# Walden University

College of Management and Technology

This is to certify that the doctoral dissertation by

Gabriel Pidomson

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

Review Committee
Dr. Anthony Lolas, Committee Chairperson, Management Faculty
Dr. Godwin Igein, Committee Member, Management Faculty
Dr. Bharat Thakkar, University Reviewer, Management Faculty

Chief Academic Officer
Eric Riedel, Ph.D.

Walden University
2016

Abstract

Unexpected Events in Nigerian Construction Projects: A Case of Four Construction Companies

By

Gabriel Baritulem Pidomson

M.Sc., Warwick University, United Kingdom, 2012

M.Sc., University of Liverpool, United Kingdom, 2011

M.Sc., University of Port Harcourt, Nigeria, 2011

B.Tech., Rivers State University of Science and Technology, Nigeria, 1994

Dissertation Submitted in Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

Management

Walden University

December 2016

Abstract

In Nigeria, 50% to 70% of construction projects are delayed due to unexpected events that are linked to lapses in performance, near misses, and surprises. While researchers have theorized on the impact of mindfulness and information systems management (ISM) on unexpected events, information is lacking on how project teams can combine ISM and mindfulness in response to unexpected events in construction projects. The purpose of this case study was to examine how project teams can combine mindfulness with ISM in response to unexpected events during the execution phase of Nigerian construction projects. The framework of High Reliability Theory revealed that unexpected events could be minimized by mindfulness defined by 5 cognitive processes: preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise. In-depth semi-structured interviews elicited the views of 24 project experts on team behaviors, tactics, and processes for combining mindfulness with ISM. Data analysis was conducted by open coding to identify and reduce data into themes, and axial coding was used to identify and isolate categories. Findings were that project teams could combine mindfulness with ISM in response to unexpected events by integrating effective risk, team, and communication management with appropriate training and technology infrastructure. If policymakers, project clients, and practitioners adopt practices suggested in this study, the implications for social change are that project management practices, organizational learning, and the performance of construction projects may improve, construction wastes may be reduced, and taxpayers may derive optimum benefits from public funds committed to construction projects.

Unexpected Events in Nigeria Construction Projects: A Case of Four Construction Companies

By

Gabriel Baritulem Pidomson

M.Sc., Warwick University, United Kingdom, 2012

M.Sc., University of Liverpool, United Kingdom, 2011

B. Tech., Rivers State University of Science and Technology, Nigeria, 1994

Dissertation Submitted in Partial Fulfillment

Of the Requirements for the Degree of

Doctor of Philosophy

Management

Walden University

December 2016

Dedication

To

My late Dad, Sir Gabriel Deede Pidomson (KSJI) who wanted me to be a medical doctor

And

My Mum, Lady Justina Legonor Pidomson (LSJI) who prevailed on Dad to let me pursue my academic desires

Acknowledgments

My crowning appreciation goes to the Almighty God for giving me the life, strength, good health, and other favors – visible and invisible – that enabled me to undertake to completion this Ph.D. program.

I wish to thank my late Dad, Sir Gabriel D. Pidomson; and my Mum, Lady Justina L. Pidomson. While my dad had wanted me to be a medical doctor, Mum prevailed on Dad to let me pursue my academic desires. Today, my parents and I are all winners in different ways; I have fulfilled their heart's desire and mine; thank you. I also thank all members of my family, especially my children, Zoe, Elliot, and Ora; and my friends for their moral support; particularly, Carmenia Amissah, Anna Usman, Anne Anaghara, Jacqueline Amobi, Sir. & Lady Celestine Omehia, Dr. Dakuku Peterside. Rt. Hon. Rotimi Amaechi, Barr. Nyesom Wike, Dr. Henry Ogiri, Livi Benjamin, Kingsley T. Zoranen, Henry Agbo, and Victor Pidomson.

I especially thank members of my dissertation committee, namely: Dr. Anthony Lolas (Committee Chair), Dr. Godwin Igein (Method Expert), Dr. Bharat Thakkar (URR), and Dr. Marydee Spillett who reviewed the Abstract, for their patience, guidance, and support; you were never tired of answering questions and making useful suggestions. My sincere appreciation goes to Professor Elmar Kutsch of Cranfield University, United Kingdom, who introduced me to the concept of High Reliability Theory (HRT); Dr. Uzoechi Nwagbara, Dr. Patrick Reid, and Professor Philip Ebow Bondzi-Simpson of University of Cape Coast, Ghana, who encouraged me to undertake the doctorate degree program.

I also thank all my instructors, interviewees, student advisers, and Walden University faculty members who spared time to contribute their expertise to this project, and all my course/school mates, especially Lambert Ofoegbu, Samuel Aikhuomogbe, and Mrs. Pamela Obi. Special thanks also go to Giwa Ibrahim, Theophilus Uttah, Engr. Nnamdi Udensi, Mrs. Vivienne Ogbona, Sylvester Naakpa, Engr. Sunny Ekanem, the four organizations, and their staff, some of whom approved, facilitated the approval, or participated in this study. It was a fruitful experience, and you all made profound contributions to my success in this program.

Table of Contents

List of Tables

List of Figures

# Chapter 1: Introduction to the Study

This study was an inquiry into how teams should anticipate and aggregate small failures that occur during project execution to highlight and respond to their future consequences. Indeed, factors associated with unexpected events are key drivers of unsuccessful construction projects (Gunduz, Nielsen, & Ozdemir, 2012). The presumption of this study is that being mindful of the future consequences of small failures should place project teams in a better position to predict unexpected events. Small failures that are ignored could pile up and cause delays and disruptions if team members do not adopt a systematic approach to handling them.

Therefore, the need for this study derived from the prevalence and consequences of unexpected events that, despite much research on the subject, continue to overwhelm many construction projects with delays and disruptions (Gunduz et al., 2012; Turskis, Gajzler, & Dziadosz, 2012; Yang & Kao, 2012). Indeed, unexpected events that occur in the lifecycle of construction projects cause time and cost overruns, and could lead to significant wastes in human and material resources (Love, Wang, Sing, & Tiong, 2012**,** Nikakhtar, Hosseini, Wong, & Zavichi, 2015; Udawatta, Zuo, Chiveralls, & Zillante, 2015). Time and cost overruns can have far reaching consequences construction projects because they are primary defining elements of a project's outcome (Gudiene, Banaitis, & Banaitiene, 2013; Lee & Yu, 2012; Mir & Pinnington, 2014). Indeed, an iron triangle links the *time, cost*, and *quality* of a project (Dimitriou, Ward, & Wright, 2013; Locatelli, Mancini, & Romano, 2014). Therefore, neglecting either time, cost, or quality could have a detrimental effect on the outcome of a project.

Furthermore, the result of construction projects has social implications because they house and link many communal facilities that drive modern society. Indeed, construction projects provide some of the essential foundational link infrastructures in human existence such as roads, railways, and airports, etc. They also provide the necessary structures required in daily life to house companies, recreation, health and other facilities on which modern society depends. Reducing time and cost overruns due to delays and disruption could contribute to the efficient use of resources, and enable organizations to reduce unnecessary expenditure. To this end, the effective management of construction projects could guarantee their desired outcome and impact on the society.

Consequently, in this chapter, I provided background information relating to unexpected events that could suffice as delays and disruptions in construction projects. I also captured the general and specific problems that informed this study, and the evidence that showed these problems to be relevant. A concise statement connecting delays and disruptions with unexpected events, the research questions, and the theoretical framework that guided this study, and a concise rationale for selecting the qualitative approach were presented. Finally, I presented definitions, assumptions, scope and delimitations, limitations, and the significance of this study.

## Background of the Study

Unexpected events that reveal themselves as delays and disruptions continue to overwhelm construction projects around the world (Gunduz et al., 2012; Idoro, 2012). These unexpected events are not only central to time and cost overruns (Akinsiku & Akinsulire, 2012; Love et al., 2012), but also they cause loss of profits, and expose organizations to environmental, social, and economic risks (Cheung & Pang, 2012; Idoro, 2012 ). Cheung and Pang (2012) identified higher interest rates, fluctuations in currency, unplanned overheads, additional labor and equipment costs, and loss of market opportunities as some economic and project risks to which delays and disruptions expose organizations. Idoro (2012) identified loss of employment and business reputation as some of the social consequences of delays and disruptions.

Despite the adverse consequences of unexpected events on construction projects, KPMG International conducted a survey in 2015, which revealed that the construction industries around the world continue to post very high records of delayed completion (KPMG International, 2015). In the United States of America (USA), the National Waterways Foundation (2012) indicated that the forgone benefits and other costs associated with delays in the execution of new inland waterway constructions projects were estimated to be $20 billion. An analysis of the $20 billion worth of forgone benefits revealed that when unexpected events delay a new project for one year, it costs the public an average of 37% on every dollar invested (National Waterways Foundation, 2012). Further analysis by National Waterways Foundation (2012) revealed that when a rehabilitation construction project is delayed for one year, it costs the public an average 17% on every dollar invested.

In some cases, delays in project delivery have resulted in disputes between clients and construction firms (Chou & Lin, 2012). Pickavance (2005, p. 322) estimated the cost of project disputes at “£8billion per annum for the UK construction industry alone.” Yang and Kao (2012) identified delays and disruptions due to unexpected events as significant problems in construction projects. The average cost overrun for Norwegian and Malaysian construction industries is estimated at 7.88% and 55% respectively. For Hong Kong, the average percentage time overrun is 9% for government projects and 17% for private projects; while Nigeria posts an average time overrun of between 59.23% and 92.64% for building projects (Olawale & Sun 2015).

Studies outlined above showed not only the negative effects of delays and disruptions, but also they showed that delays and disruptions due to unexpected events are sources of waste (Olawale & Sun 2015) and instability to projects, organizations, and the society (KPMG International, 2015; Pickavance, 2005, p. 322). This conception is imperative to the problem of unexpected events because they affect two dimensions (that is time and cost) of the *Iron Triangle* by which stakeholders measure the success of any project (Chipulu et al., 2014). Chipulu et al. (2014) argued that overlooking any dimension of the *Iron Triangle* (time, cost or quality) would be detrimental not only to the other two dimensions but also to the success of the entire project because the three dimesions that determine project success are interdependent.

However, most studies that investigated the prevalence of delays and disruptions in construction projects were focused on the interpretation of the causes and consequences of delays (Cheung & Pang, 2012; Idoro, 2012), and the effects of adverse weather on construction projects (Ballesteros-Pérez, del Campo-Hitschfeld, González-Naranjo, & González-Cruz, 2015; Ghoddousi & Hosseini, 2012). Others focused on developing and refining methodologies for analyzing delays and disruptions (Amoatey, Ameyaw, Adaku, & Famiyeh, 2015; Zegordi & Davarzani, 2012). The rest focused on proffering strategies for minimizing delays and disruptions by examining insights from practitioners (Hussin, Rahman, & Memon, 2013; Ghoddousi & Hosseini, 2012) and disputes associated with disruptions in construction project **(**Cheung & Pang, 2012; Chou & Lin, 2012; Li, Ng, & Skitmore, 2012b**)**.

Researchers have not given sufficient attention to the effect of cognitive processes on the anticipation and prediction of delays and disruptions in construction projects (Han, Park, Yeom, & Chae, 2014; Irfan, Khurshid, Anastasopoulos, Labi, & Moavenzadeh, 2011). Studies on failure anticipation and prediction were focused on best-fit attributes and models for forecasting time performance, optimizing cost, and minimizing time through efficient scheduling, and appropriate standards. Most of these studies gave little attention to the importance of combining team attitude with technology, and how combinning cognitive processes with information systems management (ISM) impact planned construction, allow for the identification of weak signals, and how such weak signals might be aggregated to identify potential risks, irrespective of their likelihood and severity. Therefore, the gap in knowledge that this study will address in the field of management is how project teams can combine mindfulness with ISM to avert unexpected events during the execution phase of Nigerian construction projects.

There are lots of documented evidence on the effect of delays and disruptions in Nigerian construction projects (Akinsiku & Akinsulire, 2012; Idoro, 2012). There are also documented evidence to show that delays and disruptions are preponderant in construction projects around the world (Amoatey et al., 2015; Doloi, Sawhney, Iyer, & Rentala, 2012; Shehu, Endut, & Akintoye, 2014). High records of time and cost overrun due to delays and disruptions continue to have adverse effects on the performance of construction projects (Shehu et al., 2014; Akinsiku & Akinsulire, 2012). Also, disputes between construction firms and their clients are also an effect of delays and disruptions in construction projects (Chou & Lin, 2012; Gunduz et al., 2012; Love, Davis, Cheung, & Irani, 2011; Yang, Chu, & Huang, 2013). The widespread attention given to the study of delays and disruptions in many developed and emerging economies is an indication that the effect of unexpected on project performance is a general problem (Dominic & Smith, 2014; Pourrostam & Ismail, 2012).

While it might sometimes be necessary to delay construction projects for safety reasons (Fang & Wu, 2013), to ensure that construction projects are not unnecessarily delayed or disrupted is a critical element in the successful management of construction projects (Akinsiku & Akinsulire, 2012; Shehu et al., 2014). To this end, I attempted to address deficiencies in current research by focusing on Abuja, Nigeria. I specifically focused this inquiry on how a combination of teamwork, mindfulness, and information technology (IT) could facilitate the identification of weak signals and point to unexpected events during the execution phase of Nigerian construction projects.

This study is needed because it proposes a shift in project management paradigm from management-as-planning and execution to management as an on-going process of response to small failures in changing environments (AlSehaimi, Koskela, & Tzortzopoulos, 2012). Since the nature of most small failures may not be apparent, properly understood, or foreseen at the conception or planning phase of a project, the approach proposed in this study was to focus on identifying and aggregating small failures to forecast unexpected events. Instead of focusing on asking *why* (Top-Down) to get to the root-cause of a problem after the fact, I investigated how project team members might better attain higher levels of abstraction by asking *what, why, and how* (Bottom-Up) when small failures occur. The answer to such questions would require several iterations to link small failures to possible outcomes that might develop into future delays and disruptions in construction projects.

## Problem Statement

Findings by Ameh and Ogundare (2013) revealed that between 50% and 70% of Nigerian construction projects encountered some form of delay due to lapses in reliability and ineffective response to unexpected events**.** Evidence from several studies indicated the importance of effective management (Li, Ng, & Skitmore, 2012a; Porwal & Hewage, 2013) and information systems (Bemelmans, Voordijk, & Vos, 2012; Zhang et al., 2013) to successful project delivery. Other studies have attempted to address the structures (Aziz & Hafez, 2013) and human resource requirements (Li et al., 2012b; Porwal & Hewage, 2013) essential to using information systems to obviate avoidable delays during construction project execution. These studies underscored the importance of management and information systems to successful project delivery (Olalusi & Jesuloluwa, 2013). They also revealed the importance of successful construction projects to positive social change (Ashford, Hall, & Ashford, 2012; Leisink & Bach, 2014).

Consequently, the general problem that motivated this study is the long records of unexpected events causing time and cost overuns resulting from the inadequate use of information technology (IT) by organizations and teams tasked with the execution of

Nigerian construction projects (Hosseini, Chileshe, Zou, & Baroudi, 2013). The inadequate use of IT has led to lapses in reliability resulting in unexpected events that suffice as failures and delay (Olalusi & Jesuloluwa, 2013). Failures and delays are fundational to time and cost overrun that often led to profit loss, exposure to environmental, social, and economic risks, and increased overhead costs (Marques & Berg, 2011). Market opportunities, jobs, and business reputation are also lost (Marques & Berg, 2011; Abdul Rahman, Memon, Karim, & Tarmizi, 2013). Delays and disruptions could also result in disputes between construction firms and their clients (Love et al., 2014; Yang et al., 2013). Where delays and disruptions were due to inefficiencies (e.g. labor inefficiencies) and failure (e.g. materials failure) rework could further aggravate time and cost overruns. Studies by Aziz and Hafez (2013) indicated that up to 45% of delays in construction projects, contributing as much as 50% of a project's total overrun costs, were due to reworks.

The specific problem is the inability of project teams to combine mindfulness, as revealed by High Reliability Organizations (HROs), with information systems to respond adequately to unexpected events during the execution phase of Nigerian construction projects. Mindfulness suffices as effective contingency planning, systematic approach to, and proactive response to weak signals, trivial issues, and outright failures (Han et al., 2014). Between 50% and 70% of Nigerian construction projects encounter some form of delay due to lapses in reliability and inadequate response to unexpected events (Ameh & Ogundare, 2013). This finding presupposes that most unsuccessful construction projects in Nigeria do not meet their time objectives (Idoro, 2012; Idoro, 2012). The high percentage (50 – 70%) of construction projects that are not successful in Nigeria is a challenge because construction projects are essential to the development of a country. Nigerian construction industry contributed 16% to GDP between 2011 and 2013, having grown by 10.7%; and 4.32 % to real GDP during the second quarter of 2014 (Nigeria Bureau of Statistics, 2014). Growth in the Nigerian construction sector is expected to explode in the coming years, and Nigeria is projected to become the fastest-growing construction industry in the world by 2020, ahead of China and India (Bucknall, 2016). Deloitte on Africa (2014) reported that, with an expenditure of about US$36.4 billion in 2014, Nigeria is leading all other African countries in major infrastructure construction projects. However, despite these positive projections, few studies have explored how mindfulness (Akinsiku & Akinsulire, 2012; Idoro, 2012) or information technology (Olalusi & Jesuloluwa, 2013; Ashford et al., 2012) enabled team members to achieve resilience in the management of unexpected events in Nigerian construction projects.

Studies by Aziz and Hafez (2013) indicated that 45% of delays and cost overrun in construction projects were due to ineffective contingency planning (55%), unsystematic approach to and non-proactive response to schedule failures (40 - 60%), accidents (3–6%), and materials failure (at least 10%). Over time, a lack of mindfulness could cause weak signals and small failures to aggregate into catastrophic events that were unexpected (Weick & Sutcliffe, 2011; Yang & Kao, 2012). Without mindfulness, adequate contingency planning, and a systematic approach to failure, it is difficult to identify and adequately respond to unforeseen events before they occur (Lee & Diekmann, 2011; Yang & Kao, 2012). Since weak signals point towards more catastrophic events, the absence of a proactive strategy and systematic approach that runs through the organization was likely to affect any appropriate response in the fast changing and complex situations that often punctuate construction projects (Pinto, 2014; Weick & Sutcliffe, 2011). In this context, Weick and Sutcliffe (2011) argued that project teams that preoccupy themselves with mitigating adverse outcomes are not only more mindful of such events but are also better armed to anticipate and appropriately respond to them.

Despite the preponderance and consequences of unexpected events in Nigerian construction projects (Idoro, 2012), the argument that unexpected events are due to lack of mindfulness (Weick & Sutcliffe, 2011; Zhou, Whyte, & Sacks, 2012), and inadequate use of Information Technology (IT) (Hosseini et al., 2013) I could not find any studies on how project teams can combine mindfulness, as revealed by HROs, with information systems to respond to unexpected events during the execution phase of Nigerian Construction Projects. The non-availability of studies that combine team mindfulness and ISM during the execution phase of Nigerian construction projects created a gap in the literature. This gap in the literature undermined findings by several studies that provide compelling evidence about the key roles team members play in the management of unexpected events during the execution phase of construction projects (Gudiene et al., 2013; Lee & Yu, 2012; Mir & Pinnington, 2014). Focusing on teams at the execution phase was important because teams at the execution phase exercise prerogative over upwards of 40% of construction projects in terms of time and cost (Eadie, Browne, Odeyinka, McKeown, & McNiff, 2013; PMI, 2012).

## Purpose of the Study

The purpose of this qualitative exploratory case study was to gain an in-depth understanding of how project teams can combine mindfulness, as revealed by High Reliability Organizations (HROs), with Information Systems (IS) to respond adequately to unexpected events during the execution phase of Nigerian construction projects. In this study, I explored how project team members such as architects, quantity surveyors, engineers, and project managers could combine principles of mindfulness, as revealed by HROs, with information systems (IS) to identify weak signals and predict unexpected events before they occur at the execution phase of Nigerian construction projects.

I adopted the qualitative approach and exploratory case study design to investigate the behavior of construction team members such as architects, quantity surveyors, civil engineers, builders, and project managers drawn from Four major construction firms in Nigeria. I used the case study design to explore how the behavior of team members could cause delays. How mindfulness, as revealed by HROs, could contribute to identifying failures that suffice as weak signals, and how to efficiently aggregate such weak signals to predict failures. I also explored how team members could leverage on Information Systems Management (ISM) strategies to anticipate and avert failures, facilitate an appropriate response to small failures, and where possible dissipate their resulting effect.

The unit of analysis was the team members that I drew from four construction firms. I expected 32 experts to participate in this study: Eight (8) from each case organization. To guard against non-response and withdrawal of participants, I proposed

32 participants as the designated sample size for this study. The final sample size was expected to fall between 24 and 28 participants.

## Research Questions

*Unexpected events* were the central phenomena investigated in this study. The central research question that guided this investigation was: *How can project teams combine mindfulness, as revealed by High Reliability Organizations (HROs), with information systems to respond adequately to unexpected events during the execution phase of Nigerian construction projects?* Drawing on this central question, I explored answers to the following research sub-questions:

RQ1: What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects?

RQ2: How does combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects?

## Conceptual Framework

The High Reliability Theory (HRT) (Salas & Rosen, 2013; Weick & Sutcliffe, 2011) was used for this study. *Reliability* described the capacity of a system or its constituent parts to function effectively under specified conditions for a stated period (Bourrier, 2011; Weick & Sutcliffe, 2011). It also described the ability of individuals or teams to function as expected at a specified moment or interval of time (High Reliability Organizing, 2013).

It is difficult to measure reliability because its true value cannot be known with certainty, can only be determined over time, and could mean different things to different people under different conditions (Bourrier, 2011). However, Zeng, Kang, Wen, and Chen (2015) noted that reliability could be relative or absolute. They pointed out that while relative reliability is the degree to which a system maintained its ability to function consistently under specified conditions for a stated period, absolute reliability is the degree to which repeated evaluation of the system vary for different activities, processes, and functions within the system (Zeng, Kang, Wen, & Chen, 2015). The lesser the variability of a system's activities, processes, and functions, the higher the reliability. While Bourrier (2011) noted the difficulty in measuring reliability due to uncertainties about its actual value, Zeng et al. (2015) argued that reliability could be estimated, based on the statistical concept of variance. In this context, *high reliability* describes the ability of a project team or an organization to post consistent failure-free performance for a specified interval under stated conditions (Bourrier (2011, Weick & Sutcliffe, 2011). Boin and Schulman (2008) noted that HROs do not treat reliability as a probabilistic property that could be swapped for organizational principles such as reward, efficiency, productivity, quality, and competitiveness, but as an objective rooted in a collective effort towards preventing specific events from occurring in the system. Weick & Sutcliffe (2015) argued that reliability could mean different things in different contexts, as does product, activity and process failure. Therefore, the concept of reliability in HRT described a continuum ranging from low, medium to high reliability depending on the system's ability to achieve failure-free performance for a specified interval under stated conditions (Weick & Sutcliffe, 2011). HRT also identified a set of specific events that must be prevented by combining technological design, organizational strategy and management (Boin & Schulman (2008).

While the terms *Quality* and *Reliability* are often used interchangeably, what is special about researching reliability, as defined in HRT, as against researching quality of processes in the chosen firms is rooted in the often overlooked differences between the two concepts. While quality refers to the standard by which a process, activity or product/output is measured (Sweis, Sweis, Al-Shboul, & Al-Dweik, 2015), reliability is both a state of being dependable and the degree of consistency over time (Zeng et al., 2015). In this context, while *reliability* is a function of the design, *quality* is a function of the output measured by the level of excellence or a state of being free from defects, deficiencies, variance from specifications after the design has been produced (Sweis et al., 2015). A system is often designed for reliability, but for an output to be reliable, the design is accompanied by a set of specifications that determine its quality. Examples of construction project specifications that can determine the quality of project outputs are: list of parts and their dimensions, listing for tolerances for each part, materials-of-construction for all the parts (e.g. steel, wood, glass, etc.), methods of construction (prefabrication, precast, insitu cast, etc.), finish (fine polished wood, painting, carvings, number of coatings), colors for each part, types of specification, and dimensions of fasteners, joints, and screws, among others. Specification gives a complete description of the output and is the basis for determining quality because it serves as the standard against which the quality of an output is measured. Indeed, reliability is the creative concept behind the design, built by engineers into the output as part of the design and specification (Zeng et al., 2015). Indeed, while the reliability of a complex system (e.g. a construction projects) is dependent on random uncertainty factors such as the environment, processes, activities, and individuals, quality is dependent on specifications that are clearly outlined in the design and are often certain.

Consequently, the High Reliability Theory (HRT) proposed that a system's reliability could be improved by the use of principles of mindfulness to anticipate, predict, identify, analyze, and contain unexpected events. Proponents of HRT rally the idea that the occurrence of unanticipated or unexpected events is mostly due to lapses in reliability (Weick & Sutcliffe, 2011; Zhou et al., 2012). The theory posited that mindfulness could minimize lapses that affect resilience in organization performance, and improve the ability of teams to take actions that predict and where possible avoid unexpected events.

High Reliability Theory (HRT) has its root in several disciplines, and one can trace its origin to the University of California in the United States (Bourrier, 2011; Weick & Sutcliffe, 2011). HRT proposes five principles of mindfulness that help High Reliability Organizations (HROs) to sustain their resilience while facing unexpected situations. The principles are: (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). I shall elaborate on these principles in chapter 2. However, note that teams can use the principles of HRT to maneuver the complex and chaotic collaboration and coordination structures of construction projects (Carlo, Lyytinen & Boland, 2012). Indeed, construction projects often operate on the edge of chaos (Cheng, Tran, & Wu, 2014), hence, the need for new ways for understanding projects and new strategies with which to respond to uncertainties within their complex and often chaotic coordination and collaborating structures. AlSehaimi, Koskela, and Tzortzopoulos (2012) proposed that project managers ought to move attention from their traditional approach of looking at tasks and projects as an ordered phenomenon to the realization that events can be self-organizing as they progress through the project life cycle.

Consequently, in adopting HRT as a lens for this study, I deemed the qualitative approach to be appropriate because while there was ample learning opportunity from HROs in construction projects, the leading body of knowledge publications, business analysis, and construction management processes are yet to recognize the core concepts of HROs directly. The lack of recognition by leading body of knowledge publications created the need to integrate the principles of mindfulness, as used in HROs, into construction projects management contexts. Doing so would create a better understanding of how the principles of HROs and construction projects relate to each other.

The use of HRO principles in construction projects is an emerging area. Hence, the amount of information on their relationship and the known value proposition they bring to each other drawing on empirical studies is limited. Using the qualitative approach made it possible to explain the complex interrelationships between the cognitive processes of team members, system dynamics of construction projects, and the occurrence of unexpected events adequately.

## Nature of the Study

### Research Approach

The qualitative research approach was used to facilitate this study. The qualitative approach was appropriate because while several studies had addressed the issues of unexpected events in construction projects, failures, and unexpected events continue to take a negative toll on the performance of projects. The increasing complexity of construction projects (Locatelli et al., 2014), the role of technology (Ghoddousi & Hosseini, 2012), and the changing contexts of construction projects continue to aggravate the high incidence of unexpected events and project failure. Therefore, it is necessary to use diverse frameworks and theoretical lenses to undertake an in-depth study of unexpected events in different contexts. Since adapting HRO principles to the execution of construction projects is an emerging area, using the qualitative approach was appropriate for a thorough initial investigation.

While it is important to study both the contextual and operational factors that cause unexpected event, there are no generally acceptable solutions (Ghoddousi & Hosseini, 2012; Gunduz et al., 2012). A generally acceptable solution has been elusive because unexpected events are not only complex and preponderant, but they are also chaotic, difficult to measure, and predict (Locatelli et al., 2014; Nikakhtar, Hosseini, Turskis, et al., 2012). In this context, the emerging area of HRT in construction projects can create valuable information about the relationship and interactions between mindfulness and the processes of project execution to effect high value proposition.

Consequently, adopting the qualitative approach helped me to focus this research on emerging questions, procedures, and data on project activity failures. Using HRT as a lens, the qualitative approach also contributed to revealing the causes of activity failure, and the practices that were pertinent to mitigating them. With the qualitative approach, I efficiently gathered in-depth information, elicited a wide variety of responses and views across a range of experiential levels. Using HRT as a lens to gather in-depth information enriched the interpretation of perspectives for building themes that captured and ascribed appropriate meaning to different points of view.

**Research Design**

I adopted the exploratory case study design for this study. Yin (2014) suggested that case studies are suitable for exploring a phenomenon, activities, events, and processes within real-life natural contexts. Yin (2014) further indicated that the use of case studies could enable the researcher to undertake a study effectively from the perspective of those who experience the phenomenon or partake in the activities, events, and processes that define them. I adopted the case study design because I intended to investigate project *processes* and *activities* within construction project settings. The binding case for this study was the group of practitioners involved in construction activities. I intended to elicit their collective mindset on how to identify and aggregate activity failures to predict unexpected events during project execution.

While I could have used the phenomenological design for this study, the exploratory case study design was more appropriate because I intended to go beyond bracketing the perspectives of individuals to understanding the *processes* and *activities* involved in the phenomenon. Cronin (2014) provided compelling evidence suggesting that qualitative case studies are most suitable for exploring real-life activities, processes, and events associated with organizations and their functional units. The position of Cronin aligned with findings by Walker and Shen (2002) who posited that case studies are suitable to investigating problems associated with construction projects and their complex interactions with people, technology, and the environment.

**Key Phenomenon to be Investigated**

The key phenomenon that I investigated in this study was unexpected events. An unexpected event is a regular event that occurs in an exceptional situation, causing loss of productivity, detracting from set goals and reducing stakeholder satisfaction (Turskis, et al., 2012; Yang & Kao, 2012). Unexpected events, therefore, reorganize planned activities and limit the ability of the project to meet its time, cost, and quality objectives. In construction projects, unexpected events come in the form of delays and disruptions (Amoatey et al., 2015; Idoro, 2012). However, delays and disruptions develop from activity failures that often occur as events that were not anticipated, or anticiapted without an adequate contingency strategy to contain them.

Unexpected events could cause disruptions or outright abandonment of a project, and may be due to the activities of clients, contractors, consultants, acts of nature, or any combination of these (Marzouk & El-Rasas, 2014; Idoro, 2012). Tasks or activities that are delayed could determine the ability of the project to meet deadlines, milestones, or other related objectives (Amoatey et al., 2015; Pourrostam & Ismail, 2011). Unexpected events, such as delays or disruptions, may be excusable (Yang, Huang, Lee, & Chiu, 2014; Yang & Kao, 2012) or inexcusable (Brawn, 2012; Idoro, 2012). However, whether a delay is excusable or not, it is often accompanied by consequences. Moreover, irrespective of who or what caused an unexpected event, or when in the project lifecycle an unexpected event occurs, it usually has time and cost consequences that challenge the outcome of the project.

**Methodology**

**Study participants.** For the purpose of this study, I explored the experiences of experts such as architects, quantity surveyors, engineers (e.g. civil engineers, structural engineers), and project managers who are involved in Nigerian construction projects. I selected two experts from each category, making 8 participants for each case organization, and 32 participants for the entire study across four firms. I drew on the experiences of participants working as team members on an ongoing project, the value of which was not less than $3 million (N1 Billion) and in progress for at least one year.

**Data collection.** I used in-depth semi-structured interviews and documentation to collect the data. The use of in-depth interviews was appropriate to engaging study participants, to grasping their perspectives on failure, and to using weak signals in predicting unexpected events. Zhou and Li (2012) argued that interviews were essential to the process of eliciting understanding about the world through the instrumentality of human interactions. To this end, I framed interview questions to facilitate the discovery of new information from descriptions, insights, and explanations rendered by study participants. Document analysis was used for data triangulation. Yin (2014) noted that document analysis is likely to be relevant to every case study because documents help to corroborate and augment evidence from other sources. Documents are stable and specific, and can also cover a long span of time, several events, and many settings (Yin, 2014).

**Data analysis.** Text analytic techniques were used to analyze the data that emerged from this inquiry. I identified keywords and short phrases that ran through all interviews, generated themes from identified codes, and interpreted the meaning of themes that emerged from the codes. The kinds of data that were expected to emerge from the analysis included team member behaviors, strategies, tactics, processes for identifying weak signals, and Information Systems (IS) practices relevant to aggregating small failures to predict unexpected in construction projects.

## Definitions

To effectively undertake a discussion on how teams can combine information systems management with the principles of High Reliability Organization (HROs) to confront unexpected events in Nigerian construction projects, it was important to define certain key terms. I identified and defined eleven terms that formed the foundation of this study; these were: activity, delay, disruptions, failure, High Reliability Theory, High Reliability Organization (HRO), information system, mindfulness, risk, unexpected event, and weak signal. I gave examples for each definition for clarity and better understanding.

*Activity:* Project Management Institute (PMI, 2012) defined an activity as a "component of work performed during a project" (p. 426). It is a measurable amount of work needed to convert inputs into deliverables (Herroelen, 2013). An activity is characterized by a fixed duration, logical relationship with other activities, resources consumption, and cost. Examples of construction activities are excavation for strip foundation, block work in the foundation, and concrete works.

*Delay:* Delay in construction projects means an activity is happening later than expected, planned, specified in the contract, or beyond the date originally agreed on by parties involved the project (Amoatey et al., 2015; Pourrostam & Ismail, 2011; Idoro, 2012). Examples of construction delays are delay by the client to provide required funds and delay by a nominated sub-contractor who is unable to supply needed material or complete a chunk of work on time.

*Disruptions:* Disruptions are events or interferences in the flow of work that inadvertently disrupt the construction program (Gunduz et al., 2012; Turskis, et al., 2012). Examples of disruptions are disruptions due to adverse weather, disruptions due to non-availability of funds, disruptions due to the negotiation of variations, disruptions due to litigation.

*Failure:* Failure is a state or condition of not meeting a set objective (Chipulu et al., 2014). An activity failure is an inability of a task or process to meet intended cost, time, or quality objectives, or when a combination of these factors does not meet expectations. Indeed, *failure* is a dependent variable that can be a function of near misses and surprises; both of which could arise from not meeting set goals. Note that in construction projects set goals are not sacrosanct and might change with circumstances (Chipulu et al., 2014). Examples of failure are structural defects that lead to the collapse of a beam, late supply of construction materials, failure due to under-budgeting in the Bill of Quantities, and failure due to non-completion of activity as scheduled on the project plan. Indeed, most clients put in a *buffer* in time and budget, but do not tell the project manager that there is a 10% or 20% buffer, as they want the project manager to work toward the lower estimate.

*High Reliability Theory:* High Reliability Theory (HRT) states that early identification of failures, in their covert state, allows interaction with fewer resources and greatest effectiveness in responding to them and the uncertainties that may result from them (Bourrier, 2011; Weick & Sutcliffe, 2011). The theory proposes that response action should move away from the central authority towards the event or process to interact with the unfolding situation. In this context, the concept of reliability proposed in HRT is different than assurance. While assurance is a positive declaration or gurantee that an event will take place as planned (Zhang & Fai Ng, 2012), reliability refers to the ability to function effectively and respond adequately in the presence of uncertainty during daily operations (Bourrier, 2011; Zeng et al., 2015. Indeed, uncetainty, by definition cannot be prepared for because uncertain events are unexpected (High Reliability Organizing, 2013); conversely, preparations can be made to assure the realizations of a quality expectation or the occurrence of an event because plans can be made for its realization. An example of assurance in construction project is the precise definition of methods, time, and personnel for pipe installation. An example of reliability is a contingency plan that creates a commitment to managing variability and uncertainty.

*High Reliability Organization (HRO):* A High Reliability Organization (HRO) is an organization that has avoided catastrophe in complex and risky environments where accidents are normal (Bourrier, 2011; Weick & Sutcliffe, 2011). Examples of High

Reliability Systems are Air Traffic Control (ATC) systems, Naval Aircraft Carriers, Nuclear Power Stations (NPS), and Spaces Stations. Typical examples are National Aeronautics and Space Administration (NASA), and Diablo Canyon Power Plant in the USA. Any failure that occurs in such systems can be catastrophic and expensive. For instance, the total estimated cost of decommissioning after the Fukushima nuclear disaster was $13.6 billion (Aoki & Rothwell, 2013). Other examples of disasters in HROs are the Three Mile Island nuclear incident, the Challenger explosion, and Columbia explosion. HROs avoid catastrophes by harnessing individual actions and shared attitudes to fill the gap between people and organizational structures (High Reliability Organizing, 2013). While High reliability depends on the action of people, management ought to structure the organization to allow proper actions (High Reliability Organizing, 2013; Weick & Sutcliffe, 2011).

*Information System:* An Information System (IS) is a system that comprises people and computers for the purpose of processing and interpreting information (Borger, 2012; Caniels, & Bakens, 2012). Typical examples of categories of information systems are Transaction Processing Systems, Customer Relationship Management Systems, Decision Support Systems, Business Intelligence Systems, Knowledge Management Systems, Office Information Systems and Database Management Systems. Examples of Database Management Systems are MySQL, Microsoft SQL Server, Oracle, Sybase, and SAP HANA. Information Systems Management as used in this study is the application of IS and other relevant technologies to support the functions and activities of construction projects.

