three projects (building (alpha), civil engineering (beta) and engineering construction (gamma)) with the focus on critical incidents and how they were managed. Critical incident is an unexpected (uncertain) occurrence which causes distress and disruption.

The framework identifies the capabilities that projects need to manage disruption and shows its related antecedents and consequence

8.7.1.1 What is the definition and dimensions of resilience?

Resilience is the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity. Identified capabilities are proactivity, coping ability, persistence and flexibility.

Proactivity is defined as an anticipatory capability that the project takes to influence their endeavours. This future-focussed capability is identified through the project management procedures, mechanisms and experience. Coping ability is the capability to manage and deal with stress caused by disruptions within the projects. It enables the persistence and flexibility. Coping ability mainly focusses on adjusting through psychological coping (responsibility coping, regulative coping). Responsibility coping is defined as a role driven approach of coping whereby one accepts responsibility in putting things right whereas regulative coping is the ability to manage and deal with stress by controlling ones feeling and attitude towards a critical incident. Flexibility is the capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained. That is, it provides an ability to adjust to change and promotes renewal and development. Within projects, flexibility is mainly manifested through accommodation and promotion of innovation. Persistence is defined as the ability to continue despite difficult situations. Persistence focusses on the entire project's working ability to ensure that the endeavour is completed irrespective of objective met, once it works towards meeting the ultimate goal.

The framework (Figure 8-1) connects resilience (these capabilities) to its antecedents and consequences.

8.7.1.2 What are antecedents of resilience?

Antecedents are defined as the cause or enabler of the dimensions of resilience. Three main antecedents namely; project management procedure, project management mechanism and experience are identified. Project management procedure is the process that is performed throughout the project life to ensure the endeavour is completed irrespective of disruption. Project management mechanism is a technique that the project utilises to manage disruption. Experience is the practical contact that project has in terms of managing disruptions.

I- Specific antecedents for Proactivity

Under project management procedure the specific antecedents for proactivity are contract, training, monitoring. For project management mechanism, the exact antecedent is contingency. Furthermore, experience enables open mindedness, curiosity, self-motivation and innovation.

II- Specific antecedents for Coping ability

Responsibility coping is enabled by the project management procedures such as the contract, whereas regulative coping is enabled by project management mechanism such as contingency and procedures training and also experience.

III- Specific antecedents for Flexibility

Flexibility manifested through accommodation is enabled by planning under project management procedure and open-mindedness from experience whereas; flexibility through innovation is by the continual monitoring and identification of ideas under project management procedure.

IV- Specific antecedents for Persistence

Persistence is promoted by project management procedures such as continual monitoring (as per risk management and innovativeness), continual planning and negotiations.

8.7.1.3 What are the consequences of resilience?

The consequences are the impact of resilience. The overall consequence of resilience is recovery. Recovery is defined as the improvement to the same or new set of objectives to ensure a successful completion of project endeavours. It comprises vulnerability reduction, readiness and response. Response is defined as the reaction to the disruption. Reduction of vulnerability is the minimisation of the project susceptibility to possible future harm, a potential change or transformation when struck with stress. Readiness is the preparedness of the project to the disruption.

I-Effects of proactivity on consequence

Proactivity seeks to, in diverse ways, ensure readiness and enable response and reduction of vulnerability in that order. Readiness is mainly identified as the recovery means with the help of antecedents to proactivity such as contract and training. Proactivity leads to response and reduction to ensure recovery through monitoring. Also, proactivity leads to response and readiness through the contingency. Proactivity also, leads to readiness and reduction to enable recovery through open mindedness, curiosity, self-motivation and innovation.

II- Effects of coping ability on consequence

Coping ability has readiness, vulnerability reduction and response as its main recovery approach. Regulative coping leads to reduction first then to response and then readiness. Responsibility coping on the other hand leads to readiness and response to ensure recovery.

III- Effects of flexibility on consequence

Flexibility leads to response and readiness with the help of open-mindedness and planning. Also, flexibility leads to readiness through continual monitoring. Again, flexibility leads to reduction and response through continual identification of innovative ideas.

IV- Effects of persistence on consequence

Persistence leads to readiness, reduction and response through continual monitoring. Also, persistence leads to readiness and reduction through continual planning whilst persistence also leads to reduction through negotiation.

Resilience in projects reveal the actual consequence of projects in terms of managing disruptions instead of the vulnerability reduction-only consequence current project management strategies; risk/ uncertainty/ crisis and change management presents.

8.8 Framework Validation

Three academics and three respondents (from project alpha, beta and gamma) were engaged to validate the framework. Academics were selected to validate the developed framework in order to assess the theoretical perspective of the framework. Thus, ensure that the developed framework is theoretically fit for purpose and contributes to theories in the project management discipline. Furthermore, given that, the conceptualisation of resilience in project presents a holistic approach to disruption management to ensure recovery, that is, going beyond vulnerability reduction to ensure readiness and response, it was essential to engage academics to confirm or challenge findings. Also, project managers from case study alpha, beta and gamma were employed to validate the framework in order to confirm or challenge capabilities, antecedents and consequences deduced from data collected across case studies. Given that findings were common capabilities across case studies, acquiring a confirmation from all three project managers justifies the framework. The validation process was through focus groups.

8.8.1 Focus group study

Two focus group meetings were carried out, one for the academics and one for the industry personnel. With the industry personnel, all respondents were project managers with over 6 years of experience within the construction industry each. The academics comprised of a lecturer and research associates within the construction management discipline with a minimum of 5 years' experience each.

The framework together with its description was handed to the academics and industry personnel. A presentation on the aim of the research and explanation of the framework was then provided. Following that, participants were allowed to ask questions in order to clarify any misunderstandings. Questions covering the five areas listed below were asked;

1. Overall Assessment,
2. Logic of the framework,
3. Completeness of framework,
4. Adequacy of framework, and
5. Adaptability of framework.

A sample of the questions is in Appendix E.

8.8.2 Data Analysis method for framework validation

From the findings, a summarisation of direct quotation from the focus group discussion was carried out. These findings were further aggregated and presented in Table 8-8. Thereafter, the implication of these findings to the framework is discussed in section 8.8.2.2.

8.8.2.1 Presentation of findings

Findings from each focus group are summarised and compared in Table 8-8.

Table 8-8 Findings from focus group

	Aggregated Response	
Question	Focus Group 1 (Industry)	Focus Group 2 (Academic)
How important are all the antecedents to resilience in projects?	Extremely important	Extremely important
	A breakdown of exact antecedents in the framework is recommended	No additional comments
How easy is it to understand the framework?	Easy to read	Extremely Easy
	Arrows connecting antecedents to dimensions to consequences can have 'contributes to' annotated on it	Detailed composition which is covered well in write up can be shown in the framework as well

To what extent is this framework logical?	Logical	Logical
	Easy to know what follows what	No additional comments
To what extent will you say this framework is adequate for projects to identify the factors (dimensions) and indicators (antecedents) to managing disruption?	Extremely adequate	Extremely Adequate
	For identification purposes yes but there is more work to be done to further show what steps to follow at each level	No additional comments
Do the elements suggested in the framework completely help manage disruptions?	Complete	Complete
	The explanation in the textual description can be used as a management tool or guide	Strategic enough to mitigate disruption
How transferable is this framework to all forms of projects?	Extremely transferable	Extremely Transferable
	No additional comments	Yes because it is high level. It can also be used outside construction except they don't use project management procedures
What do you consider as the strengths and weaknesses of the framework?	Strength; Relationship and Textual description	Strength: Simple and High level
	Weakness; lack of steps to follow at each level	Weakness; Requires a further break down, consider doing other frameworks with textual description
What can be added to and/or removed from the framework?	Add; Nothing	Add; A loop if there is
	Remove; Nothing	Remove; Hyphens before each word

I- Overall Assessment

Overall, the framework is identified to be extremely important and easy to read. Its strengths are the simplicity and high level nature and also the relationship amongst dimensions and textual description.

However, though comments such as; (1) break down of the exact antecedents in the framework and (2) textual description should be included in the framework, were made by industry and academics respectively, respondents were reminded that this was a framework to conceptualise resilience hence the high level presentation. Furthermore, the academics recommended; (1) the removal of hyphens before each text and (2) the need to close the loop. Recommendation two was given because, the consequences in turn influence antecedents (project management procedures, project management mechanisms and experience) for future projects.

II- Logic of Framework

Both academics and industry personnel agreed that the framework was logical. This was due to the flow in information and ease in identification of flow.

III- Completeness of framework

Furthermore, both academics and industry personnel agreed that the framework was complete. The explanation in the textual description was agreed to be a management tool or guide by industry personnel. Also, the academics agreed that the framework was strategic enough to mitigate disruptions.

IV- Adequacy of framework

The framework was identified to be extremely adequate for identification of dimensions (factors) and antecedents (indicators) in managing disruption in projects.

V- Adaptability of framework

Furthermore, based on the high level nature of the framework, it is identified to be extremely transferable by both industry personal and academics.

8.8.2.2 Implication of findings to framework

The only addition to the framework will be to close the open ended loop (indicated in dotted red) as recommended by academics. Hence the final framework for resilience in project is presented in Figure 8-2.

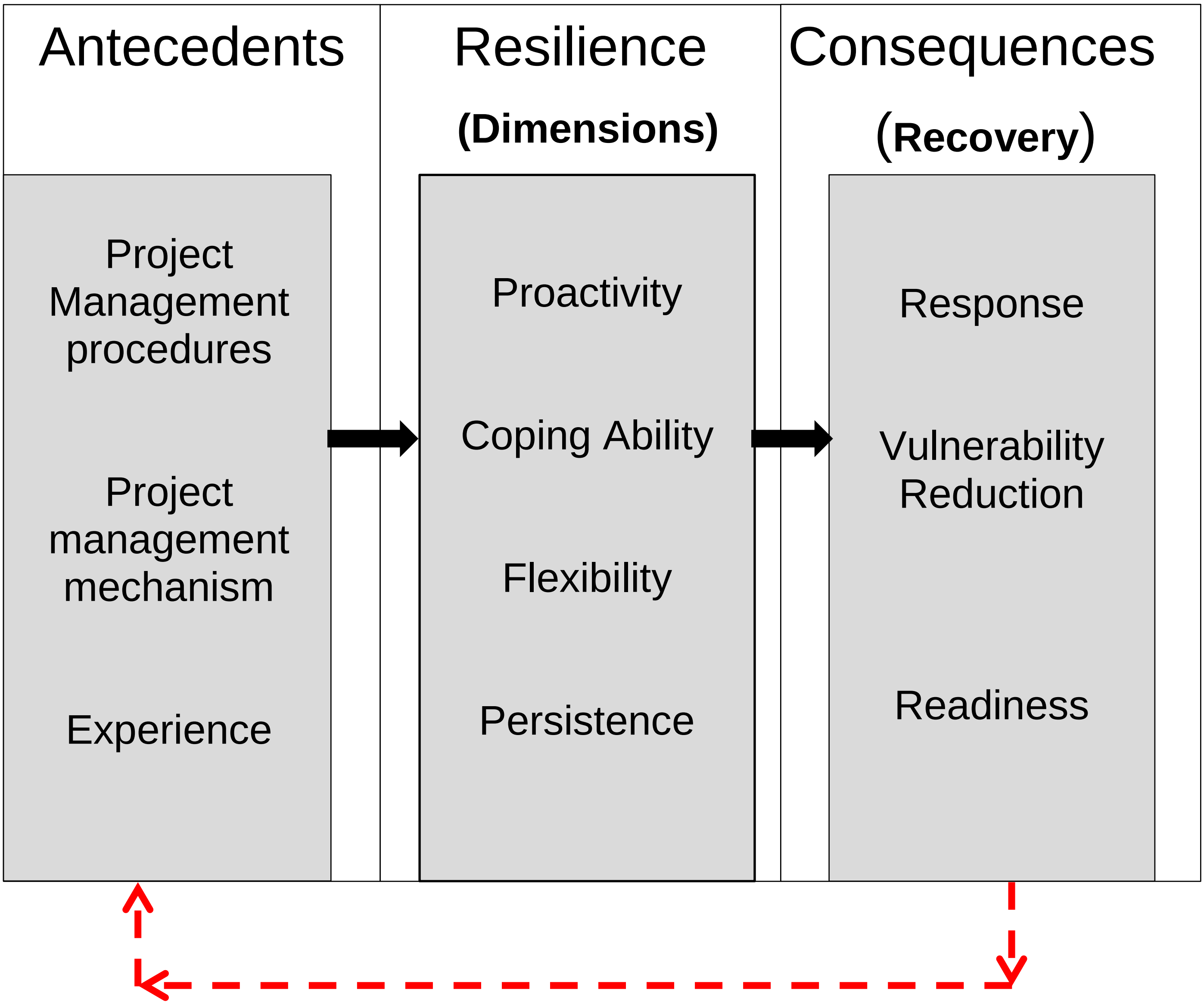


Figure 8-2 Validated framework for resilience in projects

8.9 Resilience in Project

Following the validated theory of resilience in projects, a resilient project can be said to be one that has the capability to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity. A resilient project aims to ensure recovery which comprises of response, readiness and vulnerability reduction. Capabilities manifested by a resilient project are proactivity, coping ability, flexibility and persistence.