*Mindfulness:* Mindfulness is a state of conscious mental awareness of the environment (Roberts, Bea, & Bartles, 2001; Weick & Sutcliff, 2011). Mindfulness, as revealed by High Reliability Theory, comprises five (5) cognitive processes or dimensions that coalesce to mindfulness: preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). These five cognitive processes or dimensions create an orientation that supports continuous evaluation of the environment and the structures that enable people to function under conditions of uncertainty. Mindfulness, in this context, is a function of interactions between the five elements of mindfulness, in ways similar to those enacted by multiple, contradictory technology practices that drive information technology capabilities (Carlo et al., 2012). Examples of mindfulness, as defined by HRT and used in this study are: 1) the conscious effort to sensing the early statges of events and exerting efforts to stopping their development into undesirable events, 2) making sense of and interpreting ambiguous project situations, 3) harnessing the five cognitive processes of mindfulness to overcoming complexity and tight coupling inherent in human-machine interfaces, 4) conserving and directing attention towards what is noticed and the activity that is noticed.

*Risk: A Risk* is "an uncertain event or condition that, if it occurs, has a positive or negative effect on a project objective" (Project Management Institute [PMI], 2012, p. 447). Examples of construction project risks identified by Banaitiene and Banaitis (2012, p. 441-442) are: 1) environmental risks (e.g. unforeseen encroachment into a floodplain, design changes requiring additional environmental analysis), 2) external risks (e.g.

landowners unwilling to sell, unreasonably high expectations from stakeholders), 3) design risks (incomplete design, unforeseen design exceptions), 4) engineering services risks (e.g. unforeseen aesthetic requirements), 5) right of way risks (e.g. utility company workload), 6) construction risks (e.g. Insufficient construction area), 7) project management risks (e.g. scope creep, inconsistent cost, time, scope, and quality objectives, 8) organizational risks (e.g. non-availability of funds). A risk can either be accepted or avoided. The choice between risk acceptance and risk avoidance depend on the probability of perceived threat, or the opportunity of its occurrence, and the magnitude of its impact on the project objectives. HROs are not only good at risk management, but are also good at responding to unfolding events that were not expected and, therefore, not planned for or recorded in a risk register (Weick & Sutcliffe, 2011). In managing risks, HROs rely heavily on reliability-enhancing activities such as problem anticipation, continuous training, and proactive audits, among others (Weick & Sutcliffe, 2011). The ability of HROs to manage both anticipated and unanticipated risks is one reason why they can improve resilience and reliability (High Reliability Organizing, 2013; Weick & Sutcliffe, 2011).

*Unexpected Event:* An unexpected event is a regular event that occurs in an exceptional situation, causing loss of productivity, detracting from set goals and reducing stakeholder satisfaction (Turskis, et al., 2012; Yang & Kao, 2012). Examples of unexpected events that can occur in construction projects are time overruns, cost overruns, litigations, and disruptions due to adverse weather, scope creep, poor funding, and incompetence of subcontractors, among others. Unexpected events, therefore, reorganize planned activities and limit the ability of the project to meet its time, cost, and/or quality goals. For this study, unexpected events comprise all events (delays and disruptions) that do not facilitate or facilitate the successful completion of the project.

*Weak Signal:* Weak Signals are “imprecise early indications about impending, impactful events.” (Ansoff & McDonnell, 1990, p. 20-21). Characteristics of weak signals identified by Williams, Jonny Klakegg, Walker, Andersen, and Morten Magnussen (2012) are ambiguousness (non-obvious), little or no familiarity, low value, low apparent relevance and reliability, and low visibility. Weak signals are, therefore, units of anticipatory strategic information by which an organization scans its environment to identify opportunities for reducing uncertainty and risks (Williams, Jonny Klakegg, Walker, Andersen, & Morten Magnussen, 2012). Examples of weak signals are small failures, near misses, and surprises that have insignificant value.

**Assumptions**

The term *assumption* is defined as, “a statement that is presumed to be true, often only temporarily or for a specific purpose” (Vogt & Johnson, 2011, p. 16). The key assumptions that underpined this study were based on the idea that teams could improve the performance of construction projects by combining effective Information Systems Management (ISM) with operational mindfulness during the execution phase of construction projects. In this context, the following specific assumptions were foundational to this study:

1) The principles of mindfulness adopted by High Reliability Organizations (HROs) to adequately contain the effects of unexpected

events in an operations environment can help construction practitioners to manage unexpected events in construction projects.

2) By magnifying the future consequences of weak signals, project teams should be in better position to apply appropriate strategies, technics and tools to predict events likely to delay and/or disrupt project execution.

3) Combining information systems management (ISM) with the principles of mindfulness, as revealed by HROs, can facilitate effective response of project teams to weak signals capable of causing unexpected events.

4) The performance of the execution phase of Nigerian construction projects can be improved by combining effective Information Systems Management (ISM) with the principles of mindfulness as revealed by High Reliabilty Organizations (HROs)

The first assumption was necessary because while unexpected events could occur as a result of factors such as chaos, complexity, and attitude of team members, it was not clear how cognitive processes, as revealed by HROs, could influence response to unexpected events in construction projects. To use HRO principles in this study, thus required a preliminary assumption about how these principles could impact on unexpected events in construction projects.

The second assumption was necessary because, while magnifying the consequences of an occurrence can give it a greater visibility, it was not clear whether teams would be better positioned to understand the problem, or whether they could find an appropriate strategy to mitigate them. Besides, if they can comprehend the problem and have an appropriate strategy to reduce their effect, it was not clear whether the environmental dynamics would permit the implementation of such strategies.

The third and fourth assumptions were necessary because while the independent application of mindfulness and information systems could facilitate the identification and responses to unexpected events, it was not clear how combining them would affect a team's ability to identify and respond to unexpected events.

## Scope and Delimitations

### Scope of Study

The scope of this study covers unexpected events in Nigerian construction projects. I focused on how information systems (IS) and mindfulness of project team members could lead to more successful construction projects in Nigeria. The emphasis on team practices and attitudes was based on the necessity to highlight actual activities, processes, tools, factors and principles that inform the actions of people who execute projects. Therefore, I highlighted how such actions and attitudes in conjunction with appropriate Information Systems Management (ISM) could facilitate the identification, aggregation, and prediction of unexpected events during the execution phase of Nigerian construction projects.

### Delimitations of Study

Delimitations are "conditions or parameters that the researcher intentionally imposes to limit the scope of a study" (Bloomberg & Volpe, 2012, p. 8). I focused on expert project practitioners such as architects, quantity surveyors, engineers, and project managers who have been part of a team that participated in the execution phase of construction projects in Nigeria. The initiation, design, and handover phases were excluded from this study. Limiting the study to the execution phase was necessary to focus on the operational factors that directly affect the deliverables of project execution. I excluded clients from the research population because they, to a lesser degree than project experts, partake in the professional activities necessary to delivering outputs during the execution phase of construction projects (Porwal & Hewage, 2013). I am not implying that clients do not play a role in project implementation, but that they have limited impact on the operational aspects of the execution phase of construction projects (Porwal & Hewage, 2013; Schweber, 2013). Indeed, clients define boundaries, provide funding, and assess deliverables, etc. (Porwal & Hewage, 2013).

Furthermore, while chaos theory, complexity theory, and systems theory could be used to study unexpected events in construction projects, they tend to take a holistic view that spans all phases (initiation, design, execution, and handover) of construction projects. Rather than to take a holistic view of the project, I focused this study on the execution phase where I could adequately apply operational principles that HROs have successfully adopted to avert catastrophes in their operations.

Note that construction projects follow patterns and life circles similar to projects in other industries. Therefore, I expected that, with minor modifications, practitioners could transfer the information and understanding gleaned from this study to projects in the information industry and the automobile industry, among others.

**Limitations**

The major limitation of this study is the relatively small sample of construction project firms and participants that were used for this study and the concentration on large construction firms. The exclusion of small and medium-sized construction firms limited the extent to which findings from this study could be generalized to other types of construction firms or the entire Nigerian construction industry. In this study, I did not conduct a comparison between different sizes of construction companies, or how team members partaking in projects in various sizes of construction firms perceive and act on small failures and unexpected events.

Concentrating solely on the principles of mindfulness, as revealed by High Reliability Theory (HRT), and the use of information systems also limited the scope of this study. For instance, it automatically excluded factors such as the impact of external stakeholders, and the role and influence of clients in project activity failures and unexpected events.

Also, I am the principal research instrument for this study. Having worked in the Nigerian construction industry for over ten years, I am bound to have personal biases likely to impact on the selection of organizations and engagement with participants. This bias may have affected the dependability of this study.

However, I addressed my personal biases by adopting data triangulation: interviews and document analysis. I selected interviewees from four companies to highlight contextual differences and similarities. During interviews, I ensured that questions were clear, did not provide choices for the participants, and explained to participants that their answers would not be used in ways that cold adversely affect them as a person or their jobs. Finally, I laid premium on what the data indicated and did not manipulate results. To address the issue of small sample size, I adopted the purposive sampling strategy, and particularly, the expert purposive sampling strategy. To address the issue of not comparing different firm sizes, I drew participants from two categories: people who worked on a successful project, and those who worked on an unsuccessful project**.** To address the issue of principally focusing on mindfulness and Information Systems Management (ISM) during the execution phase, I will conduct an in-depth semi-structured interview. The use of semi-structured interviews enables a researcher to elicit the perspectives of interviewees, which in Patton's (2015) conception improves the value a study brings to the field under investigation and dissipate the issues associated with having narrowed the focus of the study.

## Significance of the Study

This research is significant because it could fill the gap in understanding how project teams can combine mindfulness, as revealed by High Reliability Organizations (HROs), with information systems to respond adequately to unexpected events during the execution phase of Nigerian construction Projects. The study is unique because I could not find any studies that used High Reliability Theory (HRT) to investigate unexpected events in Nigerian construction projects. Neither could I find studies that combined HRT with ISM to focus on the adaptive behavior of team members at the execution phase of Nigerian construction projects. This study is also unique because rather than being focused on the entire organization (Koh & Rowlinson, 2014) or the entire lifecycle of construction projects (Marshall, 2014), the focus was on teams working in and during the execution phase of construction projects in Nigeria.

As the adoption of HRO principles in various sectors and more particularly the construction industry gains momentum, this study has some general practical contributions to make that goes beyond helping to understand the issues that may contribute to the success of construction projects. First, findings from this study may elevate the need for project managers and leaders in the construction sector to realize that the future of the construction industry in the modern environment is intricately intertwined with the efficient use of information systems (Hosseini et al, 2013). Second, findings from this study may bring to fore the various dimensions necessary for effective project performance and the need to clarify the multidimensional, sector-based, and situational aspects of construction management. Third, the outcome of this study may highlight the dynamics and implications of managing within team-based designs while aligning with Olde Scholtenhuis and Dorée (2013) who cautioned that while the principles of mindfulness adopted by HROs may be beneficial, it does not answer all questions needed for effective management of construction projects. Fourth, by focusing on the attitude of team members during the execution phase, I highlighted mechanisms of mindfulness required to describe various opportunities for anticipating and aggregating weak signals that led to failures and caused delays in Nigerian construction projects. I shall elaborate on ways in which this study is specifically significant to theory, practice, and social change in the subsections that follow.

## Significance to Theory

Findings from this study may strengthen the study of High Reliability Theory (Salas & Rosen, 2013; Weick & Sutcliffe, 2011) and Ansoff's theory of weak signals (Ansoff & McDonnell, 1990; Holopainen & Toivonen, 2012; Rossel, 2012) in construction management. Findings from this study may also strengthen the theory that cognitive processes are essential to identifying and understanding problems, collecting and evaluating evidence, and revising questions to facilitate a stable environment in the face of new events (Hwang & Ng, 2013; Mitropoulos & Memarian, 2012). Also, this study is likely to reinforce the idea that each time a routine activity is re-enacted, it could unfold in a slightly different way that requires proactive mutual readjustment. Dynamic adaptation is priori to generating information about capability, vulnerability, and the environment (Ghoddousi, Eshtehardian, Jooybanpour, & Javanmardi, 2013). In this context, findings from this study is expected to consolidate the theory that teams and organizations that are not mindful of operational variations were likely to experience loss of information and unreliable outcomes because of their limited ability concentrate on identifying and mitigating failures (Salas & Rosen, 2013; Weick & Sutcliffe, 2011).

## Significance to Practice

Organizations involved in both simple and complex projects might gain a better insight of the framework and tools that could enhance their ability to improve project efficiency. Operational efficiency can boost the reputation of a construction firm and improve funding opportunities (Cheung & Pang, 2012; Idoro, 2012).

For practitioners, this study is significant because it may provide better understanding and visibility for weak signals that lead to task and/or activity failures in construction projects. The study may provide practitioners with the tools and framework for proactive risk and opportunity management. Using appropriate tools may enable them to better understand the opportunities available in the use of information systems for managing construction projects, and for identifying, avoiding, and predicting failures when their occurrence is inevitable. Findings from this study may also strengthen the ability of practitioners to stay focused on failures, understand how to recover from them when they inevitably occur, and improve their ability to leverage ISM tools and tactics to restructure patterns of activities and avoid practices that normalize unexpected events.

**Significance to Social Change**

From the perspective of social change, findings from this study can highlight opportunities to improve the way the society, governments, policymakers, practitioners, and even clients view failure in construction projects. In this context, my findings could enable governments and policymakers to formulate and implement more policies that are realistic and address the need to reduce wastes. Waste, in this context, applies to public resources (taxpayers' money) that may not attract their full value due to delays and disruptions. Minimizing wastes is apt to allow the societies realize greater value from taxes and other public resources usually committed to the development of infrastructure projects (Yeheyis, Hewage, Alam, Eskicioglu, & Sadiq, 2013; Yean Yng Ling & Song Anh Nguyen, 2013).

Apart from the structural advantages that effective project management and successful construction projects bring to the society, proactive response to unexpected events could improve project performance and inadvertently lead more job creation and lower unemployment rates. Provision of gainful employment is one of the key matrices for measuring social, economic, and political stability (Ashford et al., 2012; Leisink & Bach, 2014), and these elements all contribute to positive social change. In this context, this study could be significant because it: (a) adds to the knowledge base, (b) improves the understanding of complex phenomenon, (c) tests new ideas, (d) could generate new ideas, and (e) should inform constituencies, as proposed by Newman, Ridenour, Newman, and DeMarco’s (2003) typology.

## Chapter Summary

The purpose of this study was to explore how Nigerian construction project teams could combine the principles of mindfulness, as revealed by High Reliability Organizations (HROs), with information systems management (ISM) to effectively anticipate, identify and aggregate weak signals to predict unexpected events before they occur in and during the execution phase of Nigerian construction projects. I used the five principles of High Reliability Theory (HRT), namely: (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18) as a lens to conduct this study. The use of HRT is critical to this study because the principles of HROs focus on failure rather than success, and while failure is a key driver of unexpected events, researchers are yet to apply the HRT to the Nigerian context.

The literature on the failure of construction projects due to unexpected events pointed to the need for project actors to adopt creative methods in managing their project as a whole. The literature also focused on individual activities that accumulate into the final deliverable. Since construction projects are often complex, chaotic, and require many resources, there is a need for greater understanding of the relationship between project activities and the cognitive processes of those who execute them. Such understanding could bring about significant cost savings and a reduction of waste for clients, organizations, and the society. It could also enhance future business prospects for the construction firm, translate into job opportunities, and drive positive social change.

Consequently, in chapter 1, I presented a general overview of this study comprising the background, research questions, purpose, justification, and its significance. In chapter 2, I presented an in-depth review of the literature involving unexpected events and the causes and consequences of project activity failures. I show how the principles of mindfulness, as revealed by HROs, and effective ISM could independently improve the ability of teams to identify and aggregate small failures that suffice as weak signals to predict unexpected events during the execution phase Nigerian construction projects. In chapter 3, I presented and justified the methodology that I adopted for this inquiry vis-à-vis data sources, data gathering, and data analysis techniques. In chapter 4, I presented the results and data analysis. I concluded this study with chapter 5 in which I used inferences from my findings to provide a summary of how the research objectives were realized and how I answered the research questions. Also, in Chapter 5, I recommended how project team members might combine principles of mindfulness, as revealed by HRT, with ISM to identify small failures and weak signals before they cascade into full-blown issues capable of delaying or disrupting the execution phase of Nigerian construction projects.

Chapter 2: Literature Review

## Introduction

Evidence from several studies have indicated the prevalence of unexpected events in construction projects both in Nigeria (Akinsiku & Akinsulire, 2012; Idoro, 2012) and around the world (Shehu et al., 2014; Amoatey et al., 2015; Doloi et al., 2012; Gunduz et al., 2012; Turskis, et al., 2012; Yang & Kao, 2012). Despite the multitude and consequences of unexpected events, and the argument that unexpected events, to a large extent, are due to lapses in reliability (Weick & Sutcliffe, 2011; Zhou et al., 2012), a major problem was the continued occurrence of unexpected events in construction project. Weick and Sutcliffe (2011) argued that the prevalence of unexpected events in many industries was due to the lack of research on how project teams might adapt mindfulness, as revealed by High Relaibility Organizations (HROs), to their operations. However, Bemelmans et al. (2012) argued that construction firms would be in a better posoition to avert unexpected events if project teams leveraged on information systems during project execution. The purpose of this qualitative exploratory case study was to gain an in-depth understanding of how project teams can combine mindfulness, as revealed by HROs, with information systems to respond adequately to unexpected events during the execution phase of Nigerian construction projects.

The purpose of this literature review was to explore how unexpected events in construction projects have been researched and to gain an in-depth understanding of the various aspects of unexpected events, information systems management, and how teams working on Nigerian construction projects have leveraged on the processes of mindfulness during project execution. In this literature review, I explained the High Reliability Theory (HRT) used as the theoretical lens for this study and synthesized various studies about the significance of applying Information System Management (ISM) in construction projects. I also explained how, by being mindfulness and by using information technology, teams might improve their ability to predict unexpected events during the execution phase of Nigerian construction projects.

Consequently, I used this literature review to examine and build a case for the relevance of combining mindfulness, as revealed by HROs, with information systems (IS) to enhance the ability of project teams to identify weak signals that point to unexpected events during the execution phase of Nigerian construction projects. To this end, this literature review was organized around the following principal areas:

1. Use of Case Study Design in Construction Research
2. Unexpected Events in Construction Projects
3. Information Systems in Construction Projects
4. Teams and Unexpected Events in Construction Projects
5. Responding to Unexpected Events in Construction Projects
6. Mindfulness and Information Systems in Construction Projects

In the first major area I focused on studies relating to the methodology and methods that were consistent with the scope of this study. The other major areas outlined above I focused on the two sub-research questions that formed the foundation of this study. In addition to a review of methods and current issues confronting scholars and construction industry practitioners, I concentrated this review on unexpected events in Nigerian construction projects. I explored the causes and consequences of unexpected events, the use of information systems in construction project execution, and the dimensions and sources of mindfulness leading to reliability in Nigerian construction projects.

## Literature Search Strategy

The purpose of the literature review was to build an in-depth understanding of how information systems and mindfulness, as revealed by High Reliability Theory (HRT), mediate Construction Project Teams (CPTs) and unexpected events. A desk study of books, peer-reviewed journals and articles, conference papers, Internet resources, press reports, government and non- governmental depositories were undertaken. To this end, Academic Search Complete, EBSCOhost, Business Source Complete, ABI/INFORM Complete, Dissertations & Theses, Emerald Management, IEEE Xplore Digital Library, ProQuest Central, SAGE Premier, SAGE Research Methods Online, and ScienceDirect were accessed through the Walden University Library database. Google Scholar was accessed directly over the Internet.

The procedure for locating research studies involved a general search for keywords and terms on *Google Scholar* and specific searches on academic depositories. The first step in this procedure was to link the Walden library to *Google Scholar* so that articles found on *Google Scholar* and which were also available in the Walden Library are displayed along with other results from Google Scholar. *Google Scholar* search engine automatically highlighted articles that were available in the Walden library. By clicking the associated hyperlink on Google Scholar, it was possible to have a direct access to the full text of relevant articles and publications on the Walden library database.

For both general search on *Google Scholar*, and specific searches on any of the databases databases mentioned earlier, the following keywords were used: *construction project teams, teams AND project activities, construction project failure, construction projects AND unexpected events, weak signals AND construction failure, failure prediction in construction projects, effective teamwork in construction project, effective group work in construction project, high reliability project team, high reliability teams, high reliability theory in construction projects,* and *mindfulness in construction projects*. More search terms that were used in this study are listed in Appendix A: Literature Search Terms

. When a relevant source was found, I scanned the reference list to identify the article that could be important to the subject under investigation. I also clicked the *link* titled, *Related articles,* for Google Scholar; or *Related items*, for ProQuest, in the Walden library, to further mine articles that were relevant to not only the subject of a chosen article but also to the phenomenon under investigation.

I used truncation to search keywords and terms such as *project team*, project reliab*,* and *time overrun*,* while the search for exact phrases were undertaken by enclosing terms such as *"Nigerian construction projects"* and *"high reliability team"* in quotation marks. Adjacency/proximity searches were conducted on the EBSCOhost platform. For instance, I used "*team w1 reliability*" to search for *reliability team* and *team reliability* in the EBSCOhost database. When searching for a phrase that contain commonly used words such as "in" or "and" in the ProQuest platform, the phrase was enclosed in quotes as in *"failure prediction in construction projects"* and *"time and cost overruns in construction projects."* Boolean operators such AND, OR and NOT were used to refine searches to reduce or increase the number of results. For instance, a search for "*construction projects AND unexpected events"* was conducted. I also conducted citation search to discover more about articles regarding their use by other researchers, recent papers on similar subjects, and the extent to which ideas about High Reliability Theory (HRT) and the use of Information Systems (IS) in construction projects have been confirmed, applied, improved, extended, and/or corrected in recent years.

An initial *Metasearch* revealed that there were no studies that used HRT to investigate how team behaviors affect unexpected events during the execution phase of Nigerian construction projects. Therefore, I searched generally for *"team behavior AND projects"*, "*High Reliability Theory* AND *teams*", "*HROs* AND *teams*", and "*high reliability organizations* AND *construction projects."* Ideas from articles on related subjects were synthesized to reveal critical perspectives that link philosophies, concepts, and interventions in such publications to unexpected events.

## Conceptual Framework

### High Reliability Theory (HRT): Origin and Source

The High Reliability Organization (HRO) theory, which uses principles of mindfulness to anticipate, predict, and/or contain unexpected events was used as a lens to guide this study. The High Reliability Theory (HRT) originated from studies in various disciplines (Bourrier, 2011; Weick & Sutcliffe, 2011). However, one can trace the initial research on the subject of High Reliability Organizations (HROs) to the HROs project at the University of California, in the United States. Pioneered by Todd La Porte (Professor of Political Science), Karlene Roberts (Professor of Organization Behavior), and Gene

Rocklin (originally a physicist) (Bourrier, 2011), extensive research on HROs under the University of California project followed the publication of *Normal Accidents* by Perrow in 1984. The diversity in the discipline of pioneer researchers on the subject could explain the prevalence of emerging studies on HROs in diverse fields such as management, political science, healthcare, psychology, and sociology, among others. The multidisciplinary approach to HRT has widened the breadth of understanding revealed by HROs research because each disciple furnishes a different lens of interpretation that enriches insights into its study and application.

**Primary Writings and Key Theorists**

Several authors have contributed to the concept of operational failure and organizational reliability using principles of mindfulness. Perrow (2011) in his Normal Accidents Theory (NAT) described how complexity and tight coupling predisposed technology systems to failure. Perrow's study introduced the idea that people and complex technology interaction could create whole or unitary systems. Perrow argued that system complexity and coupling determined the susceptibility of a system to accidents. Roberts, Bea, and Bartles (2001) studied the structure of organizations and how the performance of people influenced organizational response to the environment. Roberts et al (2001) argued that HROs were those organizations with structures that enabled them to avoid catastrophes or enjoy consistent high safety records over an extended period despite their hazardous environments. Achievement of high reliability by such organizations was contingent on their ability and aggressiveness in seeking to know what was not evident, design their reward and incentive systems to recognize the cost of failure and benefits of reliability, consistent communication of the big picture, and the role of individuals in achieving strategic objectives (Roberts et al., 2001). Weick and Sutcliff (2011) expanded their study of cognitive dissonance on performance to the stream of action following surprise, enactment, making sense of unexpected events, and mindfulness. Weick and Sutcliff argued that the success of HROs in avoiding unexpected events or major catastrophes went beyond individualized mindfulness or individualized enactment, to collective mindfulness and collective enactment.

In line with Roberts et al. (2001), Weick and Sutcliff (2011) posited that an organization that desired to improve reliability must maintain a structure that enabled it to function under conditions of uncertainty. However, Weick and Sutcliff added that such organizations must also harness its human resources to avoid situations where the potential for error and disaster could lead to catastrophe. Findings by Roberts et al. (2001) and Weick and Sutcliff (2011) recognized that mindfulness was a mental orientation that supported the need for continuous evaluation of the environment.

Consequently, the principal theorists of organizational reliability are opposed to acting on simple assessments and plan that continued until unexpected events ran the plan from its course. While Perrow (2011) argued that a non-linear combination of simple principles led to complexity and novel properties of the system in ways capable of triggering unexpected events, Weick and Sutcliff (2011) argued that anticipation of events was possible where organizations and teams went beyond sensing early events to exerting efforts to stop the development of undesirable events. Stoping the development of undesirable events involved using mindful organizing across the entire organization for both the unexpected and the expected (Weick & Sutcliff, 2011).

Roberts et al. (2001) and Weick and Sutcliff (2011) did not only complement Perrow's concept of "normal accidents" but they also extended the idea beyond accidents due dynamic human-machine interactions to organizational structures. In this context, Silvast and Kelman (2013) argued that beyond addressing dynamic human-machine interactions, credence should be given to the organizational structure and the idea that human cognition and behaviors and/or engineered designs are elements that facilitate or mitigate the occurrence of unexpected events. Therefore, the concept of high reliability driven by operational mindfulness could prevent expectations from developing into blind spots capable of triggering incidents that could develop into unmanageable events (Roberts et al., 2001; Weick & Sutcliff, 2011; 2015).

**Conceptual Basis of High Reliability Theory (HRT)**

High Reliability Theory (HRT) posited that the occurrence of unanticipated or unexpected events was mostly due to lapses in reliability (Weick & Sutcliffe, 2011). Proponents of High Reliability Theory (HRT) argued that lapses in reliability often did not happen suddenly as full-blown issues (Weick & Sutcliffe, 2011); but often such events provided clues that accumulated into events that inadvertently audited the resilience of organizations (Zhou et al., 2012). Weick and Sutcliffe (2015) posited that generative organizations always investigated the cause of failures. Such inquiry inadvertently led to new ideas because information were actively sought and team members were free to think and act with utter probity (Weick & Sutcliffe, 2015; Zhou et al., 2012. In this context, the principles of HRT are focused on how the interrelationship between diverse but stable cognitive processes facilitate the discovery and correction of errors and other weak signals that pointed to unexpected events (Aven & Krohn, 2014).

**Major Propositions and Dimensions of HRT**

High Reliability Theory (HRT) is defined by five principles of mindfulness that help HROs to sustain resilience in the face of unexpected circumstances. These are (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). The five principles of HROs elaborated below are the foundation of the High Reliability Theory (HRT).

**HRO principle 1: Preoccupation with failure.** This principle enacts the need to treat lapses as symptoms pointing to something wrong in the system (Aven & Krohn, 2014). The emphasis of this principle is that such symptoms could result in severe consequences if several small events of similar or diverse nature happen to coincide (Aven & Krohn, 2014; Weick & Sutcliffe, 2011). Elaboration of near misses was seen as avenues for learning. Hence, reporting of errors and other weak signals are encouraged, while complacency, reducing margins of safety/error, and drift to automatic processing are not encouraged under this principle (Goldenhar, Brady, Sutcliffe, & Muething, 2013; Vogus & Sutcliffe, 2012).

**HRO principle 2: Reluctance to simplify interpretations.** Under this principle, deliberate steps are taken to create a complete picture of what was faced and the capacity of the team/organization to face it (Aven & Krohn, 2014). The principle acknowledges that, while success in coordinated activities required simplification to focus and efficiently execute small chunks of tasks, the world, and many systems are often "complex, unstable, unknowable, and unpredictable" (Weick & Sutcliffe, 2011, p. 10). To this end, diverse experiences, and skepticism toward received wisdom were not only welcomed, but were also acknowledged because superficial similarities between present and past events could mask deeper differences that were capable of causing avoidable failures (Aven & Krohn, 2014; Vogus & Sutcliffe, 2012; Weick & Sutcliffe, 2011).

**HRO principle 3: Sensitivity to operations.** This principle encourages team members to develop increased situational awareness to make effective continuous adjustment that will prevent weak signals and errors from accumulating into events with disruptive consequences (Goldenhar, Brady, Sutcliffe, & Muething, 2013; Vogus & Sutcliffe, 2012). To this end, team/organizational awareness of the close ties between sensitivity to operations and sensitivity to relationships are encouraged. Sensitivity in this regard enabled teams to identify and isolate anomalies while they were still tractable.

**HRO principle 4: Commitment to resilience.** This principle acknowledges the imperfection of systems and promotes commitment to building an intrinsic systemic ability to maintain or regain a dynamically stable state (Weick & Sutcliffe, 2011). Such state of stability was found to be essential to continuing operations after an unexpected event had occured because such events often happened in the presence of continuous stress and other inevitable dynamics of an indeterminate world (Labaka, Hernantes, Rich, & Sarriegi, 2013; Weick & Sutcliffe, 2011). Therefore, under this principle, proponents of HRT rally the idea that resilience was a function of mindfulness that accounted for errors that have already occurred (Labaka, Hernantes, & Sarriegi, 2015). Correcting such errors before they cascade into worse situations required strong ability to make sense out of emerging patterns of activities (Labaka, Hernantes, & Sarriegi, 2015; Weick & Sutcliffe, 2011).

**HRO Principle 5: Deference to expertise.** This principle encourages project team members to both collaborate and defer to experts (Weick &Sutcliffe, 2015). To this end, the principle influenced teams to cultivate diversity because it helped them to be more alert to events in complex environments, and to do more with complexities that are spotted as a result of being more alert (Mahdavi Mazdeh, & Hesamamiri, 2014; Weick & Sutcliffe, 2011; 2015). This principle made it easier to comprehend and mitigate vulnerabilities to errors that were due to rigid hierarchies that tend to combine with errors at lower levels to aggravate problems (Weick & Sutcliffe, 2011; 2015).

**Alignment of HRT to the Qualitative Approach**

Researchers who adopt the qualitative approach must address the fact that the data and evidence used in an inquiry cannot be separated from the theoretical assumptions they hold about the social world (Bryman, 2012; Maxwell, 2013). Patton (2015) argued that qualitative researchers should use an appropriate lens to guide the methods by which they generate and analyze data. Guiding this study with HRT helped ground it in and existing theory, improve its trustworthiness, and the application of its findings in the real world (Bryman, 2012; Maxwell, 2013; Patton, 2015).

The use of High Reliability Theory (HRT) as a lens for this exploratory case study helped me to draw on the dimensions of mindfulness to providing rich, in-depth, and contextualized representations of human behaviors. It also assisted me to understand the reasons for such behaviors; and the processes and tools needed to mitigate unexpected events in Nigerian construction projects. As noted by Olde Scholtenhuis and Dorée (2013) HROs and construction firms share similarities that make them amenable to similar strategies and tactics. Hence, construction teams could avert unexpected events by adopting strategies and tactics that HROs have successfully used to avert catastrophes.

Consequently, concepts of mindfulness, as revealed by HROs, can serve questions of "What," "Why," and "How"; which could help a researcher to identify and understand why the problem of unexpected events persists in construction projects. It could also provide better understanding about how the behaviors of team members facilitated unexpected events, why mindfulness matter in identifying weak signals, and how team members may harness it to predict and/or contain such events. In this study, concepts of mindfulness were expected to specifically assist me to answer questions about *why* construction teams acted the way they did when confronted with unexpected events, and *how* combining team mindfulness with information systems (IS) could facilitate collaboration and coordination for predicting unexpected events in construction projects. Such questions and answers aligned with qualitative methodologies because they captured categories within the qualitative domain, namely: questions about meaning, questions that illuminated contexts, and questions that examined processes (Maxwell, 2013).

**Relationship between HRT and the Present Study**

The need for significant improvements in the performance of construction projects required project actors to adopt creative methods in managing their projects (AlSehaimi et al., 2012; Vogus & Sutcliffe, 2012). Creative approaches could involve new ways of understanding and managing the complexity (Lee & Yu, 2012) and chaotic nature (Cheng et al., 2014) of construction projects. AlSehaimi et al. (2012) proposed that project actors ought to shift focus from their traditional approach of looking at tasks, processes, and projects as an ordered phenomenon to the realization that events could be self-organizing as they progressed through the project life cycle.

Previous studies have attempted to show the similarities between construction organizations and HROs (Goldenhar, Brady, Sutcliffe, & Muething, 2013; Fellows, & Liu, 2012). From a macro perspective, construction firms and HROs share chaotic and complexity of working environments (Cheng et al., 2014; Fellows, & Liu, 2012; He, Luo, Hu, & Chan, 2015). Both types of organizations also use technologies with potential for error (Cheng & Teizer, 2013; Costin, Pradhananga, & Teizer, 2012; Ghoddousi & Hosseini, 2012; Lee & Yu, 2012). From a micro perspective, construction firms and HROs share similarities such as interdependence of parts (Cheng & Teizer, 2013; Fellows, & Liu, 2012; Vogus & Sutcliffe, 2012), and multiple stakeholders (Fellows, & Liu, 2012; Li et al., 2012a).

This study would benefit from the high reliability framework captured in the HRT because, as revealed by Goldenhar, Brady, Sutcliffe, and Muething (2013), construction projects and the organizations that run them share similarities with HROs that go beyond utilizing resources from people to delivering products/outputs. Goldenhar et al. (2013) noted that both HROs and construction firms adopted similar complex formal processes to integrate and manage complex tasks and activities to avoid failures. Aven and Krohn (2014) showed that projects undertaken by construction firms and those undertaken by HROs were amenable to high scales of possible consequences of errors and mistakes. Vogus and Sutcliffe (2012) showed that projects embarked on by construction firms and those undertaken by HROs were similar in their tendencies toward disruptions due to failures and unexpected events. HROs and construction companies made decisions in the absence of complete information, bounded rationality and cognitive biases; and utilized resources from people to deliver products/outputs (Goldenhar, Brady, Sutcliffe, & Muething, 2013; Locatelli et al., 2014;Olde Scholtenhuis & Dorée, 2013). These similarities make construction projects and the firms that run them amenable to strategies and tactics, which HROs have successfully used to avert project catastrophes. To this end, it can be argued that this study could benefit from the use HRT to guide the study of unexpected events in construction projects because the outcome of the study can facilitate High Reliability Projects (HRPs).

**Rationale for the Choice of HRT**

Researchers have recognized the chaotic nature (Cheng et al., 2014) and complexity (Locatelli et al., 2014) of construction activities as reasons for the prevalence of unexpected events in construction projects. However, researchers have argued that chaos and systems theories were incapable of explaining the prevalence of unexpected events in construction projects (AlSehaimi et al., 2012; Xia & Chan, 2012). While chaos and complexity theories enabled managers to engage and explain the differences, coexistence, and transitions between ordered and chaotic sequences (Brady & Davies, 2014; Xia & Chan, 2012), lapses in reliability could still make it difficult to handle operational chaos, matches and mismatches between complex tasks, projects and programs, organizational flexibility and responsiveness (AlSehaimi et al., 2012; Osipova & Eriksson, 2013).

Many models in construction projects reduced risk management to a systematic methodology that aggregated planning and experience (Aminbakhsh, Gunduz, & Sonmez, 2013). Indeed, the inability of both owners and contractors to systematically apply risk management practices to unexpected events often resulted in negative consequences for the performance of construction projects (Aminbakhsh et al., 2013; Guo, Chang-Richards, Wilkinson, & Li, 2014). Weick and Sutcliff (2011) posited that organizations could successfully manage unexpected events if they emulated paths of mindfulness chatted by successful HROs. Indeed, practitioners have used the principles rallied by HROs to engineer resilience in several fields, such as management, political science, healthcare, psychology, and sociology **(**Bourrier, 2011; Weick & Sutcliffe, 2011**)**. While these principles could be applied separately to centers of excellent project management, it should be recognize at the extreme reductionism that the consequences of human-machine interaction could be a source of physical and technological threat to the success of both organizations and projects (Stoll, Jaekel, Katz, Saenz-Otero, & Varatharajoo, 2012). Adopting the HRT as a social response to uncertainty, complexity, and threat (*behavioral and physical)* help researchers to go beyond people/group perception, the details and development of issues description, and their context, to the interaction between individual parts of the project (Guo et al., 2014; Stoll, Jaekel, Katz, Saenz-Otero, & Varatharajoo, 2012).