8.9.1 Proactivity

To be proactive, the project should have; (1) project management procedures such as a contract, training personnel and monitoring of threats and disruptions, (2) project management mechanism such as contingency and (3) experience.

The contract in a resilient project should be one that promotes collaboration and sets out the relationship for the project clearly from the start (section 7.5.1.1 and 8.2.1.1). The training provided in a resilient project should be one that empowers the team, promote collaborative understanding and calmness (section 7.5.1.2 and 8.2.1.1). Monitoring within a resilient project is through risk, uncertainty and opportunity management (section 7.5.1.3 and 8.2.1.1). This is enabled by a realistic plan and continual planning. A realistic plan influences projects to respond to the disruption through the allowance for contingencies within the plan to enable the project to be prepared. Contingencies should be allowed for within the method statement and project databases to enable efficient response. Also, continual planning in a resilient project enables early risk, uncertainty and opportunity identification, early warning identification, continual co-operation and continual work execution before and during the disruption (section 7.5.2 and 8.2.1.1).

Furthermore, a resilient project requires experience. This enables projects to be ready through the open-mindedness, curiosity and self-motivation (section 7.5.3 and 8.2.1.3). This is due to the fore-knowledge of solutions and empowerment experience provides. Experience in a resilient project contributes to the creation of innovative solution to minimise time and quality loss (section 7.5.3 and 8.2.2.2).

8.9.2 Coping ability

A resilient project copes by adjusting during disruption through psychological coping. This comprise of responsibility and regulative coping (section 7.6 and 8.3).

Under responsibility coping, a resilient project copes by utilising responsibilities set out in the contract as this enhances tolerance through the trust the contract promotes (section 7.6.2 and 8.3.1.1). Also, in a resilient project, coping through responsibility allocation enables the project leaders adjust and endure. This then drives the rest of the team through motivation, enable project team tolerate and instils trust in order to respond adequately to the disruption. Further, this responsibility taking and acceptance also helps all parties to carry out a role in responding to disruptions (section 7.6.2 and 8.3.1.1). This keeps the project busy and thus, reduces the impact of the shock on the project.

For regulative coping, a resilient project achieves this through training, contingencies and experience (section 7.6.1 and 8.3.1.2). Training such as understanding the project, communication skills and lesson learnt workshops aids the ability to regulate the impact of the disruption. Communication skill training reduces vulnerabilities by showing the team how to deliver bad news in a manner that will have minimal impact on the project (section 7.6.1 and 8.3.2.2). Sharing of lessons learnt provides the project a capacity to withstand first-hand shock, be calm and have a high tolerance ability based on the information it provides (section 7.6.1 and 8.3.2.2). Furthermore, external training such as leadership courses is carried out to show how project leaders should behave, and deal with stress in order to shape how projects respond to disruptions. These training courses empower the project and thus, provide the motivation they require to control shock from disruption. Also, a resilient project utilises contingency to absorb shock and regulate the impact of the disruption through the slack resources it provides and thus enables response. Within a resilient project, experience is required to provide the ability to control one’s feeling and awareness as this helps minimise the impact of disruption ahead of time and hence nullifies the shock (section 7.6.1 and 8.3.2.2).

8.9.3 Flexibility

Flexibility provides a capability to adjust to change and promotes renewal and development. A resilient project is flexible through open-mindedness, flexible in planning and innovativeness (section 7.7.1 and 8.4.1). Open-mindedness provides the empathy and trust required to gain a collective understanding and response within the project. Flexibility in planning is achieved through the collective understanding in re-sequencing works and ability to accommodate changes (section

7.7.1). Flexibility through innovation is by creating and allowing new opportunities once it promotes cost and time savings (section 7.7.2).

8.9.4 Persistence

Persistence focusses on the entire project's working ability to ensure that the endeavour is completed irrespective of objective met, once it works towards meeting the ultimate goal. A resilient project persists through continual monitoring (as per risk management and innovativeness), continual planning and negotiations (section 7.8.1 and 8.5). Continual risk management despite disruptions reduces vulnerabilities through the continual re-inventing and moderation ability of the project. This is attained through the continual identification of risks despite the disruption (section 7.8.1). This provides a swift responding ability by the project (section 8.5.1). Continuous planning reduces vulnerability through re-scheduling activities in order to minimise shock. A resilient project negotiates and this reduces vulnerability by restoring trust (section 8.5.3). Negotiation is through strict collaboration rules set out in contract, communication and editing the programme to ensure vulnerability is reduced. Continual innovation also makes projects prepare for and persist during disruptions through the creative abilities it continually provides. Also, a resilient project continually motivates despite the disruption and this enables the project to be ready for any new disruption.

8.10 Comparison between resilience and disruption management approaches

The conceptualisation of resilience in section 8-1 to 8-9 clearly shows how projects respond to, prepare for and reduce vulnerability during disruption. This section relates the findings with current measures in managing disruptions in order to show clearly what resilience does that current approaches do not cover.

The main difference is that current approach employs measures to reduce vulnerability only whereas the resilience approach employs measures and capabilities to ensure recovery through vulnerability reduction, response and readiness. The main similarity is that, both current approaches and the resilience approach ensure vulnerability reduction. This comparison is grouped under three headings; vulnerability reduction, readiness and response. Figure 8-3 summarises the discussion.

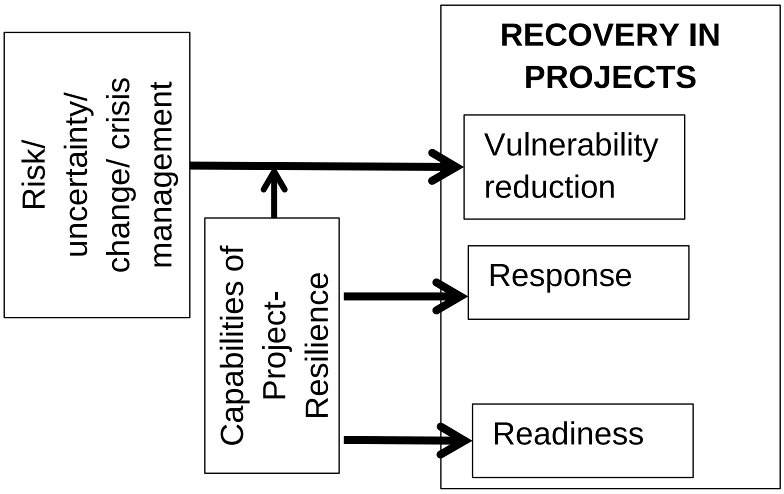


Figure 8-3 Comparison between resilience and current approaches to managing disruptions

8.10.1 Vulnerability Reduction

Vulnerability reduction is the minimisation of the project susceptibility to possible future harm, a potential change or transformation when struck with stress (Alliger et al., 2003). Approaches to managing disruption in literature focuses on reducing vulnerability through managing the known and unknown sources of project complexity and the drifting environment. Under the known source, approaches such as risk and opportunity management are employed. Under the unknown sources, change, uncertainty and crisis management approaches are employed. Evidence of vulnerability reduction within project resilience is through capabilities such as proactivity, coping ability, flexibility and persistence. Under proactivity, vulnerability reduction is by monitoring, planning and experience. Under coping ability, vulnerability is reduced by contingency, experience and training. Under flexibility, vulnerability reduction is by innovation and under persistence, it is by risk management, planning and negotiation. A comparison of vulnerability reduction between current methods and resilience approach is presented in Table 8-9.

8.10.2 Response

Response is the reaction to the disruption. It comprises following established processes and utilising capabilities to react to the disruption (Alliger et al., 2003). Response in current approaches aims at reducing vulnerability. This is achieved by following pre-determined measures to react to disruptions. These include following steps like the risk, uncertainty, opportunity, change and crisis management process just as outlined in section 2.3.

However, response as presented under project recovery goes beyond this and looks at utilising the capability of the project as well, which resilience enables. This enables shock caused by the disruption to be eased as compared to following pre-determined measures. A comparison of response between current methods and resilience approach is presented in Table 8-9.

8.10.3 Readiness

Readiness is the preparedness of the project to disruptions. This is enabled by awareness and capabilities. Awareness in projects is the knowledge of the drifting environment and complexity and the readiness to employ proactive measures to enable the project recover from disruption. Current approaches in a way focus on increasing awareness to determine readiness. This is due to its vulnerability reduction focus. This is through the risk, opportunity, change, crisis and uncertainty management approaches. However, this rather increases the impact of shock from disruptions if they occur due to the unpreparedness for the disruptions.

Resilience enables readiness by increasing awareness and utilising capabilities. Readiness reduces shock by the disruptions through the utilisation of capabilities proactivity, coping ability, flexibility and persistence. Since current approaches to manage disruption focus on vulnerability reduction, based on awareness, they are ready to the knowns only. A comparison of readiness between current methods and resilience approach is presented in Table 8-9.