**Use of Case Study Design in Construction Research**

The effectiveness of the qualitative case study approach is well established in the study of various phenomena in construction projects. Studies by Arif, Bendi, Toma-Sabbagh, and Sutrisna (2012) presented two cases and results from semi-structured interviews that shed light on major issues, challenges, and drivers of waste management implementation in Indian construction projects. Zhang and Fai Ng (2012) adopted the case study approach and a semi-structured interview to explore factors that affect the attitude of individuals toward information sharing in Hong Kong construction teams. Davies and Harty (2013) described an empirical case study of Site Business Information Modeling (Site BIM) system implemented on a major hospital construction project in which the main contractor developed a tool that enabled site workers to access synchronously design information, and capture work progress and quality. While Arif et al. (2012), and Zhang and Fai Ng (2012) examined construction projects from the cost-benefit perspective, while Davies and Harty (2013) examined construction projects from the information sharing perspective. However, these studies failed to reveal how individual attitudes affect information sharing, the efficacy of inforamtion feedback, and how information sharing behaviors affect construction project activities, waste management, risks/uncertainty, and unexpected events.

Hosseini, Chileshe, Zou, and Baroudi (2013) adopted the qualitative approach to describe the current state of information and communication technologies (ICTs) in the construction industry. They found that the construction industry has not kept pace with information and communication technologies (ICTs). This, they argued, was probably due to the fragmented structure of construction industries. Indeed, the inability of the building industry to keep pace with ICT is affecting performance (Piperca & Floricel, 2012). Shi, Zuo, and Zillante (2012) adopted the case study approach in analyzing the planning and implementation of sustainable construction projects across the entire program lifecycle. Their study used the Shanghai World Expo 2010 to display the application of sustainable development principles in construction projects in China. Shi, Zuo et al. (2012) revealed that the key factors that promote sustainable construction at the program level were the establishment of a department dedicated to coordinating various stakeholders, and the effective implementation of conceptual guidelines for ISM.

The multiple case study design has also been used to study the complexity and nature of unexpected events in construction projects (Brady & Davies, 2014; Carlo, Lyytinen, & Boland, 2012; Piperca & Floricel, 2012). From the social systems' perspective, Piperca and Floricel (2012) attempted to understand the origins and nature of unexpected events and their effect on complex projects in construction, information technology, information systems, and pharmaceutical industries. Piperca and Floricel (2012) argued that the management of unexpected events depended largely on event predictability and *locus* (sic) of generation. In this context, Piperca and Floricel (2012) revealed through their findings that appropriate lines of communication between project participants were key mediators between projects and the environment.

Brady and Davies (2014) adopted the multiple case study design to compare the management and complexity of two successful construction mega-projects: Heathrow Terminal 5 and the London 2012 Olympic Park. Findings from their study revealed that while shared similarities likely to facilitate the achievement of positive outcomes were adopted on mega projects, different project actors were more likely to take different approaches to managing the structural and dynamic complexities that affect cost, time, and quality objectives. Carlo, Lyytinen, and Boland (2012) used the case study design to investigate the relationship between high reliability and collective mindfulness on complex construction projects. Carlo et al. (2012) argued that collective mindfulness was possible only through an interactive process in which project and organizational actors simultaneously exhibit elements of *mindfulness* and *mindlessness*. Carlo et al. (2012) noted that the interaction between the five dimensions of mindfulness was similar to those enacted by multiple, contradictory technology practices that drive information technology capabilities. In this context, they suggested the need for further studies on collective minding and the appropriation of IT capabilities in construction projects.

Studies outlined above provided compelling evidence that the case study design had been used effectively to study various phenomena in construction projects. The use of case study design to research construction phenomena spaned waste management (Arif, Bendi, Toma-Sabbagh, & Sutrisna, 2012), attitude of individuals towards information sharing (Zhang & Fai Ng, 2012), information systems (Davies & Harty, 2013), and organization/ industry structure (Hosseini et al., 2013). The multiple case study design had been used to investigate unexpected events (Piperca & Floricel, 2012), high reliability and collective mindfulness (Carlo et al., 2012), sustainability (Shi, Zuo, & Zillante, 2012) and complexity in construction projects and programs (Brady & Davies, 2014; Shi, Zuo, & Zillante, 2012).

While these studies may not be representative, they provided valuable insights and highlighted the ways by which the qualitative case study design had been used to study various phenomena in construction projects and the constructs/concepts that were considered in this study, namely: Unexpected events, weak signals, delays, information systems, and mindfulness. These studies also shed light on the need to extend the study of unexpected events, the need to prepare for the unforeseen, and the need for further studies on the use of information systems in construction management. As noted by Costin, Pradhananga, and Teizer (2012) project-based case studies are useful research tools for assessing the benefits and difficulties that come with technology.

## Unexpected Events in Construction Projects

In construction projects, unexpected events come in the form of delays and disruptions (Amoatey et al., 2015). Delays and disruptions mean to make a task or activity happen later than expected or planned (Amoatey et al., 2015; Pourrostam & Ismail, 2011; Idoro, 2012). Unexpected events could cause disruption or outright abandonment of a project (Pourrostam, & Ismail, 2012). In construction projects, the client, the contractor, consultants, acts of nature or any combination of these factors may cause unexpected events at any point in the project lifecycle (Idoro, 2012). Irrespective of the form, what, or who caused the unexpected event, the occurrence, to some extent, could determine whether the project will meet its deadline, milestones, or other related objectives (Amoatey et al., 2015; Pourrostam & Ismail, 2011). When an unexpected event occurs in the project lifecycle, it usually has time and cost consequences that challenge the outcome of the project. While delays could be inexcusable or excusable, irrespective what caused it to happen, delays bring about certain consequences.

**Inexcusable Delays**

Inexcusable delays are traceable, principally, to contractors, subcontractors, or suppliers (Idoro, 2012). A delay caused by a contractor's failure to provide sufficient manpower is an inexcusable delay. Inexcusable delays may be due to contractor negligence, underestimation of productivity, improper or unrealistic planning and scheduling, inadequate site management, poor supervision, adoption of inappropriate construction methods, employment of inefficient or unreliable subcontractors or a combination of these (Pourrostam & Ismail, 2011; Idoro, 2012). Contractors or their agents are usually not entitled to any relief for an inexcusable delay.

Conversely, contractors are liable to damages in the event of an inexcusable delay. Idoro (2012) argued that contractors are liable for damages caused by inexcusable delays because factors that trigger them do not only fall within their control and skills but are also often within their power to avoid. To this end, contractual agreements may compel a contractor to make up for lost time and cost by project acceleration or by financial compensation to the client. Provided the terms are stated in the contract, compensation may come in the form of penalty damages or liquidated damages (Brawn, 2012; Yoke-Lian, Hassim, Muniandy, & Mee-Ling, 2012). Penalty damages are punitive; intended to reform or deter a party from non-performance (Brawn, 2012). Conversely, liquidated damages are the forecasted cost to the client for non- performance by the contractor (Yoke-Lian et al., 2012).

**Excusable Delays**

Excusable delays are unforeseeable and often not within the control of the contractor (Yang et al., 2014; Yang & Kao, 2012). Yang and Kao (2012) distinguished two type of excusable delays in construction projects. These are non-compensable delays and compensable delays.

**Non-compensable delays**. These are delays traceable to third parties or due to factors beyond the control of the client, contractor, or their agent(s). Such delays are principally due to chance occurrences, unavoidable accidents, or other extraordinary events such as war, strike, or acts of nature (e.g. hurricane, flooding, earthquake, etc.) usually referred to as *force majeure. Force majeure* are events that drastically disrupt the project to the extent that continuing would make no economic, social, or business sense; leaving the option of either delaying or abandoning the project (Marzouk & El-Rasas, 2014). While *force majeure* does not entirely excuse a party's non-performance in all cases, it suspends the requirement for performance for the duration of the *force majeure*. Essentially, for non-compensable delays, both parties are free from any liability or obligation, and the contractor may be entitled to an extension of time.

**Compensable delays.** These are delays that, though unforeseeable, are caused by the client or his agent(s). Such delays are beyond the control of the contractor; hence, the contractor is entitled to both time compensation and/or time extension (Yang & Kao, 2012). Compensable Delays may be due to direct change (e.g. specification), suspension of work, late release of drawings, and/or delayed payments, etc. Compensable Delays usually lead to the extension of project schedules and exposure of both the client and the contractor to financial risks (Yang & Kao, 2012; Yoke-Lian et al., 2012). However, Yang and Kao (2012) argued that a contractor must demonstrate that the delay was caused by the client or his representative to successfully request for a time extension and/or compensation for that chunk of activity.

**Causes of Delays and Disruptions in Construction Projects**

Several studies for delays, time, and cost overrun in gas pipeline projects, building projects, infrastructure projects, public utility projects, and groundwater projects, among others; all identify several causes of delay in construction projects. Idoro (2012) identified 16 key factors that cause delays, disruptions, time, and cost overrun in Nigerian construction projects. Al-Khalil and Al-Ghafly (1999) identified 56 major factors that cause delays in large construction projects in Saudi Arabia. While Idoro (2012) identified funding, payment arrangements, ineffective contract management, shortage of materials, corruption, price fluctuation, and inflation as the most important causes of delay, Al-Khalil and Al-Ghafly (1999) argued that delays in the preparation and approval of drawings, inefficiency of contractors, irregular payments, and incessant design changes by clients were the most important of the 56 factors they identified.

However, while Idoro (2012) drew on the contractor and consultant's perspectives, which Doloi, Sawhney, Iyer, and Rentala (2012) supported, Al-Khalil and

Al-Ghafly (1999) viewed the causes of delay from only the contractor perspective. The 56 causes of delay identified by Al-Khalil and Al-Ghafly (1999) were supported by findings from several studies (Fallahnejad, 2013; Pourrostam & Ismail, 2011; Shehu et al., 2014). However, from the perspective of project consultants such as architects and engineers, funding problems during the execution phase and the relationship between contractors and sub-contractors were the most important causes of delays (Ameh & Ogundare, 2013; Akinsiku & Akinsulire, 2012). Drawing on the perspective of consultants, Doloi et al., 2012) discovered that, in addition to the findings above, slow decision-making by clients was an important cause of construction project delays.

Furthermore, clients/project owners were found to be generally of the opinion that design error, shortage of manpower, and inadequate labor skills were the main causes of delays in construction projects (Ameh & Ogundare, 2013; Kazaz, Ulubeyli, & Tuncbilekli, 2012). A survey by Shehu, Endut, and Akintoye (2014) that aggregated the perspectives of architects, project engineers, clients, and contractors revealed that while clients were more concerned with financial issues, and contractors considered contractual relationships as most important, consultants considered project management issues to be the most significant cause of delays in construction projects.

**Consequences of Delays and Disruptions in Construction Projects**

Several studies have identified the effects of, and contributed to the ramifications and understanding of, delays in construction projects. Researchers have conducted studies to find the general causes of delays in construction projects in Turkey (Kazaz et al., 2012); time and cost overrun in the Malaysian construction industry (Shehu et al., 2014);

and gas pipeline projects in Iran (Fallahnejad, 2013). Other studies have focused on construction project delays in fast-growing economies (Ameh & Ogundare, 2013); causes of delays in infrastructure projects (Doloi et al., 2012; Park & Papadopoulou, 2012); and commercial projects (Shehu et al., 2014). While other studies were focused on public utility projects (Al-Khalil, & Al-Ghafly, 1999) and the quantification of delay factors (Gunduz et al., 2012). Several researchers (e.g. Ameh & Ogundare, 2013; Akinsiku & Akinsulire, 2012; Idoro, 2012) have also conducted research on delays and disruptions in Nigerian construction projects.

Pourrostam and Ismail (2012) studied the effects of delay in Iranian construction projects and identified five effects of delay to include, time overrun, cost overrun, disputes between key project stakeholders, litigation, and abandonment of projects. They, however, argued that time and cost overruns were the most important of these effects. Yang, Chu, and Huang (2013) identified arbitration, in addition to time and cost overruns as important consequences of delays in construction projects. Fallahnejad (2013) argued that while abandonment is an important result of delays, abandonment is a less important consequence in developed and emerging economies than in developing economies where funding is a critical issue. Abandonment important in developing countries, especially those in Africa, because, firm are less able to cope effectively with project interruptions (Fallahnejad, 2013; Shebob, Dawood, & Shah, 2012). For instance, apart from having a poor reputation for dealing with delays, project managers leading construction projects in Nigeria are known to have little or no delay analysis strategy. Shebob, Dawood, and Shah

(2012) noted that it is common practice for Nigerian project managers to ignore project delay analysis, or perform delay analysis by simply adding a contingency.

Indeed, the result of most inexcusable delays includes late completion, cost overrun, and work disruption, loss of productivity, disputes, litigation and claims, project abandonment or termination of the contract. These consequences ultimately lead to unsuccessful projects and dissatisfaction of stakeholders (Brawn, 2012; Idoro, 2012; Yoke-Lian et al., 2012). The aggregate indication of these studies (Fallahnejad, 2013; Pourrostam & Ismail, 2012; Park & Papadopoulou, 2012; Shebob et al., 2012; among others) is that project delays or time overruns are not only common but are also attended by complicated and expensive consequences. This indication, perhaps, explains why understanding and analyzing the causes and consequences of unexpected events such as time overruns, cost overruns, litigations, and disruptions have become an important aspect of effective project management.

**Delays in Nigeria Construction Projects**

In Nigeria, the construction industry is a principal instrument of growth, and together with trade, agriculture, crude petroleum, natural gas, and telecommunications, is one of the highest contributors to economic expansion (Babatunde, & Low, 2013; Imoudu, 2012). Although the government, via public infrastructure projects, is the highest consumer in the Nigerian construction industry, private sector consumption has increased with the population explosion and demand for residential accommodation (Babatunde, & Low, 2013). The Nigerian construction industry has a significant impact on the country’s development; haven contributed 16% to GDP between 2011 and 2013, grown by 10.7% and contributed 4.32 % to the country's real GDP in the second quarter of 2014 (Nigeria Bureau of Statistics, 2014). The increasing demand for construction projects informed government decision to vote N657 billion representing 15.27 % of its 2015 appropriations for fixed capital projects (Vanguard, 2014).

However, delays and outright abandonment have persisted in the Nigerian construction industry (Idoro, 2012). While it is common to experience poor time performance in the Nigerian construction industry, the concern for the delay, disruption, or outright abandonment has become more critical in recent years (Ameh & Ogundare, 2013; Idoro, 2012). Findings by Ameh and Ogundare (2013) revealed that between 50% and 70% of Nigerian construction projects encounter some form of delay. Such high levels of construction delay imply that most Nigerian construction projects are unsuccessful when their operational performance is measured against time, cost, and quality. Studies by Ameh and Ogundare (2013) and Idoro (2012) were unanimous in their conclusion that most construction projects in Nigeria fail to meet their performance expectations, that delayed projects in the industry riased serious concerns, and that more stakeholders were aware of and concerned about the problem.

Several studies (Ameh & Ogundare, 2013; Idoro, 2012; Han et al., 2014) reported that delays were due to negligence by clients, contractors and their representatives; while inexcusable delays constituted a major percentage of project delays in construction projects. Idoro (2012) also found that the attitude of project managers and their teams were important reasons for the high level of delayed construction projects in the Nigeria.

## Information Systems in Construction Projects

Utilizing information systems (IS) in construction projects has been in the front burners of research for decades (Bemelmans et al., 2012; Ashford et al., 2012). Zhang et al. (2013) argued that apart promoting innovation, collaboration, and corporate governance, utilizing Information Systems (IS) in construction projects can help firms to enhance project team effectiveness across the project life cycle, across different construction business functions, and to achieve competitive advantage. However, the initiation, design, and implementation of construction projects vary with context (Chipulu et al., 2014; Doloi et al., 2012). Therefore, factors that cause delays and disruptions, and how project teams might harness the power of information systems to identify, analyze, interpret, aggregate, and predict their causes are also likely to change with context.

### Information Technology (IT) and the Nigerian Construction Industry

Nigeria, like most parts of the world, has experienced significant growth in the use of technology in its construction industry (Olalusi & Jesuloluwa, 2013; Ashford et al., 2012). The acceptance and spread of IT among construction industry practitioners have accelerated competition and the mechanics for keeping projects on course and successful (Olalusi & Jesuloluwa, 2013). The acceptance IT in construction projects has led to widespread adoption of various developments in diverse areas of computer application in the Nigeria, ranging from expert systems, knowledge-base systems (KBS), and computer-aided design (CAD) (Waziri, Ali, & Aliagha, 2015; Olalusi & Jesuloluwa, 2013).

Findings by Olalusi and Jesuloluwa (2013) revealed that 26% - 50% of staff in the Nigerian construction industry have had some form of computer training. While information technology is well oriented in the Nigerian construction industry, and the use of internet ubiquitous, most firms do not use network systems. Construction firms are more reliant on standalone systems, while office supplies, purchasing, document tracking and management, economic and risk analysis solutions are rarely used (Irani & Kamal, 2014; Olalusi & Jesuloluwa, 2013). Regarding the percentage of use, drawing solutions (e. g. AutoCAD, ArchiCAD), general administration, and preparation of Bill of Quantities solutions were ranked the highest; followed by tender/bidding software, specification writing software, and Microsoft Projects for scheduling (Olalusi & Jesuloluwa, 2013).

While there are very minimal barriers to the use of technology in Nigerian construction projects, the use of technology were often fraught with inefficiencies from errors and misunderstanding arising from misinterpretation and data reentry by construction practitioners (Olalusi & Jesuloluwa, 2013). Several studies have indicated that changing technology, weak leadership, cost, and technology infrastructure pose no barriers to the use of IT in the Nigerian construction industry (Olalusi & Jesuloluwa, 2013; Waziri et al., 2015). Also, irrespective of the size of a firm (i.e. small, medium, or large-scale), system integration/capability problems, management, and teamwork were not barriers to IS adoption by Nigerian construction firms or, in the projects they executed (Waziri et al., 2015).

**Information Systems in the Execution of Nigerian Construction Projects**

Construction projects are characterized by complexities and fragmentations both within individual activity phases and across project phases (Lee & Yu, 2012; Williams et al., 2012). The use of information systems in designing and executing (architecture, planning, and controlling) construction projects have affected both project and business productivity (Kerzner, 2013; Lee & Yu, 2012). IT-driven business administration has improved productivity through quicker response on projects, flexible and efficient capture and analysis of meaningful information, which has facilitated successful project delivery in Nigeria and the world (Carlo et al., 2012; Olalusi & Jesuloluwa, 2013).

Olalusi and Jesuloluwa (2013) noted that the use of IT in Nigerian construction projects was yet to produce sufficient benefits in capturing changes to project expectations during the execution phase, and lessons learned from previous projects. Olalusi and Jesuloluwa (2013) found that most Nigerian firms (especially small and medium-sized companies) did not consistently use IS for core project activities such as design, monitoring/controlling project schedules, cost, and material requirement changes/modification, or keeping an audit trail of such modifications. Furthermore, while the Internet is one of the most ubiquitous information technology used in the Nigerian construction industry (Olalusi & Jesuloluwa, 2013; Opawole, Jagboro, Babalola, & Babatunde, 2012), it was mostly used for communicating with the central office, making interpersonal communication, and browsing (Olalusi & Jesuloluwa, 2013). The use of IS often stopped at the planning phase for preparing architectural drawings, Bill of Quantities, and activity schedules (Olalusi & Jesuloluwa, 2013; Waziri et al., 2015).

Inconsistency in the use IS across the project lifecycle detracts from the value that IT was expected to bring to project productivity (Hartmann, Van Meerveld, Vossebeld, & Adriaanse, 2012). Many processes of construction projects required complex data and information exchange among project participants on a daily basis (Olalusi & Jesuloluwa, 2013; Hartmann, Van Meerveld et al., 2012). But how users harness information exchange across the project life cycle is crucial to identifying and presenting an adequate response to task/activity failures, cost, schedule, and design discrepancies (Kim, Son, & Kim, 2013; Hartmann, Van Meerveld et al., 2012).

**Information Systems (IS) and Unexpected Events in Construction Projects**

The use of Information Systems (IS) in project design (e.g. architectural design), planning (e.g. costing, scheduling), and implementation (e.g. monitoring, control) have motivated practitioners to work better, and handle more inquiries with greater efficiency (Porwal & Hewage, 2013; Wang et al., 2013). Efficient use of information systems could prevent unexpected events by providing seamless access to project information and facilitating team communication, collaboration, decision-making, and transparency (Olalusi & Jesuloluwa, 2013). Apart from effective project management control, data handling is more cost-effective and less prone to error where information systems are used in managing construction projects (Olalusi & Jesuloluwa, 2013;Porwal & Hewage, 2013). Findings by Olalusi and Jesuloluwa (2013) suggested that data entry errors sometimes led to an extension of project schedule (delays) and higher costs. Similarly, faulty or error-laded information could result in ineffective decision-making, leading to cost, time and quality failures (Park, Lee, Kwon, & Wang, 2013).

Incorrect data could result in unnecessary delays and costly failures (Pourrostam & Ismail, 2012; Schoemaker et al., 2013). Pourrostam and Ismail (2012) found that the efficiency of construction projects and the ability to avoid unexpected events depended on the quality, integrity, and effectiveness of information flowing between project actors. A combination of errors, ineffective and inefficient decisions could be exacerbated by the absence of an integrated and/or systematic information system (IS) (Schoemaker et al., 2013). An integrated information system should be designed to enhance the quality and speed of construction projects (Ashford et al., 2012). Schoemaker, Day, and Snyder (2013) found that the absence of an integrated information system led to functional silos and isolated departments with control and decision independence over areas of responsibility. Zhang et al. (2013) noted that an unsystematic and fragmented IS could cause uncoordinated information gathering, reporting, and management.

A project affected by functional and departmental isolation and decision independence is prone to duplication of efforts (Ellegaard & Koch, 2014; Nawi, Lee, Kamar, & Hamid, 2012; Shehu et al., 2014). Ellegaard and Koch (2014) showed how projects and project firms that failed to properly integrate their efforts experienced multiple re-drawing, and data reentry, which ultimately led to increased errors, unproductive use of time, unnecessarily cost escalation, misunderstanding between project team members, and demotivation. Misunderstanding between project team members have been identified as a primary cause of unexpected events, and time and cost overruns in construction projects (Nawi et al., 2012; Park et al., 2013; Shehu et al., 2014).

**Teams and Construction Project Execution: Right Vs. Best Team**

Construction projects typically involve the collaboration of several organizations or a group of individuals. For the project duration, organizations and/or individuals are brought together to form the project team (Koh & Rowlinson, 2014; Ling, Dulaimi, &

Ho, 2012). Teams are essential elements of project execution because teams are responsible for the execution of most projects.

In forming a construction team Ling et al. (2012) suggested that the focus should be on selecting the right team rather than the best team. While the best team is valuable to the successful outcome of construction projects, choosing the best team must not be an overriding objective in team formation (Aapaoja, Herrala, Pekuri, & Haapasalo, 2013; Ling et al., 2012). Choosing the right team players from the inception of the project has been found to be a key factor in creating a good working relationship and a successful project outcome (Ling et al., 2012). Aapaoja, Herrala, Pekuri, and Haapasalo (2013) argued that even where a company assigns few high-performing and experienced experts to a project team, the right team would understand and appreciate the business and technical requirements of the project in ways that could facilitate team integration.

Zou, Kumaraswamy, Chung, and Wong (2014) argued that even good and very competent people have *failings* that may not be right for a particular project, team, client, or environment. Such *failings* could determine how teams collaborate and coordinate their efforts (Zou, Kumaraswamy, Chung, & Wong, 2014). Additionally, the suitability of a team for a project determines the extent to which team members channel their efforts toward detecting and responding to weak signals likely to cause unexpected events during project execution (Kaivo-oja, 2012; Rossel, 2012; Osipova & Eriksson, 2013).

**Teams, Weak Signals, and Unexpected Events in Construction Projects**

Weak signals that come in the form of small failures can sometimes cascade into unexpected events that get projects into problems such as delays, disruptions, and abandonment (Pinto, 2014; Kazaz et al., 2012; Weick & Sutcliffe, 2011). Several studies have suggested that unless an organization creates a mindful infrastructure that is sensitive to operations, maintains capabilities for resilience, monitor shifting locations of expertise, continually track failures and contain them, small failures that suffice as weak signals would aggregate into catastrophic events (Alzahrani & Emsley, 2013; Fallahnejad, 2013; Pinto, 2014; Weick & Sutcliffe, 2011). Such infrastructure should not only be built to enhance the adaptive behavior teams, but should also facilitate management support for teams (Song & Eldin, 2012).

Additionally, a project team should be led by a project manager who understands the importance of using IS to minimize errors, and that a small misjudgment could develop into larger problems which, though were easy to detect, may be difficult and costly to solve if they occur (Pinto, 2014; Weick & Sutcliffe, 2011). I am not implying that the absence of a designated leader within a team would diminish the capacity of the team to effectively use IS or harness its adaptive behaviors. Breevaart, Bakker and Demerouti (2014) showed by their findings that self-managing team models were as effective as teams with a designated leader (Breevaart, Bakker, & Demerouti, 2014). Stewart, Courtright, and Barrick (2012) demonstrated by their findings that the use of self-managing teams positively affects team performance, attitudes of team members, team cohesion, and withdrawal behaviors. The emphasis should be on the ability of the team, whether self-managing or with a designated leader, to have a complete understanding of the different dimensions and dynamics of the project.

A project team may be incapable of detecting and responding effectively to weak signals likely to cause unexpected events during project execution if they have an incomplete understanding of the system and what they face (Kaivo-oja, 2012; Rossel, 2012; Osipova & Eriksson, 2013). Ineffective use of appropriate information tools (Ellegaard & Koch, 2014) or infective collaboration and coordination could exacerbate an incomplete understanding of the system (Porwal & Hewage, 2013; Schoemaker et al., 2013). In this context, an efficient team is one that operates beyond being mindful, resilient, and preoccupied with failure (Kaivo-oja, 2012; Weick & Sutcliffe, 2011). An efficient team is also one that is self-organizing, adopts appropriate information tools, and operates in an environment that allows them to collaborate and coordinate their efforts effectively. Under such condition the team can notice an unexpected event in the making, halt or contain them, and ultimately restore the functioning of the system (Brochner & Badenfelt, 2011; Kaivo-oja, 2012; Rossel, 2012). In reality, projects are not expected to be error-free or without weaknesses (Pourrostam & Ismail, 2012). Weick and Sutcliffe (2015) argued that project teams should understand the dynamics of the project, its relationship with the internal and external environment, possess the capability and tools to spot and identify errors, and contain weak signals that could otherwise cause unexpected events capable of disabling the system.

The degree of responsiveness of construction project teams to unexpected events reflects in how they harness their efforts for adaptability, learning from experience, interpreting emerging situations and devising an appropriate response strategy, instead of implementing a preplanned contingency strategy (Koh & Rowlinson, 2014). Team designs that accommodate diverse backgrounds and independence, optimal levels of interaction, and efficient communication are bound to generate innovative ideas when dealing with problems (Koh & Rowlinson, 2014; Zou et al., 2014). Aapaoja et al. (2013) noted that differentiation and interaction within teams, and between teams and the organization, are fundamental to how teams react to ambiguous situations or weak signals, making sense of, and interpreting project situations and building consensus for an appropriate response strategy during project execution. Weick and Sutcliffe (2015) argued that mindfulness was essential to making sense of and interpreting ambiguous project situations. When collaboration among the *right project team* and coordination between the team and the *project context* are appropriately mediated by mindfulness, the team could effectively focus on anticipating emerging developments, and identify weak signals that indicate likely occurrence of major risks or unexpected events (Farrington & Crews, 2013; Weick & Sutcliffe, 2015).

**Team Collaboration in Construction Projects**

Beyond choosing the right team, practitioners should lay emphasis on team integration and the ability of the team to understand their responsibilities, limits of authority, project requirements, schedule, and specifications (Aapaoja et al., 2013; Ling et al., 2012). The ability of the team to understand their scope of work and meet targeted objectives is critical to a successful project execution (Kazaz et al., 2012). Pinto (2014) noted that a missed goal or a task left undone could cascade into an unexpected event. Consider the long-term effect of reinforcement that was not properly checked before applying concrete, or material not delivered because a team member failed to place an order. Both events could combine with other failures and cause more disruptive events.

From the perspective of construction projects, integration typically refers to collaborative working practices, processes, activities, and behaviors that promote an environment of unrestricted exchange of information among the project actors (Izam Ibrahim, Costello, & Wilkinson, 2013). Che Ibrahim, Costello, and Wilkinson (2015) described integration as the introduction of work practices, methods, and behaviors that produce effective and efficient collaboration between individuals, teams, and the organization. Real integration entails the utilization of collaborative efforts of project team members, who by their attitudes improve project success by creating harmonious relationships that eliminate interpersonal friction during project execution (Ren, Anumba, & Yang, 2013).

Several studies have shown by their findings that effective collaboration improves the performance of construction project teams (Izam Ibrahim et al., 2013; Ren et al., 2013). Due to the complexity of construction projects, many stakeholders are involved at every point in a project's lifecycle. Zhang, He, and Zhou (2012) posited that since construction projects are composed of several organizations and groups of individuals with diverse characteristics, cultures, and styles of management, their complementary skills and expertise could improve the successful delivery of a project. However, Porwal and Hewage (2013) noted that the presence of many stakeholders is the principal cause of fragmentation and functional silos in construction projects. Fragmentation and functional silos have led to well-documented problems linked to communication and information processing during project execution (Bemelmans et al., 2012; Izam Ibrahim et al., 2013). This is consistent with Porwal and Hewage (2013) who opined that fragmentation is a major contributor to unexpected events and low productivity during construction project execution. Bemelmans, Voordijk, and Vos (2012) argued that fragmentation of functional units could lead to poor communication and adversarial relationships among project team members. Izam Ibrahim, Costello, and Wilkinson (2013) found that communication and information processing problems are fundamental contributors to adversarial relationships between parties working on construction projects.

**Team Coordination in Construction Projects**

Interdependencies in construction project execution have prompted researchers to raise strong augments for effective coordination. Mitropoulos and Memarian (2012) noted that breakdowns in team coordination were responsible for over 70% of aviation construction accidents. The ability of an organization to analyze project activities and functional relationships, and use the knowledge to implement designs and communication is key to facilitating effective team coordination (Sacks & Pikas, 2013). Knowledge of activities and functional relationships did not only create a holistic understanding of construction processes, it also improve performance (Koh & Rowlinson, 2014; Sacks & Pikas, 2013).

Construction teams have adopted numerous techniques and tools to facilitate effective coordination as they execute projects. Mitropoulos and Memarian (2012) showed by their findings that effective leadership, meetings, direct contact and indirect contacts, and information technology facilitates team coordination. Evidence revealed by

Keung and Shen (2012) indicated that culture match, information exchange, the level of trust, and the manner of resource distribution could encourage open communication, minimize communication barriers, and improve coordination. Liu, Chen, and Cui (2012) suggested that using information systems such as a portal based systems could improve communication and information sharing among various disciplines and stakeholders involved in construction projects.

Effecive exchange of information requires coordination and trust (Jiang, Xu, & Liu, 2013; Keung & Shen, 2012). Zhao, McCoy, Bulbul, Fiori, and Nikkhoo (2015) explained that one of the principal reasons for communication breakdown between project teams was ineffective coordination. Ineffective coordination could exacerbate the consequences of differentiation and fragmentation that usually result from a high degree of specialization inherent in construction projects (Che Ibrahim, Costello, & Wilkinson, 2015). During the execution of construction projects, management typically divide activities into functional areas performed by different disciplines such as architects, quantity surveyors, civil engineers, and subcontractors that operate interdependently (Hussin et al., 2013). Each discipline does not only develop its objectives, goals, and value system, but they also dedicate themselves to optimizing their function (Hussin et al., 2013; Schoemaker et al., 2013). By committing to functional areas, practitioners often fail to coordinate their decision processes with other teams or fully consider the impact of their decisions on other key stakeholders (Schoemaker et al., 2013, Zhang et al., 2012).

Practitioners that implement ineffectively coordinated actions and decision processes may not also give due regard to, or understand the effects of such decisions on projects or project activities in which they are not involved (Zhang, Teizer, Lee, Eastman, & Venugopal, 2013). Wasif, Josephson, and Styhre (2012) demonstrated by their findings how ineffective coordination could lead to isolated units, fragmentation of tasks, and uncertainty in information during the execution of construction projects. Uncertainty during project execution could be averted by effective coordination of the multidisciplinary professionals, information structures, and activities that are often dynamic during the execution phase of construction projects. Conversely, isolated units mostly focus on functional objectives, and thus increase the need for a top-down approach that integrates functional objectives and directs these objectives toward achieving project goals (Zhang et al., 2013; Wasif, Josephson, & Styhre, 2012).

Lack of coordination among construction practitioners is a major problem in the Nigerian construction industry (Doloi et al., 2012; Jacob, 2013). Findings by Jacob (2013) showed that ineffective coordination among team members contributed to the weak integration of information needed for effective project management during the execution phase of Nigerian construction projects. Bryde, Broquetas, and Volm (2013) argued that it is not feasible to consistently deliver on project goals without effective coordination. Coordination did not only ensure the harmonious functioning of people, objectives, roles, responsibilities, and understanding; it also provided effective integration of functions, work units, tasks, and processes (Bryde, Broquetas, & Volm, 2013; Karlaftis, Easa, Jha, & Vlahogianni, 2012).

Indeed, coordination in construction projects enable leaders to bridge gaps, minimize overlaps, facilitate effective communication, and ensure that independent parts meet desired objectives or produced desired results (Karlaftis et al., 2012; Schoemaker et al., 2013). Several studies have indicted that interfaces between functional disciplines were potential barriers to efficient communication and coordination in construction projects (Hussin et al., 2013; Schoemaker et al., 2013; Ashford et al., 2012). Problems of communication breakdown were typically traced to supply chains, and to points where informational disconnections occurred along the process (Ashford et al., 2012; Zegordi & Davarzani, 2012). Zegordi and Davarzani (2012) argued that there was a link between the weakness of information sharing and information channels, and coordination failures attributable to communication breakdown.

**Information Systems, Team Collaboration, and Coordination**

The complexity of modern construction project execution makes it necessary to adopt information systems for managing team integration, and team coordination (Bemelmans et al., 2012; Jacob, 2013). Teams can use information technology (IT) tools to manage technically related and nontechnical factors, guide collaboration with policies, and workflow elements effectively (Bemelmans et al., 2012; Braglia, & Frosolini, 2014). As evident in Project Management Information Systems (PMIS), project teams can also use technology solutions to institutionalize best practices (Bemelmans et al., 2012; Braglia, & Frosolini, 2014; Pinto, 2014). Braglia and Frosolini (2014) demonstrated by their findings how PMIS was used to manage team interaction, intellectual exchange, monitor and modify contributions while providing a shared understanding of facts as the project progresses. Indeed, a shared understanding of events, interoperability, and interaction are essential to effective coordination and collaboration (Braglia and Frosolini, 2014; Caniels, & Bakens, 2012).

To solve the problem of fragmentation, a coherent system is needed to integrate the diverse fragments, functions, and activities needed to successfully execute projects (Bemelmans et al., 2012; Izam Ibrahim et al., 2013). To solve communication problems, functional silos, and adversarial relationships among project participants, Information Systems could be used to support coordination and collaboration by ensuring coherence of form, procedures, conversation, and communication structures (Ashford et al., 2012; Porwal & Hewage, 2013). Information systems have been shown to integrate construction systems effectively (Ellegaard & Koch, 2014; Porwal & Hewage, 2013). But Schoemaker et. Al. (2013) suggested that IT solutions for construction projects should go beyond creating a structure for collaboration to creating a system that could facilite organizations and coordination of work processes. Zhang, Teizer, Lee, Eastman, and Venugopal (2013) suggested that the use of IT could improve the management of shared resources, supplier/consumer activities/relationships, simultaneity constraints, tasks and subtasks relationships, group decision-making, and communication.

IT-driven systems could adequately cater to and integrate the general design, implementation, information, and relationship needs of project stakeholders (Izam Ibrahim et al., 2013; Porwal & Hewage, 2013). Systems such as Web-based Project Management System (WPMS) and Project Management Information Systems (PMIS) provide centralized, accessible, and reliable means for storing and transmitting designs, managerial, and financial information for construction projects (Liu, Chen, & Cui, 2012;

Porwal & Hewage, 2013). Data accuracy and wise use of data were key elements of effective PMIS (Braglia & Frosolini, 2014; Liu et al., 2012). Braglia and Frosolini (2014) argued that ISM is only useful to the effective collaboration, coordination, and the management of project execution if data are correct, accurate, and current; and then correctly interpreted and used to catch problems on time, to ensure the timely implantation of remedial actions.

The use of information technology (IT) to drive team collaboration and coordination did not only allow team members to pay attention to and not overlook details that could result in enormous problems, but it also enabled the team to focus on the big picture (Caniels, & Bakens, 2012; Pinto, 2014). While it was important to delegate responsibilities to the team and ensure that they collaborate to execute assigned tasks, it was equally necessary to coordinate their efforts and monitor their performance to ensure proper adaptation to environmental and operational changes that were likely to affect the project timeline (Doloi, Sawhney, & Iyer, 2012). Beyond integration and coordination, it was also important for team members to share information in the right manner. Izam Ibrahim et al. (2013) showed by their findings that active information sharing was a crucial indicator for effective team collaboration and coordination.

Team efforts may not be adequately coordinated and monitored in the absence of accurate and timely information (Che Ibrahim, Costello, & Wilkinson, 2013). Project information should not only be available on time, but also should be open, accurate, accessible to team members, and be used for decision-making (Che Ibrahim et al., 2013; Izam et al., 2013). Accurate and accessible information-driven collaboration and coordination enabled team members to have a complete understanding of the system and what they face (Kaivo-oja, 2012; Rossel, 2012; Osipova & Eriksson, 2013). Complete understanding of the system improved collaboration and coordination (Porwal & Hewage, 2013; Schoemaker et al., 2013), and the efficient use of appropriate information tools enhanced the ability to detect weak signals likely to cause unexpected events during project execution (Ellegaard & Koch, 2014).

## Responding to Unexpected Events in Construction Projects

### Unexpected Events, Weak Signals, and Failures in Construction Projects

An unexpected event can occur when (1) an event that was expected to happen fails to happen, (2) an event that was not expected to happen does happen, and (3) an event that was not thought of happens (Weick & Sutcliffe, 2011, p. 27-28). The non-performance of tasks and/or activities could often cause unexpected events, described as failures. Failures could cascade into unexpected events that cause delays. Irrespective of the nature of the unexpected event, it firstly suffices as a weak signal that either went unnoticed, or noticed without an appropriate response, or noticed and ignored (Pinto, 2014; Weick & Sutcliffe, 2015). Weak Signals are often ignored because *"they* are imprecise" (Ansoff & McDonnell, 1990, p. 20), and while they provided early indications about impending, impactful events, they were ignored due to their low visibility, ambiguousness (non-obvious), little or no familiarity, low value, low apparent relevance and reliability, and low palpability (Weick & Sutcliffe, 2015; Williams et al., 2012).

In reality, weak signals are not failures but they can become failures in the future. While failure is a state or condition of not meeting a set objective (e.g. a structural defect that caused a beam to collapse and created a need for rework and extension of time), a weak signal is an imprecise early indication about an event that might occur in the future (Ansoff & McDonnell). Examples of weak signals are: 1) *small failures*, such as faults in equipment or technology, use of substandard or insufficient amount of materials, or declining compliance; 2) *near misses,* such as exceeding planned delivery of a milestone by a few days or work-hours, or exceeding the cost of a task by few dollars; 3) *surprises,* such as the failure of a piece of equipment, or unexpected labor shortage. While such small failures, near misses, or surprises may have insignificant value given the entire project, their aggregate effect could lead to failures that were unexpected and which could have been avoided or contained easily if the weak signals that pointed to them were not ignored. Therefore, weak signals are units of anticipatory strategic information with which a team or an organization could scan its environment to identify opportunities for reducing uncertainty and risks (Ansoff & McDonnell, 1990; Williams et al., 2012).

Pinto (2014) provided compelling evidence suggesting that a failure does not just occur; rather it often provides weak signals that go unnoticed or undetected in the chaos of project activities. Findings by Shepherd, Patzelt, and Wolfe (2011) suggested that failures were most likely to occur at the human interface. An unconfirmed expectation could be a weak signal for trouble, but a team could ignore the event because the human interface failed to interpret it in relation to other occurrences (Shepherd, Patzelt, & Wolfe, 2011; Weick and Sutcliffe, 2015).

However, failures in interdependent systems like construction projects tend to come in clusters (Alzahrani & Emsley, 2013; Fallahnejad, 2013; Weick & Sutcliffe, 2011). Alzahrani and Emsley (2013) argued that failure to spot and respond effectively to weak signals that led to unexpected events were due to lapses on operational reliability. Indeed, failures and the unexpected events that emanate from weak signals often audit the resilience of experts (Alzahrani & Emsley, 2013; Fallahnejad, 2013; Weick & Sutcliffe, 2015). However, Pinto (2014) argued that in most cases small failures cascaded into catastrophes because weak signals pointing to them went unnoticed, simple diagnosis were accepted, best practices were taken for granted, recovery taken as routine, and experts differed to authorities. To this end, Weick and Sutcliffe (2011) suggested that a small failure is to be treated as a weakness or a clue to the health of the system; the wider implication of which experts and team members have to be aware, acknowledge, analyze, and effect appropriate response.

**Weak Signals and Detecting Unexpected Events in Construction Projects**

Weak signals that point to impending failures abound in construction projects (Williams et al., 2012). However, if weak signals are not identified and contained, they can remain unnoticed, and cascade into failure(s) that could cause delays (Schoemaker et al., 2013; Rossel, 2012). Williams et al. (2012) found that undetected weak signals could introduce a turbulent environment, strategic discontinuity, and strategic surprise that are difficult to anticipate. Failure to adequately leverage weak signals creates a situation in which projects, the teams, and firms are confronted by threatening events (Rossel, 2012).

For project managers to adequately define strategic targets across the project lifecycle, it was necessary to collaborate with their team members to anticipate changes and failures that generate them (Holopainen & Toivonen, 2012). Team members must be equipped and coordinated not only to identify and analyze a vague threat, but should also be able to predict its future effect (Holopainen & Toivonen, 2012; Schoemaker et al., 2013). However, weak signals and isolated failures on their own can only provide weak evidence for major future catastrophe. To this end, the importance of identifying weak signals is in their cluster effect, made clear when isolated events are aggregated to forecast future events, such as delays and disruptions, based on trend extrapolation (Williams et al., 2012).

Consequently, the management of weak signals requires sensitivity and expertise (Holopainen & Toivonen, 2012; Rossel, 2012), while aggregating weak signals to forecast future events requires a collective approach to gathering information about them (Rossel, 2011). In a changing environment such construction projects, improved adaptive behaviors were needed not simply to average out randomness in the system's behavior, but also to respond effectively to system changes that could lead to disruptive events (Song & Eldin, 2012). Going further, Schoemaker et al. (2013) suggested that identifying and aggregating weak signals required gathering and filtering content, presenting trends, and making visible contributions. Undeniably, the nature of early warning signals changed with an evolving situation (Holopainen & Toivonen, 2012). However, findings by Williams et al. (2012) indicated that the detection and aggregation of early warning signals could be enhanced by improving the quality of information, risk identification, decision location, guidelines, and technology, on one hand, and ensuring that sponsors set clear expectations, tackle leadership and cultural issues, ensure regular training and by replacing missing competence in project teams.

**Weak Signals and Predicting Unexpected Events in Construction Projects**

Weak signals are first symptoms of strategic discontinuity and a possible change in a task or activity in the future (Holopainen & Toivonen, 2012). In recent years, the ability to predict unexpected events by focusing on failures and weak signals in construction projects have attracted the attention of researchers (Davies & Mackenzie, 2014; Salet, Bertolini, & Giezen, 2013; Love et al., 2012; Špačková, Šejnoha, & Straub, 2013). To effectively manage unexpected events, it is not sufficient to only identify weak signals and predict failures; it is equally important to have a good understanding of *expectations* and how to mindfully manage them (Pinto, 2014; Weick and Sutcliffe, 2015). Davies and Mackenzie (2014) argued that while organizational roles, routines, and strategies determined expectations, events should trigger mutually adjusted actions. Integrating actions and expectations improved not only the detection of unexpected interactions but also enhanced the ability of a team to respond to weak signals and failures that intertwine with such expectations to enact future events that may not be expected (Kaivo-oja, 2012; Weick & Sutcliffe, 2011).

Although expectations create orderliness and predictability necessary for effective organizing, it could also create a blind spot in the form of a belated recognition of a threatening event (Weick & Sutcliffe, 2011; 2015). While an event(s) may be initially small, it may get larger due to a biased search of evidence that confirmed an original expectation (Weick & Sutcliffe, 2011), a phenomenon that Diane Vaughan, in her study of the culture of NASA prior to the Challenger, described as *normalization of deviance* (Pinto, 2014). Hence, including weak signal analysis component in project management would enable a team to generate basic information about potential crises (Rossel, 2012; Turskis, et al., 2012; Weick & Sutcliffe, 2011; 2015). An examination of the literature in the domain of weak signal analysis by Rossel (2012) revealed the value of early detection, early warning, and early containment. Rossel argued that while detecting faint evidence for possible future occurrence is easy, it is not an off-the-shelf process because it raised cost-benefit questions and shortcomings that could substantially increase the vulnerability of both the project and the organization if ignored.

Consequently, the structure and culture of an organization are critical to a team's ability to detect weak signals that point to a future failure (Davies & Mackenzie, 2014; Weick & Sutcliffe, 2015). An organization must provide an environment that supports mindfulness as an optimal combination of team attitudes necessary for scrutinizing existing expectations, driving preoccupation with failures, the tendency to doubt, inquire, and update expectations (Pinto, 2014; Weick and Sutcliffe, 2015). It is also important to allow project teams to hone the willingness and capability to contrive new expectations that reasonably define unprecedented events (Pinto, 2014; Rossel, 2012).

**Responding to Construction Delays with Information Systems**

The complexity and daily requirement of large volumes of information have led to the evolution of a vast number of specialized and interdependent organizations and individuals. In most cases the primary objective of specialized and interrelated organizations and individuals go beyond ensuring the realization of the cost, time and quality goals of construction projects (Nawi et al., 2012). Porwal and Hewage (2013) noted that in addition to cost, time and quality goals, effective communication, collaboration and coordination of efforts were important objectives of these organizations. Information systems could facilitate design and implementation; integrate sophisticated delivery approaches, while promoting consistency between functional disciplines, task/activities, and expectations at the human-machine interface (Hussin et al., 2013; Schoemaker et al., 2013).

The increased spending on information technology (IT) by Architecture/Engineering/Construction (AEC) firms in the past decade is a testimony to the increasing interest in using IT applications in construction projects (Liu et al., 2012). The use of IT improves collaboration and coordination not only between project teams, and between team members, but also between construction firms (Porwal & Hewage, 2013; Valdes-Vasquez & Klotz, 2012). Weick and Sutcliffe (2011) suggested that effective collaboration and coordination of efforts were essential to building consistent methods for identifying errors, faults, and other weak signals. The use of IT could improve the quality of documents, speed of work, efficient financial control, decrease in errors, and faster access to common data, among others.

For collaboration and coordination to be effective, a firm must build on enabling culture and structures (Pinto, 2014). But Osipova and Eriksson (2013) found that effective collaboration and coordination depended heavily on an efficient system that engineered a disciplined process for facilitating reliability and resilience. Indeed, mindfulness, risk management, and operational efficiency as drivers of resilience were indispensable to effective collaboration and coordination (Weick & Sutcliffe (2011). It appeared that IT-mediated collaboration and coordination depended on culture, tools, structures, and individual cognitive processes (Porwal & Hewage, 2013; Pinto, 2014)

**Predicting Weak Signals and Failures Using Information Systems**

Information systems (IS) are used to effect better communication, integration, coordination, collaboration, and teamwork (Ellegaard & Koch, 2014; Olalusi & Jesuloluwa, 2013). Information systems are used to identify, analyze, and respond to inefficiencies in construction projects (Turskis, et al., 2012). Information systems are also used as a primary medium to facilitate the collection, storage, and exchange of information (Turskis, et al., 2012; Yang & Kao, 2012). Indeed, IS have been used to integrate processes and relationships for effective project delivery (Turskis, et al., 2012; Yang & Kao, 2012). With an effective information system (IS) in place, team members concentrated on potential risks and the weak signals that point to their occurrence. Holopainen and Toivonen (2012) argued that with an appropriate IS in place, teams could efficiently identify and remove faults, errors, inefficiencies, and weak signals that cause failures. When potential failures are detected and removed, and therefore not added to failures that inevitably occurred, the aggregate number of failures was reduced, and project outcomes improved (Holopainen & Toivonen, 2012; Schoemaker et al., 2013).

More so, information systems (IS) enable team members to keep track of complicated interrelationships and tendencies, and when used as a central platform for planning and executing construction projects, sketchy information could be more efficiently aggregated and extrapolated to predict future events (Holopainen & Toivonen, 2012; Pourrostam & Ismail, 2012). Teams that intend to adequately aggregate weak signals (e.g. task/activity failure, communication breakdown, functional disconnection) to predict delays using communication systems must understand that not all failures can be expected in advance of occurrence (Holopainen & Toivonen, 2012; Weick & Sutcliffe, 2011). Therefore, the focus should not be restricted to what can go wrong and how to correct them, but also on the reliability of the tools and software with which to detect and mitigate what could go wrong (Holopainen & Toivonen, 2012). The proactive use of reliable tools/software solutions to analyze, interpret, aggregate, and extrapolate events into a coherent flow could enable teams to effectively predict points of failures during project execution (Holopainen & Toivonen, 2012; Weick & Sutcliffe, 2011; 2015). To this end, project teams should aspire to establish credibility and reliability in IS prediction of future events. Holopainen and Toivonen (2012, p. 198) identified (1) the method of validation, and (2) the way by which predictions are interpreted, as the two most critical factors that establish credibility and reliability when using IS to predict future events.

However, while the method of validation and how predictions are interpreted are important, team members are required to measure and verify information before they can be reliably used (Gunduz et al., 2012; Holopainen & Toivonen, 2012). Measurement should involve data collection and analysis of observed events. Verification should certify whether an event in a project phase did, or did not satisfy conditions imposed by the preceding or future phase in the project lifecycle. Verified measurements are then be used to forecast future event(s); which could, in turn, be validated to ensure that deliverables in a given project phase satisfy predetermined requirements or objectives (Holopainen & Toivonen, 2012).

While conservative predictions could provide an additional margin of confidence in the reliability of a system, technology, and the prediction of project events, it is necessary to establish an acceptable threshold with which to assess and predict failures. To this end, Gunduz, Nielsen, and Ozdemir (2012) argued that IS can provide historical failure data and dates with which to compare predicted outcomes to actual events, to appropriately evaluate the performance of the model, and the reliability of predicted event(s). This approach will not only enable project teams to establish levels of problem severity, develop assurance criteria, and set a threshold for future events; it can also enhance the credibility of predictions, facilitate decision making, and increase the confidence of team members in using weak signals to predicting unexpected events.

**Detecting Weak Signals and Failures Using Information Systems**

Sometimes predicted failures may not occur, or where they occur, suffice as a weak signal that goes undetected (Weick & Sutcliffe 2015). As noted earlier, weak signals are not failures but they provide early indications about impending, impactful events that can become failures in the future. The use of information systems (IS) enables project teams to identify efficiently the risk paths (Taroun, 2014; Zhao, Hwang, & Yu, 2013) and weak signals likely to cause future failures (Holopainen & Toivonen, 2012; Turner & Zolin, 2012). Bootz, Lievre, and Schenk (2015) argued that accurate and timely information was foundational to proper identification, analysis, interpretation, and response to weak signals likely to evolve into an unexpected event.

Timely and accurate information are important elements of successful construction projects. Zhang et al. (2013) found that many projects failed because of inaccurate or delayed information. An infromation that is late is unlikely to be filtered and delegated to specified parameters as needed, neither can such information be clustered effectively with existing information to predict their impact on the project schedule, cost, and other outcomes (Park et al., 2013). Timely and accurate information is advantageous because it enables project managers and teams to leverage on opportunities provided by Information Technology (IT) to manage and communicate information effectively in an integrated manner (Park et al., 2013; Porwal & Hewage, 2013). An integrated IT-driven communication in projects did not only facilitate efficient quality management (Park et al., 2013); it also enabled teams to monitor tasks, activities, project performance, and their interrelationships (Idoro, 2012; Zegordi & Davarzani, 2012).

To effectively monitor tasks, activities, project performance, and their interrelationships, it is an essential part of any management system to pursue the goal of active monitoring (Yang & Kao, 2012). *Active monitoring* is a safety and risk management strategy for proactively checking the status of events, processes, performance, and controls to (or "intending to") identifying barriers and failures in risk control systems before they manifest in an incident (Talmaki, Kamat, & Saidi, 2015; Yang & Kao, 2012). *Active monitoring* should enable an organization or team to identify proactively and respond to quality, cost, and schedule failures, the need for rework, and how decisions on these elements affect both individual deliverables and the entire project (Turskis, et al., 2012; Yang & Kao, 2012). *Active monitoring*, therefore, acknowledges the increasing complexity of project points and the need to adopt appropriate IS tools in construction projects (Irani & Kamal, 2014; Olalusi & Jesuloluwa, 2013).

The design, development, and use of an appropriate Information System (IS) is a viable effort in managing project complexities (Giezen, 2012; Irani & Kamal, 2014). Irani and Kamal (2014) argued that an appropriate Information System helped teams to untangle project complexities required to gathering information on failures and detecting weak signals likely to cause failures. Several studies (Holopainen & Toivonen, 2012; Turskis, et al., 2012) provided evidence suggesting that an appropriate IS enables project stakeholders to effectively weigh and adopt alternative courses of action.

## Mindfulness, Reliability, Information Systems, and Unexpected Events

### Mindfulness and Reliability

**Mindfulness.** The concept of mindfulness as proposed by Weick and Sutcliffe was to improve group awareness as a requirement for attaining group (team or organizational) reliability in the face of complexity and tight coupling (Weick & Sutcliffe, 2011; 2015). Weick and Sutcliffe coined their model of mindful as *Collective Mindfulness* to differentiate it from Langer's (1989) model of individual level mindfulness. While *Individual Level Mindfulness* focused on the individual, *Collective Mindfulness* is a distributed form of mindfulness that concentrated on the group. In HROs, collective mindfulness enabled the firm or groups in the firm (e. g. teams and departments) to act in unison to overcome the complexity and tight coupling inherent in their human-machine interface (Weick & Sutcliffe, 2011; 2015). I am not saying that the group or organization has a mind of its own, but that the group or organization harnesses *Individual Level Mindfulness* into *Collective Mindfulness* towards achieving group goals and objectives (Weick & Sutcliffe, 2011). It is important to note that the role of collective mindfulness in HRT does not suggest that awareness is solely an issue of how scant attention is allocated to events (Langer, 1989) but also about the quality and conservation of attention (Langer, 1989; Weick & Sutcliffe, 2011). Sutcliffe and Vogus (2012) opined that awareness is much about what individuals do and notice, as it is about the interest in and activity of *noticing* something. Mindfulness, as used in HROs, encompasses interpretive work directed at weak signals (Weick & Sutcliffe, 2011), and the delineation and reframing of received wisdom to expand what is known about what is *noticed* (Sutcliffe & Vogus, 2012). It is the expanded set of options that indicate unexpected departures from planned activities that need rectification and the new sources of uncertainties that create new imperatives for *noticing*.

Indeed, the active application of cognitive processes is the foundation for effective noticing (High Reliability Organizing, 2013; Sutcliffe & Vogus, 2012). Cognition is the psychological result of perception, learning, and reasoning that enable the performance of a cognitive activity or process in ways that affect the mental content of an individual (Carlo et al., 2012; High Reliability Organizing, 2013). In HROs, the cognitive processes that generate a state of continuous awareness of variations in the system are: (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). The stability of these cognitive processes induces a state of mindfulness that enables HROs to *notice* and generate potential information about vulnerability, capability and context while allowing constant ongoing re-adjustment in an unknowable and unpredictable world (Bourrier, 2011; High Reliability Organizing, 2013). In this context, Weick and Sutcliffe (2011) argued that information is lost unless there is a continuous mindful awareness of variations in the system and unreliable outcomes suffice when cognitive processes vary or are unstable; not focused on failure, simplification, and recovery from disaster; or when undesirable events are normalized.

**Reliability.** Reliability is the degree to which a system maintains the ability to function consistently under specified conditions for a stated period (Zeng et al., 2015). Note that reliability is different than quality and assurance. While assurance is a positive declaration or gurantee that an event or process will take place as planned (Zhang & Fai Ng, 2012), reliability refers to the ability to function effectively and respond adequately in the presence of uncertainty during daily operations (Bourrier, 2011; Zeng et al., 2015). Also, quality is a distinctive attribute or characteristic possessed by the system or its components measured against stakeholder expectations, other elements of the system, or systems of a similar kind (Sweis, Sweis, Al-Shboul, & Al-Dweik, 2015). In this context, Jafari and Rodchua (2014) noted that reliability mediates both quality and assurance in a construction environment.

Also, reliability as conceptualized in HRT is not a function of operating times or Bath-tub behavior as conceptualized in reliability engineering. Bath-tub behavior describes the lifetime of a population of products using a hypothetical failure rate versus time curve (the Bath-tub curve) (Levy, Render, & Benenson, 2015). Conversely, reliability, as revealed by HRT, describes collective mindfulness, driven by five cognitive processes, as a driver of system resilience (Weick & Sutcliffe, 2011).

Bath-tub behavior suggests a stable curve that consists of three periods: an infant mortality period (with decreasing failure rate), normal life period (with a low, relatively constant failure rate), and wear-out period (with increasing failure rate) (Levy et al., 2015). Bath-tub behavior emphasizes a stable system and depicts the expected behavior for a particular family of products, assuming certainty in system behavior (Levy et al., 2015). In reality, the three-time period can vary considerably and there is no guarantee that a product will pass through all three-time periods during the product lifecycle (Assis, Borges, Vieira de Melo, & Schnitman, 2015). Conversely, reliability as conceptualized in HRT and used in this study assumes a complex and an unstable system that is dependent on random uncertainty factors such as the environment, processes, activities, and individuals that can diversely reenact themselves in response to changing state of works (Bourrier, 2011; Weick & Sutcliffe, 2011). Under HRT, reliability is driven not by expected product behaviors over time, but by a proactive response to changing state of works, effected by encouraging the five cognitive processes of HRT, which coalesce to mindfulness as shown on Figure 1. In this context, reliability under HRT goes beyond acknowledging the Bath-tub behavior of products; it also identifies five cognitive processes that facilitate an on-going process of response to small failures in changing, multi-parameter environments fraught with uncertainties (AlSehaimi, Koskela, & Tzortzopoulos, 2012) Consequently, Assis, Borges, Vieira de Melo, and Schnitman, (2015) argued that Bath-tub behavior is more suitable to analyzing the reliability of manufactured products and single parameter environments than to analyzing the reliability of complex dynamic systems because the number of parameters in a complex system complicate and makes it difficult to estimate reliability based on Bath-tub model. It can be argued that using Bath-tub behavior for reliability analysis of construction projects would be less effective for multiple parameter analysis, especially when such applied in the context environmental complexities and uncertainties.

In this context, Weick and Sutcliffe (2015) showed that effective HROs operated in unforgiving environments with high potential for error and scale of consequences. Therefore, the functioning of HROs precludes learning by experimentation while focusing on cognitive processes that enable them to quickly notice and react to errors and unexpected events (Weick & Sutcliffe, 2011). Sutcliffe and Vogus (2012) argued that HROs can manage fluctuations in the system by continually revising their understanding of the situation, collecting evidence, evaluating their tactics and response strategies in the face of new events. The capability of HROs to modify assessments, plans and tactics were contingent on having stable cognitive processes such as understanding, collecting evidence, detecting, and revising in the face of new events (Weick & Sutcliffe (2015).

**Mindfulness and High Reliability Theory (HRT)**

Mindfulness, as revealed by HRT, centers on the concept of *Collective Mindfulness*, coined and proposed by Weick and Sutcliffe (2011). Collective Mindfulness is different from *Individual Level Mindfulness* that was suggested by Langer (1989). While *Individual Level Mindfulness* focused on the individual, *Collective Mindfulness* is a distributed form of mindfulness that concentrates on the group. Weick and Sutcliffe's model of mindfulness are the group level equivalent of Langer's model, but could also be referred to as a referent shift compromise model. Vogus and Sutcliffe (2012) argued that while *collective mindfulness* as proposed by Weick and Sutcliffe is conceptually distinct than Langer's (1989) construct of *individual mindfulness*, it is still composed of individual responses because the group (e.g. team or organization) is made of individuals.

In Langer's (1989) model the attentiveness associated with individual level mindfulness manifest in at least three ways: 1) dynamic differentiation and refinement of existing classifications and peculiarities (p. 138), 2) openness to new information and diverse viewpoints that create discontinuous classifications out of the constant flow of events streaming through activities (p. 157), and 3) high sensitivity to contexts and alternative ways of dealing with it (p. 159). In Weick and Sutcliffe's extension of Langer's model to the group level, they assumed that awareness is expressed in the three ways articulated by Langer (1989) as by-products of five cognitive processes: (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). These five cognitive processes have been discussed earlier under the section *Major Propositions and Dimensions of HRT.* These five principles of collective mindfulness, revealed in HRT, increase the capability of an organization or team to minimize errors, detect, and manage unexpected events (Sutcliffe & Vogus, 2012; Weick & Sutcliffe, 2011).

Although the importance of cognitive processes to high reliability functioning has been recognized in the literature (Carlo et al., 2012; Mitropoulos & Memarian, 2012; Sutcliffe & Vogus, 2012), Weick and Sutcliffe (2011) provided a precise specification of how the diverse processes interrelate to facilitate efficient error detection. Weick and

Sutcliffe suggested that when individuals, teams, or organizations focus on failures, predisposition to simplify, current operations, competencies for resilience, and enticements to overlook expertise, these interests cover a wider collection of unexpected events. Weick and Sutcliffe argued that these separate concerns are entwined by their combined *capability* to induce an increased awareness of intolerable details and a capacity for action as shown in Figure 1. Following Langer (1989), Weick and Sutcliffe labeled this *capability* mindfulness. It is this improved awareness, prompted by the idiosyncratic concerns of HROs with potentials for disaster that accelerates the construction, detection, and rectification of unexpected events capable of escalation (Sutcliffe & Vogus, 2012; Weick & Sutcliffe, 2011).

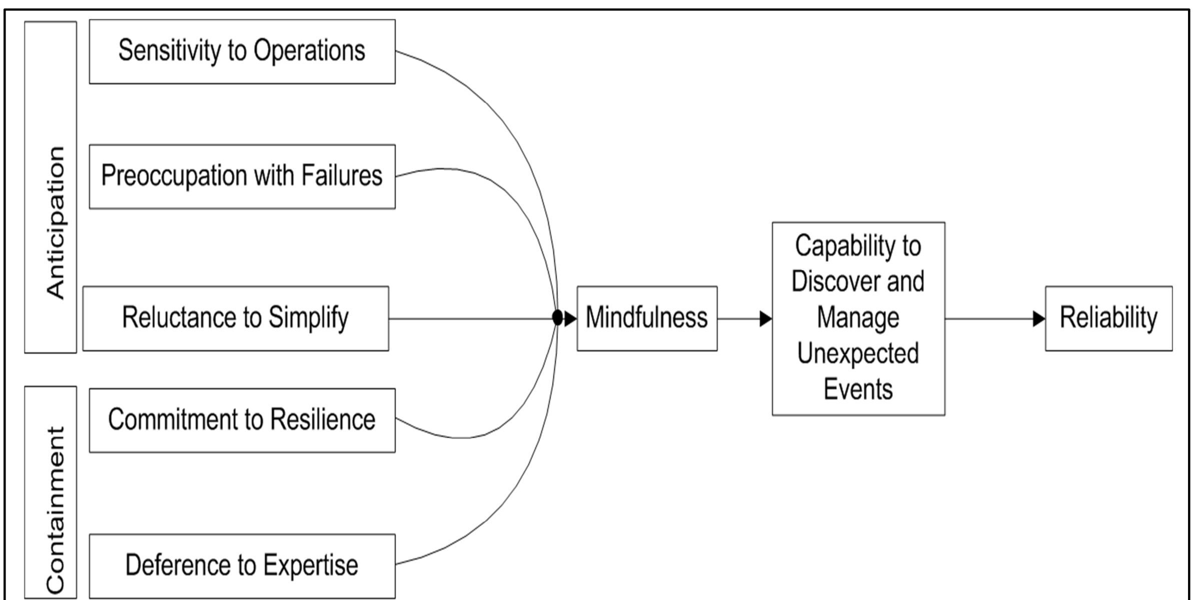


*Figure 1.* A mindful infrastructure for high reliability
*Adapted from Olde Scholtenhuis and Dorée (2013)*

Consequently, reliability, as conceptualized by HRT, is more about adaptive human cognition than the engineering definition that equates reliability with repetitive cognition and action (Carlo et al., 2012; Mitropoulos & Memarian, 2012; Weick & Sutcliffe, 2015). This conceptualization stresses reliability as the overarching goal of the system and that the entire system, not only individual components or subsystems, works appropriately. This distinguishes reliability as defined in HRT from definitions of reliability that lay emphasis on the extent to which single observable actions can be repeated or reproduced. It also describes a continuum ranging from low, medium to high reliability depending on the system's ability to achieve failure-free performance for a specified interval under stated conditions.

In this conception, the effectiveness of combined cognitive processes, labeled mindfulness (an aggregate of five cognitive processes shown in *Figure 1*), as a driver of high reliability, could be linked to its close relationship with a collection of action capabilities. Pentland and Hærem (2015) argued that teams and organizations that were willing to act on specific threats were more likely to think about such risks and put mechanisms in place to mitigate them than those that did not. When teams bring new threats under control, the team enlarges its capacity to act on such threats and the range of threats they can notice in a mindful manner (Carlo et al., 2012). Conversely, restricting team members from acting on threats can lead to the accumulation of threats and errors because of a predilection for teams to ignore or deny such threats or errors (Gärtner, 2013). Thus, a wide range of action repertoire enables mindful teams to drive high reliability because they exert a vast collection of action capabilities to uncover and manage unexpected events, and expand these capabilities to react to changing and developing uncertainties (Carlo et al., 2012; Gärtner, 2013).

**Mindfulness and Reliability in Construction Project Execution**

Mindfulness as a driver of reliability goes beyond quality to encapsulate awareness, conservation and channeling of attention toward change. Reliability is different than quality because while reliability refers to the ability to function effectively and respond adequately in the presence of uncertainty (Bourrier, 2011; Zeng et al., 2015), quality is a distinctive attribute or characteristic possessed by the system or its components measured against stakeholder expectations, other elements of the system, or systems of a similar kind (Sweis, Sweis, Al-Shboul, & Al-Dweik, 2015). However, Vogus and Sutcliffe (2012) noted that even though reliability is broadly described as a subset of quality, this is not the case for HROs where quality is more about the present and certainty, while reliability is about the future and uncertainty, and the capacity of a group to repeatedly produce collective outcomes of a certain minimum quality.

However, Sutcliffe and Vogus (2012) argued that mindfulness is much about the quality as it is about the conservation of attention: what is noticed and the activity that is noticed. Carlo et al. (2012) noted that mindfulness required interpretive work directed at weak signals, delineation of received wisdom and reframing, which in the view of Weick and Sutcliffe (2011) could broaden what is known about what was noticed. It is the expanded set of possibilities that creates unexpected deviations, which require correction, and new sources of uncertainty that creates the new necessity for mindfulness in noticing subtle changes in the system. To this end, HRT defines the group mental processes that increase the quality of attention and vigilance of both individuals and the group to detect subtle contextual variations efficiently and respond appropriately are the hallmarks of High Reliability Organizations (HROs) (Weick & Sutcliffe 2011).

Group mental processes, as described by HRT, have five dimensions that coalesce to mindfulness as shown on *Figure 1*. Indeed, Mindfulness is a complex phenomenon that encourages individuals, teams, and the entire organization to be constantly on guard as to how things fail (Mitropoulos & Memarian, 2012; Olde Scholtenhuis & Dorée, 2013). The requirement for HROs to be constantly on guard as to how things fail creates the need for *active monitoring*. As described earlier, *active monitoring* is a strategy for proactive response to changing state of works, which in HROs is effected by encouraging the five cognitive processes of HRT, which coalesce to mindfulness, to drive reliability as shown in *Figure 1*. The first basis of mindfulness, as a driver of reliability, is for individual team members to interact continually, develop, refine and update a combined mental representation of unfolding situations, and respond with an appropriate action. (Mitropoulos & Memarian, 2012; Olde Scholtenhuis & Dorée, 2013). The second basis of mindfulness is the interaction of individuals from different functional units and networks to expedite, build, and contribute to understanding project goals and work patterns that are conducive to high reliability organizing within the same system (Carlo et al., 2012; Mitropoulos & Memarian, 2012). Mindfulness, as a facilitator of reliability, strives on relational infrastructure, continuous individual and inter-functional interaction, and response to changing states of work (Weick & Sutcliffe 2011). Through organizing processes, team members working on the execution phase of construction projects could harness their cognitive processes to improve group capabilities to detect and react appropriately to subtle contextual changes to improve system or project performance.

In this context, Carlo et al. (2012) suggested that high reliability is achieved where a team confronts the paradox that error is frequently spread where teams principally rely on orderly procedures and repeatability to reduce error; an observation that has also been made by AJehn and Techakesari (2014). Olde Scholtenhuis and Dorée (2013) argued that solely focusing on repeatability and orderly response as a defining property of reliability cannot address the reality of construction project execution. In line with the conception of Olde Scholtenhuis and Dorée (2013), AJehn and Techakesari (2014) found that activities/tasks and the interactions that drive them were often under fluctuating working conditions, and it is not always possible to know, with certainty, their impact on future events. Mitropoulos and Memarian (2012) clarified the uncertainty of future events by arguing that instead of the team to focus on repeatability and orderly response as a defining property of reliability, construction teams should concentrate on achieving reliability using mindful achievements of a carefully interwoven socio-technical system that demonstrates the characteristics HROs.

Indeed, the pressure on execution teams to handle unexpected situations in ways that forestall inadvertent consequences have increased over the years. The need for continuous performance improvement coupled with uncertainties associated with the complex and chaotic nature of construction projects have exacerbated the demand by stakeholders for optimal project performance (Cheng et al., 2014; Turner & Zolin, 2012).

There is, therefore, an increasing need to demonstrate HRO characteristics during the execution phase of construction projects.

**Mindfulness and Unexpected Events in Construction Project Execution**

Mindfulness, as revealed by HROs, is predicated on the presumption that unexpected events are avoidable, and there are processes that organizations and teams can adopt to avoid undesirable events (Weick & Sutcliffe 2011). The five principles of mindfulness are, thus, a set of organizing processes that allow teams to continuously execute project tasks and activities under trying conditions to reduce the impacts of unexpected events and help with the process of recovery (Weick & Sutcliffe 2015). In this conception, reliability suggests the capacity of a group to repeatedly produce collective outcomes of a certain minimum quality (Vogus & Sutcliffe, 2012).

In construction projects, teams at the execution phase have to simultaneously deal with possibilities that create unexpected deviations as well as limited budgets, tight schedules, demanding stakeholders, isolated units, and fragmented supply chains (Pourrostam & Ismail, 2012; Shehu et al., 2014). Dealing with multiple possibilities of uncertainty did not only require extensive coordination and collaboration but also required teams to frequently confront unexpected events that involved continual improvisation and re-planning in responses to the changing state of the system (Mitropoulos & Memarian, 2012). Osipova and Eriksson (2013) found that continuous revision of assessments, plans, and tactics during the execution phase of construction projects was a necessary response to unexpected events. But Vogus and Sutcliffe (2012) noted that teams achieved adequate continues response to unexpected events where processes were stable and understood; and were used for collecting evidence, detecting, evaluating, and revising failures and errors in the face of new events.

In this context, for a team to reliably respond to changing circumstances, they required stable cognitive processes for detecting the variable patterns of activities, to effectively adapt to the events that required revision (Mitropoulos & Memarian, 2012; Osipova & Eriksson (2013). Therefore, while stable cognitive processes enabled teams to make sense of activities and detect weak signals that pointed to unexpected events, variable patterns of activities enabled them to adapt events that required revision. Vogus and Sutcliffe (2012) argued that reliability was more an outcome of continuous management of fluctuations in job performance and inter-departmental interaction than it was of organizational variance. The key point to note is that during project execution, routines unfold in a slightly different way each time it was re-enacted (Shehu et al., 2014). In a complex, chaotic, and unpredictable system like construction projects, mutual re-adjustment was not only a constant, but also the essential element that generated potential information about capability, vulnerability, and context (Mitropoulos & Memarian, 2012). Information about capability, vulnerability, and context was lost unless there was a constant mindful awareness of such variations (Sutcliffe & Vogus, 2012). Sutcliffe and Vogus' (2012) line of argument was reinforced by Weick and Sutcliffe (2015) who suggested that unreliable outcomes ensued when cognitive processes were unstable and no longer focused on failures, simple interpretations, sensitivity to operations, and structures that drove resilience; or when patterns of activity did not vary, and when unexpected events were normalized.

**Mindfulness and Information Systems in Construction Project Execution**

Mindfulness as a driver of reliability is built on group mental processes that upsurge the quality of attentiveness across the team (Weick & Sutcliffe 2015). Through watchfulness and responsiveness, teams can detect and appropriately react to subtle contextual changes (Vogus & Sutcliffe, 2012; Weick & Sutcliffe 2015). To a large extent, the ability of a team to engage in proactive analysis of adverse events while creating a complete picture of current operations to cope with them depended on the capacity to collaborate and coordinate their efforts (Porwal & Hewage, 2013; Schoemaker et al., 2013). It also depended on the ability of the team to adopt appropriate tools, such as information technology, to drive efforts geared toward greater efficiency (Ellegaard & Koch, 2014; Lee & Yu, 2012).

While greater coordination and collaboration among execution teams were needed to improve performance during project execution, speed and accuracy of information were essential elements of the communication process (Lee & Yu, 2012). Lee and Yu (2012) found that accurate and timely information enhanced communication. In addition, efficient communication is emerging as a key determinant of construction project performance (Caniëls & Bakens, 2012). PMIS provide project managers and teams working during the execution phase of construction projects with decision-making support for organizing and controlling projects (Caniëls & Bakens, 2012; Lee & Yu, 2012). Findings by Mitropoulos and Memarian (2012) revealed that the success of teams in assimilating and applying IT to their work processes depended on their collective alertness or mindfulness towards expectations and changes in operational contexts.