Table 8-9 Comparison between current and resilience approaches to managing disruption

	Current Approaches		Resilience Approach	
	Approach	Means	Approach	Means
VULNERABILITY REDUCTION	*Risk Management*	-Predict the threat accurately and develop strategies to cater for it (Perry & Hayes, 1985; Qazi *et al.*, 2016). -The process comprise identifying, analysing, responding and implementing, monitoring and reviewing the risk - Project managers have set up team members to proactively identify risk by; recruiting people with creative ability, training those without, enhancing relationship which aid creativity, idea elicitation techniques forecasting, soft system analysis, brainstorming, electronic brainstorming, influence diagram, fault tree analysis and simulations (Loosemore *et al.*, 2006; Sanderson, 2012). -Responding to risk is either by doing something or doing nothing. The ultimate goal here is to mitigate potential threats.	*Proactivity*	This is through monitoring, continual planning and experience. (1)Monitoring- through risk, uncertainty and opportunity management (2) Continual planning- through enabling early risk, uncertainty and opportunity identification, early warning identification, continual co-operation and continual work execution before and during the disruption (3)Experience-through the creation of innovative solution to minimise time and quality loss
	Opportunity Management	-By exploiting, sharing, enhancing and ignoring opportunities (Hillson, 2002). -The exploit strategy is to ensure that opportunities definitely happen in order to realise its benefits. - sharing seeks to partner with the party best able to make the opportunity occur. - Enhancing seeks to increase the impact of the opportunity to acquire maximum benefit - Minor opportunities are ignored and a reactive approach employed, this is to enable the focus on high impact opportunities	*Regulative coping*	This is through experience, contingency and training. (1) Experience provides the ability to controlling ones feeling and awareness required to reduce vulnerability by minimising the impact of disruption ahead of time and hence nullifying the shock. (2) Contingency aids the ability to regulate the impact of the disruption through the utilisation of slack resources and provide the opportunity to tap into additional resources in order to cope with broader interruptions when needs be. (3) Training such as communication skills and lesson learnt workshops aids the ability to regulate the impact of the disruption. - Communication skill training reduces vulnerabilities by showing the team how to deliver bad news in a manner that will have minimal impact on the project - Sharing of lessons learnt provides the project a capacity to withstand first-hand shock, be calm and have a high tolerance ability based on the information it provides
	Change Management	Early set out of a generic process to minimise shock through the sequential steps; start up, identify and evaluate, approval and propagation and post stage	*Flexibility*	This is through innovation. Innovation reduces vulnerability through cost and time saving the new ideas creates and also creates new opportunities
	Uncertainty Management	(1)incorporating strategies to understand uncertainties- this is to increase awareness in order to minimise shock (2)ignoring it-if the overall impact is insignificant	*Persistence*	This is through continual risk management, planning and negotiation. (1) Continual risk management despite disruptions reduces vulnerabilities through the continual re-inventing and moderation ability of

		(3)reacting to uncertainties- responding using risk, opportunity and change management strategies		the project (2) Continuous planning reduces vulnerability through re-scheduling activities in order to minimise shock. (3) Negotiation also reduces vulnerability by restoring trust. This is through continual collaboration, communication and editing the programme to ensure vulnerability is reduced. Negotiation is eased by the strict collaboration rules set out in contract.
	Crisis Management	(1)utilising pre-developed plan; this is to buy time for the command centre (experts) to develop a strategy (2) employing command centre strategy; Experts employed to manage disruption (3)training; develop ability to increase the predictability and consistence of the crisis response without considering social adjustment, behavioural instability, information management and conflict management		
RESPONSE	Risk, uncertainty, opportunity and crisis management	These steps are followed to respond through ultimate aim is to reduce vulnerability	*Proactivity*	This is through risk uncertainty and opportunity management, realistic plan and contingencies. (1)Risk, uncertainty and opportunity management aids response through the utilisation of planned processes to react to the disruption. (2)A realistic plan influences projects to respond to the disruption through the allowance for contingencies within the plan to react to the disruptions (3)Contingencies within the method statement and project databases enables efficient response
			Regulative coping	This is through training and contingencies. (1)Training such as understanding the project is carried out to ensure that the ultimate goal for the project is well known to all in order to gain a collective response approach. Furthermore, external training such as leadership courses aims at capturing how project leaders should behave, enable the project manage and deal with stress is carried out to shape how projects respond to disruptions. (2)Contingency enables shock to be absorbed by the resources it provides and thus enables response.
			Responsibility coping	This is through responsibility, allocation, acceptance and taking. (1)Responsibility allocation drives the rest of the team through motivation, enable the project leaders adjust and endure, enable project team tolerate and instils trust in order to respond adequately to the disruption. (2)Responsibility taking and acceptance also helps all parties carry out a

				role in responding to disruptions. This keeps the project busy and thus reduces the impact of the shock on the project.
			Flexibility	This is through open-mindedness, flexibility in planning and innovativeness. (1)Open-mindedness provides the empathy and trust required to gain a collective response within the project. (2)Flexibility in planning enhances response through the re-sequencing of works and ability to accommodate changes. (3)Innovativeness aids response by the cost and time savings it provides.
			Persistence	Through the continual identification of risks despite the disruption. This provides a swift responding ability by the project.
READINESS	Risk, uncertainty, opportunity and crisis management	These steps are followed to respond through ultimate aim is to reduce vulnerability	*Proactivity*	This is through the contract, training, contingency and experience. (1)The contract enables readiness through the collaboration and relationship it sets out and this makes the project prepared to absorb any shock from disruption (2)Training ensures readiness through its ability to empower the team, promote collaborative understanding and calmness. (3)The contingency enables the project to be prepared through its allowance for works to be redone. (4)Experience enables projects to be ready through the open-mindedness, curiosity and self-motivation. This is due to the fore knowledge of solutions and empowerment experience provides.
			Regulative coping	This is through experience and training (1)Experience enables readiness through the foreknowledge of disruption and hence nullifies the shock of the disruption. (2)Training empowers the project and thus provides the motivation they require to control shock from disruption.
			Responsibility coping	The contract promotes readiness through the responsibility it sets out and enhances tolerance through the trust it enables and promotes
			Flexibility	This is through open-mindedness, flexibility in planning and innovativeness. (1)Open-mindedness enables the empathy and trust required to gain a collective readiness within the project.

				(2)Flexibility in planning enhances readiness through the re-sequencing of works and ability to accommodate changes. (3)Innovativeness aids readiness by the cost and time savings and contingencies it provides.
			Persistence	This is through continual risk management, motivation and innovation. (1)Continual management of risk provides projects to be ready for any potential threat (2)Continual motivation despite the disruption enables the project to be ready for any new disruption. (3)Continual innovation also makes projects prepare for disruptions through the creative abilities it continually provides.

8.11 Chapter summary

Resilience in projects has been conceptualised. This chapter establishes that resilience in project is different from permanent organisation (organisational resilience). Organisational resilience follows engineering resilience whereas project resilience follows ecological resilience.

Resilience in project is defined as 'the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity'. Dimensions of resilience in projects are proactivity, coping ability, flexibility, persistence instead of situational awareness comprising adaptive capacity (coping ability, flexibility, persistence) as in permanent organisations. The consequence of resilience in projects seeks to ensure recovery whereas in organisations it seeks to reduce vulnerability due to its relatively stable environment. The identified antecedents, dimensions and consequences of resilience in projects, has been synthesised into a developed and validated framework.

Furthermore, this chapter compared current approaches in managing disruption with the resilience approach. Current approaches were identified to manage disruption by focussing on reducing vulnerability with minimal focus on general response and readiness. The resilience approach on the other hand manages disruption by ensuring recovery (vulnerability reduction, response and readiness). This is achieved by utilising project capabilities such as proactivity, coping ability, flexibility and persistence.

9- Conclusion

This research has developed a framework for resilience in projects capturing antecedents, dimensions and consequence of resilience. This chapter assesses how the aim of this research which is; to develop a framework to conceptualise resilience in projects, has been met. It is presented in five parts; (1) main findings of the research (2) overview of the research methods employed to address objectives (3) contributions to theory (4) contributions to practice (5) limitation of study and recommendation for further research.

9.1 Main findings

The main findings of this research is the conceptualisation of resilience in projects. Within the conceptualisation, resilience has been defined and dimensions, antecedents and consequences identified.

Resilience in projects is defined as *the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity.*

The identified dimensions of resilience are; proactivity, coping ability, flexibility and persistence. Proactivity is defined as an anticipatory capability that the project takes to influence their endeavours. Coping ability on the other hand is defined as the capability to manage and deal with stress caused by disruptions within the projects. Flexibility is the capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained whereas persistence is defined as the capability to continue despite difficult situations.

The identified antecedents to the dimensions of resilience are;

- For *proactivity* these include project management procedures (contract, training, monitoring), project management mechanism (contingency) and experience (open mindedness, curiosity, self-motivation and innovation).
- For *coping ability* these include the contract, training, contingency and experience.
- For *flexibility* these include open-mindedness, planning, continual monitoring and continual identification of ideas.

- For *persistence* these include continual monitoring, planning and negotiation.

The identified consequence of resilience in projects is recovery. Recovery is defined as; the improvement to the same or new set of objectives to ensure a successful completion of project endeavours.

9.1.1 Addressing Objectives

The objectives of this study are;

1. Identify the theoretical definitions and the dimensions of resilience in projects,
2. Identify antecedents of resilience in projects,
3. Identify the consequences of resilience in projects, and
4. Develop and validate a framework for resilience in projects

These were addressed by the following;

1. ***Identify the theoretical definitions and the dimensions of resilience in projects.***

Based on the synthesis of literature and findings, resilience is defined as *the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity.* The dimensions of resilience identified are; proactivity, coping ability, flexibility and persistence. Objective 1 is therefore fully met.

2. ***Identify antecedents of resilience in projects***

Several antecedents of resilience are identified. For *proactivity* these include project management procedures (contract, training, monitoring), project management mechanism (contingency) and experience (open mindedness, curiosity, self-motivation and innovation). For *coping ability* these include the contract, training, contingency and experience. For *flexibility* these include open-mindedness, planning, continual monitoring and continual identification of ideas and for *persistence* these include continual monitoring, planning and negotiation. Objective 2 is therefore fully met.

3. *Identify the consequences of resilience in projects*

The consequence of resilience in projects is identified as recovery. Recovery is defined as; the improvement to the same or new set of objectives to ensure a successful completion of project endeavours. This is enabled by the resilience approaches of response, vulnerability reduction and readiness. Objective 3 is therefore fully met.

4. *Develop and validate a framework to conceptualise resilience in projects*

The developed and validated framework for resilience in projects is shown in Section 8.8.2.2 (Figure 8-2). Objective 4 is therefore fully met.

9.2 Overview of research methodology and methods

This research followed the interpretivist (epistemological) perspective. The interpretivist view was employed due to the complexity of the resilience construct. Within this research, attachments to the subjects were required in order to identify the manifestations of capabilities during the critical incidents. Also, an abductive approach was employed because of its ability to gain insights in order to create this conceptualisation and also affords this theory building process. The interpretivist and abductive approaches employed in this research favour a qualitative approach. Under qualitative research, a case study method was employed.

A comparative case study approach (comprising a building (alpha), engineering construction (beta) and civil engineering project (gamma)) was employed. This is because projects are classified either as building, engineering construction and civil engineering projects (Office of National Statistics, 2007). These embody important contrasts (example; endeavour being carried out and the contractual agreements) which enable conceptualisation. The project were located across the United Kingdom, thus; in the midlands (project alpha-building), northern (project beta- engineering construction) and southern (project gamma- civil engineering) parts.

Each case study comprised interviews, document analysis and observations. The key staff showed a vast range of experience both in construction and in their current roles on the project. Respondents were identified to be members of at least one professional association. The leadership-target focus of respondent influenced the high level of experience captured. General information on project such as, key deliverables, key drivers and specific information on critical change events and how they are managed within the project context were sought to better contextualise findings.

Data acquired were coded under two major themes namely; (1) background of project and critical incident and (2) capabilities with their antecedents and consequences using Nvivo 10 software (Figures 3-5, 3-6 and 3-7) and discussed with literature to arrive at findings.

9.3 Contribution of research to theory

The implication of this research to theory is the conceptualisation of resilience in projects. This provides a definition, dimensions, antecedents and consequences of resilience in project. The identified dimensions, antecedents and consequences are presented in a validated framework (Figure 8-2). The framework (section 8.8.2.2, Figure 8-2) connects resilience (these capabilities) to its antecedents and consequences.

9.3.1 Conceptualisation of resilience in projects

Prior to this research, there was no clear definition, dimensions, antecedents and consequences of resilience in projects. This conceptualisation defines resilience in projects and reveals that, resilience goes beyond the current vulnerability-reduction only based approach of managing disruptions as focussed on in projects in literature and ensures recovery. The resilience approach represents a more holistic perspective of managing disruptions in projects, a perspective that highlights a clear difference between resilience in permanent organisations and projects.

9.3.1.1 Definition of resilience in projects

The definition of resilience provides a theoretical starting point for the concept of resilience in projects. From findings, the definition of resilience in projects arrived at is; ‘the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity’. This definition is different from organisational resilience definition which is 'the capability of an organisation to respond to and prepare for disruption'.