Collective mindfulness could facilitate how execution teams make sense of the multiple sources and dependencies required for efficient project implementation (Memarian & Mitropoulos, 2014). They could also use information tools to facilitate the process of making sense of risk control processes to improving team decision-making and performance (Olde Scholtenhuis, 2015). Osipova and Eriksson (2013) showed by their findings that stable cognitive processes helped teams to revise and adapt variable events. Mitropoulos and Memarian (2012) demonstrated the importance of stable cognitive processes to detecting variable patterns of activities and changing contexts. Findings by Abanda, Vidalakis, Oti, and Tah (2015) showed how teams could use IT to integrate interactively complex and extremely hard to anticipate outcomes that would, otherwise, be impossible within acceptable timeframes. Lee and Yu (2012) showed the impact of IT on the performance of project-related participants. Caniëls and Bakens (2012) demonstrated that Information Technology (IT) could now accommodate and support many of the processes previously handled by cognitive information processing.

Consequently, it could be argued that information technology (IT) and the cognitive processes underlying mindfulness (preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise) are not antagonistic to each other. Abanda, Vidalakis, Oti, and Tah (2015) found that IT artifacts such as *Catia* could be used to facilitate the five cognitive processes of mindfulness to enhance team performance. Lee and Yu (2012) argued that combining IT with the five dimensions of HRT was useful to identifying the diverse layers of interdependence between project activities, and therefore, can facilitate the performance of teams working during project execution. Weick and Sutcliffe (2015) highlighted reliability as the overall goal of a mindful system, whether relying solely on cognitive processes or mediated by Information Systems. In the global sense, the principal objective of the execution team is to combine individual components or subsystems (Sutcliffe & Vogus, 2012), and harnessing such information with mindful organizing to ensure reliability (Memarian & Mitropoulos, 2014; Sutcliffe & Vogus, 2012). Therefore, information technology complements mindfulness by enhancing the awareness of an execution team, their ability to accurately interpret the system's readiness statistics, quality-control processes and weak signals that point to unexpected events likely to disrupt the execution of construction activities (Abanda, Vidalakis, Oti, & Tah, 2015; Memarian, & Mitropoulos, 2014).

## Gap in the Literature

The gap in the literature that informed the significance of this study was the lack of research on how project teams could combine mindfulness, as revealed by High Reliability Theory, with information systems (IS) to respond adequately to unexpected events in Nigerian construction Projects. I expected this inquiry to offer solutions to the problem of unexpected events by providing an in-depth understanding of how project teams can combine mindfulness with IS to respond effectively to unexpected events that occur during the execution phases of Nigerian construction projects.

This study is unique because I could not find any studies that used High Reliability Theory (HRT) to investigate unexpected events in Nigerian construction projects. Neither could I find studies that combined HRT with Information Systems

Management (ISM) to focus on the adaptive behaviors of team members working on the execution phase of Nigerian construction projects. This study is also unique because rather than focusing on the entire organization as Koh and Rowlinson (2014) did, or the entire lifecycle of construction projects as Marshall (2014) did, I focused on team members who worked in and during the execution phase of construction projects in Nigeria. In this context, this study is bound to provide an in-depth understanding of how mindfulness, as revealed by the five cognitive processes of HRT, affected the attitudes of project team members and mechanisms for anticipating and aggregating weak signals that could lead to failures and cause delays in construction projects. The results allowed me to propose responses that may be appropriate to preventing and where necessary contain unexpected events during the execution phase of Nigerian construction projects.

## Chapter Summary

The purpose of this literature review was to explore how previous researchers had investigated unexpected events in construction projects. The review was also intended to gain an in-depth understanding of the various aspects of unexpected events, information systems management, and how teams applied the processes of mindfulness, as revealed by HROs, during the execution phase of Nigerian construction projects.

The extant literature revealed that the exploratory case study design had been used to research unexpected events, information technology, information systems management, and high reliability/mindfulness in construction projects. The literature also revealed that project based case studies were effective research tools for assessing the benefits and difficulties that accompanied the use of technology in construction projects (Costin, Pradhananga, Teizer, 2012).

Several themes that related to unexpected events, information systems management, and mindfulness, as revealed by High Reliability Theory (HRT), and which were applicable to the execution phase of construction projects were gleaned from the literature. First, while unexpected events could occur during any phase of construction projects, the complexity and interdependencies of activities and tasks often exacerbated the possibility of unexpected events during the execution phase of construction projects. Second, although unexpected events were inevitable during project implementation, some unexpected events were not excusable (Yang et al., 2014; Yang & Kao, 2012) while others were excusable (Idoro, 2012). Third, unexpected events did not often occur without providing clues in the form of weak signals that gradually accumulated and pointed to their occurrence (Zhou et al., 2012). The fourth theme that emerged was that the occurrence of unexpected events was often due to lapses in reliability (Weick & Sutcliffe, 2011; Zhou et al., 2012). Fifth, mindfulness on the part of execution teams could minimize lapses that affect resilience, thereby improving their ability to predict and, where possible, take actions to avoid unexpected events during project execution. Sixth, the use of cognitive processes, as revealed by HROs, could facilitate the discovery and correction of errors and other weak signals that pointed to unexpected events (Aven & Krohn, 2014). Seventh, the use of IT in Nigerian construction projects was yet to accrue sufficient benefits to project execution because most Nigerian firms did not consistently use information systems (IS) across the project lifecycle for core project activities (Olalusi & Jesuloluwa, 2013). Eighth, Information technology complements mindfulness by enhancing execution team awareness, as well as their ability to interpret accurately the system's readiness statistics, processes, and weak signals that pointed to unexpected events during the execution of construction activities (Abanda et al., 2015; Memarian, & Mitropoulos, 2014). Nineth, information systems could be used to enhance collaboration and coordination (Kaivo-oja, 2012; Rossel, 2012). It could also be used to harness the cognitive processes of mindfulness in ways that could facilitate the identification, analysis, interpretation, prediction, and containment of unexpected events during the execution phase of construction projects (Memarian, & Mitropoulos, 2014; Osipova & Eriksson, 2013).

Furthermore, it was known from the extant literature that mindfulness and information systems could improve, *independently,* the ability of teams to exercise control over project activities, identify weak signals, and manage unexpected events during the execution phase of construction projects. It was also known that there are needs for further studies on collective minding and the appropriation of IT capabilities in construction projects (Carlo et al., 2012). What was not known from the extant literature was whether combining Information Systems Management (ISM) with mindfulness, as revealed by HROs, could improve the capacity of a construction team to untangle the complex dynamics of construction projects and enable them to initiate timely identification of weak signals that point to unexpected event, and take appropriate timely actions regarding such signals during the execution phase of construction projects.

In chapter 3, I discussed the components of the research method adopted for this study. I also articulated a concise account of the qualitative approach, the case study design, and the strategies I used to capture the perspectives of experts on unexpected events in Nigerian construction projects. A detailed description of the research methodology vis-à-vis data sources, data gathering, data analysis techniques, and justification for their use were also be presented. The discussion on research methodology captured data collection instruments, the data analysis procedure, and ethical considerations.

# Chapter 3: Research Method

## Introduction

The purpose of this study was to explore how Project Teams could combine the five principles of mindfulness, as revealed by High Reliability Theory (HRT), with Information Systems Management (ISM) to identify weak signals and predict unexpected events during the execution phase of Nigerian construction projects. The five principles of HRT that I explored in relation to ISM were (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18).

Consequently, in this chapter, I discussed the components of the research method to be adopted for this study by identifying, defining, and justifying the philosophical assumptions that underpinned this inquiry. I also identified and described the design components of this study, namely: The data, sources of data, data collection strategy, my role as the researcher, issues of trustworthiness, method and process for data analysis, and ethical considerations guided this study. I concluded this chapter with a summary of the main points in this chapter, and summarized the key points discussed in chapter 4.

## Research Design and Rationale

The central question that guided this inquiry was: *How can project teams combine mindfulness as revealed by High Reliability Organizations (HROs) with Information Systems to respond adequately to unexpected events during the execution phase of Nigerian construction projects?* Drawing on this central question, I explored answers to the following research sub-questions:

RQ1: What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects?

RQ2: How does combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects?

Consequently, unexpected events were the central phenomenon that I investigated in this study. An unexpected event is a regular event that occurs in an exceptional situation, causing loss of productivity and detracting from set goals (Turskis, et al., 2012; Yang & Kao, 2012). Unexpected events often cut short the expectations of stakeholders because they reorganize planned activities and limit the ability of the project to meet its time, cost, and/or quality objectives (Akinsiku & Akinsulire, 2012; Chipulu et al., 2014).

**Qualitative Research Approach**

I adopted the qualitative approach for this study. The qualitative approach aligns with constructivist philosophical assumptions (Gray, 2013; Patton, 2015). Constructivists use analytic induction of the perspectives of study participants and reflexivity of the researcher to establish the meaning of a phenomenon (Maxwell, 2013). The qualitative approach was appropriate because the premise of this study aligned with the constructivist philosophy that advocates a continuously unfolding conversation about the nature of knowledge (Gray, 2013; Maxwell, 2013). More so, the qualitative approach is appropriate where the researcher intends to investigate the phenomenon (e.g. unexpected events) in a natural setting. Patton (2015) posited that the qualitative approach was suitable where rich, in-depth, and contextual representations of human behavior in natural settings were required to understanding the reasons for these behaviors. To this end, the qualitative approach helps a researcher to identify and understand why a problem occurred, what led to its occurrence, and why they are important (Maxwell, 2013). It also enables a researcher to have a better understanding of "Why" an individual or group had acted in a particular way, and "Why" processes, activities and events occured the way they did (Bryman, 2012; Maxwell, 2013; Patton, 2015).

While several studies have been undertaken to address unexpected events in construction projects, the increasing complexity, the role of technology, and changing contexts of construction projects continue to aggravate the incidence of unexpected events in construction projects (Ghoddousi & Hosseini, 2012; Locatelli et al., 2014). To this end, it became necessary to compartmentalize the study of failure and unexpected events, and to undertake an in-depth study of individual contexts using different frameworks and theoretical lenses. The qualitative approach is most suitable for such a thorough investigation into the emerging area of HRT in construction project execution.

I adopted the qualitative approach in preference to the quantitative approach because I did not intend to examine relationships between variables, or identify samples with which to generalize to the population. Also, I did not plan to provide numeric descriptions of trends, attitudes, or opinions in this study. Since the study did not require the integration of any quantitative attributes, but rather focused only on qualitative elements, the use of the mix method approach was also inappropriate. Adopting the qualitative approach enabled me to concentrate on emerging questions, procedures, and data on project activity failures, their causes, and the practices that were pertinent to mitigating them, using High Reliability Theory (HRT) as a lens. With the qualitative approach, I efficiently gathered in-depth information from a wide variety of responses and opinions across a range of experiential levels. Gathering a wide variety of responses and opinions enabled me to deepen the interpretation of perspectives, identify appropriate themes, and ascribed meanings that were appropriate to them.

**Case Study Design**

I utilized the qualitative exploratory case study design for this investigation. Yin (2014) suggested that case studies were suitable for exploring a phenomenon, activities, events, processes, and natural contexts, from the perspective of participants. In this case, I investigated project processes and activities within construction project settings. I focused this study on a unique system – construction projects. Researchers have noted that construction projects have patterned behaviors, dynamic properties, and defined features (Gunduz et al., 2012; Turskis, et al., 2012). The binding case was the project team: the group of project practitioners involved the construction activities. The intent was to elicit their collective mindset on how best to identify and aggregate activity failures to predict unexpected events.

The use of case study design was more appropriate than the phenomenological design because in phenomenology the researcher focuses on individuals and brackets their perspectives in a particular context (Gray, 2013). Also, the case study design is more appropriate than ethnography where the researcher focuses on the culture-sharing behavior of persons or groups (Bryman, 2012; Gray, 2013). The exploratory case study design was appropriate because I intended to go beyond bracketing the perspectives of individuals and their culture-sharing behaviors to the activities and processes involved in the phenomenon. Cronin (2014) argued that qualitative case studies were suitable for exploring real-life activities, processes, and events associated with organizations. Cronin's findings aligned with Walker and Shen (2002) who posited that case studies were suitable for investigating problems related to construction projects and their complex interactions with people, technology, and the environment.

## Role of the Researcher

For the purpose of this study, I functioned as the person solely responsible for all phases of inquiry: definition of the problem, data collection and data management, reading and reviewing the literature; describing, categorizing, and interpreting data; and visualizing and representing the data. To this end, I undertook this study as a participant observer focused on asking probing questions, listening to the response of participants, and asking more questions where necessary. Patton (2015) posited that probing issues using participant observation enabled researchers to elicit a deeper understanding of the phenomenon from the perspectives of participants. Patton also asserted that through immersion and participation, participant observation connects a researcher with the most fundamental of human experiences in ways that facilitated insights into "the hows and whys of human behavior in a particular context" (p. 75). In this regard, participant observation aligned with the case study design proposed for this study since "case study is most likely to be appropriate for "how" and "why" questions" (Yin, 2014, p. 29). Therefore, combining participant observation with case study design was suitable for this study because the central research question proposed for this study focused on the “how” of unexpected events in construction projects.

It is important to note that I am a quantity surveyor and project manager by training, with over ten years experience in the Nigerian construction industry. I have also occupied political offices where decisions on policies and legislation affecting the Nigerian construction industry were made. These experiences and opinions did not only allow me access to the main players in the Nigerian construction industry, but also, drove a predisposition towards making arbitrary, and unsystematic conclusions on issues concerning the Nigeria construction sector.

To address issues concerning my extensive participation in the Nigerian construction industry, conflict of interest, and relationship with individuals and firms in the construction industry, I make known my personal biases. Apart from following the suggestion of Patton (2015) who advised researchers to state explicitly any possible sources of conflict and bias, my participation was limited to taking notes, analyzing documents and information that participants and their organizations offered on their volition. I followed ethical procedures that accounted for the rights of participants and did not directly or indirectly apply tactics that could manipulat or bias participants, or elicit information that participants and their organizations were not willing to share. As suggested by Yin (2014), I adopted mental cleansing, well-established and predetermined processes for this study.

# Methodology

## Participant Selection Logic

**Study site.** The location for this study was in Abuja, the Federal Capital Territory (FCT) of Nigeria. Abuja was appropriate for the study of unexpected events in Nigerian construction projects because, being the Federal Capital Territory, it was also the center of Nigerian construction policy formulation (Ameh & Ogundare, 2013; Ijigah, Oloruntoba & Mohd, 2012). Also, most major construction firms in Nigeria have their offices located in Abuja (Abubakar, 2014; Ameh & Ogundare, 2013). In value terms, large construction projects accounted for about 60% of all construction projects in Nigeria (Abdul Rahman, Memon, Karim, & Tarmizi, 2013; Waziri, Ali, Aliagha, & Majid, 2015). Besides, Abuja and its environs accounted for a major chunk of large construction projects in Nigeria (Abubakar, 2014; Ameh & Ogundare, 2013).

**Case selection procedure.** In selecting the cases, I gave priority to choosing the proper type and number of cases that should yield the data capable of meeting the research objectives. To this end, I identified ten major construction companies in Nigeria. From the list of ten firms, I selected five companies, but concentrted on four, which had successfully delivered projects in at least 18 states out of the total of 36 states (representing 50% of states) in Nigeria. The suitability of the four firms was contingent on a preliminary review of each company's website and predetermined criteria shown in Table 1.

*Table 1*

*Case Selection Criteria*

| Criteria | Description |
|---|---|
| Company type | Large construction firm |
| Number of states with current project sites | Minimum of 15 states |
| Years of operation in Nigeria | Minimum of 5 years |
| Stage of project | Execution phase |
| Team composition | Five members, minimum |
| Least value of current project | $3,000,000.00 and above |
| Existence of current project | At least one year |
| Location of office | Federal Capital Territory, Abuja, Nigeria |

**Sampling strategy**. The non-random purposive sampling strategy was adopted for this study. Purposive sampling strategy provided a reliable information-rich data needed for effective analysis of research questions, and for gaining deeper theoretical insights (Boardman & Ponomariov, 2014). I adopted expert purposive sampling strategy because unexpected events in construction projects required gleaning evidence from individuals with expertise in construction management. Peh and Low (2013) suggested that expert sampling is particularly useful where the experts are available, empirical evidence in the area is lacking, and levels of uncertainty in the period when findings of a particular phenomenon could be uncovered are high. Indeed, any claims about the use of HROs principles in Nigerian construction projects lacked empirical evidence.

The convenience sampling strategy could have been used for this study. However, while the primary emphasis of convenience samples is to make generalizations pertaining to the entire population (Etikan, Musa, & Alkassim, 2016; Miles, Huberman, & Saldana (2014), the purpose of this study was not to generalize but, as noted in the purpose statement, was to saturate evidence to gain an in-depth understanding of the phenomenon (unexpected events) under investigation. Indeed, the study site (Abuja) was *convenient* regarding geographical proximity, and the participants were available to participate within the study's time limit. But, Etikan, Musa, and Alkassim (2016) noted that apart from being unpredictable and vulnerable to severe biases, studies that use convenience sampling could make only weak statements about the quality and characteristics of the sample because participants might not apply to the research problem.

Consequently, the purposive sampling strategy was used in preference to the convenience sampling strategy due to certain general and specific reasons. The general reasons were drawn from studies by Etikan et al. (2016) and Oppong (2013) who argued that convenience samples were: 1) neither purposeful nor strategic, 2) often not representative of the sample in terms of traits and phenomenon under investigation, 3) may be unpredictable, and 4) could be vulnerable to severe hidden biases. The weak foundation of convenience samples increased the difficulty of convincing other researchers to accept the findings from a study (Oppong, 2013). The specific reasons why purposive sampling strategy was chosen in preference to the convenience sampling strategy were: 1) the purpose of this study was to gain an in-depth understanding of, and not to generalize about, unexpected events using HRT; 2) the study sight (Abuja) was selected purposively not only due to convenience but also because it is the center of Nigerian construction policy formulation (Ameh & Ogundare, 2013; Ijigah et al., 2012) accounting, in value terms, for about 60% of all construction projects in Nigeria (Abdul Rahman, Memon, Karim, & Tarmizi, 2013); 3) since the use of HRT in Nigerian construction projects is an emerging area, a preliminary study, such as this, required an in-depth investigation using carefully selected participants that could provide unique and rich insights; 4) it was not clear how well a convenience sample would represent the population regarding the traits or mechanism under investigation.

Apart from the general and specific reasons for not choosing the convenience sample, the expert purposive sampling adopted for this study used experts in the field of construction project management. Etikan et al. (2016) argued that expert purposive sampling was useful and most appropriate where there was a lack of observational evidence on a phenomenon or when the study is in a new area. This study falls within both criteria identified by Etikan et al. as requiring expert purposive sampling and was, therefore, bound to provide a richer inductive inference concerning the population of interest with regards to HRT and unexpected events during construction project execution than would have been possible with a convenience sample.

**Study participants.** Participant selection was limited to construction experts working in large construction firms in Abuja, Nigeria. I interviewed experts such as architects, quantity surveyors, civil engineers, structural engineers, and project managers, who were involved in construction projects; and selected experts from each category, and 24 participants for the entire study. Patton (2015) noted the need to use the characteristics of participants as the basis for selection and suggested that the choice of participants should reflect the diversity and breadth of the sample population. In this context, the participants did not need to be representative because the purpose of non-probability sampling is not to produce a statistically representative sample or draw a statistical inference (Gray, 2013; Patton, 2015).

However, I used predetermined criteria to identify and select the research participants using nonrandom purposive sampling. With a non-random purposive sample, the criteria used to select participants were more important than the number of participants (Gray, 2013). Details of the criteria for selecting participants are shown in Table 2. Gray (2013) noted that adopting predetermined criteria for selecting study participants was bound to reduce bias, enable the researcher to achieve a true cross-section of the population, effectively define the relevance of participants, and enhance how their participation would affect understanding the phenomenon under investigation.

*Table 2*

*Criteria for Selecting Study Participants*

| Criteria | Description |
|---|---|
| Profession | Expert in the construction sector – Architects, Quantity Surveyors, Engineers – civil, structural, mechanical, and electrical, etc., and Project Managers |
| Qualification | Minimum of a bachelors degree in relevant Profession |
| Working experience in the construction industry | Minimum of 5 years post graduate experience |
| Working experience in present company | Minimum of 5 years |
| Value of project for which insight was sought | $3,000,000.00 and Above |
| Membership of professional Organization | Important but not compulsory |

**Sample size.** I proposed a sample size of between 24 and 32 participants across six teams drawn from four construction companies. Thirty-two participants (8 from each case organization, comprised of at least 1 expert from each category of experts) was the designated sample size. The final sample size was expected to fall between 24 and 28 interviewees (between 5 and 7 from each case organization, comprised of at least 1 expert from each category of experts). A high sample size of 32 participants was designated to guide against non-response, withdrawal of participants, and poor quality audio. The distribution of study participants is shown on Table 3. For each company, I interviewed a set of participants from projects considered successful, and another set from projects considered unsuccessful. Chipulu et al. (2014) defined a successful project as one that met its operational objectives defined by time, cost and quality. Winch (2010) extended Chipulu's definition beyond operational parameters to include business and stakeholder requirements defined by outputs, outcomes, and impacts.

*Table 3*

*Study Participants for Successful and Unsuccessful Projects*

| | Participants | | | | |
|---|---|---|---|---|---|
| Case Company | Company A | Company B | Company C | Company D | Total |
| Successful project | 4 | 4 | 4 | 4 | 16 |
| Unsuccessful project | 4 | 4 | 4 | 4 | 16 |
| Total | 8 | 8 | 8 | 8 | |

For this study, the success of a project was determined by operational objectives defined by the *Iron Triangle* – time, cost, and quality (Chipulu et al., 2014) because this study was concentrated on the execution (operational) phase of construction projects. While quality is also a dimension of the iron triangle, the focus was on time and cost because they were the project elements most affected by unexpected events during construction projects execution (Ameh & Ogundare, 2013; Aziz & Hafez, 2013; Chipulu et al., 2014; Idoro, 2012; Marques & Berg, 2011; Pourrostam & Ismail, 2012). For the purpose of this study, an unsuccessful project was one that exhibited one or more of the following characteristics: 1) exceeded its time estimate by six months, 2) exceeded its cost estimate by 25%, 3) required external arbitration, and 4) was suspended for at least six months, 5) abandoned completely, or any combination of these.

Choosing a set of experts who had participated in a project considered successful and another set from a project considered unsuccessful revealed multiple contextual and operational perspectives about the same phenomenon (unexpected events). Yin (2014) noted that designing research to account for different contexts and perspectives enabled a researcher to "draw unbiased conclusions" (p. 29). Note that while the *team* was the unit of analysis, a team is comprised of individuals. It is the behavior, judgments, prerogatives, and actions of these persons that determine the performance of the team (Kerzner, 2013), and the outcome (success or failure) of the project (Kerzner, 2013; Yang, Chen, & Wang, 2012).

**Procedure for gaining access to participants.** I sent letters of cooperation to ten (10) construction firms in Nigeria. The purpose of the letter was to seek their consent to participate in this study. To this end, the letter contained the purpose of the study, inclusion criteria, and provided other information pertinent to getting their informed consent (See Appendix B: Sample Letter of Cooperation). Following the approval by organizations to take part in this study, I sent letters directly to prospective participants, via email, seeking their individual consent to participate (See Appendix C: Consent Form). In case of non-response, I sent a maximum of three reminders to prospective participants.

**Saturation and sample size.** Data saturation in qualitative sample size is achieved when the number of interviews needed by a researcher gives him a reliable sense of thematic exhaustion and variability within the data set (Bryman, 2012). For qualitative research, there is no consensus among scholars on an acceptable number of interviews. While Marshall, Cardon, Poddar, and Fontenot (2013) suggested 15 to 30 interviews as sufficient for a qualitative study, Gerson and Horowitz (2002, p. 223) argued that sixty interviews were not sufficient to "support convincing conclusions." Both arguments suggested the difficulty of determining either a minimum or a maximum sample size in a qualitative study. However, Guest, Bunce, and Johnson (2006) suggested that while the number of people required to make an adequate sample for a qualitative study could vary between one to a hundred, with 30 being the mean, saturation could generally be achieved at 12 interviews.

Consequently, 24 to 32 interviewees proposed for this study was higher than the minimum of 12 interviews that Guest et al. (2006) found to be the number at which saturation in qualitative studies could generally be achieved. Indeed, sample sizes in theoretical sample terms often changed with context; hence, saturation rather that larger samples should be the focus of qualitative sample sizes (Gray, 2013; Maxwell, 2013). In this context, several authors have argued that the crucial point was to justify rigorously any sample size that was adopted in a qualitative study than focusing on the sample size itself (Bryman, 2012, Cronin, 2014).

**Instrumentation**

Data collection instruments were the fact-finding strategies used for a study (Bryman, 2012; Gray, 2013). The importance of a data collection instrument depends on the extent to which it aids the researcher to collect valid and reliable data. This is because the validity and reliability of a study relies heavily on the appropriateness of data collection instruments (Gray, 2013; Maxwell, 2013). Yin (2014) identified and discussed six instruments commonly used in case study research: documentation, archival documents, interviews, direct observation, participant-observation, and physical artifacts. I used interviews and documentation as data collection instruments for this study.

**Interviews**. Interviews were the primary instrument of data collection during this study. Interviews were used because of their capacity to illuminate meaning by rendering accounts, presenting descriptions, explanations, and evaluations about a particular phenomenon or subject (Castro & James, 2014). Yin (2014) identified interviews as one of the most important sources of case study evidence. Several studies have adopted interviews as the data collection tool of choice to investigate different phenomena in construction projects. For instance, Cheung and Pang (2012) used interviews to collect data with which they studied the sources, causes, characteristics, and manifestations of disputes in construction projects. Fulford and Standing (2014) in their case study used interviews to examine the factors that impact collaboration in the project networks of three construction companies in Australia. Using interviews and desk reviews, Guo, Chang-Richards, Wilkinson, and Li (2014) investigated the effects of different governance structures on the management of Chinese construction projects. Olatunji and Diugwu (2013) used interviews in their case study of Minna-Bida road, in which they sought to elicit strategies for improving road infrastructure in Nigeria. These studies suggested that researchers have used interviews to collect data for studies in construction projects, and specifically in Nigeria.

Consequently, I adopted the traditional method of interview – face-to-face interaction (Irvine, Drew, & Sainsbury, 2013) for this study. Face-to-face interviews were appropriate for several reasons. First, other researchers have effectively used face-to-face interviews to gather data for research in the construction industry (Cheung & Pang, 2012; Guo et al., 2014). Second, face-to-face interviews were feasible because of the proximity between the researcher and the participants. Third, Patton (2015) noted that face-to-face interaction was suitable for exploring the experiences and perceptions of people about the occurrence and response to a particular phenomenon in a specific context. Fourth, there were no context- and culture-specific issues about the population, or against using face-to-face interviews for research in the Nigerian construction industry.

***Semi-structured interview.*** In-depth semi-structured interviews were adopted for this study. The use of in-depth interviews was appropriate to engaging study participants, and for grasping their perspectives on failure, anticipating and aggregating failure, and using the occurrence of failures to project the possibility of undesirable events. Semi-structured interviews enabled me to engage participants effectively, elicit in-depth perspectives of unexpected events in the context of Nigerian construction projects. Zhou and Li (2012) noted that interviews were effective at educing understanding about the world through the instrumentality of human interactions.

The interview protocol that was adopted for this study comprised open-ended questions. I designed each interview session to last about 1 hour and 1½ hour. As suggested by Bryman (2012), I framed interview questions to be neutral, specific, and understandable. In line with Yin (2014), I will frame questions to permit the discovery of new information from descriptions and explanations rendered by interviewees. Open-ended questions were adequate for exploring the perspectives of diverse project practitioners about specific actions that relate to unexpected events and interventions needed to mitigate their occurrence and impact during the execution phase of construction projects. I also framed questions to define the critical areas while allowing participants to diverge and pursue ideas in detail. Patton (2015) noted that allowing such divergence enabled the discovery and elaboration of previously unanticipated perspectives. Therefore, the interview protocol was structured to be effective at engaging participants, capturing their detailed responses and point(s) of view about unexpected events, information systems, and HRO principles in Nigerian construction projects.

Interview protocol. A basic interview protocol comprising three sections as indicated in Appendix D: Sample Interview Protocol was adopted for this study. Section 1 captured the research topic, proposed date, time, place, and method of the interview, a brief description of this study, and participant profile. I framed preliminary questions to be clear and easy to answer. Gray (2013) noted that starting with simple and easy-to-answer questions did not only help interviewees to build confidence and rapport, but also contributed to generating rich data that enriched the interview. Section two of the interview protocol comprised of core questions subdivided into four subsections: 1) unexpected events, 2) application of information systems in construction projects, 3) application of the five principles of HRT in construction projects, and 4) other questions. Section 3 was used for field notes.

**Documentation.** Documentation was used as a data collection instrument in this study. A document is any material that gives information about the phenomenon under investigation and exists independently of the actions of the researcher (Forcher, Agne, Dengel, Gillmann, & Roth-Berghofer, 2012; Yin, 2014). Document analysis is a systematic procedure for reviewing and evaluating materials present in printed or electronic form (Forcher et al., 2012; Lee, Mortara, Kerr, Phaal, & Probert, 2012).

***Rationale for using document analysis.*** Documents are normally produced for purposes other than those of the research; hence, they often provide valuable evidence relevant to verifying data collected from other sources. Yin (2014, p. 105) opined that "documentary information is likely to be relevant to every case study topic" because documents play a distinct role in any data collection while undertaking a case study research. More so, "For case study research, the most important use of documents is to corroborate and augment evidence from other sources" (Yin 2014, p. 107). Yin concluded that the value of documents to case studies allowed little or no excuse for omitting a thorough review of the documentary evidence in a case study research. Besides, documents are stable (could be reviewed repeatedly), specific, and could cover a long span of time, several events, and many settings (Yin, 2014). Also, information contained in documents is unobtrusive, not subject to distortions due to interaction between the researcher and respondents, and is cost-effective (Bryman, 2012).

***Types of documents used.*** For the present study, I used administrative documents such as proposals for projects and progress reports. I also used personal documents (e.g. diaries, and notes) of project some team members, written reports of project events, and excerpts from minutes of projects. Other documents that I reviewed were, 1) evaluations relating to the cases/phenomenon under investigation, 2) clippings and other articles in the mass media relating to the specific project and the phenomenon (unexpected events) under investigation. Reviewing such documents before conducting the interview was valuable to this study because it enabled me to have an independent analysis of different perspectives in ways that enriched my understanding of unexpected events in Nigerian construction projects. Furthermore, document enabled me to highlight and pursue any contradictions and/or inconsistencies between the documents and interviews with study participants.

**Sufficiency of data collection instruments.** Interviews and documentation were used to acquire evidence from multiple sources. Interviews enable a researcher to aggregate cases of individuals to inform perspectives about an organization, a program, a project, and a team (Patton, 2015). Documents were analyzed and used to corroborate evidence gathered from interviews. Yin (2014) argued that the value of documents to case studies allowed little or no excuse for omitting a thorough review of the documentary evidence in a case study research. Therefore, the use of multiple evidences enabled efficient data triangulation, which provided a confluence of evidence that bred validity (Bryman, 2012). Yin (2014) emphasized the importance of triangulation in qualitative case studies. Using multiple sources – interviews and documents – was not only sufficient as data collection instruments to answer the research questions proposed for this study, they also supported the requirement for this qualitative study to converge and corroborate evidence (Patton, 2015; Yin, 2014).

**Procedures for Recruitment, Participation, and Data Collection**

I was the primary data collection instrument for this study. However, I adopted two other forms of data collection instruments – interviews and documentation – to have multiple sources of evidence. The Use of multiple evidences enabled efficient data triangulation. Yin (2014) emphasized the importance of triangulation in qualitative case studies. Patton (2015) discussed four types of triangulation in doing an evaluation:

1. Triangulation of data sources (data triangulation)
2. Triangulation among different evaluators (investigator triangulation)
3. Triangulation of perspectives (theory triangulation), and
4. Triangulation of methods (methodological triangulation)

In this study, I adopted data triangulation – documentation and interview. Using multiple sources supported the need for qualitative studies to seek convergence and corroboration (Patton, 2015; Yin, 2014). Triangulation of data provided a confluence of evidence that enhanced credibility (Bryman, 2012). Yin (2014) noted that case studies that used multiple sources of evidence had higher ratings regarding overall validity and reliability than case studies that relied on a single source of information. Using converging evidence went a long way to strengthening the reliability of this study and the multiple measures for unexpected events in construction projects. It also reinforced answers to the research questions in ways that meet the objectives of this study.

**Interviews**

As with every qualitative case study, the purpose of this study was to "gather comprehensive, systematic, and in-depth information about each case of interest" (Patton, 2015, p. 447). It is possible to aggregate cases of individuals to inform perspectives about an organization, a program, a project, and a team; but one cannot disaggregate perspectives gleaned from the study of an organization, a program, a project, or a team to construct individual perspectives (Patton, 2015). In this context, while I examined two extremes – successful and unsuccessful projects, in this study, I based such examination on the perspectives of individual experts in the Nigerian construction industry.

In collecting data, experts (e.g. architects, quantity surveyors, civil engineers, structural engineers, and project managers) that meet the criteria outlined in Table 2 were interviewed. These experts were drawn from construction firms, with offices in FCT Abuja, that meet the criteria outlines in Table 1. It was my responsibility to interview each participant; and all interviews were based on a consistent interview protocol (See Appendix D: Sample Interview Protocol).

Participants were offered the option to be interviewed face-to-face, or via telephone, or via Skype. The time and place for each interview was at the discretion and convenience of each participant. However, for the exigency of this research, I did set a timeframe within which the interview was conducted. Such timeframe allowed sufficient time for the participant to exercise personal discretion in deciding the actual time for the interview. Phone calls were used to confirm dates and time for interviews, and a "Study Leaflet" that outlined the purpose and key objectives of the study was sent in advance of each interview (see Appendix E: Sample Study Leaflet).

One interview session was designated for each participant. Where necessary and participants were favorably disposed, I scheduled a follow-up (face-to-face or telephone) interview to elicit further information or to clarify certain perspectives elicited by the interviewee. Each interview lasted approximately one hour and thirty minutes. I adhered to questions on the interview instrument, but, where necessary, I ask follow-up questions in line with the nature of semi-structured interviews and the use of open-ended questions (Patton, 2015). I created rapport with interviewees by describing the process of the interview, asking for, and securing permission to record the interview, and guaranteed the confidentiality of information.

In addition to taking field notes during each interview session, I used a Sony digital audio recorder to capture each interview session. I used field notes to capture cues about important points that enabled me to quickly formulate follow-up questions as needed. Field notes served to reduce the effort needed to locate important points during data analysis. I personally transcribed all interviews into word document files, and stored them with the digital audio files on a computer that was protected with a password and accessible to only me. A backup of all audio files and word documents was stored in my Dropbox and on an external hard drive.

In cases where a lower number of participants from one project in the case organization met the predetermined criteria needed to take part in this study, I enlisted experts from other projects who met the criteria prescribed on Table 2. Enlisting experts from other projects was valid because my purpose for this study was to elicit the perspectives of experts who worked on either a successful or an unsuccessful project in the case organization; a requirement that did not limit my scope to one particular project. While getting the views of those who had worked on the same project was desirable, the objective was to elicit the cognitive processes of team members and the processes that made a project successful or unsuccessful in the case organization. In this context, the perspective of an individual who met all set criteria was more important than whether such perspectives were based on experienced gained on multiple projects. Kerzner (2013) found that individuals brought experiences from one project to another, and experiences acquired from multiple projects were bound to enrich the study. However, while a person may have worked on both successful and unsuccessful projects, I asked participants to comment on only experiences gathered from either a successful or an unsuccessful project, but not both.

At the beginning and end of each interview, I reminded participants of their freedom to withdraw from the study at anytime. At the end of each interview, I also asked participants if they had any additional comments or questions, followed by a request for their consent to contact them for a follow-up interview or for clarification where the need arose. I also sought the consent of interviewees to send them a transcript of the interview for review. Post interview review by interviewees helped to validate the overall themes that emerged from the session and ensured that the transcript was an accurate representation of their perspectives. For follow-up interviews, I sent a request to prospective participants, established specific period of time during which the follow-up may be completed, and conducted the follow-up interview. I closed each interview session by expressing my appreciation to interviewees for accepting to participate in this study, verified whether the tape recorder worked throughout the interview, noted important points and any observations made during the interview.

**Documentation**

Documents were the secondary data sources for this case study. Documents were collected from administrative records of the case organizations and team members of projects under investigation. Documents were analyzed and used to corroborate evidence gathered from interviews. Such documents included: 1) proposals for projects or programs, 2) progress reports on individual projects, 3) company project policies, 4) cost, material, and project schedules, 5) personal documents (e.g. diaries, and notes) of project team members, 6) minutes of project team meetings, 7) reports on company websites, 8) other reports of events relating to projects, and 9) media reports.

The purpose for collecting and reviewing documents was to 1) gather background information, 2) determine whether project implementation reflected the project plan, and 3) independently verify information provided by interviewees. Apart from media reports that were collected by searching the web, and some from clippings held in the archives of the firms under investigation, I collected other documents from the case organizations. Where necessary, I personally applied for, collected, and analyzed such documents, and stored all documents in multiple locations for security reasons and to avoid any need to request for the a document twice.