The dynamic project behavioural and changes in processes to address disruptions and challenges encountered portrays the ecological resilience focus. Organisational resilience focuses on engineering resilience and has awareness as its main enabler because permanent organisations are routine based. It therefore puts in measures to ensure the continual increase of awareness of the incident in order to reduce vulnerability. Unlike permanent organisations, projects are dynamic and hence focus on proactivity in order to respond to its drifting environment. In terms of awareness, projects are aware of the drifting nature of the environment and thus, need to focus on preparedness, vulnerability reduction and response as identified in project resilience instead of the vulnerability reduction-only approach it has been employing in order to ensure overall project success and better manage disruptions.

9.3.1.2 Dimensions of resilience in projects

Identified dimensions from the definition of resilience are proactivity, coping ability, flexibility and persistence. Coping ability, flexibility and persistence are common capabilities with organisational resilience except that these manifest differently within projects. Within organisations, these capabilities are enabled by the adaptive capacity developed by the organisational processes. Projects on the other hand enable the capabilities by proactivity. Thus, the novel dimension within project resilience is proactivity. These dimensions, their antecedents and consequence are presented in a framework (Figure 8-2).

Proactivity within projects is defined as an anticipatory capability that the project takes to influence their endeavours. It enables coping ability, flexibility and persistence.

Coping ability is the capability to manage and deal with stress caused by disruptions within the projects. It enables the persistence and flexibility. Coping ability mainly focusses on adjusting through psychological coping (responsibility coping, regulative coping). Responsibility coping is defined as a role driven approach of coping whereby one accepts responsibility in putting things right whereas regulative coping is the ability to manage and deal with stress by controlling ones feeling and attitude towards a critical incident.

Flexibility is the capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained. That is, it provides an ability to adjust to change and promotes renewal and development. Within projects, flexibility is mainly manifested through accommodation and promotion of innovation.

Persistence is defined as the capability to continue despite difficult situations. It focusses on the entire project's working ability to ensure that the endeavour is completed irrespective of objective met, once it works towards meeting the ultimate goal.

9.3.1.3 Antecedents of Resilience in projects

Identified antecedents provide a theoretical basis for indicators required in order to manage disruptions in projects. The antecedent is defined as the cause or enabler of the dimensions of resilience. Three main antecedents namely; project management procedure, project management mechanism and experience are identified. Project management procedure is the process that is performed throughout the project life to ensure the endeavour is completed irrespective of disruption. Project management mechanism is a technique that the project utilises to manage disruption. Experience is the practical contact that project has in terms of managing disruptions.

I- Specific antecedents for Proactivity

Under project management procedure the specific antecedents for proactivity are contract, training, monitoring. For project management mechanism the exact antecedent is contingency. Furthermore, experience is enabled by open mindedness, curiosity, self-motivation and innovation.

II- Specific antecedents for coping ability

Responsibility coping is enabled by the project management procedures such as the contract whereas regulative coping is enabled by project management mechanism such as contingency and procedures training and also experience.

III- Specific antecedents for Flexibility

Flexibility manifested through accommodation is enabled by open-mindedness from experience and planning under project management procedure, whereas, flexibility through innovation is by continual monitoring and identification of ideas under project management procedures.

IV- Specific antecedents for Persistence

Persistence is promoted by project management procedures such as continual monitoring (as per risk management and innovativeness), continual planning and negotiations.

9.3.1.4 Consequence of Resilience

The consequence is defined as the impact of resilience. The overall consequence of resilience is recovery. Recovery is defined as the improvement to the same or new set of objectives to ensure a successful completion of project endeavours. It comprises vulnerability reduction, readiness and response. Response is defined as the reaction to the disruption. Reduction of vulnerability is the minimisation of the project susceptibility to possible future harm, a potential change or transformation when struck with stress. Readiness is the preparedness of the project to the disruption.

I- Effects of proactivity on consequence

Proactivity seeks to, in diverse ways, ensure readiness and enable response and reduction of vulnerability. Readiness ensures recovery with the help of antecedents to proactivity such as contract and training. Proactivity leads to response and reduction to ensure recovery through monitoring. Also, proactivity leads to response and readiness through the contingency. Proactivity also, leads to readiness and reduction to enable recovery through open mindedness, curiosity, self-motivation and innovation.

II- Effects of coping ability on consequence

Coping ability leads to readiness, vulnerability reduction and response. Regulative coping leads to reduction, response and readiness. Responsibility coping on the other hand leads to readiness and response to ensure recovery.

III- Effects of flexibility on consequence

Flexibility leads to response and readiness with the help of open-mindedness and planning. Also, flexibility leads to readiness through continual monitoring. Again, flexibility leads to reduction and response through continual identification of innovative ideas.

IV- Effects of persistence on consequence
Persistence leads to readiness, reduction and response through continual monitoring. Also, persistence leads to readiness and reduction through continual planning whilst persistence also leads to reduction through negotiation.

Resilience in projects reveal the actual consequence of projects following the theory of projects instead of the vulnerability reduction-only consequence current strategies; risk/ uncertainty/ crisis and change management provides.

9.4 Contribution of research to practice

Findings from the research contributes to practice in two ways; (1) a holistic perspective to disruption management on projects and (2) further development of knowledge areas (example, eleventh knowledge area; project risk management) to include resilience in the Project Management Book of Knowledge (PMBOK).

9.4.1 Implication of the resiliency approach

A more holistic approach to managing disruption in projects has been developed. This goes beyond the vulnerability reduction-only approaches and enables response and readiness also as depicted in Figure 8-3 and discussed below.

9.4.1.1 Vulnerability reduction

Resilience in projects enable vulnerability reduction by not only; (1) identifying, analysing, responding (utilising contingencies) and implementing, monitoring and reviewing the risk, (2) exploiting, sharing, enhancing and ignoring opportunities, (3) following sequential steps to manage change and (4) incorporating strategies to understand uncertainties as current approaches in literature do but also utilising experience, innovation, training and negotiations to develop the general capacity for reducing vulnerability to disruptions.

Experience enables vulnerability reduction through the calmness, awareness required by minimising the impact of disruption ahead of time and hence nullifying the shock and creation of innovative solution (section 7.3.2 and 8.3.2.2). Innovation reduces vulnerability through cost and time saving the new ideas brings and it also creates new opportunities. Trainings such as communication skills and lesson learnt workshops aid vulnerability reduction (section 7.3.2 and

8.3.1.2). Communication skill training reduces vulnerabilities by showing the team how to deliver bad news in a manner that will have minimal impact on the project (section 7.3.2 and 8.3.1.2). Sharing of lessons learnt provides the project a capacity to withstand first-hand shock, be calm and have a high tolerance ability based on the information it provides (section 7.3.2 and 8.3.1.2). Negotiation also reduces vulnerability by restoring trust. This is through continual collaboration, communication and editing the programme to ensure vulnerability is reduced. Negotiation is eased by the strict collaboration rules set out in contracts (section 8.5.3).

9.4.1.2 Response

Resilience in projects focusses on developing the general capacity for responding to disruptions to ensure recovery. This goes beyond following established steps to manage risk and uncertainties and utilising contingencies as current approaches cover but also include training, responsibility allocation, responsibility taking, open-mindedness and innovativeness

Training such as understanding the project is carried out to ensure that the ultimate goal for the project is well known to all in order to gain a collective response approach (section 7.3.2 and 8.3.1.2). Furthermore, external training such as leadership courses which captures how project leaders should behave, is carried out to enable the project manage and deal with stress and thus, shape how projects respond to disruptions. Also, responsibility allocation drives the rest of the team through motivation, enable the project leaders adjust and endure, and enable project team tolerate and instils trust in order to respond adequately to the disruption (section 7.3.2 and 8.3.1.1). Responsibility taking and acceptance also helps all parties carry out a role in responding to disruptions. This keeps the project busy and thus reduces the impact of the shock on the project (section 7.3.2 and 8.3.1.1). Also, open-mindedness provides the empathy and trust required to gain a collective response within the project whilst innovativeness aids response by the cost and time savings it provides (section 7.3.3 and 8.4.1).

9.4.1.3 Readiness

Again, resilience in projects goes beyond established steps prepared to manage perceived disruption and contingency but utilises contract, training, experience (open-mindedness), innovation and motivation to ensure general readiness.

The contract enables readiness through the collaboration, responsibility and relationship it sets out and this makes the project prepared to absorb any shock from disruption (section 7.3.1 and 8.2.1.1). Training ensures readiness through its ability to empower the team, promote collaborative understanding and calmness (section 7.3.1 and 8.2.1.1). Experience enables projects to be ready through the open-mindedness, curiosity and self-motivation (section 7.3.1 and 8.2.1.3). This is due to the fore knowledge of solutions and empowerment experience provides. Open-mindedness enables the empathy and trust required to gain a collective readiness within the project (section 7.3.3 and 8.4.1). Innovativeness aids readiness by the cost and time savings and contingencies it provides and also makes projects prepare for disruptions through the creative abilities it continually provides. Further, continual motivation despite the disruption enables the project to be ready for any new disruption (section 8.9.4).

9.4.2 Implication of resiliency approach to Project Management Practice

Findings from this research contributes to the Project Management Book of Knowledge (PMBOK) through the identification of capabilities and antecedents for resilience. These identified capabilities and antecedents provides clarity for the roles of project managers and team members in managing disruptions, more specifically, for the role of a project manager in ensuring resilience. The findings add on to the competency areas of project managers, namely; knowledge, performance and personal (PMBOK, 2013). In terms of knowledge, the identification of capabilities such as proactivity, coping ability, flexibility and persistence creates the awareness of capabilities he or she and the team require to manage disruptions. Also, the identification of the antecedents to these dimensions of resilience show project managers what they are to do to ensure these capabilities are attained, therefore, enabling project and project management performance during disruptions.

The findings identify, the role interpersonal skills (example, trust building, leadership, influencing, decision making) outlined in the PMBOK play in managing disruptions. Thus, capabilities and antecedents identified guides project managers on the interpersonal skills required during disruption management. For example, to cope during disruptions, this research identifies utilising responsibilities set out in the contract as this enhances tolerance through the trust the contract promotes (section 7.6.2 and 8.3.1.1). For instance, coping through responsibility allocation enables the project leaders to adjust and endure. This then drives the rest of the team through motivation, enable project team to tolerate and instils trust to respond adequately to the disruption. Furthermore, responsibility taking, and acceptance also helps all parties to carry out a role in responding to disruptions (section 7.6.2 and 8.3.1.1). This keeps the project busy and thus reduces the impact of the shock on the project. Also, to ensure flexibility, the findings show that, the project and project manager should have an open-mind, be flexible in planning and innovative. Open-mindedness provides the empathy and trust required to gain a collective understanding and response within the project. Flexibility in planning is achieved through the collective understanding in re-sequencing works and ability to accommodate changes (section 7.7.1). Flexibility through innovation is by creating and allowing new opportunities once it promotes cost and time savings. Furthermore, the project and project manager are to persist through continual monitoring (as per risk management and innovativeness), continual planning and negotiations (section 7.8 and 8.5). Continual risk management despite disruptions reduces vulnerabilities through the continual re-inventing and moderation ability of the project. This is attained through the continual identification of risks despite the disruption (section 7.8.1). This provides a swift responding ability by the project (section 8.5.1). Continuous planning reduces vulnerability through re-scheduling activities to minimise shock. Negotiation is through strict collaboration rules set out in the contract, communication and editing the programme to ensure vulnerability is reduced. Continual innovation also makes projects prepare for and persist during disruptions through the creative abilities it continually provides. Also, the project and project manager should continually motivate despite the disruption and this enables the project to be ready for any new disruption.

In addition, findings from this research expand the eleventh knowledge area; project risk management. For example, risk management is identified under proactivity and mainly ensures vulnerability reduction in projects, given that project resilience goes beyond vulnerability reduction and ensures recovery, the knowledge area labelled Project risk management in the PMBOK can be replaced and labelled as Project Resilience, thus, not just showing processes for project members to follow but rather outlining the capabilities, processes and resources required to manage disruptions and to ensure recovery.

In addition to the above, the definition, identified dimensions, antecedents and consequences contribute to the curriculum development in project management and therefore, create the awareness of capabilities and antecedents that project managers and the project need to consider in managing disruptions.

9.4.2.1 Curriculum development

Project resilience can be a qualification requirement for project managers. This can be added to the qualification examinations organised by the Association of Project Managers (APM) for project managers. Specifically, as a module under APM project professional qualification which aims at assessing capabilities in delivering projects, programmes and portfolios and therefore add on or replace the APM project risk management single subject certification qualification. This is because, findings from this research show risk management as being a subset of project resilience and thus, better awareness for the management of disruptions.

This qualification is to provide the requirements project managers need to manage disruptions. This will be deduced from the identified capabilities and the resources needed to recover from disruptions. For instance, the identification of capabilities such as proactivity, coping ability, flexibility and persistence highlight the capabilities required to manage disruptions. Furthermore, the systematic identification of antecedents to these capabilities and their impact shows project managers how to maximise these capabilities and thus manage disruptions in projects. For example, to be proactive (section 8.9.1), the project should have; (1) project management procedures such as a contract, training personnel and monitoring of threats and disruptions, (2) project management mechanism such as contingency and (3) experience.

Also, findings from this research show project managers how to maximize existing resources within the projects to manage disruption. For example, all projects utilise contracts of various forms to carry out projects, however, until this research, there was little awareness on the need and how project managers can utilise relationships and responsibilities set out in the contract to make project team members cope and be proactive during disruptions. This research identified that, the taking and allocation of responsibility by project members keeps them busy and thereby reduces the negative impact of the disruption and thus enables them to manage disruptions. Furthermore, the findings from this research has identified that training on sharing lessons learnt and understanding the project enables the goal for the project to be known and helps gain a collective response approach in managing disruptions and thus, coping and being proactive. In detail, impacts of these research findings to curriculum development, thus, reduce vulnerability, increase response and readiness in projects are highlighted in 8.10.1.

This will therefore add to other qualifications organised for project managers such as APM project fundamentals qualification which provides fundamental awareness of project management terminologies and APM project management qualification which provides knowledge of elements of project management.

9.5 Limitations and recommendations for future research

This research focuses on construction projects and may limit its application to other forms of projects. Although other disciplines employ projects as per construction discipline, generalising the findings may be restricted based on discipline differences. Future research on validating findings on projects in other disciplines other than construction is recommended.

Also, future work on developing or adapting measurement scales to measure capabilities identified which could be used to measure the level of resiliency of a project and thus identify areas of strength and weakness is recommended. As it stands now, the current framework identifies the antecedents to each dimension of resilience and its consequence within projects. As such, future work on developing or adapting measurement scales to measure capabilities such as proactivity, coping ability, flexibility and persistence within projects to enable recovery in projects is recommended. Furthermore, empirical interrelationships among these capabilities are recommended. Additionally, developing or adapting measurement scales for identified antecedents to these capabilities comprising of project management procedures (contract, training, planning, continual monitoring, continual identification, planning and negotiation), project management mechanism (contingency) and experience (open-mindedness, curiosity, self-motivation and innovation) is recommended to enable projects manage disruption better and gain competitive advantage.

Finally, the validated framework can be further developed into a diagnostic tool for assessing the level of project resilience to disruptions in construction. This will therefore motivate projects to attain higher ranking similar to metrics employed within organisational resilience. Due to the discipline and field specific nature of resilience, metric developed in other fields cannot be adopted but rather a separate metric should be developed.

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APPENDIX

Appendix A-Letter to respondents

«Address_line_1»«Address_line_2»«Address_line_3»
«Post_Code»

Dear «First_name» «Last_name»,

MANAGING CHANGE IN PROJECTS

I am Karen Oppong Banahene, a PhD student at the School of Civil and Building Engineering, Loughborough University. I write to seek your help in facilitating access to the «Project» project to undertake a case study on managing change in projects as part of my PhD research at Loughborough University. This research is under the supervision of Dr Aaron Anvuur and Professor Andrew Dainty.

The aim of the study is to better understand how to effectively manage change within construction projects. Access to interview key personnel (e.g. «People_to_contact_on_poject_») on this particular project is essential due to the «Choice». This will enable us tap into the expertise and experience of key personnel on this project to aid in identifying opportunities for managing change better in projects.

I assure you of the confidentiality of any information acquired which will be used for research purposes only. At no time will your true identity or that of the project or anyone interviewed be disclosed. The focus for this study is on the result of the aggregate and not the particular individual projects. Your participation is voluntary, however, should you choose not to participate, we will miss an opportunity to learn from your rich experiences. Your participation will shape the current PhD study and go a long way to reinforce or unveil new areas in managing change in construction projects. In return for your participation, you will receive a summary of the research findings upon completion of this study.

In the meantime, if you do have any questions or require further clarification about this research study, please feel free to contact me on Mobile phone:07539826726; Email:K.Oppong-Banahene@lboro.ac.uk. If you want to know if this study complies with the University's ethical standards, please contact Jacqueline Green, the Secretary for the University's Ethics Approvals (Human Participants) Sub-Committee: Rutland Building, Loughborough University, Epinal Way, Loughborough, LE11 3TU. Tel: 01509 222423. Email: J.A.Green@lboro.ac.uk

I would like to thank you in advance for your time and look forward to obtaining access to study the management of change on this project.

Yours Faithfully,

Karen Oppong Banahene
PhD Student
School of Civil and Building Engineering (Built Environment)
Loughborough University
Leicestershire, UK
LE11 3TU

Data protection notice: We obtained your contact details through «Location_for_finding_details». The information on the website is freely available to the general public. This research project is covered by the Loughborough University Data Protection Registration, reference no Z3179802. All data collected will be destroyed after the information has been analysed (that is, within three months of the data analysis).

Appendix B- Adult Participant Information Sheet

Main investigator: Karen Banahene Blay
School: School of Civil and Building Engineering, Loughborough University, LE11 3TU
Email address: K.Banahene.Blay@lboro.ac.uk
Phone number: 07539826726

What is the purpose of the study?

The aim of the study is to understand how to effectively manage change within construction projects. This is because the only certainty within these construction projects is change. This therefore hinges the success of projects to how effectively change is managed. Little evidence on how to systematically manage change effectively is currently available.

Who is doing this research and why?

This study is being undertaken by Karen Banahene Blay, towards a PhD study. This study is sponsored by a studentship from the School of Civil and Building Engineering, Loughborough University under the supervision of Dr Aaron Anvuur and Prof Andrew Dainty.

Are there any exclusion criteria?

This study seeks to focus on complex projects such as Building, Civil engineering and Engineering Construction projects. Information will be acquired mainly from senior management on the project.

What will I be asked to do?

You will be asked questions about your experiences of change management on the construction project.

Once I take part, can I change my mind?

Yes! After you have read this information and asked any questions you may have, we will ask you to complete an Informed Consent Form, however if at any time, before, during or after the sessions you wish to withdraw from the study, please just contact the main investigator. You can withdraw at any time, for any reason and you will not be asked to explain your reasons for withdrawing.

Will I be required to attend any sessions and where will these be?
You will only be required to undertake an interview at any convenient place for you.

How long will it take?

The interview should not last longer than 45 minutes.

What personal information will be required from me?
Position in your organisation, role on the project, professional affiliations, years of experience in construction and experience in current role

Are there any risks in participating?
No, there is no risk for participating in this study. However, should you choose not to participate, we will miss the opportunity to learn from your rich experiences.

Will my taking part in this study be kept confidential?
Yes. At no time will your true identity or that of the project or any respondent be disclosed. The focus for this study is on the result of the aggregate and not the particular individual projects. Data collected will be stored in accordance with the Data Protection Act. This research is covered by Loughborough University Data Protection, Registration Reference No Z3179802. All data collected will be destroyed after the information has been analysed (that is, within three months of the data analysis).

I have some more questions; who should I contact?
In the meantime, if you do have any questions or require further clarification about this research study, please feel free to contact me on Telephone:07539826726; Email:K.Banahene.Blay@lboro.ac.uk and Supervisors: 1) Dr Aaron Anvuur, A.M.Anvuur@lboro.ac.uk and 2) Prof Andrew Dainty, A.R.J.Dainty@lboro.ac.uk

What will happen to the results of the study?
The results will be reported as part of the PhD study. These will all lead to contributing to effectively managing change in construction projects.

What if I am not happy with how the research was conducted?
If you are not happy with how the research was conducted, please contact Jacqueline Green, the Secretary for the University's Ethics Approvals (Human Participants) Sub-Committee: Rutland Building, Loughborough University, Epinal Way, Loughborough, LE11 3TU. Tel: 01509 222423. Email: J.A.Green@lboro.ac.uk

The University also has a policy relating to Research Misconduct and Whistle Blowing which is available online at http://www.lboro.ac.uk/admin/committees/ethical/Whistleblowing(2).htm.

What do I get for participating?
In return for your participation, you will receive a summary of the research findings upon completion of this study. Your participation will inform the current PhD study and go a long way to reinforce or unveil new areas in managing change in construction projects.

Appendix C- INFORMED CONSENT FORM
(to be completed after Participant Information Sheet has been read)

The purpose and details of this study have been explained to me. I understand that this study is designed to further scientific knowledge and that all procedures have been approved by the Loughborough University Ethics Approvals (Human Participants) Sub-Committee.

I have read and understood the information sheet and this consent form.

I have had an opportunity to ask questions about my participation.

I understand that I am under no obligation to take part in the study.

I understand that I have the right to withdraw from this study at any stage for any reason, and that I will not be required to explain my reasons for withdrawing.

I understand that all the information I provide will be treated in strict confidence and will be kept anonymous and confidential to the researchers unless (under the statutory obligations of the agencies which the researchers are working with), it is judged that confidentiality will have to be breached for the safety of the participant or others.
I agree to participate in this study.

Your name ______________________________

Your signature ______________________________

Signature of investigator ______________________________

Date ______________________________

Appendix D- Interview Protocol

INTERVIEW QUESTIONS

Karen Banahene Blay, K.Banahene.Blay@lboro.ac.uk, 07539826726
School of Civil and Building Engineering LE11 3TU

A. Personal details

1. What is your position in your organisation?
2. How many years of experience do you have in your current role?
3. How many years of experience in construction do you have?
4. What professional associations do you belong to?
5. What is your role on this project?
6. When did you join this project?

B. Project Details

1. What is the type of project being executed?
2. What is the overall objective of the project?
3. When did it commence?
4. How long is the project for?
5. What stage of the project lifecycle are you in?
6. What are the key deliverables?
7. What are the key priorities on this project (in terms of cost, quality and time)?
8. What are the key drivers of this project?
9. Who are the parties involved on this project?
10. What procurement route is employed in this project?
11. Has the project evolved as planned since commencement?
12. What are the major risks on the project?
13. How have they been managed?
14. What are the major opportunities identified till date?
15. How have they been taken advantage of?
16. Are there any identified uncertainties on the project?
17. How have these uncertainties been managed?

C. Actual Change experience on the project

1. Can you think of a change event during the project which you thought was make or break to the delivery and/or success of the project?
2. A) If yes, move to question 3 B) If no, no more questions
3. Was it expected or not?
4. What was it?
5. When did it begin/ you become aware of it?
6. How did it evolve/ manifest?
7. How did it affect the delivery and success of the project?
8. What measures were employed to manage the change on the project?
9. 9a.What impact did these measures have on the project?
   [What impact did these measures have on the team, process and technology?]
   How would you say this measure helped you bounce back and stronger?
10. How successful will you say these measures were in managing this type of change?

11. What was your role in managing the change?
12. Were any training given to you in relation to managing this change before and /or after this change?
13. Were there any skills you developed in relation to this change before and /or after this change?
14. A) If yes, what were they?   B) If no, finish
15. How did these skills influence the management of change?
16. How were these skills monitored?
17. What measures have been put in place to overcome future similar change?