Patton (2015) advised that document review should be an ongoing process, but should commence before conducting the interview. Following Patton's advice enabled me to have a better understanding of projects, teams, and organizations under investigation; formulate and refine interview questions, and to answer basic evaluation questions. Collected documents that exist only in hard copy were photocopied, downloaded when transferred by email or found on the Internet, or copied from softcopy when supplied in soft copy.

The documents review process provided many opportunities to systematically identify, analyze, and derive useful information from existing documents. In line with Patton (2015) I developed a number of themes to help me focus on documents that were relevant to this study, namely: 1) identified existing documents, 2) secure access to identified documents, 3) ensured confidentiality, 4) compiled documents relevant to this study, 5) assessed how and why documents were produced, 6) determined the accuracy of the document by comparing them with documents that contained similar information, 7) summarized information from documents reviewed. I linked core issues identified through document analysis with findings from interviewing experts that participated in projects in which unexpected events had occurred during project execution.

## Data Analysis Plan

**Data analysis strategy.** The fundamental nature of the qualitative approach centers on understanding the social construction of phenomenon by examining the perspectives and interpretations of participants (Gray, 2013). Inductive reasoning, thinking, and theorizing informed the process of data analysis. The data analysis strategy was an iterative process that transverse the entire lifecycle of this study; from identifying the problem, defining the purpose of this study, reviewing existing literature, designing this study, collecting data, and analyzing the data to reveal emerging themes. The objective of the pragmatism qualitative interpretation was to provide a concise explanation of the results based on the research questions and the theoretical framework. For the analysis, I extracted emerging themes by interpreting and comparing results from the primary data with those that emerged from document analysis and the literature review**.** To this end, I cited specific quotes from interviews and used information from documents to reinforce evidence from participants using the conceptual framework as a lens.

I began data analysis with individual cases, followed by cross-case pattern analysis. This was in recognition of Patton's (2015) argument that a researcher must recognize each case as a "unique, holistic, entity" (p. 450), and should be represented and understood as an idiosyncratic representation of the phenomenon of interest. In this context, the analysis built upwards from individual participants to their teams, projects, and the organization. Patton (2015) posited that this kind of layering recognizes the possibility of building larger case units out of smaller ones.

In line with inductive analysis, data were processed and recorded as soon as they were collected (Bryman, 2012; Patton, 2015). Data analysis involved data reduction and identification of meaningful patterns and themes. Gathering, organizing and compressing the data into a display format that allowed easy comprehension and for drawing more in-depth conclusions followed. Miles, Huberman, and Saldana (2014) noted that effective display of data facilitates pattern identification, and observation of relationships within and across groups. The final step in the data analysis was to draw conclusions and to verify such conclusions in the context of the conceptual framework. Indeed, the data analysis process was a dynamic, intuitive, and creative process that involved the identification, examination, and interpretation of patterns and themes in textual data, and using these patterns and themes to answer the research questions.

**Connection of data to specific research questions.** Two interview questions were associated with the first research question: *What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects?* The interview questions and data related to this research question were:

1. What are the types of unexpected events that you have experienced on your projects?

The interview question asked the interviewee to identify the types of events that were not expected to happen, but happened on their projects; events that were expected to happen but did not happen; and events that were not thought of, but happened. The question did set the context for understanding the various forms of unexpected events and their consequences during the execution phase of Nigerian construction projects.

2. What do you think are the effects of unexpected events (tasks and activity failures) in Nigerian construction projects?

The interview question asked the interviewees to reflect on the potential causes of unexpected events. This question sought to reveal the general reasons why unexpected events occur in Nigerian construction projects.

- What do you think are the reasons that trigger activity failures in Nigerian Construction Projects?

The interview sub-question was intended to reveal perspectives that gave greater insight than the general causes of unexpected events, to highlighting the attitudes and behaviors of team members that trigger undesirable events during construction project execution.

The second research question was: *How does combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects?* Interview questions relating to this research question were divided into three sections: Information systems, mindfulness, and combining information systems with mindfulness. Focusing the individual elements provided a deeper insight that addressed the question of how information systems with mindfulness could be combined to facilitate an effective response to unexpected events during project execution.

***Information systems.*** The objective of this section was to elicit the perspectives of interviewees about how the use of information systems by teams matter in the management of unexpected events during the execution phase of Nigerian construction projects. One interview question and two sub-questions were related to this section. The key interview question was:

3. How sufficient was the use of information systems by team members in facilitating the management of unexpected events during the execution phase of a project (successful/unsuccessful) on which you have worked?

Data collected in response to this question were expected to highlight the importance of information systems (IS) in the management of unexpected events, and whether IS strategies that were in use produced desired results. The two sub-questions were intended to elicit a more focused reflection of the interviewee on the sufficiency of existing IS strategies. An interviewee was expected to answer only one of two sub-questions, which depended on his/her response to the central question. The sub-questions were:

- If sufficient, what specific strategies were most effective?

Data collected from this question are expected to identify specific IS management strategies that were most effective in facilitating the attainment of desired results in the management of unexpected events.

- If not sufficient, what kinds of improvement are needed?

Dated collected from this question are expected to suggest potential enhancements to IS management strategies likely to improve the attainment of desired results in the management of unexpected events.

***Mindfulness.*** The purpose of this section was to reveal the perspectives of participants about how team mindfulness facilitated an effective response to unexpected events during the execution phase of Nigerian construction projects. Seven interview questions were associated with this section. I categorized questions to cover the five dimensions of mindfulness revealed by HRT, namely: Preoccupation with failure, reluctance to simplify, sensitivity to operations, commitment to resilience, and deference to expertise (Weick & Sutcliffe, 2011, 2015). Question 4 was associated with *preoccupation with failure*, question 5 was associated with *reluctance to simplify*, questions 6, and 7 were associated with *sensitivity to operations*, questions 8 and 9 were be associated with *commitment to resilience*, while question 10 was *associated with deference to expertise* (See Appendix D: Sample Interview Protocol).

***Combining Mindfulness and Information systems.*** As noted earlier, segregating the interview questions into the core elements (mindfulness, information systems, combining mindfulness with information systems) of the second research question provided greater insight into the contribution of each element to facilitating an effective response to unexpected events. The data collected in response to the 8 interview questions were expected to reveal the behavior of team members as it concerns a desire to intervene when an undesirable event occurs, and their willingness to use IT tools in analyzing and managing such errors/events. Questions 3 and sub-questions 4, 5, 6, 8, and 10 were intended to evaluate the attitude of team members on the norms, rigid behaviors, and willingness to use IT solutions to deal with unexpected events across the five dimensions of mindfulness revealed by HRT. Responses to these questions were used to address the multidimensional concept of mindfulness; assess team member's awareness of potential issues likely to trigger undesirable events, and their willingness to using IT solutions to discover them. Also, response from participants provided an insight into the attitude of team members towards learning and reflecting on facts that generate problems, gathering information about such problems, and combining mindfulness with IS tools in collecting, reporting, and responding to such problems.

**Type of and procedure for coding.** The objective of qualitative data analysis is to describe the phenomenon under investigation using the shared experiences of study participants (Bryman, 2012). The coding process began with pre-coding – identifying and listing keywords from research questions, the problem area, interviews, documents, and field notes. Pre-coding involved fracturing data (Saldana, 2012). Creating categories by bringing codes together at higher levels of abstraction followed pre-coding. Linking the data together through axial coding followed data categorization. Axial coding involved reconstructing and connecting the data that were fractured during open coding (Maxwell, 2013; Saldana, 2012). As with all qualitative data analysis, coding was used to drive ongoing data collection and was, therefore, a part of the continuing process of analysis that spanned the entire research process (Miles, Huberman, & Saldana, 2014). Coding enhanced data management – security and integrity – because coded materials were easier to preserve while raw data were stored away securely in their original state. Furthermore, coding simplified data inspection, and placed me in a better position to identify where codes overlapped, where data were missing, and where further data collection were necessitated by missing information (Rademaker, Grace, & Curda, 2012).

**Software for analysis.** Text analytic technique using NVivo software was used for this study. Recordings were transcribed, member checked, and loaded into the NVivo software. NVivo software supports rich text-based and/or multimedia analytics (Leech & Onwuegbuzie, 2011). NVivo offered flexibility for organizing and analyzing non-numerical and unstructured data and to classify, sort, and arrange information (Gilbert, Jackson, & di Gregorio, 2014). It also supported robust examination of data relationships, searching, linking, shaping, and modeling information. With NVivo, I was be able to rigorously interrogate data, identify trends, and cross-examine information in various ways to uncover subtle connections, in a manner that enabled me to justify my findings.

**Manner of treatment of discrepant cases.** Discrepancies in information were handled by submitting interviews for member check (Maxwell, 2013). Preliminary findings were communicated to all participants for scrutiny, and their comments used to correct misrepresentations, enhance perspectives, or directly integrated into this study to enrich analysis and findings. Handling discrepant cases in this way did not only uncover errors and discrepancies, which were then be corrected, it also increased what Guba and Lincoln (1994, p. 115) described as "goodness of fit."

## Issues of Trustworthiness

Attempts to establish validity and reliability are necessary for a qualitative study. While validity in a broader sense refers to the ability of a research instrument to demonstrate that its findings were what it was designed for, reliability refers to the consistency of its results when used repeatedly (Maxwell, 2013). Guba and Lincoln (1994, p. 105-117) suggested a framework of four criteria as part of the constructivism paradigm paralleling 'validity' and 'reliability' that determine the trustworthiness of a study. These are *credibility, transferability, dependability, and conformability* (Guba & Lincoln, 1994, p. 114).

*Credibility* involves "establishing that the results of a qualitative research are credible or believable from the perspective of the study participants (Trochim & Donnelly, 2007, p. 149). Credibility for this study was judged by the extent of respondent concordance. To this end, it was necessary to take findings to the research participants for confirmation, congruence, validation, and approval as suggested by Maxwell (2013). It was also necessary to account for personal biases, establish comparison studies, and demonstrate clarity of terms. Data triangulation was also used to ensure credibility. Triangulation involved multiple sources of evidence – four organizations, two sets of perspectives (teams from successful and unsuccessful projects), and four sets of documents. Patton (2015) noted that triangulation prevents accusations that findings of a study were artifacts of a single source or the bias of an individual investigator.

*Transferability* "refers to the degree to which the results of a qualitative research can be generalized or transferred to other contexts or settings" (Trochim & Donnelly, 2007, p. 149). The first step to ensuring transferability in this study was to provide a rich contextual description of the process I adopted. To this end, I clearly stated the number and kinds of people that participated in this study, and the relationship between participants and the researcher. In addition, I clearly presented an in-depth description of the context, the methods for data collection, and the techniques for data analysis.

*Dependability* is concerned with the ability to obtain similar results if the same phenomenon was observed again (Maxwell, 2015; Trochim & Donnelly, 2007). Maxwell (2015) noted that dependability focused on accounting for changing conditions in the phenomenon. To ensure dependability, first, I provided a detailed contextual and methodological description of the fieldwork to allow an audit trail for the replication of this study. Second, I kept an extensive and detailed record of the processes and boundaries of investigation (e.g. number of organizations, restrictions in the type of participants, number and length of collection session, and time period for data collection) so that other researchers could ascertain the level of dependability.

*Confirmability* is the degree to which other researchers can confirm or corroborate the results of a study (Trochim & Donnelly, 2007). Apart from triangulation that was an essential element to reducing investigator bias, I reflected on, admitted to, and expressly state my predispositions to reduce the effect of investigator bias as suggested by Miles et al. (2014). To this end, the believes underpinning decision to favor the qualitative over the quantitative approach, case study over other qualitative designs and other theories which could have been used in preference to HRT were clearly discussed. I provide a detailed methodological description so that other researchers could scrutinize the emergence and acceptability of the constructs that were used.

## Ethical Procedures

This study involved human beings. Therefore, I guided the study with the principles of beneficence, justice, and respect for people as suggested by Dresser (2012). To this end, I obtained informed consent from individual participants using a *Consent Form* that contained a clear and explicit description of the purpose and benefits of this study, and other information required by the Institutional Review Board (IRB) (see *Appendix C*). Also, I obtained consent from each case company via a company official who had the authority to approve research studies in company (see *Appendix B*). I obtained the consent of participants with a *Consent Form* that was approved by Walden University's Institutional Review Board (IRB) number 09-14-16-0384801.

In this study, I recognized and protected the freewill of respondents to participate. I expressly stated the right of a participant to withdraw from this study at any point during the research process as suggested by Dresser (2012) and Wendler (2012). I adhered strictly to what the participants elected to share and did not share my perspectives with them in order not to manipulate the participants and bias the results of this study. I did not also attempt to project my attitudes or perceptions by the way I framed questions or in the way I reacted to responses volunteered by participants.

As much as possible, I did choose participants that had a direct relationship with the phenomenon, and did not intrude or exert pressure on them, but allowed them to respond freely. To ensure confidentiality, participants were interviewed at times and locations chosen by each participant. Interviews/transcripts were stored with codes, and actual names were not mentioned in either transcripts or the research report. After coding, raw data were stored in files on a computer that was protected with a password and accessible only to me. However, as required by Walden University, data were kept for at least five years.

## Chapter Summary

In chapter 3, I presented a concise account of the qualitative approach, and the case study design proposed for this study. The qualitative case study design was intended to help capture the perspectives of experts on unexpected events in Nigerian construction projects. The research methodology was described vis-à-vis data sources, data gathering, data analysis techniques, and justification for their use. In this context, I presented a detailed description of the data collection instruments, and how each interview question related to each research question. A systematic data analysis procedure was used to extract significant statements, themes, and categories that described the experiences of experts in the management of unexpected events in Nigerian Construction Projects.

In chapter 4, I presented the data, results, and an analysis of the data. I commenced by presenting the demography and experiences of participants, and the background of the case organizations. I also presented a summary of the data collection, and data analysis processes that comprised a description of themes and categories emerging from the interviews and document analysis. Excerpts from the interviews were organized around interview questions and specific research questions formed the bulk of the remaining sections of chapter 4.

# Chapter 4: Results

## Introduction

The purpose of this qualitative exploratory case study was to gain an in-depth understanding of how project teams can combine mindfulness, as revealed by High Reliability Organizations (HROs), with Information Systems (IS) to respond adequately to unexpected events during the execution phase of Nigerian construction projects. The five principles of HRT that I explored in relation to ISM were (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). The central question that guided this study was: *How can project teams combine mindfulness as revealed by High Reliability Organizations (HROs) with Information Systems to respond adequately to unexpected events during the execution phase of Nigerian construction projects?* Drawing on this central question, I explored answers to the following research sub-questions:

RQ1: What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects?

RQ2: How does combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects?

Consequently, in this chapter, I presented the data, results, and an analysis of the data. I commenced by presenting the demography and experiences of participants, and the background of the case organizations. I also presented a summary of the data collection and data analysis processes that comprised a description of themes and categories emerging from the interviews and document analysis. Excerpts from the interviews, organized around interview questions and specific research questions formed the bulk of the remaining sections of chapter 4. I concluded with a summary of the most important points captured by the results analyzed in the chapter.

## Research Setting

All participants were experts in the Nigeria construction industry, worked in the same geographical area (FCT, Abuja), and have been working in the case organization for at least five years. However, the experiences shared by the 24 participants were from four (4) organizations, and within each organization, interview questions were focused on either a successful or an unsuccessful project. Therefore, I was not aware of any personal or organizational conditions likely to influence participants or their experiences at the time they shared their experiences on unexpected events and their use of ISM during project execution. Also, all participants were interviewed face-to-face because they all opted for face-to-face interviews even though they were also offered the option to be interviewed via telephone, or via Skype. The use of one mode of interview (face-to-face interview) provided consistency in the format used for all participants.

## Demographics

The emphasis of this study was on unexpected events that occurred during the execution phase of Nigerian construction projects. Architects, quantity surveyors, engineers, and project managers from Four major construction firms in Nigeria participated in the study. The demography of participants is show on Table 4. Codes such as P1A/SuP and P2A/USuP were used to represent participants. P1A/SuP is a participant from Company A that gave perspectives for a project considered successful, while P2B/USuP is a participant from Company B that gave perspectives for a project considered unsuccessful.

*Table 4*

*Research Participant Profile*

| | | | | | | | Work experience (years) | | Familiarity with subject | |
|---|---|---|---|---|---|---|---|---|---|---|
| Coy | Participant | Project | Profession | HQ | VP-I ($) | MPO | Industry | Firm | HRT | ISM |
| A | P1A/ SuP | P1 | Architect | M.Sc. | 13.5 | RIBA | 18 | 7 | Yes | Yes |
| | P2A/SuP | P1 | Civil Eng. | M. Sc. | 11.7 | NSE | 22 | 12 | No | Yes |
| | P3A/SuP | P2 | Q/S | B.Tech. | 9.7 | NIQS | 10 | 7 | No | Yes |
| | P4A/USuP | P3 | Architect | M.Sc. | 28.5 | NIA | 12 | 5 | No | Yes |
| | P5A/USuP | P3 | Q/S | M. Sc. | 28.5 | NIQS | 20 | 8 | No | Yes |
| | P6A/USuP | P4 | Mech. Eng. | M. Sc. | 12.3 | NSE | 11 | 8 | No | Yes |
| | P7A/USuP | P5 | PM | M. Sc. | 8.5 | PMI, P2 | 21 | 15 | Yes | Yes |
| B | P1B/SuP | P6 | Architect | M.Sc. | 9.8 | NIA | 11 | 7 | Yes | Yes |
| | P2B/SuP | P6 | Q/S | B. Sc. | 7.9 | NIQS | 20 | 8 | No | Yes |
| | P3B/SuP | P6 | Civil Eng. | M. Sc. | 7.2 | NSE | 22 | 12 | No | Yes |
| | P4B/USuP | P7 | Q/S | B.Tech. | 9.8 | NIQS | 10 | 7 | No | Yes |
| | P5B/USuP | P8 | PM | M.Sc. | 8.9 | P2, CCNA | 12 | 5 | Yes | Yes |
| | P6B/USuP | P9 | PM | M. Sc. | 8.3 | PMI | 21 | 15 | No | Yes |
| C | P1C/SuP | P10 | Architect | M.Sc. | 5.8 | PMI | 12 | 7 | No | Yes |
| | P2C/SuP | P10 | PM | M.Sc. | 6.9 | PMI | 10 | 7 | No | Yes |
| | P3C/USuP | P11 | Q/S | B.Tech. | 6.4 | NSE | 20 | 8 | No | Yes |
| | P4C/USuP | P12 | Elect. Eng. | M.Sc. | 12.3 | NSE | 11 | 5 | No | Yes |
| | P5C/USuP | P13 | Struct. Eng. | M. Sc. | 5.2 | NSE | 22 | 12 | No | Yes |
| D | | | | | | | | | | |
| | P1D/SuP | P14 | Architect | M.Sc. | 11.5 | RIBA | 10 | 7 | Yes | Yes |
| | P2D/SuP | P14 | PM | M. Sc. | 5.4 | P2 | 21 | 15 | No | Yes |
| | P3D/SuP | P15 | Q/S | M.Sc. | 8.3 | P2 | 20 | 8 | No | Yes |
| | P4D/SuP | P15 | Struct. Eng. | M. Sc. | 6.7 | COREN | 22 | 12 | No | Yes |
| | P5D/USuP | P16 | PM | M.Sc. | 5.7 | PMI, P2 | 11 | 7 | Yes | Yes |
| | P6D/USuP | P17 | Elect. Engr. | B.Eng. | 9.3 | COREN | 12 | 5 | No | Yes |

*Note.* Coy = Company; PartCod = participant code; PrjCod = project code; HQ = highest qualification; VP-I = value of project for which insight is given; HRT = high reliability theory; ISM = information systems management; MPO = membership of professional organization; Q/S = quantity surveyor; PM = project manager, Civil Eng. = civil engineer; Elect. Eng. = electrical engineer; Struct. Eng. = structural engineer; M.Sc. = Master of Science; B. Tech. = Bachelor of Technology; B. Eng. = Bachelor of Engineering; RIBA = Royal Institute of British Architects; NIQS = Nigeria Institute of Quantity Surveying; PMI = Project Management Institute; P2 = Prince-2; NSE = Nigeria Society of Engineers; CCNA = Cisco certified network associate; NIA = Nigeria Institute of Architects; COREN = Council for the Regulation of Engineering in Nigeria. SuP = successful project; USuP = unsuccessful project.

Architects were chosen because they are trained to plan, design, and oversee construction projects, and the space within the site (Winch, 2010). Quantity surveyors (QS) are professionals concerned with the cost components of construction projects. A quantity surveyor differ from a building estimator because, beyond making estimates, he or she is formally trained and accredited to plan, manage, and control project costs (Wasif et al., 2012; Winch, 2010). Project managers are responsible for the planning, procurement, and execution of projects in the diverse areas of engineering, and often the primary technical point of contact for construction projects (Winch, 2010). Project managers are responsible for the planning, procurement, and execution of projects in the diverse areas of engineering, and often the primary technical point of contact for construction projects (Winch, 2010). They are also in charge of the *Project Office* where they oversee schedule preparation, pre-planning, resource forecasting, and a wide of array technical activities. Engineers are responsible for designing, analysis, testing, production, and maintenance of construction materials and structures, and in doing so account for limitations imposed by cost, safety, regulations, and practicality (Fellows & Liu, 2012; Winch, 2010). For this study, civil, mechanical, electrical and structural engineers were interviewed. Project experts were chosen because of their ability to render deep insights into construction activities, processes, and events.

Note that in selecting experts for this study, age, gender, race, and tribe were not considered important; rather competence, qualification, and experience were the critical factors. As show in Table 4, all participants met the inclusion criteria of 5 years on work experience (see Table 2); having had post-graduate experience in the construction sector ranging between 11 and 22 years, and between 5 and 15 years in the case company organizations. The 24 participants had a combined postgraduate working experience of 381 years and 209 years in the Nigerian construction industry and their companies respectively. While most participants (79%) were not conversant with the concept of HRT, all participants were familiar with and have, at some point, used IT solutions in construction projects. Participants discussed projects valued between US$5.2 Million and US$28.5 Million; a figure that exceeded the minimum value ($3 Million) set for this study. As shown on Table 4, the 24 participants gave perspectives on 17 projects with a combined value of US$248.1 Million. The minimum qualification for inclusion in this study was a bachelor's degree; however, apart from 4 participants (17%) who had only a first degree, the rest participants (83%) had a master's degree. Also, membership of a professional organization was not compulsory, but all participants were members of at least one professional organization as indicated on Table 4.

## Data Collection

The qualitative data were collected using two instruments – documents and interviews. Document served as a secondary source of data. Documents such as project proposal, progress report, and project schedule were provided by the case organizations, while project managers who participated in the study provided personal notes, and some minutes of meetings. Note that for each project that was considered, the project manger that supervised the project was part of this study. Other sources of documents were reports on the various company websites, and media reports of events relating to projects.

The primary qualitative data were from 24 project experts using a consistent semi-structured interview protocol (see Table 4 and Appendix D: Sample Interview Protocol). I used the same interview protocol to conduct all of the face-to-face interviews, each of which lasted an average of one-hour. I conducted an average of two interviews each day, and the entire data collection process lasted fifteen days. Each interview session lasted approximately one hour, and was recorded with a Sony digital recorder.

I transcribed each recorded interview into a Microsoft Word document and started transcription the very day I conducted the interview. I immediately commenced interview transcription to ensure that key aspects of the interview remained fresh on my mind. Bryman (2012) noted that to transcribe an interview as soon as possible after the interview enabled the researcher to relate notes taken during an interview with the recorded session. The originally transcribed interviews were filtered to ensure clarity and readability before it was forwarded for post interview review by interviewees. The primary objective of the post interview review by participants was to ensure that the transcript and overall themes that emerged from the interview session were accurate representations of perspectives revealed by participants. I loaded reviewed documents into the NVivo software for thematic analysis, and filed all information in a password protected electronic file and folder that were accessible only to me.

Data collection concentrated on the case organization, the interviewees, and projects for which participants gave perspectives about unexpected events and the use of IT during project execution. Twenty-four interviewees (7 from Company A, 6 from Company B, and 5 from Company C, and 6 from company D) participated in the study.

All participants opted for the face-to-face interview. I identified fifteen (15) large construction companies in Nigeria and sent letters to ten (10). The data collection process followed the steps outlined below. There were only minimal delays as most of the chosen organizations were eager to participate in the study.

1. The first step was to seek the cooperation of prospective research partners. I conducted a preliminary investigation of company websites and identified ten (10) prospective partners who met the case selection criteria on Table 1. I then did an email to IRB to seek guidance with respect to how research partners should give a positive response to my request to conduct a research in their organization.
2. After receiving URR approval for my proposal, I sent letters, via courier, inviting 10 prospective companies in Abuja, Nigeria, to participate in this study. A sample of the letter is shown in Appendix F: Sample Request for Research Partnership. A total of 6 sampled companies (60%) gave a positive response to my invitation to collaborate in this study. Four companies gave a positive response within one week of mailing their letters, one company declined, while two gave a positive response 2 weeks after I had completed data analysis. Three companies gave no response, so it is assumed that 4 companies (40% of samples companies) declined to participate.
3. The four case organizations were large construction firms that have undertaken construction projects in at least 18 out of the total of 36 states (representing 50% of states) in Nigeria. Table 5 indicates the profile of selected firms, all of which exceeded the minimum inclusion criteria outlined on Table 1.

*Table 5*

*Profile of Case Organizations*

| Criteria | Case Company<br>Company A | Company B | Company C | Company D |
|---|---|---|---|---|
| Company Type | Large construction | Large construction | Large construction | Large construction |
| Locations of current project | 25 States | 22 States, | 18 States, | 19 States, |
| Years of operation in Nigeria | 26 Years | 21 Years | 20 Years | 18 Years |
| Stage of project | Execution phase | Execution phase | Execution phase | Execution phase |
| Team composition | 18 members | 13 members | 15 members | 12 members |
| Least value of current project | US$25 Million | US$32 Million | US$28 Million | US$17 Million |
| Value of project(s) for which perspective was given | US$8.5 to US$28.5 Million | US$7.2 to US$9.8 Million | US$5.2 to US$12.3 Million | US$5.4 to US$11.5 Million |
| Existence of current project | 2 year | 4 years | 3 years | 3 years |

4. Upon receiving approvals to conduct research in the case organizations via a letter similar to the one shown in Appendix B: Sample Letter of Cooperation, I did set up initial meetings with the Personnel Mangers at the offices of Community Research Partners to present and discuss the inclusion criteria for prospective participants, and to secure the emails of prospective participants. The inclusion criteria for individual participants are shown in Table 1.

5. Sent letters to potential participants through email after contact persons in each organization had identified potential participants using the inclusion criteria. I used the consent form (See Appendix C: Consent Form) to double as the invitation e-mail. A total of thirty-eight prospective participants from the case companies contacted me via email to schedule an interview. After reviewing their responses

against the participation criteria in Table 1, I selected 16 participants, and assigned a participation code to each of them (e.g. P1A/SuP, P2A/USuP); see Table 4. Note for a description of P1A/SuP, P2A/USuP. Apart from not meeting the minimum of 24 participants designated for this study, on segregating the prospective participants into successful and unsuccessful projects, only 2 prospective participants from each of the 4 case companies indicated interest to give perspectives on successful projects, and 4, 3, and 2 participants from companies A, B, and C, respectively for unsuccessful projects; while none from Company D indicated interest to give perspectives on unsuccessful projects.

6. A reminder was sent to all prospective participants in all 4 case companies who did not respond to the initial email. Fifteen (15) prospective participants from the 4 case companies contacted me via email to schedule an interview. After reviewing their responses against the participation criteria in Table 1, I selected 10 participants. Therefore, a total of twenty-six participants met the minimum inclusion criteria set for this study, 6 each from Companies A, B, and C, and 8 from Company D. Prospective participants were segregated into successful and unsuccessful projects depending on the choices expressed in the emails indicating their interest to participate.

7. Further communication led to the schedule of 26 interviews. However, 24 interviews were conducted because 2 prospective participants (1 each from Companies A and C) had to travel outside of Abuja before their interview dates; thus, they were presumed to have withdrawn from the study.

8. An email was sent to participants two days before an interview to reconfirm the interview time, date, and place. A call was made to participants on the day of interview to remind them of the interview.

9. Each interview session lasted an average of 1 hour. The data collection instrument consisted of 7 preliminary questions that were intended to capture the profile/demographics of participants, 10 core questions that elicited core perspectives needed for the study and related to the two research questions, and 4 other questions requesting any ideas that were not captured by the core interview questions (see Appendix D: Sample Interview Protocol).

10. Interviews were segregated into successful projects (SuP) and unsuccessful projects (USuP). Distribution of the number of participants for successful and unsuccessful projects across the 4 case companies is shown in Table 6.

*Table 6*

*Distribution of Participants for Successful and Unsuccessful Projects*

| Case company | Participants | | | | Total |
|---|---|---|---|---|---|
| | Company A | Company B | Company C | Company D | |
| Successful project (SuP) | 3 | 3 | 2 | 4 | 12 |
| Unsuccessful project (USup) | 4 | 3 | 3 | 2 | 12 |
| Total | 7 | 6 | 5 | 6 | |

11. A total of 12 interviewees gave perspectives on projects that, based on the inclusion criteria, were considered successful, namely: Met its operational objectives of time, cost and quality as defined by Chipulu et al. (2014) and/or met the business and stakeholder requirements defined by outputs, outcomes, and impacts as suggested by Winch (2010). Participants who were interviewed about

unsuccessful projects did so for projects that were considered unsuccessful for one or more of the predetermined reasons identified in Chapter 3 under the subsection, *Sample Size*, namely: 1) exceeded its time estimate by six months, 2) exceeded its cost estimate by 25%, 3) required external arbitration, and 4) was suspended for at least six months, 5) abandoned completely, or any combination of these. To this end 12 participants gave perspectives covering 11 unsuccessful projects, and a minimum of 2 unsuccessful projects for each case organization. Details of unsuccessful projects for which participants from each case company gave perspectives are shown on Table 7.

*Table 7*

*Unsuccessful Projects by Case and Participants*

| | | | Reason for project failure | | | | |
|---|---|---|---|---|---|---|---|
| Company | Participant | Project | Time overrun | Cost overrun | External arbitration | Abandoned | Suspended |
| A | P4A/USuP | P3 | 8 Months | 38% | No | No | No |
| | P5A/USuP | P3 | 8 Months | 38% | No | No | No |
| | P6A/USuP | P4 | 2 Years | 69% | Yes | No | 8 months |
| | P7A/USuP | P5 | - | - | - | Yes | - |
| B | P4B/USuP | P7 | 29 Months | 73% | No | No | 6 months |
| | P5B/USuP | P8 | - | - | Yes | Yes | - |
| | P6B/USuP | P9 | 9 Months | 38% | Yes | No | 3 months |
| C | P3C/USuP | P11 | 9 Months | 33% | No | No | No |
| | P4C/USuP | P12 | 19 Months | 62% | Yes | No | 8 months |
| | P5C/USuP | P13 | - | - | No | Yes | - |
| D | P5D/USuP | P16 | 9 Months | 31% | No | No | No |
| | P6D/USuP | P17 | - | - | No | Yes | - |

12. The 10 core interview questions were related to the two research questions, and responses of participants were recorded with a Sony Recorder. Each interview

session concluded with the tenth interview question, but participants were given the opportunity to provide additional comments that was also recorded.

13. No unusual circumstances were encountered during data collection and each interview was successfully completed within an average of one-hour without interruption. Also, there were no variations in data collection from the plan presented in Chapter 3. While 26 participants met the participation criteria for this study, withdrawal of 2 participants left 24 participants as the final sample size.

**Data Analysis**

The principal objectives for qualitative data analysis were to reveal commonalities in the experience and perception of participants, and to use the essence of their common experience and perceptions to describe the phenomenon (Bryman, 2012; Maxwell, 2013). The qualitative data collected during the face-to face interviews were transcribed, filtered, and sent to research participants for post-interview reviewed to ensure accuracy, before being imported into the NVivo software. NVivo software is suitable for organizing and analyzing non-numerical and unstructured rich text-based and multimedia data. NVivo facilitates deep levels of inquiry, identification of positive evidence, data relationships, and divergent themes (Gilbert, Jackson, & di Gregorio, 2014).

Text analytic strategy was used for this study, but the data analysis did not adopt an automated coding system. The analytic strategy followed a three-step process (a) prepare and organize data, (b) reduce data into themes, and (c) represent the data in tables and figures, and discuss findings. To this end, pertinent information was captured from the response to interview questions on the two research questions. The relationship between each research question and the various interview questions are shown in Table 8. Table 8 aligns research interview questions with each research question and identified the objective for each set of questions. Table 8 also shows a distinction between interview questions relating to information systems, mindfulness as revealed by HRT, and questions that specifically provided on how information systems management can combine with mindfulness to provide an effective response to unexpected events during the execution phase of construction projects.

*Table 8*

*Research Questions and Related Interview Questions*

| Research question | Related interview question | Objective |
|---|---|---|
| RQ1: What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects? | 1 and 2 | To identify the types, effects, and reasons for unexpected Events |
| RQ2: How does combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects? | Information Systems: 3 | To reveal the use of information systems in the management of unexpected events during construction project execution |
| | Dimensions of mindfulness:<br>1. Preoccupation with failure: 4<br>2. Reluctance to simplify: 5<br>3. Sensitivity to operations: 6 and 7<br>4. Commitment to resilience: 8 and 9<br>5. Deference to expertise: 10 | To show how team mindfulness, as revealed by HRT, facilitates an effective response to unexpected events during construction project execution |
| | Combining mindfulness and information systems: 3, 4, 5, 6, 8, and 10 | To provide insight on the attitude of team members towards problems, and using IS to gather information and report problems |

Keywords and short phrases that ran through the twenty-one interviews were identified and categorized. Categories were related to each other, and to the analytic framework – High Reliability Theory (HRT) to create themes. Themes were used to develop descriptions that represented the experiences and perceptions revealed by participants and to interpret meanings to report a point of view. Details of specific themes that emerged from the data were grouped by research questions and shown in Table 9.

*Table 9*

*Research Questions and Response Themes*

| Research Question 1: Unexpected Event in Construction Projects | | | Research Question 2: Combining Mindfulness and Information Systems Management (ISM) | | |
|---|---|---|---|---|---|
| Unexpected events | Effects of unexpected events | Reasons for unexpected events | Use of information systems | Use of HRO principles (mindfulness) | Combining mindfulness and ISM |
| Failures | Operational effects | Environmental instability | Inadequate use of information technology | Attitude of Team members | Weak signals management |
| Near misses | Relational effects | Lapses in organizational management | Attitude of team members | Risk management | Information management |
| Surprises | | Attitude/behavior of team members | Communication | Team management | Communication management |
| | | Lapsing in plans and benchmarks | Implementation of defined procedure | Communication | Team management |
| | | | Implementation of appropriate IT infrastructure<br>Regular training | Training and use of skills | |
| | | | Encouragement to apply IT skills | | |

Table 9 indicates 9 response themes for answers to the 2 interview questions designated for research question 1. Table 9 also shows a total of 15 response themes for answers to the 8 interview questions designated for research question 2, divided into three sections: Information systems, mindfulness, and combining information systems with mindfulness.

To provide an accurate report of the perspectives revealed by participants, any discrepant response to specific interview question were recorded and included in the results. For example, participant P1B/SuP had a different view about the effect of remuneration on corruption. His responses were noted and quoted in the results.

## Evidence of Trustworthiness

The need to establish trustworthiness during the process of data analysis relied on the information that was gathered from the interviews. In responses to the open-ended questions used for this study, the interviewees provided rich descriptions of their practices and experiences. Trustworthiness followed the four criteria (*credibility, transferability, dependability, and conformability*) described by Guba and Lincoln's (1994, p. 105-117), which I described in Chapter 3.

### Credibility

The strategy adopted to establish credibility for this study was to involve participants in the process of member checking (Maxwell, 2013). I provided all participants with an editing version of the interview transcript to scrutinize and assert whether the themes and categories identified from the interview session were accurate representations of their views. Before sending interview transcripts for member checking they were edited to filter incomplete sentences, redundant phrases, vague words, or slangs such as "meaning to say," "you know," "ehhhmmmm," and "so therefore." Also, company names, references to particular project, agencies, and individuals were filtered from the final version sent to participants for member checking. Apart from three participants that clarified their response to interview questions, one participant who added a new perspective, and one participant who did not respond, all other participants confirmed that the transcripts represented their views. Clarification by the three participants and the new perspective added by one participant were included into the final version of the interview transcript.

**Transferability**

Qualitative studies are rarely generalized to other populations (Bryman, 2012). However, findings from a qualitative study could have transferability if the results and findings are sufficiently detailed for other researchers to decide if the findings could apply to their study (Bryman, 2012; Maxwell, 2013). To this end, an in-depth description of the characteristics of participants, organizations, and the entire process of this study were presented. These descriptions were presented in form of Research Participant Profile, Table 4; Profile of Case Organizations, Table 5; Distribution of Participants for Successful and Unsuccessful Projects, Table 6; Unsuccessful Projects by Case and Participants, Table 7; Appendix D: Sample Interview Protocol; presentation of interview questions and their relationship to each research question, Table 8; and a description of the themes that emerged from the Study, Table 9. These tables and descriptions would enable researchers to have an in-depth insight to the context of the study, my methods for data collection, and the techniques adopted for data analysis.