Thank you.

Appendix E- Frame work validation questions for focus group

The aim of this questionnaire survey is to validate the attached "Framework for resilience in projects" (Figure 1-1). This framework was developed by carrying out a case study on three projects (building, civil engineering and engineering construction) with the focus on critical incidents and how they were managed. Critical incident is an unexpected (uncertain) occurrence which is outside the planned works and causes distress and disruption.

The framework identifies the capabilities that projects need to manage disruption and shows its related antecedents and consequence

1.0 Textual description of framework

1.1 What is Resilience?

Resilience is the capability of a project to respond to, prepare for and reduce the impact of disruption caused by the drifting environment and project complexity. Identified capabilities are proactivity, coping ability, persistence and flexibility.

Proactivity is defined as an anticipatory capability that the project takes to influence their endeavours.

Coping ability is the capability to manage and deal with stress caused by disruptions within the projects. It enables the persistence and flexibility. Coping ability mainly focusses on adjusting through psychological coping (responsibility coping, regulative coping). Responsibility coping is defined as a role driven approach of coping whereby one accepts responsibility in putting things right whereas regulative coping is the ability to manage and deal with stress by controlling ones feeling and attitude towards a critical incident.

Flexibility is the capability of a project which manages a disruption by allowing change but ultimately making sure that the aim is maintained. That is, it provides an ability to adjust to change and promotes renewal and development. Within projects, flexibility is mainly manifested through accommodation and promotion of innovation.

Persistence is defined as the ability to continue despite difficult situations. It focusses on the entire project's working ability to ensure that the endeavour is completed irrespective of objective met, once it works towards meeting the ultimate goal.

The framework (Figure 1-1) connects resilience (these capabilities) to its antecedents and consequences.

1.2 What are the Antecedents?

The antecedent is defined as the cause or enabler of the dimensions of resilience. Three main antecedents namely; project management procedure, project management mechanism and experience are identified. Project management procedure is the process that is performed throughout the project life to ensure the endeavour is completed irrespective of disruption. Project management mechanism is a technique that the project utilises to manage disruption. Experience is the practical contact that project has in terms of managing disruptions.

1.2.1 Specific antecedents for Proactivity

Under project management procedure the specific antecedents for proactivity are contract, training, monitoring. For project management mechanism the antecedent is contingency. Furthermore, the antecedents under experience are open mindedness, curiosity, self-motivation and innovation.

1.2.2 Specific antecedents for Coping ability

Responsibility coping is enabled by the project management procedures such as the contract whereas regulative coping is enabled by project management procedures such as contingency and training and also experience.

1.2.3 Specific antecedents for Flexibility

Flexibility manifested through accommodation is enabled by open-mindedness from experience and planning under project management procedure. Whereas, flexibility through innovation is through continual monitoring and continual identification of ideas under project management procedure.

1.2.4 Specific antecedents for Persistence

Persistence is promoted by project management procedures such as continual monitoring (as per risk management and innovativeness), continual planning and negotiations.

1.3 What are Consequences?

The consequence is defined as the impact of resilience. The overall consequence of resilience is recovery. Recovery is defined as the improvement to the same or new set of objectives to ensure a successful completion of project endeavours. It comprises vulnerability reduction, readiness and response. Response is defined as the reaction to the disruption. Reduction of vulnerability is the minimisation of the project susceptibility to possible future harm, a potential change or transformation when struck with stress. Readiness is the preparedness of the project to the disruption.

1.3.1 Effects of proactivity on consequence

Proactivity seeks to, in diverse ways, ensure readiness and enable response and reduction of vulnerability in that order. Readiness is mainly identified as the recovery means with the help of antecedents to proactivity such as contract and training. Proactivity leads to response and reduction to ensure recovery through monitoring. Also proactivity leads to response and readiness through the contingency. More so, proactivity leads to readiness and reduction to enable recovery through open mindedness, curiosity, self-motivation and innovation.

1.3.2 Effects of coping ability on consequence

Coping ability has readiness, vulnerability reduction and response as its main recovery approach. Regulative coping leads to reduction first then to response and then readiness. Responsibility coping on the other hand leads to readiness and response to ensure recovery.

1.3.3 Effects of flexibility on consequence

Flexibility leads to response and readiness with the help of open-mindedness and planning. Also, flexibility leads to readiness through continual monitoring. Again flexibility leads to reduction and response through continual identification of innovative ideas.

1.3.4 Effects of persistence on consequence

Persistence leads to readiness, reduction and response through continual monitoring. Also persistence leads to readiness and reduction through continual planning whilst persistence also leads to reduction through negotiation.

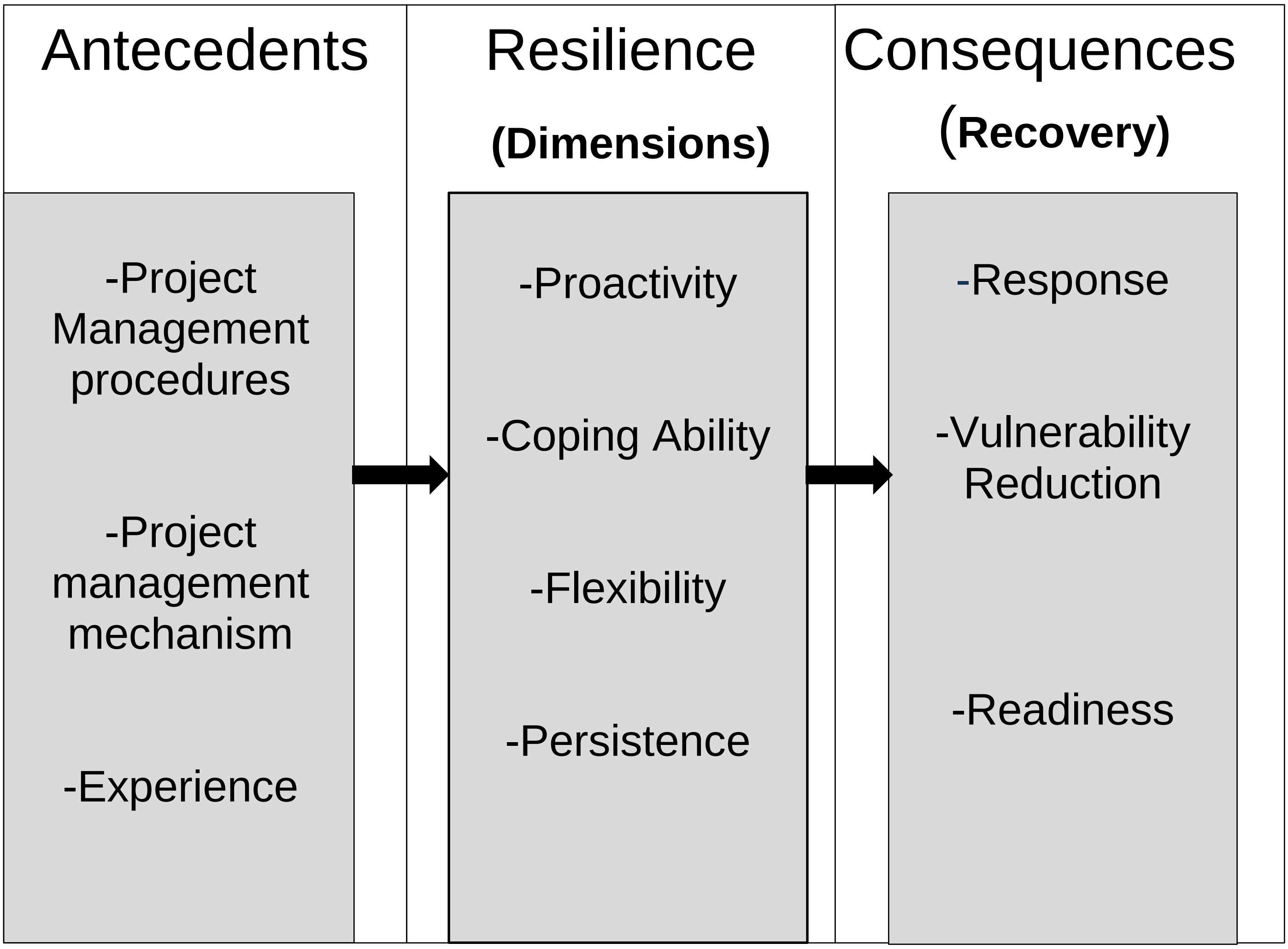

Figure 1-1 Framework for resilience in project

Questions

Please answer the questions by ticking the appropriate box (tick one box per question) and add comments where required.

1.0 How important are all the antecedents to resilience in projects?

☐ Extremely important ☐ Important ☐ Unimportant ☐ Extremely unimportant

Additional comments …………………………………………………………………

…………………………………………………………………………..

2.0 How easy is it to understand the framework?

☐ Extremely easy ☐ Easy ☐ Difficult ☐ Extremely difficult

Additional comments …………………………………………………………………

…………………………………………………………………………..

3.0 To what extent is this framework logical?

☐ Extremely logical ☐ Logical ☐ Illogical ☐ Extremely illogical

Additional comments …………………………………………………………………

…………………………………………………………………………..

4.0 To what extent will you say this framework is adequate for projects to identify the factors (dimensions) and indicators (antecedents) to managing disruption?

☐ Extremely adequate ☐ Adequate ☐ Inadequate ☐ Extremely inadequate

Additional comments …………………………………………………………………

…………………………………………………………………………..

5.0 Do the elements suggested in the framework completely help manage disruptions?

☐ Extremely complete ☐ Complete ☐ Incomplete ☐ Extremely incomplete

Additional comments ………………………………………………………………………

……………………………………………………………………………..

6.0 How transferable is this framework to all forms of projects?

☐ Extremely transferable ☐ Transferable ☐ Untransferable ☐ Extremely untransferable

Additional comments ………………………………………………………………………

……………………………………………………………………………..

7.0 What do you consider as the strengths and weaknesses of the framework?

Strength

………………………………………………………………………………………

………………………………………………………………………………………

Weakness

………………………………………………………………………………………

………………………………………………………………………………..…….

8.0 What can be added to and/or removed from the framework?

Add ……………………………………………………………………………………………
…………………………………………………………………………………………………
……………………………………………………………………………………

Remove ………………………………………………………………………………………
…………………………………………………………………………………………………
…………………………………………………………………………………………

Appendix F- Conference Paper-ARCOM

CONCEPTUALISING Organisational Resilience: An investigation into Project Organising

Karen Oppong Banahene[1], Aaron Anvuur and Andrew Dainty

School of Civil and Building Engineering, Loughborough University, Leicestershire, UK

Organisational resilience is a capability which enables organisations to adjust to perturbation, moderate the effects of risk and uncertainty and take advantage of emergent opportunities. The concept of organisational resilience has in the main been developed and operationalized in relation to permanent and stable organisations. The concept is, however, far less applied to project-based forms of organisation, where the temporary, cross-functional and dispersed nature of delivery teams renders some of these concepts problematic. This paper identifies the challenges in applying the concept of organisational resilience to project organisations by systematically reviewing and relating the lines of literature on organisational resilience and project organising. For example, the temporary nature of project organisations hinders learning and knowledge sharing necessary to ensure a dynamic response to evolving threats and perturbations. Other inherent factors, such as the distributed locations of project personnel, also impede this development. This paper goes on to refine the research necessary to develop the concepts so as they respond to the challenges of project-based working.

Keywords: adaptive capacity, organisational resilience, project organising, risk, uncertainty.

Introduction

Organisations are complex entities which manage and maintain our infrastructure and contribute to the economy and the society as a whole (Seville *et al*. 2006). As such, organisations need to adjust to perturbations and take advantage of available opportunities and mitigate threats (Giezen 2013; Seville *et al*. 2006). Perturbations are major external or internal spikes in pressure beyond the normal range of variability in a system (Gallopín, 2006). The notion of resilience; ‘a functional capacity of a system to manage perturbations’ has been used to reflect the ability of organisations to moderate the effects of risk and uncertainty and take advantage of any available opportunities (Gunderson 2000; Luthans 2002; Folke 2006; Gallopin 2006). However, the notion of organisational resilience has in the main been developed and operationalized in relation to permanent and stable organisations (Luthans 2002; Vogus & Sutcliffe 2007; McManus 2008).

The current promotion of continual improvement and development of innovative ways (Emmitt 2010; Gareis 2010; BSI 2014) of executing an activity or endeavour in both permanent and temporal organisations has called for continual employment of personnel from diverse organisations with complementary skills to come together (Hodgson & Cicmil 2006; van Donk & Molloy 2008) to execute a project, thus, forming an unstable and temporary organisation; project organisation (Killen *et al*. 2012; Winch 2013). In a project based sectors

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such as construction, the employment of the notion of resilience has largely been infrastructure and asset-based focused (Bosher 2008; Boin and McConnell 2007) with minimal or no focus on the personnel who execute the works. However, authors such as Packendorff (1995), Söderlund (2004), Winch (2013) and Giezen (2013) have called for research into developing measures to strengthen these forms of organisations so as to continually withstand future possible perturbations.

Arguably, the temporary, cross-functional and dispersed nature of delivery teams renders employing the notion of organisational resilience in project-based forms of organisations problematic. This paper therefore identifies the specific challenges in applying the concept of resilience in project organising by systematically reviewing the lines of literature on resilience, organisational resilience and project organising. The review is divided into three parts comprising defining the notion of resilience and its dimensions in general and in organisations, the identification of the challenges in embedding resilience in project organising, and the suggestions as to the research that is necessary to develop the concept of resilience so as to respond to the specific challenges of project-based working.

Defining resilience

Evolution of the Construct

The first application of resilience in systems was in the 1800's in mechanics (physics) to describe the capacity of steel as a material to withstand stress (Pimm 1984; Alexander 2013). This capacity to 'absorb shocks and maintain function' has come to be known as engineering resilience (Pimm 1984; Holling 1973, 1996; Tilman & Downing 1994). Thus, the focus of engineering resilience is efficiency, stability, predictability and return time to normal functioning (Holling 1973; Walker *et al*. 2004; Folke 2006). The notion of engineering resilience was then employed in psychology in the 1950's to describe how children suffering from schizophrenia could withstand shock (Garmezy *et al*. 1984; Glantz & Johnson 1999).

Another definition of resilience emerged in ecology in the 1970's following Holling's (1973) seminal paper in which he introduced the notion of 'ecological resilience'. This notion captures resilience as 'the capacity for renewal, re-organisation and development' and, thus, focuses on persistence, change and flexibility (Holling 1973,1996; Folke 2006; Gunderson 2000) . Therefore, ecological resilience subsumes the concept of engineering resilience and emphasizes a dynamic adaptive response to change and higher and better levels of functioning (Holling 1996; Folke 2006; Klein *et al*. 1998).

An engineering resilience perspective, thus, implies a reactive focus on building in resistance to or developing response mechanisms for predictive perturbations (Bruneau *et al*. 2003; Rice & Sheffi 2005). In other words, engineering resilience primarily focuses on risk and usually involves the use of mathematical tools in assessing the likelihood and impact of each perturbation (Winkler 1996; cf. Knight, 1921). On the other hand, the ecological resilience perspective implies a proactive focus, on managing both risk and uncertainty; hence the emphasis on flexibility and dynamic and continual development of the system to sustain higher and better levels of functioning (Carpenter *et al*. 2001; Seville *et al*. 2006). In building on these engineering and ecological foundations of the construct and focusing on different targets and research domains, scholars have developed numerous definitions of the resilience construct. These definitions of the resilience construct, which compete for primacy across numerous research domains stand in the way of a unified understanding of the theoretical dimensionality, antecedents and outcomes of the construct. These issues are discussed in the following subsections.

Review of definitions used in previous research

Growth in resilience research over the past few years has been marked. For example, a Google Scholar search conducted by the authors in April 2014 revealed that research in resilience increased by 10% from 1991 to 2002 and over 60% from 2002 to 2013. A comprehensive review of the studies on resilience reveals 35 emergent definitions of the construct from the engineering and ecological perspectives. The review shows that resilience is clearly a malleable and nebulous term that has been appropriated across a multiplicity of different application domains and blended with a range of other related concepts. Its malleability might explain the enduring utility of the term to account for so many natural, organisational and societal phenomena, including being: a process (Rutter; 1999; Coutu 2002); an outcome (Klein *et al*. 1998; Timmerman 1981); and ‘circumstance dependent’ (Carpenter *et al*. 2001; Bhamra *et al*. 2011; Gunderson 2000). However, the versatility of the resilience construct has also meant there is, as yet, no agreement on its theoretical dimensionality, antecedents and consequences (McCubbin 2001; Seville *et al*. 2006).

Table *1: Representative definitions of resilience*

Author	Focus	Broad Perspective	
		Engineering	Ecological
Klein *et al*, (1998) p. 259	Coast	-	‘The self-organising capacity of the coast to preserve actual and potential functions under changing hydraulic and morphological conditions’.
Bruneau *et al* (2003) p.735	Community	-	‘Ability of social units to mitigate, contain hazards and carry out recovery activities’.
Holling (1973) p.14	Ecological system	-	‘A measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables’.
Bosher (2008) p.13	Infrastructur e	‘A quality of abuilt environment’s capability (in physical, institutional, economic and social terms) to keep adapting to existing and emergent threats’.	
Coutu (2002) p.4.	Individual	-	‘The ability to accept, have a strong belief that life is meaningful and that there is the need to improvise’.
Rutter (1999) p. 119;	Individual Child	‘A process of relative resistance to psychosocial risk experiences’.	-

Bhamra *et al*., (2011) p. 5587	Organisation	-	'Resilience is the emergent property of organisational systems that relates to the inherent and adaptive qualities and capabilities that enables an organisation's adaptive capacity during turbulent periods'.
Timmerman (1981) p. 21	Society	'The measure of a system's or part of a system's capacity to absorb and recover from the occurrence of a hazardous event'.	-
Walker *et al*, (2004) p. 2	Socio-ecological system	'The capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks'.	-
Pimm (1984) p. 322	Specie	'The speed with which a system returns to its original state following a perturbation'.	-
Rice & Sheffi (2005) p.41	Supply chain	-	'Ability to recover from disruption quickly by building redundancy and flexibility into its supply chain'.
Adger (2000) p. 347	Workgroup/ community	-	'The ability of groups or communities to cope with external stresses and disturbances as a result of social, political, and environmental change'.

Table 1 summarises the main definitions of the notion of resilience reviewed from the 35 emergent ecological and engineering resilience definitions. (Glantz & Johnson 1999; Adger 2000; Gunderson 2000; Rice & Sheffi 2005; Bhamra *et al*. 2011). From Table 1, it can be seen that the definitions of resilience from an engineering resilience perspective, such as those by Walker *et al* (2004) and Rutter (1999), emphasize stability and resistance during perturbation and, thus, imply hardening the organisation against shocks through building in redundancy or by hardening systems. On the other hand, definitions of the resilience construct from an ecological perspective place emphasis on responding flexibly to perturbations, bouncing back to a stronger, more resilient states (Rice & Sheffi 2005).

There is also a lack of conceptual clarity on how resilience is different from related concepts such as vulnerability, adaptation, and transformation. For example, Janssen *et al*. (2006) define vulnerability as a characteristic of a system which makes it susceptible to possible future harm, a potential change or transformation when struck with a perturbation or stress. A meta-analytic review of definitions of vulnerability by Ionescu *et al*. (2009) identified the key concepts of exposure, sensitivity, coping, persistence, stability, and adaptive capacity as underpinning the dominant interpretations of the vulnerability construct. The concepts of persistence, stability and adaptive capacity are also employed in explaining the notion of resilience (Carpenter *et al*. 2001; Gallopin 2006; McManus 2008; Timmerman 1981). Gallopin (2006) defines adaptive capacity as the common attribute of a system which provides it with an ability to adjust to change, moderate potential damages, take advantage of opportunities and cope with consequences. This is the definition that has also been given to the concept of 'coping ability' (Cumming *et al*. 2005). Some authors use the term 'adaptive capacity' to refer to the capacity of response of organisations (Seville *et al*. 2006) and ‘adaptability’, for individuals’ capacity of response (Folke 2006) to perturbations; yet others use the terms the other way around (Luthans 2002; Coutu 2002).

The applications of the above dimensions are influenced by the context in which they are applied. For instance, Carpenter *et al*. (2001) points this out by explaining that, the system configuration and interested perturbation drives resilience, hence authors should begin by clearly defining resilience in terms of what to what.

Organisational resilience

Defining organisational resilience

The construct of organisational resilience suffers from the same conceptual-definitional issues with the general construct of resilience, as discussed above. For example, there is no agreement on what a resilient organisation is. According to Weick and Sutcliffe (2001), the notion of resilience in organisations seeks to promote competence, restore efficacy, and encourage growth through the behavioural processes of mindful organizing enacted by front-line employees; therefore, a resilient organisation is one that is able to do this on a sustainable basis. Mallak (1998) describes a resilient organisation as one which is able to design and implement effective actions to advance organisational development and ensure survival. These definitions, thus, seem to conflate the notion of organisational resilience with that of organisational competitiveness. One definition of a resilient organisation that has gained considerable traction in the literature is a high reliability organisation (HRO; Weick and Sutcliffe 2001): an organisation which works in highly trying conditions, with few to no errors due to its very flexible systems. The HRO conceptualisation of organisational resilience has been criticised for (McManus 2008): oversimplifying accidents, hence underestimating accidents and the vulnerability of an organisation to perturbations; prioritising, through its ‘culture of safety’ approach, risk management over uncertainty management. Also, there is as yet no agreement on the source of resilience in organisations: some authors argue that organisational resilience is dependent solely on the resilience of the individual (e.g. Mallak 1998); others argue that individual characteristic do not necessarily justify organisational resilience (e.g. Hone & Orr 1998); and some authors settle for the middle ground (e.g. Bhamra *et al*. 2011).

More crucially, the notion of organisational resilience has to date only been explored in relation to stable and permanent organisations (McManus 2008; Bhamra *et al*. 2011). Within this context, the literature identifies redundancy (i.e. time and resource buffers), organisational learning, co-location and continuity of employment, knowledge management, team development and managerial participation as being central to the development of adaptive capacity (McManus 2008), flexibility (Keong and Mei 2010), coping ability (Vogus & Sutcliffe 2007) and persistence (Hamel & Valikangas 2003); all fundamental tenets of organisational resilience.

However, not all organisations are permanent in nature; temporary organisations abound. Specifically, project organisations are used in diverse fields such as advertising (Grabher 2002a), construction (Emmitt 2010) and biotechnology (Powell *et al*. 1999). Winch (2013: 8) defines a project organisation as the "configuration of permanent organisations coming together to form a temporary coalition to deliver a particular outcome". Indeed, it has been suggested that most permanent organisations use projects as the means for organising and executing organisational functions due to the beneficial consequences of this approach, such as innovation and continual improvement (Winch 2013;Emmitt 2010; Gareis 2010). Therefore, it is essential to create and develop resilience in all forms of organisations, specifically projects. However, there is a paucity of research on the theme of resilience in projects; for example, it is not clear what a resilient project is. In particular, the peculiarity of projects may pose significant challenges to the theoretical utility and substantive relevance of the organisational resilience construct in areas such as construction. These challenges are discussed next.