**Dependability**

Dependability in this study was driven by the understanding other researchers might want to apply the strategies used in the study to conduct a similar study. To this end, I ensured dependability by presenting a detailed description of the study to provide research audit and enable the replication of this study under similar or slightly different conditions (Maxwell, 2013). In this context, first, I provided a detailed contextual and methodological description of the fieldwork to allow an audit trail. Keeping an audit trail was necessary to capture my approached to the study to ensure that other researchers were able to replicate it. The physical audit trail was revealed through the methodology decisions made during the principal stages of the study, while the intellectual audit trail was revealed by justifying my thought process throughout the study. Second, I kept an extensive and detailed record of the processes and boundaries of the investigation, and how they were executed. These included, 1) problem identification, 2) literature review, 3) conceptual framework, 4) interview protocol, 5) number of organizations and their selection process, 6) restrictions on the type and number of participants, 7) number and length of collection session, and period for data collection, 8) filtered interviews, and 9) analysis of the data.

**Confirmability**

Confirmability is the degree to which other researchers can confirm or validate the results of a study (Trochim & Donnelly, 2007). Confirmability was established by meticulously ensuring that the findings emerged from the participants and not influenced by my preferences (Trochim & Donnelly, 2007). Reflective explanations, contextual descriptions, triangulation, and audit trails provided traceability and reduced potential researcher bias. I also provided a detailed methodological description so that other researchers could scrutinize the emergence and acceptability of the constructs and processes that were adopted for this study.

## Study Results

The study results were organized by research questions and the related interview questions. The interview questions were based on the research questions as shown in Table 8, and used to guide the conduct of the face-to-face interviews.

### Research Question 1: Unexpected Events in Construction Projects

Two core interview questions and one sub-question were designated for Research Question 1: *What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects?* The interview questions captured three categories necessary to understanding unexpected events. As shown in Table 9 and Table 10, these included unexpected events, effects of unexpected events, and reasons for unexpected events.

*Table 10*

*Results: Research Question 1, Unexpected Event in Construction Projects*

| | | Subthemes | | |
|---|---|---|---|---|
| Subtopic | Themes | Successful projects | Successful /Unsuccessful projects | Unsuccessful projects |
| Unexpected events | Failures | • Substandard materials | • Judgmental error<br>• Faults in equipment<br>• Technology failure | • Insufficient amount of materials<br>• *Declining compliance*<br>• Scope creep |
| | Near misses | | • Exceeding the cost of a task | • Exceeding planned delivery of a milestone |
| | Surprises | • Labor shortage<br>• Material shortage<br>• Inclement weather | • Cancellation of an initial approval<br>• Poor funding | • Litigations,<br>• Incompetence of subcontractors |
| Effects of unexpected Events | Operational effects | • Rework of project items | • Costs overruns<br>• Time overrun | • Abandonment |
| | Relational effects | • Disputes between stakeholders | • Adversarial relationships | • Arbitration<br>• Litigation |

*table 10 continued*

| Subtopic | Themes | Subthemes: Successful projects | Subthemes: Successful /Unsuccessful projects | Subthemes: Unsuccessful projects |
|---|---|---|---|---|
| Reasons for unexpected events | Environmental instability | • Price fluctuation<br>• Level of development | • Corruption<br>• Lax regulatory procedure<br>• Terrorism | • Political instability<br>• Currency fluctuation<br>• Irregular payments |
| | Lapses in organizational management | • Poor work environment<br>• Poor coordination framework | • Corruption<br>• Working conditions<br>• Inadequate labor skills | • Disruption/unrest by workforce<br>• Poor communication framework |
| | Attitude/behavior of team members | • Disagreement on work and activity goals<br>• Greed<br>• Failure to follow rules | • Corruption<br>• Demotivation<br>• Adversarial relationships<br>• Negligence Misunderstanding of expectations | • Unethical professional practices<br>• Slow decision making<br>• Sabotage |
| | Lapsing in plans and benchmarks | • Underestimation of productivity<br>• Improper planning | • Corruption Unrealistic scheduling<br>• Frequent changes in technical specification<br>• Poor funding projection | • Errors in human resource estimate<br>• Design errors |

**Interview question 1: Unexpected events.** The participants described the types of unexpected events experienced during project execution in response to the interview question: *What are the types of unexpected events that you have experienced on your projects?* As shown on Table 10, three themes emerged with respect unexpected events: Failures, near misses, and surprises.

***Response theme: Failures.*** Participants were unanimous on the issue of *failures* being a key element of unexpected events in their projects (See Appendix G: Data for Research Question 1: Themes by Participant Response). Participants noted that failures were often due to faulty equipment, technological failures, and error judgments. Two participants noted that error judgment during project execution had been a source of major concern because they come in forms that, ordinarily, were unbecoming of a professional, but inevitably occurred. Participant PA5/USuP noted, “On several occasions, substandard materials were accepted and used. Most times it did not cascade into major issues, but it once led to the collapse of a large chunk of the concrete slab in an upper deck.” PA6/USuP stated that “faulty equipment led to 8 months suspension of a project; a suspension that caused time overrun of 2 years and over 50% cost overrun.”

***Response theme: Near misses.*** As shown in Appendix G, 63% participants specifically identified near misses that cascaded into problems. They noted that while near misses, such as exceeding a planned milestone by a few days or exceeding the cost of a task by few dollars may initially seem insignificant, they often accumulate, in the financial term, in ways that jeopardize the outcome of a project. Participant P2B/SuP commented:

> Once we exceed the planned delivery of a milestone by two days because a subcontractor was unable to complete delivery of reinforcements needed for that milestone. The company did not only incur a cost but also needed extra two days to complete that milestone. Unfortunately, because of the sight layout, materials required for the next milestone could not be delivered on site. Trucks had to park at a hired garage at the expense of the company, and we had to pay for the days the truck remained in the company’s custody.

Similarly, participant P4C/SuP noted that when such changes occur at pick points during project execution “it is not only harder to get the project back on schedule, you may have to revisit parts of the project…in many cases you may have to revisit a part of the project that you thought should be complete; make changes to execution plans, and make financial provisions to cushion any unforeseen excesses."

***Response theme: Surprises.*** Participants noted surprising events such as labor shortages and incompetence of subcontractor as key dimensions of unexpected events that occur during the execution of projects. As shown in Appendix G, 18 participants (75%) indicated the preponderance surprises as against 15 participants (63%) that reported near misses as an element of unexpected events. Table 10 revealed that participants that gave perspectives on successful and unsuccessful projects identified cancellation of an initial approval and poor funding as two events that spring of surprises in projects. Participant P6D/USuP noted that the economic environment of the Nigeria necessitate the provision of an effective contingency plan for project funding, "sometimes we inflate the project value to account for excessive bank charges, delayed payments, and currency fluctuations…we do not see poor funding as a risk but an issue that has to be tackled at the planning phase. So it is often a surprise when funding issues prop u during the execution phase." Similarly, participant P3C/USuP noted, "it is better to get bank funding for the project and get it completed or, at least complete a significant milestone then begin to pursue payment than waiting for the government to pay before moving on. Other forms of surprises identified by participants were cancellation of an initial approval and incompetence of a sub-contractor.

**Interview question 2 (main question): Effects of unexpected events.** Interview question 2 extended the first research question by exploring: *What do you think are the effects of unexpected events (tasks and activity failures) in Nigerian construction* *projects?* Two themes emerged for the effects of unexpected events: operational effects and relational effects.

***Response theme: Operational effects***. Seventeen participants (71%) explained that unexpected affected work processes, time and cost. Participants focused particularly on rework due to unexpected events. Participant P3B/SuP noted, "most rework that occurred on our site had its origin in the design phase…they are often in response to owner scope change, changes in specification, and procurement errors." While participant P4A/USuP blamed most reworks on client design changes, participants P2B/SuP, P5C/USuP, and P2C/SuP attributed most reworks on design consultant error, poor construction technique, and poor construction management processes. Participants noted that reworks that are undertaken late during project execution compounded the ability to get the work back on schedule as it creates the need to revisit parts of the project that were presumed to have been completed: making changes, incurring costs, extending time, and cancelling commitments to other chunks of work.

***Response theme: Relational effects.*** Eighteen participants (75%) (See Appendix G) noted that unexpected events could have relational effects such as disputes between stakeholders, and adversarial relationships between team members. P7A/USuP revealed that an unexpected event was the primary reason why project P7 was abandoned. P7A/USuP noted:

> An unexpected equipment failure significantly degraded project cost and schedule performance. Team members blamed each other, and the procurement and facilities managers resigned…circumstances surrounding their resignation

led to a violent rampage that resulted in the death of two community members, and the kidnap of the project manager. The core team had to return to Germany, and the project was abandoned.

Views rallied by P5A/USuP, and P6B/USuP emphasized the idea that how the occurrence of unexpected events can increase friction inter- and intra-team conflict. Such relational effects prevent project teams from collaborating effectively.

**Interview question 2 (sub-question): Reasons for unexpected events.** The sub-question asked: *What do you think are the reasons that trigger activity failures in Nigerian Construction Projects?* Four themes emerged from insights that participants gave as reasons for unexpected in Nigerian construction project. Twenty-one participants (88%) identified environmental instability, 21 participants (88%) – lapses in organizational management, 22 participants (92%) – attitude and behavior of team members; while 16 participants identified lapses in plans and benchmarks (67%). These themes stressed the need to not only have a complete understanding of the contextual, organizational, project, and personal dynamics as they relate to unexpected events, but also to have an understanding of their interrelationships.

***Response theme: Environmental instability.*** Participants considered weaknesses in the Nigerian environment as a key driver of the unexpected event during project execution. Prominent among factors identified under environmental instability were corruption, lax regulatory procedure, and terrorism. Although other factors were identified under environmental instability (see Table 10), participants that gave perspectives for both successful and unsuccessful projects laid emphasis on these three factors. P2B/SuP and P6D/USuP argued that the Nigerian society promotes a culture of corruption. P2B/SuP explained, “Societal pressures on people to display success forced them to ignore ethical discretion in ways that cause problems on projects.” P7A/USuP surmised that “while the level of develop and political instability are issues that cause unexpected events in Nigerian construction projects, organizations undermine projects by deploying insufficient manpower or showing favoritism in project team formation; thus creating environments conducive to unethical practices, corruption, and failure to follow rules.” In this context, participants across the four organizations (P1B/SuP, P3B/SuP, and P1C/SuP, P4D/SuP) opined that while terrorism was increasing a cause for concern, corruption is exacerbated by lax regulatory procedures, and the difficulty in tracking, reporting, and punishing those involved in unethical professional practices.

***Response theme: Lapses in organizational management.*** Poor working conditions, corruption and poor communication framework were the key coalescing factors driving organizational lapses leading to unexpected events in Nigerian construction projects. P3A/SuP noted, “When team members are focused on immoral self-enrichment, it is only natural for them to abuse their offices or engage in practices that undermine the project or result in undesirable events during project execution.” P1A/SuP surmised, “Corruption is the cause of unethical and nonprofessional practices such as manipulation of specifications and subverting procurement policies.” Most participants also identified poor working condition are a reason why team member indulge in practices that cause unexpected events. P5B/USuP noted, “When a staff is not properly remunerated, the staff tend not to have a strong commitment to project success, and may indulge in practices capable of undermining the outcome of events." In support of the perspective of P5B/USuP, P4C/SuP gave an example of a store manager who was sacked when it was discovered that he connived with a subcontractor to record supplies that were not delivered, "his activities were discovered when the project was beset by significant shortage of cement and the project was delayed for three weeks." While all participants that gave perspectives on corruption were unanimous that adequate remuneration could avert corruption, unethical practices, and encourage commitment to the success of the project, P1B/SuP had a discrepant view:

> Remuneration can not change a greedy and ethically bankrupt person; he would rather use an increase in salary or promotion to perpetrate his or her harmful practices. The answer to corruption is a culture change and to ensure that opportunities for corruption are, as much as possible, reduced on construction projects in Nigeria.

***Response theme: Attitude/behavior of team members.*** P3C/USuP noted that Nigerian firms lacked commitment to staff regarding working conditions, hence "staff result to unethical practices, negligence, and sometimes, outright sabotage." P1D/SuP said, "Because staff is not motivated to do their job, they may not exercise the discretion needed to identify and contain errors and unexpected events." P6D/USuP noted:

> Greed and the desire for kickbacks in the Nigerian society creates a fertile environment for favoritism and the appointment of people to positions that their technical competence would ordinarily not permit…in such positions, they are bound to misunderstand expectations, are unable to relate effectively with their

> colleagues, and because they are incompetent to taking decisions on critical issues, they fail to identify and manage unexpected events effectively.

Participants identified the adversarial relationship as a cause of unexpected events. P5C/USuP noted, "The incompetence of a supervisor led to serious team friction that affected work and activity goals and sabotage on P12. The project was suspended for several months, causing over 1 year time overrun, and over 50% cost overrun."

***Response theme: Lapsing in Plans and benchmarks.*** Participants noted that appropriate plans and benchmarks were essential to identifying and managing unexpected events. P1B/SuP posited, "If project plans are not fairly accurate, then, the project is bound to experience several unexpected problems during the execution phase." The 16 participants (67%) who identified issues associated with lapses in plans and benchmark as factors that drive unexpected events suggested that frequent changes to technical specifications, unrealistic scheduling, and poor funding projections were the most critical lapses in plans that cause unexpected events in Nigerian construction projects. In this context, P3D/SuP suggested, "Projects with plans that are replete with design error and unrealistic productivity estimates are bound to encounter unexpected event." However, P4B/USuP and P2D/SuP noted that in Nigeria, corrupt consultants sometime introduce deliberate errors into the designs and estimates to reap the benefits of the excesses for themselves. P3D/SuP said, "I was part of a bridge project with estimates based on 350 meters but the actual measurement was 155 meters. It was later discovered that the quantity surveyor, civil and structural engineer had increased the length of the bridge deliberately."

**Research Question 2: Combining Mindfulness with Information Systems**

Several themes emerged in response to research question two: *How does combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects?* The nine interview questions designated for Research Question 2 were subdivided into three sections: Information systems, mindfulness, and combining mindfulness with information systems. Themes that emerged were also organized around the three core elements: 1) Uses of HRO principles (mindfulness), 2) information systems, and 3) combining mindfulness with information systems. Segregating themes, revealed by participants, into the core elements of research question 2 gave a better understanding of the contributions of individual elements and provided a deeper insight about how combining mindfulness and ISM can facilitate an efficient response to unexpected events.

**Interview question 3: Use of information systems.** The participants described information management issues in response to the main interview question and the two sub-questions that followed. The responses of participants were divided into 1) sufficiency of information systems, representing the main interview question designated 3-0; 2) effective strategies used, for the sub-question 3-1; and 3) recommendations for improvement, for the sub-question 3-2. Themes emerging from participants' responses are shown on Table 11 and discussed in the forgoing sections.

*Table 11*

*Research Question 2, Combining Mindfulness and IS: Use of Information Systems*

| | Response theme |
|---|---|
| 3-0 Sufficiency of information systems | • Use of information technology<br>• Attitude of team members |
| 3-1 Effective strategies used | • Communication<br>• Implementation of defined procedure |
| 3-2 Recommendations for improvement | • Implementation of appropriate IT infrastructure<br>• Regular training<br>• Encouragement to apply IT skills |

**Interview question 3-0: Sufficiency of information systems:** Participants commented on the use of information technology in the management of construction projects in Nigeria by responding to the question: *How sufficient is the use of information systems by team members in facilitating the management of unexpected events during execution phase of a project (successful/unsuccessful) on which you have worked?*

***Response theme: Use of information technology.*** Inadequate use of information technology was a common theme in response to interview question 3-0. As shown on

Appendix H: Response Themes for Interview Question 3

, while 15 (63%) participants held that the use of information systems management (ISM) was not sufficient, out of 9 (37%) participants who held that the use of ISM was sufficient, 5 (21 %) opined that the use of ISM in construction projects needed improvement. P6D/USuP noted, "Despite the fact that participants used information technology in their daily routines during project execution, they hardly leverage capabilities provided by information systems during project execution. P3C/SuP indicted:

> Honestly, for a majority of projects, I think the available technology and information systems available in the company are sufficient, but are not the well-utilized mechanism or not used consistently throughout the project execution phase…I think there is room for improving how we use information systems and ensuring compliance to the rules that would enable us to do so.

***Response theme: Attitude of team members***. Participants noted that the Attitude of team members was a limitation in use ISM in the Nigeria construction industry. P2D/SuP noted, "Apart from the disconnectedness in team collaborative efforts, project team members over-rely on human memory instead of using the information systems to analyze problems." In line with P2D/SuP, P6B/USuP suggested that "when failure arises due to over-reliance on memory, project actors resort to blaming each other, creating misunderstanding between team members, and adversarial relationships capable of obstructing the progress of the project." Several participants also noted that poor information systems management skills were a key issue. P3D/SuP opined, "Apart from many professionals not being up-to-date with their information Systems management skills, those who managed to continually update their abilities often make poor use of those skills or are not encouraged to do so." P5C/USuP concluded that the poor use of ISM in coordinating construction projects led to uncoordinated and inconsistent points of view among team members, and it is "one reason why project team members were not as vigilant as they ought to be toward errors that latter cascaded into catastrophic events."

**Interview question 3-1: Effective strategies used:** Participants commented on practical strategies that have been used to manage information systems by responding to the research sub-question: *If sufficient, what specific strategies were most effective?* Two themes emerged on effective IT strategies that have been used to facilitating an effective response to unexpected events in Nigerian construction project. These were, 1) implementation of defined procedures and 2) Communication.

***Implementation of defined procedure.*** Participants suggested that implementing clearly defined, and open procedures had enhanced the use of IT in their projects. P2A/SuP noted how codes of procedure were made simple and to the point, so as to be easy to understand and "critical procedures sent as alerts to the mobile phones of all team members in the morning." P6A/USuP noted, "Although the project (P4) exceeded its time estimate by 2 years and was subject to external arbitration, the project was not abandoned because procedures and their implementation were clearly defined and recorded on the company's database be with timestamps pointing to imputes by all stake holders. P1A/SuP noted that implementing IT driven procedures on P1 "did not only improve transparency and team building, it also encouraged all members of our team to take notice of diversity while improving our affinity to using information systems."

***Response theme: Communication.*** Participants suggested that team members were more open to reporting errors and deviations from project plans when the work environment encouraged open communication. P2D/SuP noted how open communication was improved on project P14 by creating a project forum that was accessible to the team and all project stakeholders:

> Discussion on the project forum was limited to issues affecting the project, and while everyone on is immediately alerted when a person posts a report, their

identity was anonymous. Team members could set the priority or urgency of the message and determine levels of escalation.

P2A/SuP noted how minutes of meetings concerning all projects were made available via email to all members of the team and to all staff who have been in the company's employment for upwards of three years. To encourage open communication, P4B/USuP noted how he led his team working on P7 to agree on having all project meetings audio recorded and preserved for record purposes.

**Interview question 3-2: Recommendations for improvement.** Interview research sub-question 3:1: *If not sufficient, what kinds of improvements are needed?* As shown on Table 11, participants made 3 recommendations for improving the use of information systems (IS) in facilitating an effective response to unexpected events in Nigerian construction projects.

***Response theme: Implementation of appropriate IT infrastructure.*** Twenty-three participants (96%) recommended the implementation of an integrated IT infrastructure as a key factor that should improve the use and efficiency of IT in the management of unexpected events in Nigerian construction projects. Out of 23 participants who recommended the implementation of an integrated IT infrastructure, 12 (52%) gave perspective for successful projects while 11 (48%) gave perspective for unsuccessful projects. P5D/USuP noted, "Implementing an organization-wide IT infrastructure should enhance data management and real-time trend analysis and reporting signals that may translate into unexpected events." P1A/SuP viewed having an integrated IT infrastructure as relevant to structured data management, avoiding incessant data reentry and uncertainty in reporting events that affect the outcome of project activities. P4B/USuP noted, “When there is an appropriate IT infrastructure one can aggregate and extrapolate minor failures effectively.” But P6D/USuP suggested, “A strategy to implementing an efficient IT infrastructure must also consider the need to update IT Tools that drive the system continually.”

***Response theme: Regular training.*** Twenty-one participants (88%) recommended regular training as an effective strategy that should improve the use and efficiency of IT in the management of unexpected events in Nigerian construction projects. Out of 21 participants who recommended regular training, 9 (43%) gave perspective for successful projects while 12 (57%) gave perspective for unsuccessful projects. P5D/USuP suggested, “Training should cover relationship management, leadership, communication, and the use of IT tools…and skills should be updated to align with system improvements.” Most participants opined that with regular training, team members are not only equipped to use the system effectively, but are also more confident to use the system in facilitating the identification and forecasting of failures.

***Response theme: Encouragement to apply IT skills***. Nineteen participants (79%) suggested that team members should be encouraged to use acquired IT skills. P5D/USuP argued, “Having a sophisticated information system in place, and training staff to use the system would yield minimal results if they are not encouraged to use the system.” Most participants argued that if team members were encouraged to leverage their IT skills adequately, they were likely to be less reliant on human memory and instinct, and become more productive. In this context, P2C/SuP surmised, “When the use of IT skills are encouraged, the people who use the solution become more at home with the system, and depend in large part on it to improve productivity."

**Interview questions 4 – 10: Dimensions of High Reliability Theory (HRT)**

Interview questions 4 through 10 covered the five dimensions of mindfulness as revealed by High Reliability Theory (HRT), namely: (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). These five dimensions were used as a lens to conduct this study. I asked at least one central question and a sub-question for each dimension of HRT. The main questions were intended to elicit participants' perspectives on the core elements of each dimension of mindfulness, while sub-questions were designed to reveal the role of information systems in each dimension of mindfulness. A summary of the themes for both main- and sub-interview questions that emerged from the five dimensions of HRT are shown in Table 12.

*Table 12*

*Interview Questions 4 – 10: Response Themes by Dimensions of HRT*

| | | Response theme | | |
|---|---|---|---|---|
| Dimension of HRT | Interview Question | 1 | 2 | 3 |
| Preoccupation with failure | Interview question 4 | Attitudes of team members | Risk management | Team management |
| | Sub-question 4 | Weak signals Management | Information management | |
| Reluctance to simplify | Interview question 5 | Risk management | Communication | |
| | Sub-question 5 | Communication | Information management | Weak signals Management |
| Sensitivity to operations | Interview question 6 | Attitudes of team members | Risk management | Team management |
| | Sub-question 6 | Information management | Weak signals Management | |
| | Interview question 7 | Communication | Attitudes of team members | |
| Commitment to resilience | Interview question 8 | Training and use of Skills | Attitudes of team members | |
| | Interview question 9 | Team management | Training and use of Skills | |
| | Sub-question 9 | Information management | Team management | Communication management |
| Deference to expertise | Interview question 10 | Team management | Training and use of Skills | |
| | Sub-question 10 | Team management | Communication management | |

Consequently, interview questions 4 through 10 were intended to elicit the perspectives of participants on mindfulness, as revealed by HRT, as well as the role of ISM in enhancing mindfulness, as revealed by HRT, to facilitating an adequate response to unexpected events in Nigeria construction projects. A table of specific response themes organized by participants, projects, and organizations are presented in Appendix I: Data for Research Question 2: Response Themes for Interview Question 4-10. A close examination of Table 12 reveals the emergence of similar themes for different dimensions of HRT. For instance, the *attitude of team members* was common to interview questions 4, 6 7 and 8 designed to elicit participants' perspectives on *preoccupation with failure, sensitivity to operations,* and *commitment to resilience,* respectively. Communication was a common response theme to interview questions 5 and 7, designed for *reluctance to simplify* and *sensitivity to operations.* Therefore, I further aggregated subthemes into themes discussed under two broad sections: 1) Use of HRO Principles, and 2) Combining mindfulness with Information Systems Management (ISM). The emerging themes did not only enhance clarity, but they also reflected the key purpose of this study: Combining mindfulness, as revealed by High Reliability Theory (HRT), with information systems to facilitate an adequate response to unexpected.

### Use of High Reliability Organization (HRO) principles (Mindfulness)

Five (5) themes emerged when participants described the used of HROs principles in facilitating an effective response to unexpected events (see **Error! Reference source not found.**). The 5 themes were, 1) attitude of team members, 2) risk management 3) team management, 4) communication, and 5) training and skills application.

*Table 13*

*Research Question 2, Use of HRO Principles: Aggregated Response Themes*

| | | Dimension of Mindfulness | | | | |
|---|---|---|---|---|---|---|
| Response theme | Interview question | Preoccupation with failure dimension | Reluctance to simplify | Sensitivity to operations | Commitment to resilience | Deference to expertise |
| Attitudes of team members | 4, 6, 7, 8 | Yes | No | Yes | Yes | No |
| Risk management | 4, 5, 6 | Yes | Yes | Yes | Yes | No |
| Team management | 4, 6, 9, 10 | Yes | No | Yes | Yes | Yes |
| Communication | 5, 7 | No | Yes | Yes | No | No |
| Training and skills application | 8, 9, and 10 | No | No | No | Yes | Yes |

***Response theme: Attitude of team members.*** Seventeen (17) participants, representing 71% of participants, spoke concerning the attitude of team members toward near misses of planned activities, gathering feedbacks on things that were not going according to plan, and accessing information needed to analyze undesirable events. P4A/USuP, P3B/SuP, P1C/SuP, and P5C/USuP opined that many team members often have inconsistent points of view and being eager to meet deadline do not take extra steps to probe events that slightly exceeded their targets. P4A/USuP noted:

> People are often focused on completing the job and set their focus on delivery, they take no measures to probe minor misses… this attitude was a problem in our project because we hired our equipment and paid insurance on them per days, and while we might exceed planned usage by a few hour, the cost implication was the equivalent of using the equipment for a whole day.

P5C/USuP surmised, “lax attitude towards gathering feedbacks on things that were not going according to the plan was mainly due to reduced sense of personal accountability, over reliance on convention.” In this context, P2C/SuP was of the view that the “lax attitude of team members towards minor error was more because they do not always have direct access to information that should enable them to act on errors or minor misses.”

***Response theme: Risk management.*** Participants identified lax risk awareness as a key factor that influences the attitude of team members toward minor errors, the way they capture and report such errors, and the way they gather feedback on unexpected. P4A/USuP noted, “lack of proper risk management is the reason why team members often propose simplistic explanations to minor errors, disregarding the possibility of other deep root causes of an event.” P6C/USuP offered, “While a simple process can be used to manage risks, a riskaware team would regard small, inconsequential errors or misses as a symptom that something is wrong, and that thing could have terrible, I mean very terrible consequences.” In this context, P1C/SuP argued, “A proper risk management system should have defined methods of managing feedback within the team, providing feedback to higher authorities, and making the best use of lessons learned.”

***Response theme: Team management.*** Team management was a key theme that emerged on how team members respond to new misses, attitude to gathering feedbacks, exercising of discretion to solving problems, and respect for expertise as 15 participants (63%) held the view that team management influenced how people acted to prevent errors. P3A/SuP noted, “The way some leaders behave or drive team processes place restrictions on team member’s freedom to exercise personal discretion when minor errors occur." Besides, P7A/USuP, P3B/SuP, P6B/USuP noted that when teams are manage in a way that the show of favoritism is evident to hardworking members, there is bound to be both negligence and adversarial relationships among team members or clusters of a team within a team. P1C/SuP noted:

> We had problems that almost jeopardized our project due to centralized decision making and inconsistency in measuring and assigning workload…this puts pressure on individual members of the team identified to be competent while other became team members only in name.

In this context, P3C/USuP noted, "Team members should not only have access to communication resources, but should also be subject to equal conditions with a transparent relation between identifying, reporting and solving project problem, and sharing communication resources across multiple layers of communication."

***Response theme: Communication.*** Communication featured prominently as a key factor suggested by 17 participants (71%) on accessing valuable information, and capturing and reporting information necessary to inform decision making. Participants suggested that team members were more open to reporting errors and deviations from project plans when the work environment encouraged open communication. P2D/SuP noted how open communication was improved on project P14 by promoting two layers of reporting undesirable events:

> A complaints box was positioned in the toilet where any one could anonymously post a problem and the likely person that was responsible for the problem…the

> second layer was an open meeting where all team members where allowed to comment on the problem.

P3C/USuP suggested that while open communication was essential to encouraging team members to report problems, “it was necessary to create project environment team members trusted each other and unnecessary restrictions are not placed on their access to important information needed to make a proper and timely assessment of issues.” P2B/SuP surmised, “A situation where the outcomes of investigations on unexpected events are not available to all team members does not encourage open communication, neither does it encourage them to report and act on minor problems.”

***Response theme: Training and skills application.*** Training and skills application was the most suggested theme in the use of HROs principles. Most (19 out of 24) participants (79%) indicated that training team members and encouraging them to apply acquired skills were indispensable to getting them to build effective risk awareness, exercising discretion about solving problems, and reliance on experts rather than leaders to facilitating an effective response to problems. P5D/USuP, a certified project manager (PMI and Prince 2) noted, “irregular training does not only create capacity gaps and reduce people’s confidence to act, but it is also the main reason for poor knowledge documentation, lax commitment to analyzing problems, forecasting errors, and ineffective response to problems.” In this context, P3B/SuP, a certified civil engineer with 22 years working experience in the Nigerian construction industry said:

> I have noticed, over the years, that team leaders and members who were subjected to regular technical and relationship training were more effective at

managing both relational and project issues than their counterparts who were not subjected to regular training.

P5A/USuP, a chartered quantity surveyor with 20 years experience in the Nigerian construction industry, argued, “Training improves risk and communication awareness, and helps team members to cultivate the idea that both leaders and their subordinates are collaborators in mitigating unexpected events, and in ensuring the success of projects.”

**Combining mindfulness with Information systems management (ISM)**

Four (4) themes emerged when participants described how information systems management (ISM) was combined with HRO principles to facilitate an effective response to unexpected events. The themes were, 1) Weak signal management, 2) Information management, 3) Communication management, and 5) Team management, (see Table 14).

*Table 14*

*Research Question 2, Use of HRO Principles and ISM: Aggregated Response Themes*

| Response theme | Interview sub-question | Preoccupation with failure dimension | Reluctance to simplify | Sensitivity to operations | Commitment to resilience | Deference to expertise |
|---|---|---|---|---|---|---|
| Weak signal management | 4, 5, 6 | Yes | Yes | Yes | NO | NO |
| Information management | 4, 5, 6, 9 | Yes | Yes | Yes | Yes | NO |
| Communication management | 5, 10 | Yes | NO | NO | Yes | NO |
| Team management | 9, 10 | NO | NO | NO | Yes | Yes |

***Response theme: Weak signal management.*** Weak signal management emerged as a theme identified by all participants (100%) for both successful and unsuccessful projects. Participants rallied the idea that the effective management of weak signals was critical to how project team members regarded close calls and near misses, captured and reported information necessary to inform decisions that impact the timely execution of project activities, and the attitude of team members towards gathering and reporting feedback on things that are not going according to plan.

Participants identified lax attitude to IT-based trend analysis and restrictions on IT in reporting problems as key issues that reduce the capacity of project teams from predicting and contain minor errors or near misses effectively. P3A/SuP noted, "Procedures for reporting problems were not only cumbersome but were mostly done manually. Manual reporting discouraged people from reporting a complex issue, and encouraged them to ignore minor problems." P5B/USuP, a project manager, with Prince 2 certification, a Cisco Certified Network Associate (CCNA) with 12 years work experience, and one of the few participants with knowledge of HRT (see Table 4) argued, "Lax IT-driven weak signal management did not only encourage team members to ignore procedures, it also discouraged them from ensuring adequate documentation of failures that occur on a project." In line with P5B/USuP, P4D/SuP argued:

> Relying on the analytic capacity of the human mind and his ability to sense problems, and combining such capabilities with information systems management as the primary drivers of failure analysis should motivate project teams to using IT consistently in failure analysis. It should also influence them to rely more on the views of experts, undertake significant failure analysis, and failure extrapolation. Persons with such mindset and who are dependent on data-

> driven analysis would not consider recovery from adverse events as a routine and are bound to be sensitive and react to events that are not going according to plan appropriately.

Several participants noted that the complexity of modern construction projects makes it expedient to integrate team attitude and work processes with IT. P4B/USuP said, “Even though my company currently use Information Technology (IT) to accommodate and support many of the processes previously handled by cognitive information processing, there is room for improvement”

***Response theme: Information management.*** Information management emerged as an important theme suggested by 21 participants (88%) in response to questions relating to how IT can be combined with mindfulness, as revealed by HRT, to facilitate an effective response to unexpected events. Participants noted the importance of effective information management to managing *close calls* and *near misses*, capturing and reporting information necessary to inform decisions on adverse events, and the level of discretion allowed team members to exercise prerogative over the use of IT in failure analysis. Recommendation in a document dated September 12, 2013, provided by Company B on P7, a project considered unsuccessful because it was subject to time overrun of 29 months, cost overrun of 73%, and suspended for 6 months (see Table 7) proposed:

> All team members should have free access to all project information on an ongoing basis. Team members should have unhindered access to reports on unexpected events, unlimited opportunities and protection to report failure in

real-time through a flexible IT infrastructure that allows for open communication.

Most participants were unanimous on the advantages of a robust information system. P6D/USuP and P2B/SuP were of the opinion that an efficient information system combined with training could improve the attitude of team members toward the collection and use of information. P3C/SuP opined, "Implementing a robust information system should enhance collaboration as team members a abler to provide and access information on the fly, and are less likely to postponed capturing and transmitting problems to team leaders or subject experts who may not be on site." The 6 participants who had an explicit knowledge of HRT opined that ISM was indispensible to effective weak signal management. For instance, P1A/ SuP said, "Using Information systems management to facilitate the 5 cognitive processes of HRT is key to quickly and accurately identifying and dealing with the complex interrelationships present in construction projects."

***Response theme: Communication management.*** Nineteen (19) participants, 10 of who gave perspectives on successful projects and 9 on unsuccessful projects identified factors bordering on communication management in response to questions about whether team members gave greater priority to information analysis of advocating the views of members, and their frequency of deferring to information technology expertise when there was a problem. The Introduction of a report dated February 11, 2014, provided by Company A on P3, a project considered unsuccessful because it was subject to time overrun of 8 months and cost overrun of 38% (see Table 7) noted:

> To effectively integrate IT with any process in construction projects, it is important to have a systematic plan to implement, monitor and revise all channels of communication with the team and between the team and other parts of the organization."

P1C/SuP noted that the successes achieve on P10 were partly due to, "Clarity on channels of communication and dissemination of new communication directives within the project team, between the team and the organization and entire communication network using an appropriate communications technology." However, all participants (9), that gave perspectives for unsuccessful projects and identified communication management as an essential requirement for effective IT integrate with construction process opined that their organizations did not have a well defined communication strategy. P4B/USuP noted:

> My Company has been trying to develop a comprehensive communication strategy for as long as I can remember. But the company had yet to come up with clear internal and external communications directives, which could enable teams to manage effectively the complex flows of information needed to track, analyze and response to unexpected events that occur, daily, in our projects.

On the attitude of leaders towards open communication, P1D/SuP remarked, "Sometimes project manager, in a bid to impress bosses, are poised to do everything, and this amounts to micromanagement. They do not possess all the skills, cannot be at all the points in the project, and their preference for centralized decision-making often result in slow decision-making, poor collaboration and coordination, and a diminished sense of personal accountability." In conclusion, the aggregate response of participants was for a robust IT-driven communications system that addressed questions concerning information that needed to flow in and out of the project, recipients of different information, frequency and format of information, and those responsible for disseminating different information.

***Response theme: Team management.*** Seventeen (17) participants (71%), 8 of who gave perspectives on successful projects and 9 on unsuccessful projects identified team management as a key factor that affect the leverage allowed team members to exercise discretion in the use of information technology (IT) in the management of unexpected events, and the frequency at which they defer to IT expertise when confronted with both minor and complex problems. P6B/USuP noted that even though the IT infrastructure was available, the attitude of the project leader for Project P9 "Did not help matters because she focused more on achieving milestones than ensuring that team members were actively engaged in IT-driven collaboration and whether minor issues that caused misunderstanding within the team were properly resolved." P6C/USuP commenting on project P17 explained:

> While team members were eager to meet deadlines, there were restrictions on the use of IT tools in problem analysis, had limits on exercising personal discretion in times of emergency, and often did not have access to information about what happened in parts of the project that was not under their duties. This did not allow for clarity of situational assessment, and we were often left with only vague answers to critical questions.

In line with P6C/USuP, P3A/SuP, P1B/SuP, P2C/SuP and P5D/USuP rallied the idea that team members had limited advantage to exercise discretion in the use of IT when problems occurred. P5D/USuP said, “Because team members were not incentivized to exercise personal discretion in the use of IT, they were not motived to exercise personal discretion to undertake IT-based problem resolving. P1B/SuP argued, “Effective team management is fundamental to meeting increased expectations to deliver quality and highly complex projects faster while adapting as rapidly as possible to change.” P5D/USuP surmised, “Effective team management should not only focus increasingly on becoming agile and collaborative, but should also be data driven because of the volume of information shared across the organization and within the team.”