Challenges of employing resilience in projects

The diversity in the definition of the notion of resilience and its 'circumstance dependent' (Carpenter *et al*. 2001) nature poses challenges to employing resilience in project organising. For instance, for resilience in ecology, the more species that are available, the more the other specie tend to be stable and adaptive in the environment due to contingencies (Gallopin 2006). However, this is not the case with personnel in project organising because Lundin & Soderholm (1995) reveal that, the more personnel from diverse organisations are made to make critical decisions on projects, the more inconsistent and unstable the project is and this is due to interpersonal conflict it creates. Hence, if this analogy is brought into project organising, it might rather impede on the development of resilience.

The most related concept of resilience that could be employed in project organising is the notion of organisational resilience. However, the antecedents which lead to the employment of this notion in organisations are absent in project organising. This is due to the temporary, cross-functional and dispersed nature of delivery teams in project organising (Emmitt 2010). Hence it is essential to explore these challenges and identify whether the notion of organisational resilience can be embedded in project organising or new avenues should be explored in embedding resilience in project organising.

Concept building towards resilience in project organising

Since the first application of resilience (to describe the capacity of steel as a material to withstand stress) in systems in the 1800's (Pimm 1984; Alexander 2013), there has been a growing recognition of the concept within academic publications. Scholars have developed numerous varying definitions of the resilience construct, which compete for primacy across a number of research domains. These varying definitions of the concept of resilience stand in the way of a unified theoretical understanding of resilience in project organising. Researchers such as Bosher (2008), Seville *et al*. (2006), Burnard (2013) and McManus (2008) have also mentioned within their review that there is diversity and variation in the definition of the notion. The definition of resilience in organisations also remains ambiguous as such, research into unlocking the definition of resilience and related dimensions and its application in organisations (as stated under research agenda in Table 2) will inform its theoretical understanding in project organising since authors of resilience such as Carpenter *et al*. (2001); Bhamra *et al*. (2011); Gunderson (2000) explained that resilience is a circumstance dependent concept (i.e the most related concept of resilience to project organising is organisational resilience).

Authors of the notion of organisational resilience explain that, organisational resilience is dependent on fundamental tenets such as the organisational personnel's adaptive capacity (McManus 2008), flexibility (Keong and Mei 2010) and coping ability (Vogus & Sutcliffe 2007) hence, developing the organisational personnel in order to allow organisations to cultivate the essential capabilities is required. However, the time and resource constraint of project organising (Emmitt 2010) hinders the antecedent such as redundancy required to develop these fundamental tenets of resilience (Luthans *et al*. 2002; Braes & Brooks 2010; Vogus & Sutcliffe 2007) as such, research outlined in Table 2, into exploring the potential of antecedents such as redundancy in project organising will provide the awareness and avenues for the development of the fundamental tenets of resilience.

Organisational resilience is driven by the organisations ability to continually promote knowledge management, situational awareness and organisational learning in order to be able to adjust to perturbations, adapt and take advantage in the face of potential opportunities and reduce the effect of uncertainty and risk (Seville *et al*. 2006; Carpenter *et al*. 2001; McManus 2008). However, the dispersed, temporary and unique nature of projects hinders this main driver i.e 'continuity' of knowledge management, situational awareness and organisational learning required to manage perturbations. Hence research agenda outlined in Table 2 about identifying drivers of resilience will aid project organisations to adequately manage perturbations.

The efficient employment of the notion of resilience in organisations as stated by Glantz & Johnson (1999), Bhamra *et al*. (2011) and Giezen (2013) is mainly driven by the development of a resilient culture (the planned or routinized way of managing perturbations). However, this culture is sustained by the leaders and management team. The simultaneous management of varying projects by leaders and the affiliation of project personnel to different parent organisations before, during and after the project hinders the commitment and collaboration (van Donk & Molloy 2008) required to sustain and develop the resilient culture to manage perturbations. Hence, identifying strategic leadership qualities which will sustain resilience in the project team will aid in the efficient employment of the notion of resilience in project organising.

Below in Table 2 presents identified issues in project-based forms of organisations which hinder organisational resilience as discussed above together with the emerged research agenda for the efficient and effective employment of the notion of resilience in project-based organisations.

Table *2: Summary of assumptions, research issues and research agenda*

Assumptions of resilience	**Research Issues in project organisations which challenges**	**Research agenda**

	organisational resilience	
Resilience is a malleable and nebulous term	The diversity of definitions of resilience instigates important issues about any common understanding of this construct across research domains.	Unlock the theoretical definitions and the dimensions of resilience and its application in organisation
Resilience requires antecedents such as Redundancy (i.e. time and resource buffers)	The time and resource scarcity hinders the development of adaptive capacity (McManus 2008), flexibility (Keong and Mei 2010), coping ability (Vogus & Sutcliffe 2007) and persistence (Hamel & Valikangas 2003); all fundamental tenets of resilience	Explore the potential of antecedents of resilience in project organising
Resilience develops on a 'continuous' platform	The temporary, dispersed and cross functional nature hinders the drivers of resilience in permanent organisations to be employed in project organisations	Identify drivers of resilience in project organising
Resilient leadership qualities	The simultaneous management of varying projects by leaders and the affiliation of project personnel to different parent organisations before, during and after the project hinders the commitment and collaboration (van Donk & Molloy 2008) required to sustain and develop the resilient culture to manage perturbations.	Identify strategic leadership qualities which will sustain resilience in the project team

The above listed research agenda provides a foundation for both theoretical and practical tendencies to embed resilience in project organising to be explored.

Concluding Remarks

In this paper, a synthesis of literature on resilience has been undertaken to explore the discourse and challenges of embedding resilience in project organising. It has been argued that the characteristic nature of project organising, diversity in resilience definition and circumstance dependent nature of resilience renders its employment in project organising problematic. As such there is the need for a fresh theoretical model or ideas for resilience in project organising.

Identifying and developing resilient measures will enable project organisations to adjust to perturbations, moderate the effects of risk and uncertainty and take advantage of emergent opportunities (i.e reduce project teams' vulnerabilities and increase their adaptability) whilst undertaking a project. This will therefore, go a long way in practice to promote the development of efficient infrastructure and sustain companies in the competitive world so as to contribute to the economy and the society as a whole in future. Hence, the identified research agenda which is part of a wider study forms the basis for future studies into developing strategies to embed resilience in project organising.

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Appendix G- Skills Development

YEAR 1

- Introduction to spss
- Data analysis using spss
- Finding information for literature review (theory)
- Finding information for literature review (theory)
- Statistical method
- Plagiarism & citations
- Keeping up tp date
- Managing your reference
- Reading & writing research articles - exploring generic structures & key features
- Getting most out of supervision
- Successful interviews
- Copyright and your thesis
- Tools for creative thinking
- Making an impact with posters
- Ethical thinking in research
- Public engagement and research
- Marketing your research skills
- Teaching skills a
- Teaching skills b
- Teaching skills c
- Café academic
- Jacqui Glasses' inaugural lecture
- ECI Seminar
- Doctorial seminar
- Claudia Parsons Memorial Lecture
- Inaugural lecture- Malcom Cook

YEAR 2

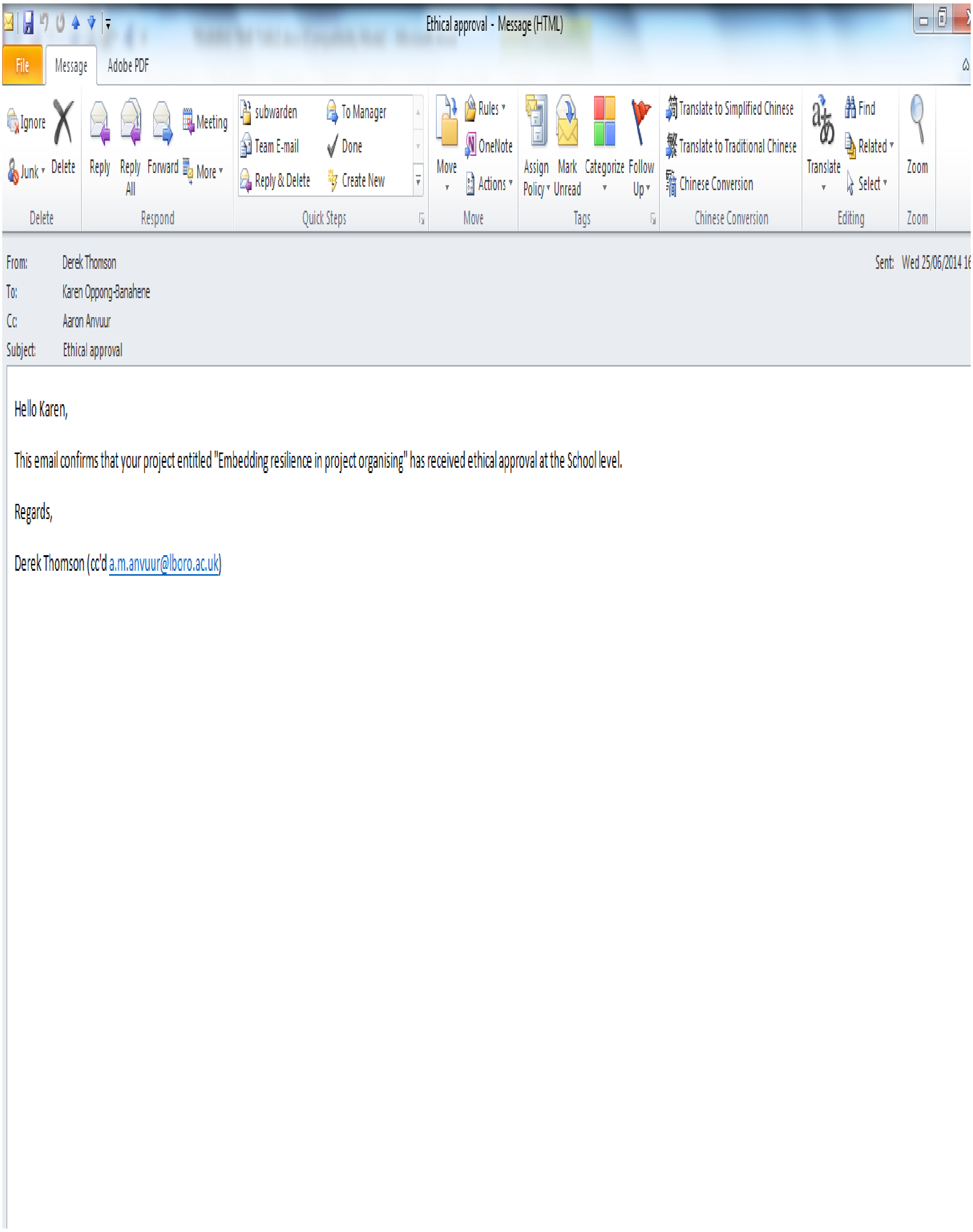
- Phd workshop
- Writing thesis in word
- Making an impact - communicating your research to a non-academic audience
- Reading & writing research articles - exploring the findings section
- The enterprising researcher – assessing and exploiting the commercial potential of academic research findings
- Ethical thinking in research
- 3 minutes thesis
- Eci Seminar- Loughborough
- CBE Workshop- Loughborough
- ECI Workshop- Ichemi London
- Brown Bag Seminar- Online Research Tools
- Doctoral Seminar

YEAR 3

- Creating an effective publication strategy

- Introduction to the job of lecturer for postgraduates and ras
- CBE Alumni Event
- Promoting your research for maximum impact
- Doctoral Seminar

Appendix H- Ethical approval



Ethical approval - Message (HTML)

From: Derek Thomson

Sent: Wed 25/06/2014 1

To: Karen Oppong-Banahene

Cc: Aaron Anvuur

Subject: Ethical approval

Hello Karen,

This email confirms that your project entitled "Embedding resilience in project organising" has received ethical approval at the School level.

Regards,

Derek Thomson (cc'd a.m.anvuur@lboro.ac.uk)