**Summary**

In Chapter 4, I described how the research data were collected, recorded, and analyzed, and presented the results that emerged from the data. The purpose of this qualitative exploratory case study was to gain an in-depth understanding about how project teams can combine mindfulness, as revealed by High Reliability Organizations (HROs), with information systems management (ISM) to respond effectively to unexpected events during the execution phase of Nigerian construction projects. I derived 2 research questions from a central research question and organized 10 interview questions around the two research questions answered by middle to upper-level construction experts such as architects, quantity surveyors, engineers, and project managers, involved in Nigerian construction projects. I interviewed 24 participants and analyzed their perspectives to create 24 themes, 9 for research question 1, and 15 for research question 2 as shown in Table. I organized the themes around the 2 research questions, and 6 categories, namely: Unexpected events, effects of unexpected events, reasons for unexpected events, use of information systems, use of HRO principles (mindfulness), and combining mindfulness and ISM.

**Summary: Research Question 1.** *What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects?* Participants' responses revealed that unexpected events that cause delays and disruptions in construction projects could be categorized as failures, near misses, and surprises. Participants noted that failures were often due to faulty equipment, technological failures, and error judgments; near misses principally sufficed as costs that were in excess of planned estimates, completing tasks later than planned delivery estimates; while surprises were mainly due to labor and material shortages, sub-contractors not meeting expectations, and scope changes required by clients.

**Summary: Research Question 2.** *How **does** combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects?* Participants' responses revealed that combining mindfulness with information systems could facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects by:

1. Reducing or completely eradicating reliance on human memory, which is often prone to errors.
2. Ensuring direct and real-time access to project information
3. Enabling team members to avoid data duplication or multiple date entry, which should reduce data errors.

4. Ensuring accurate analysis and extrapolation of data to predict the possible occurrence and impact of unexpected event

**Summary: Central Research Question.** The central question that guided this study was: *How **can** project teams combine mindfulness as revealed by High Reliability Organizations (HROs) with Information Systems to respond adequately to unexpected events during the execution phase of Nigerian construction projects?* I derived the two research sub-questions from the central question. Note that while research question 2 asked, "How does…" the central research question asked, "How can…" In this context, while the response to research question 2 was intended to provide an in-depth understanding about the *effect* of combining mindfulness with information systems management, the purpose of the central research questions was to *gain an in-depth understanding about the factors that should enable project teams to* combine mindfulness, as revealed by HRT, with information systems management. Indeed, research questions 1 and 2 were relevant to the central research question because having knowledge of the types, causes, and effect of unexpected events, and understanding *the effects* of combining mindfulness with information systems management, should provide a better understanding of *the factors* that should enable project teams to combine mindfulness, as revealed by HRT, with information systems management.

Consequently, in answer to the central research question, the study revealed that project teams could *combine mindfulness, as revealed by High Reliability Organizations (HROs), with Information Systems to respond adequately to unexpected events during the execution phase of Nigerian construction* projects by:

1. Implementation of an appropriate IT infrastructure. Such infrastructure should account for weak signal management, information management, communication management, and team management.
2. Subjecting team members to regular training and encouraging them to apply acquired skills. Regular training should improve not only the skills of team members but also their attitude towards unexpected events and the use of information systems
3. Implementation of a risk management strategy that is geared towards continuous improvement of risk awareness of team members through clearly defined methods of managing feedback within the team, providing feedback to higher authorities, and making the best use of lessons learned.

In chapter 5, I shall summarize and provide an interpretation of the key findings in the context of the literature and the conceptual framework. Drawing on my findings and their interpretation, I shall recommend how project teams might combine the principles of mindfulness, as revealed by HRT, with ISM to manage unexpected events, discuss opportunities for future research, and the implications of this study for social change.

# Chapter 5: Discussion, Conclusions, and Recommendations

## Introduction

The purpose of this qualitative case study was to explore how project teams could combine the 5 principles of mindfulness, as revealed by High Reliability Theory (HRT), with Information Systems Management (ISM) to identify weak signals and predict unexpected events during the execution phase of Nigerian construction projects. The 5 principles of mindfulness, revealed by HRT, and adopted as a lens for this study were, (1) preoccupation with failure, (2) reluctance to simplify interpretations, (3) sensitivity to operations, (4) commitment to resilience, and (5) deference to expertise (Weick & Sutcliffe, 2011, p. 9-18). The exploratory case study design was suitable because it enables a researcher to undertake a study effectively from the perspective of those who experience the phenomenon or partake in the activities, events, and processes that define them (Yin, 2014). It was important to conduct this study because several studies show that between 50% and 70% of Nigerian construction projects encountered some delay due to lapses in reliability, inadequate response to unexpected events (Ameh & Ogundare, 2013; Idoro, 2012; Idoro, 2012), or inadequate use of Information Technology (IT) (Hosseini et al., 2013).

While few studies had explored how mindfulness (Akinsiku & Akinsulire, 2012; Idoro, 2012) or information technology (Olalusi & Jesuloluwa, 2013; Ashford et al., 2012) enabled team members to achieve resilience in the management of unexpected events in Nigerian construction projects, I could not find any studies on how project teams can combine mindfulness, as revealed by HROs, with ISM in managing unexpected events during the execution phase of Nigerian Construction Projects.

The research questions were focused on the essense of construction experts such as architects, quantity surveyors, engineers, and project managers, and how they combine mindfulness and ISM to facilitate an effective response (anticipate, predict, identify, analyse, and contain) to unexpected events during project execution. Key findings are in accord with the principles of mindfulness, as revealed by HRT and the effect of adopting information systems management in construction projects encountered in the literature reviewed in Chapter 2. The impact of mindfulness on construction projects frequently depended on how it is combined with contingency planning, and a systematic approach to activity or process failure (Lee & Diekmann, 2011; Yang & Kao, 2012). Also, ISM enables project teams to have and process accurate and timely information that enables them to identify and respond efficiently to the risk paths and weak signals likely to cause failures (Holopainen & Toivonen, 2012; Taroun, 2014; Zhao, Hwang, & Yu, 2013).

Findings from the study revealed that while the attitude of team members, risk management, team management, communication, and training were essential to enhancing high reliability and efficient management of unexpected events in construction projects, IT was indispensable to an ongoing identification and effective response to unexpected events in Nigerian construction projects. However, I found that while 63%) of participants revealed that the use of IT in the management of unexpected events in Nigerian construction projects was insufficient, and 92% suggested the need to not only implement a viable IT infrastructure for project execution, but also to train teams on their use, and encourage them to use the system in facilitating an effective project execution. Also, the study revealed the need to implement a risk management strategy that is geared towards continuous improvement of risk awareness of team members through clearly defined methods of managing feedback within the team, providing feedback to higher authorities, and making the best use of lessons learned. Findings from the study also revealed that combining mindfulness with information systems could facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects by reducing or completely eradicating reliance on human memory, ensuring direct and real-time access to project information, enhancing data integrity, and facilitating accurate analysis and extrapolation of data to predict the possible occurrence and impact of unexpected event.

**Interpretation of Findings**

This section focused on the interpretation of the study’s findings. The 2 research questions represent the core of the interview questions and participants’ responses as they spoke directly concerning unexpected events, the use of information systems management, and the application of High Reliability Organization (HRO) principles during the execution phase of Nigerian construction projects. Their responses gave a in-depth understanding about how 1) combining team mindfulness with Information Systems Management (ISM) could facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects 2) project teams could combine mindfulness, as revealed by High Reliability Organizations (HROs), with Information Systems Management (ISM) to respond adequately to unexpected events during the execution phase of Nigerian construction, and 3) to improve the use of information systems during the execution phase of construction projects.

A discussion was made concerning how the data relates to the literature. Indeed, the literature reviewed in Chapter 2 comprised books, peer-reviewed journals and articles, conference papers, Internet resources, press reports, government and non-governmental depositories that supported the prevalence and consequences of unexpected events in construction projects (Gunduz et al., 2012; Olawale & Sun 2015; Yang & Kao, 2012). The reviewed literature also supported the use of High Reliability Organization (HRO) principles (Carlo et al., 2012; Mitropoulos & Memarian, 2012; Olde Scholtenhuis & Dorée, 2013) and Information Systems Management (ISM) (Bemelmans et al., 2012; Ashford et al., 2012; Hosseini, Chileshe, Zou, & Baroudi, 2013), respectively in construction projects.

Also, a discussion was made concerning how the data relates to the conceptual framework, how the combining mindful with ISM necessitates a modification of the conceptual framework to facilitate an effective response to unexpected events during the execution phase of construction projects. Modifying the conceptual framework to reflect the use of ISM was in based on the responses offered by participants. To participate in the study, the criteria specified that the project expert must have a minimum of a first degree in architecture, quantity surveying, any of the relevant engineering professions, or projects management. The inclusion criteria also specified a minimum post-graduate experience of 5 years. Participants were to give perspectives on either a project considered successful as defined by Chipulu et al. (2014) and Winch (2010), or one considered unsuccessful for: 1) exceeded its time estimate by six months, 2) exceeded its cost estimate by 25%, 3) required external arbitration, and 4) was suspended for at least six months, 5) abandoned completely, or any combination of these. In addition to the perspectives given by participants, I reviewed certain documents (e. g. document dated September 12, 2013, provided by Company B on P7, and report dated February 11, 2014, provided by Company A on P3) provided by the research partners and included relevant insights in the study results.

**Research Question 1**

Research question 1: *What are the unexpected events that cause delays and disruptions during the execution phase of Nigerian construction projects?* The 2 interview questions captured three categories necessary to understanding unexpected events. As shown in Table 9 and Table 10, these included unexpected events, effects of unexpected events, and reasons for unexpected events.

**Unexpected events.** All participants (for both successful and unsuccessful projects) revealed that their projects have experienced some form of unexpected events (See Appendix G: Data for Research Question 1: Themes by Participant Response). Their unanimous response concerning the occurrence of unexpected events in both projects considered successful and those considered unsuccessful aligns with the reviewed literature that suggested the prevalence of unexpected events in construction projects (Amoatey et al., 2015; Doloi, Sawhney, Iyer, & Rentala, 2012) and Nigerian construction projects in particular (Idoro, 2012).

Participants revealed three dimensions of unexpected events, namely: Failures, near misses, and surprises. These dimensions were also revealed in the literature (Patzelt & Wolfe, 2011; Weick & Sutcliffe, 2015; Williams et al., 2012). While participants did not directly link the three dimensions of unexpected events to weak signals, their descriptions of events considered to be unexpected indicted that such events sufficed as weak signals that later cascaded into catastrophic events, as indicted in the literature.

Participant PA5/USuP noted, "On several occasions, substandard materials were accepted and used. Most times it did not cascade into major issues, but it once led to the collapse of a large chunk of the concrete slab in an upper deck." PA6/USuP stated, "faulty equipment led to 8 months suspension of a project; a suspension that caused time overrun of 2 years and over 50% cost overrun." Reponses by PA5/USuP and PA6/USuP seem to suggest that use of substandard materials and faulty equipment were undetected until their consequence became catastrophic. The non-vigilance of team member to such minor issues such as fault in equipment and considering minor deviation for what was considered an appropriate material led to grave consequences.

In this context, participants' views aligned with the literature, which identified weak signal as units of anticipatory strategic information by which an organization scans its environment to identify opportunities for reducing uncertainty and risks (Williams et al. 2012). Participant P2B/SuP commented, "Once we exceed the planned delivery of a milestone by two days because a subcontractor was unable to complete delivery of reinforcements needed for that milestone. The company did not only incur a cost but also needed extra two days to complete that milestone." It possible that the company in question was incompetent and activities pointing to her incompetence were ignored or went undetected in the chaos of construction activities, a point noted by Pinto (2014) in the literature; or because the team were not focused on failure or the future consequences of not making a delivery on time. In the literature, Weick and Sutcliffe (2015) noted that unreliable outcomes ensued when cognitive processes were unstable and no longer focused on failures, sensitivity to operations, and unexpected events.

**Effects of unexpected events.** Participants identified 2 effects that result from unexpected events in Nigeria construction projects. These were, *operational effects* and *relational effects*. Operational effects covered the reenactment of processes and activities due to an unexpected event and the consequences that occurred because of such reenactment (e.g. rework of project items). Relational effects covered relational consequences of unexpected events (e.g. adversarial relationships). Seventeen participants (71%) explained that unexpected events often led to *rework*, time, and cost overruns. Perspectives offered by participants were in tandem with the literature review where Aziz and Hafez (2013) indicated that up to 45% of delays in construction projects, contributing as much as 50% of a project's total overrun costs, were due to reworks. Also, 18 participants (75%) noted that unexpected events had relational effects such as disputes between stakeholders, and adversarial relationships between team members. P7A/USuP revealed that an unexpected event was the primary reason why project P7 was abandoned. P7A/USuP noted, "An unexpected equipment failure significantly degraded project cost and schedule performance. Team members blamed each other, and the procurement and facilities managers resigned…the core team had to return to Germany, and the project was abandoned." However, while participants attributed relational effects to the occurrence of unexpected events, the literature attributed relational effects such as adversarial relationships to complexity of modern construction project execution (Bemelmans et al., 2012; Jacob, 2013), insufficient use of ISM (Bemelmans et al., 2012; Braglia, & Frosolini, 2014), poor coordination and collaboration (Ashford et al., 2012; Porwal & Hewage, 2013). Therefore, it can be argued that while participants held unexpected events as drivers of relational effects, the literature held the opposite; suggesting that relational factors were the drivers of unexpected events. In reality, while perticipants and the literature seem to hold opposing views, as shown in *Figure 2.* Cyclical relationship between relational effects and unexpected eventsthey actually indicte a cyclical relationship between *unexpected events* and *relational effects,* mediated by factors such as nature of project, team integration, and other elements of the interation such as nature of project, team integration, and infrasture used to facilitate integration (e.g. IT) which were identified in the literature (Izam Ibrahim et al., 2013; Porwal & Hewage, 2013). It also interesting to note that more participants (75%) sited relational effects than operational effects (71%). In this context, it could be argued that paying close attention to the health of relationships between team members is key to managing unexpected events because, as shown in Figure 2, there exists a cyclical relationship between unexpected events and relational effects.

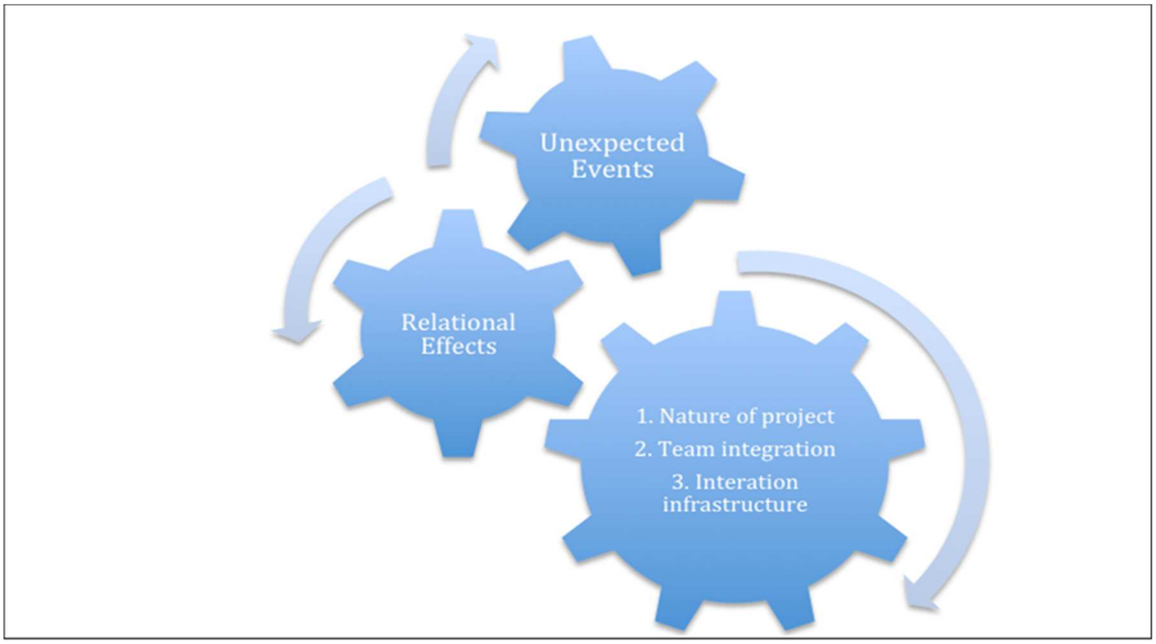


*Figure 2.* Cyclical relationship between relational effects and unexpected events

**Reasons for unexpected events.** Participant identified 4 principal themes in suggesting reasons for the occurrence of unexpected event, namely: Environmental instability, lapses in organizational management, attitude/behavior of team members, and lapses in plans and benchmarks. The reviews literature identified reasons for unexpected events based on three categories: clients/project owners (Ameh & Ogundare, 2013; Kazaz, Ulubeyli, & Tuncbilekli, 2012), contractors (Akinsiku & Akinsulire, 2012) Ameh & Ogundare, 2013) and consultants (Doloi et al., 2012). A survey by Shehu et al (2014) aggregated several perspectives and categorised the reasons for unexpected events under perspectives of consultants, clients, and contractors.

However, while most causes of unexpected events identified in the literature were also identified by participants, most participants (92%) indicated that the attitude of team members was a key reason for the occurrence of unexpected event, ahead of Environmental Instability (88%), Lapses in Organizational Management (88%), and Lapsing in plans and benchmarks (67%) (See Appendix G: Data for Research Question 1: Themes by Participant Respons). P2D/SuP noted, "Apart from the disconnectedness in team collaborative efforts, project team members over-rely on human memory instead of using the information systems to analyze problems." *Over-reliance on human memory*, lax attitude towards gathering feedbacks, and poor sense of personal accountability identified by participants, and all of which were attitudes that could trigger unexpected events, were not identified in the literature. P5C/USuP noted, "lax attitude towards gathering feedbacks on things that were not going according to the plan was mainly due to reduced sense of personal accountability, over reliance on convention."

In this context, P2C/SuP was of the view that the "lax attitude of team members towards minor error was more because they do not always have direct access to information that should enable them to act on errors or minor misses." The reviewed literature revealed that *clients* were more concerned with financial issues, *contractors* considered contractual relationships, and *consultants* considered project management issues (Ameh & Ogundare, 2013; Shehu et al., 2014). None of these studies considered how the attitude/behavior of *clients*, *contractors, and/or consultants* affected the issues in which they were interested. For instance, participants cited corruption as a major issue in all the 4 principal response themes identified as reseasons for unexpecte events in Nigerian construction projects (see Table 10). Under response them: Attitude/behavior of team members, participants also cited greed, failure to follow rules, slow decision making and unethical professional practices as reasons for unexpected events (see Table 10). The aforementioned considerations could affect factors cited for response theme: 1) Environmental instability, 2) Lapses in organizational management, and 3) Lapsing in plans and benchmarks.

Also, both the literature and the participants identified learning as a tool that could be used to guide and encourage team members to exercise better discretion towards project issues. Learning, in this context, is creating, retaining, and transferring knowledge, and applying that knowledge to solving problems in construction projects (Bartsch, Ebers, & Maurer, 2013; Wong, Cheung, Yiu, & Hardie, 2012). The literature revealed that the degree of responsiveness of construction project teams to unexpected events reflects in how they harness their efforts for adaptability, learning from experience, interpreting emerging situations, and devising an appropriate response strategy (Koh & Rowlinson, 2014; Weick & Sutcliffe, 2011). The literature also revealed that the functioning of HROs precludes learning by experimentation (Weick & Sutcliffe, 2011). Weick & Sutcliffe (2011) noted that learning enabled team members to reflect on facts that generate problems, gather appropriate information about problems, and combine information management (ISM) with mindfulness to collect, report, and respond to problems. Nineteen participants (79%) indicated that training team members and encouraging them to apply acquired skills were indispensable to getting them to build effective risk awareness, and exercising discretion about solving problems. P5D/USuP, a certified project manager (PMI and Prince 2) noted, “irregular training does not only create capacity gaps and reduce people’s confidence to act, but it is also the main reason for poor knowledge documentation, lax commitment to analyzing problems, forecasting errors, and ineffective response to problems."

Therefore, based on the literature and participants' responses, I am proposing 4 dimensions for analyzing the causes of unexpected events in construction projects. These dimensions are, 1) Financial issues – funding, payment arrangements, price fluctuation, inflation, and irregular payments, etc., 2) Contractual issues – adversarial relationships (with team, between stakeholders), ineffective contract management, and inefficiency of contractors, etc. 3) Project management issues – preparation and approval of drawings, incessant design changes by clients, slow decision-making, design error, shortage of manpower, and inadequate labor skills, etc., 4) learning issues – training, staff experience, capacity to interpreting emerging situations, and the ability to devise appropriate response strategies, 5) Attitudinal Issues – corruption, greed, failure to follow rules, slow decision making, and unethical professional practices, etc. In this context, I am proposing a new framework for identifying, analyzing, and dealing with causes of unexpected events in construction projects as shown on *Figure 3.* Framework for

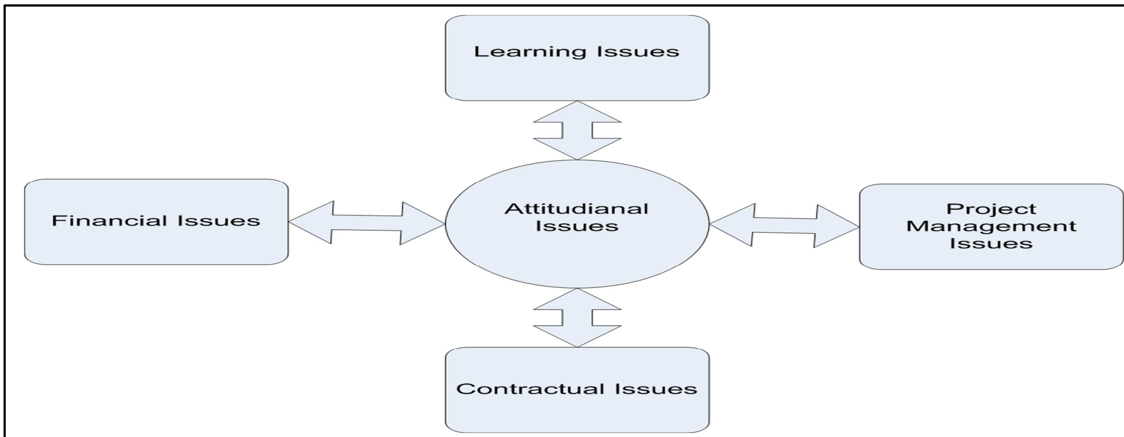


*Figure 3.* Framework for analyzing the causes of unexpected events.

analyzing the causes of unexpected events.

Consquently, I argue in this study that personal attitudes could influence the issues that cause unexpected events found in the literature (Ameh & Ogundare, 2013; Akinsiku & Akinsulire, 2012; Shehu et al., 2014) to be most important to clients, contractors, and consultants. However, apart from Idoro (2012) who based his investigation on clients, attidinal issues such as corruption and greed did not feature prominently in the literature review. Therefore, perspectives offered by participants in this study is revealing and contributes to an in-depth understanding of the issues that cause unexpected events because all participants were selected from contracting firms and by virtue of their professional affiliations are qualified to become consultants.

**Research Question 2**

Research question 2: *How does combining team mindfulness with Information Systems facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects?* The nine interview questions designated for Research Question 2 were subdivided into three sections: Information systems management, mindfulness, and combining mindfulness with information systems. Themes that emerged were also organized around the three core elements under the headings: 1) Uses of HRO principles (mindfulness), 2) Use of information systems, and 3) Combining mindfulness with information systems.

**Use of information systems.** Participants' discussion on the use of information systems revealed three core elements: 1) Sufficiency of information systems, 2) Effective strategies used, and 3) Recommendations for improvement. As shown in Table 11, the 3 elements mentioned above covered 7 principal themes concerning the use of information systems management. Also, both the literature (Olalusi & Jesuloluwa, 2013; Shehu et al., 2014) and participants suggested that Nigerian project teams did not use information systems sufficiently during the execution phase of Nigerian construction. While 63% of participants held that the use of information systems management (ISM) was not sufficient, 4 (20%) out of the 9 (37%) participants who suggested that the use of ISM was sufficient opined the need to improve the use of ISM during the execution phase of Nigerian construction projects (see Appendix H).

Both the literature (Olalusi and Jesuloluwa (2013) and participants agreed on the inconsistent use of ISM in the management of Nigerian construction projects. P6D/USuP noted, "Despite the fact that participants used information technology in their daily routines during project execution, they hardly leverage capabilities provided by information systems during project execution. P3C/SuP said, "I think the available technology and information systems … are sufficient, but are not the well-utilized mechanism or not used consistently throughout the project execution phase…I think there is room for improving how we use information systems."

Perspectives revealed by participants and those found in the literature also revealed the importance of implementing an appropriate IT infrastructure. In suggesting the importance of an appropriate IT infrastructure to managing unexpected events effectively, Schoemaker et al (2013) noted that a combination of errors, ineffective and inefficient decisions could be exacerbated by the absence of an integrated and/or systematic information system (IS). The literature revealed also that data handling is more cost-effective and less prone to error where an appropriate IT infrastructure is used in managing construction projects (Olalusi & Jesuloluwa, 2013;Porwal & Hewage, 2013). In line with the literature, P5D/USuP noted that "implementing an organization-wide IT infrastructure should enhance data management and real-time trend analysis" P1A/SuP suggested that an integrated IT infrastructure was relevant to structured data management, avoiding incessant data reentry and uncertainty in reporting events**.**

The literature reviews and views offered by participants identified the importance of open communication to the effective use of information systems management on construction projects**.** P2D/SuP noted how open communication was improved on project P14 by creating a project forum that was accessible to the team and all project stakeholders. It was found in the literature that efficient communication was emerging as a key determinant of construction project performance (Caniëls & Bakens, 2012). Participants also revealed as did the literature (Ashford et al., 2012; Porwal & Hewage, 2013) that nformation Systems could be used to support coordination and collaboration, while reducuing functional silos, and adversarial relationships among project participants. P6B/USuP suggested that "when failure arises due to over-reliance on memory, project actors resort to blaming each other, creating misunderstanding between team members, and adversarial relationships capable of obstructing the progress of the project."

Both the literature and participants recommended the use of recgular training as a tool for improving the use of infromation systems in construction projects. While, in the literature Olalusi and Jesuloluwa (2013) revealed that 26% - 50% of staff in the Nigerian construction industry have had some form of computer training, several participants noted that poor information systems management skills were a key issue. P3D/SuP opined, “Apart from many professionals not being up-to-date with their information systems management skills, those who managed to continually update their abilities often make poor use of those skills.” It could be argued that team members often made poor use of IT skills either because 1) the right training was not offered, 2) team members lacked the appropriate foundation for assimilating training objectives effectively, 3) team member were not encouraged to apply their skills. However, while the need to encourage team members to use their IT skills did not occur in the literature, it was a theme suggested by 19 (79%) participants (see Appendix H). P2C/SuP surmised, “When the use of IT skills are encouraged, the people who use the solution become more at home with the system, and depend in large part on it to improve productivity.”

Consequently, perspectives offered by participants concerning the inadequate use of information systems, the importance of an appropriate IT infrastructure, the importance of open communication, and the need for regular training. However, the study extended the literature by suggesting the need to encourage the use of IT skills acquired during training. P5D/USuP argued, “Having a sophisticated information system in place, and training staff to use the system would yield minimal results if they are not encouraged to use the system.” Most participants argued that encouraging team members to leverage on their IT skills adequately would make them less reliant on human memory and instinct, and become more productive.

**Use of HRO principles (mindfulness).** Participants identified 5 themes in their discussion of the use of HRO principles (mindfulness) in Nigerian construction projects.

These were 1) Attitude of Team Members, 2) Risk management, and 3) Team management, 4) Communication, and 5) Training and use of Skills. The reviewed literature and participants held similar views on the importance of risk management, team management, communication, and training to the use of HRO principles in the management of unexpected events in construction projects.

Three participants noted that lax risk awareness was a key factor influencing the attitude of team members towards minor errors, the way they capture and report errors, and giving feedbacks on unexpected. P6C/USuP noted, “While a simple process can be used to manage risks, a riskaware team would regard small, inconsequential errors or misses as a symptom that something is wrong, and that thing could have terrible, I mean very terrible consequences.” Aminbakhsh et al. (2013) noted that the inability of project clients and contractors to systematically apply risk management practices to unexpected events often resulted in negative consequences for the performance of construction projects. Williams et al (2012) noted that the detection and aggregation of early warning signals could be enhanced by improving risk awareness and learning; an idea also rallied by P1C/SuP who argued, “A proper risk management system should have defined methods of managing feedback within the team, providing feedback to higher authorities, and making the best use of lessons learned.”

Furthermore, 63%, 71%, and 79% of participants identified *effective team management, communication,* and *training and use of skills*, respectively, as important requirements for the use of HRO principles in construction projects. 15 participants (63%) held that team management influenced how people acted to prevent errors.

P3A/SuP noted, "The way some leaders behave or drive team processes place restrictions on team member's freedom to exercise personal discretion when minor errors occur." P3A/SuP opinion is in tandem with the reviewed literature in which studies identified the importance of effective team management to collaboration and coordination (Porwal & Hewage, 2013; Schoemaker et al., 2013) and to improving team capability to detecting and responding effectively to weak signals likely to cause unexpected events during project execution (Kaivo-oja, 2012; Rossel, 2012; Osipova & Eriksson, 2013).

Indeed, both the reviewed literature and the study participants linked effective team management to communication, training, and risk awareness. Williams et al. (2012) indicated that the detection and aggregation of early warning signals could be enhanced by improving the quality of information, communication, risk awareness, decision location, guidelines, and technology, on one hand, and ensuring that clients and contrators set clear expectations, tackle team problem, training, and replacing missing competence in project teams. Perspectives suggested by participants aligned with the literature. For instance, P3C/USuP noted, "Team members should not only have access to communication resources, but should also be subject to equal conditions with a transparent relation between identifying, reporting and solving project problem, and sharing communication resources across multiple layers of communication." P5D/USuP said, "Irregular training does not only create capacity gaps and reduce people's confidence to act, but it is also the main reason for poor knowledge documentation, lax commitment to analyzing problems, forecasting errors, and ineffective response to problems."

However, while participants linked lapses in risk awareness, communication, and team management with the attitude of team members; the literature linked them to the complexity and uncertainties in construction project environments (Bourrier, 2011; Weick & Sutcliffe, 2011). Yang et al (2014) argued that the complexity and interdependencies of activities and tasks often exacerbated the possibility of unexpected events during the execution phase of construction projects. But P4A/USuP, P3B/SuP, P1C/SuP, and P5C/USuP opined that many team members often have inconsistent points of view and being eager to meet deadline do not take extra steps to probe events that slightly exceeded their targets. P2C/SuP was of the view that the "lax attitude of team members towards minor error was more because they do not always have direct access to information that should enable them to act on errors or minor misses."

Also, the finding that most participants (79%) considered Training and use of skills as the most important factor to enhancing an effective use of HROs principles in Nigerian construction projects, ahead of attitude of team members (71%) and communication (71%) is telling (see Appendix I). Indeed, findings from this study, shown in Table 4, revealed that despite 18 out of 24 participants (75%) not having an explicit knowledge of HRT, they unconsciously applied principles of HRT. Yet, the literature revealed that 50% and 70% of Nigerian construction projects encountered some form of delay due to lapses in reliability and ineffective response to unexpected events (Ameh & Ogundare (2013). Therefore, it could be argued that their lack of an explicit knowledge of and use HRO principles is having an adverse effect on projects. The data on Table 4 also revealed that qualification and professional affiliation in Nigeria did not portend knowledge of HRT, neither did the size of a construction firm determine whether a Nigerian construction firm would make a conscious effort to apply the principles of HRT. For instance, while company C had executed projects in 18 States of Nigeria, been operating in the country for 20 years (at the time of this study), executed projects between US$5.2 to US$12.3 Million, and was executing projects, the least of which had a value of US$28 Million, no participant from the company indicted having an explicit knowledge of HRT (see Table 4). Lack of explicit knowledge creates the need for training in the use of HRO principles, and could explain why projects experience unexpected events, and why teams managed unexpected events poorly.

**Combining mindfulness and ISM.** Participants identified 4 themes while fielding answers to questions intended to reveal how teams combine mindfulness, as revealed by HROs, with ISM in Nigerian construction projects. These were 1) Weak signal management, 2) Information management, and 3) Communication management, and 4) Team management. All the themes identified by participants were found in the literature review. For instance, on weak signal management, the literature revealed that an appropriate Information System should help teams to untangle project complexities required to gathering information on failures and detecting weak signals likely to cause failures (Irani & Kamal, 2014). P5B/USuP, argued, “Lax IT-driven weak signal management did not only encourage team members to ignore procedures, it also discouraged them from ensuring adequate documentation of failures that occur on a project.” Also, participants identified the importance of IT to not only the successful implementation of information management and communication, but also to the mangement of unexpected event in construction projects. P4D/SuP argued that when an information system is the primary driver of failure analysis it should enable project teams to facilitate consistent and data-driven failure analysis of events. A report dated February 11, 2014, provided by Company A on P3, a project considered unsuccessful suggested that a systematic plan to implement, monitor and revise all channels of communication with the team and between the team and other parts of the organization should enable effective integration of IT with construction processes. In a similar context, the literature revealed that IT-driven communication and information management in construction projects was found to enabled teams to effectively monitor tasks, activities, project performance, and their interrelationships (Idoro, 2012; Zegordi & Davarzani, 2012). The literature also revealed that the complexity of modern construction project execution makes it necessary to adopt information systems for managing team integration, and team coordination (Bemelmans et al., 2012; Jacob, 2013), manage technically related and nontechnical factors, guide policies, and workflow elements effectively (Bemelmans et al., 2012; Braglia, & Frosolini, 2014). Abanda et al (2015) showed how teams could use IT to integrate interactively complex and extremely hard to anticipate outcomes that would, otherwise, be impossible within acceptable timeframes.

However, while the extant literature supported the idea that independent application of mindfulness, as revealed by HRT, and information systems facilitated the identification and responses to unexpected events (Carlo et al., 2012, Weick & Sutcliffe, 2011; Zhou, Whyte, & Sacks, 2012) it did not clarify how combining them would affect a team's ability to identify and respond to unexpected events in construction projects. But response by participants indicted that combining mindfulness, as revealed by HRT, and information systems management should facilitate an effective response to unexpected events in construction project execution. Several particpants who did not have an explitcit knowledge of HRT identified the need to combine cognitive processes with IT. P4B/USuP said, “Even though my company currently use Information Technology (IT) to accommodate and support many of the processes previously handled by cognitive information processing, there is room for improvement.” Therefore, ideas rallied by participants revelaed that information technology (IT) and the cognitive processes underlying mindfulness were not antagonistic to each other when combined and applied during project execution. Indeed, the reviewed extant literature revealed that IT artifacts such as *Catia* could be used to facilitate the five cognitive processes of mindfulness to enhance team performance (Abanda et al. 2015). Interestingly the 6 participants who had an explicit knowledge of HRT opined that ISM was indispensible to effective weak signal management. For instance, P1A/ SuP said, “Using Information systems management to facilitate the 5 cognitive processes of HRT is key to quickly and accurately identifying and dealin with the complex interrelationships present in construction projects.” Therefore, I argue by my findings that combining ISM with stable cognitive processes could help construction project teams to manage unexpected events effectively because of the diverse ways in which such combination could facilitate the identification, forecast, revision and adaption of variable events.

**Conceptual Framework**

The conceptual framework discussed in Chapter 2 focused on the High Reliability Theory (HRT). HRT states that early identification of failures, in their covert state, allows interaction with fewer resources and greatest effectiveness in responding to them and the uncertainties that may result from them (Bourrier, 2011; Weick & Sutcliffe, 2011). HRT is theory proposes *Mindfulness as* state of conscious required to faciliate an effective response action that is moved away from the central authority towards the project event or process to interact with the unfolding situation (Roberts, Bea, & Bartles, 2001; Weick & Sutcliff, 2011). As discussed in Chapter 2 and shown on *Figure 1.* A mindful infrastructure for high reliability, Mindfulness, as revealed by HRT, comprises five (5) cognitive processes or dimensions: preoccupation with failure, reluctance to simplify interpretations, sensitivity to operations, commitment to resilience, and deference to expertise (Weick & Sutcliffe, 2011, p. 9-18).

The purpose of this exploratory case study was to gain an in-depth understanding of how project teams can combine mindfulness, as revealed by High Reliability Organizations (HRT), with Information Systems (IS) to respond adequately to unexpected events during the execution phase of Nigerian construction projects. The participants described the need for and how ISM could be used to enhance cognitive processes needed to facilitate the forecast, detection, revision and containment of unexpected events in Nigerian construction projects. P4B/USuP said, “Even though my company currently use Information Technology (IT) to accommodate and support many of the processes previously handled by cognitive information processing, there is room for improvement." P1A/ SuP said, "Using Information systems management to facilitate the 5 cognitive processes of HRT is key to quickly and accurately identifying and dealing with the complex interrelationships present in construction projects." Indeed, findings from this study reveals that ccombining ISM with the principles of mindfulness, as revealed by HRTs, can provide a better response to the management of unexpected events during the execution phase of construction projects, better than either ISM or the principles of HRT. Therefore, I propose a modification to the conceptual framework shown in *Figure 1.* A mindful infrastructure for high reliability to a new framework that

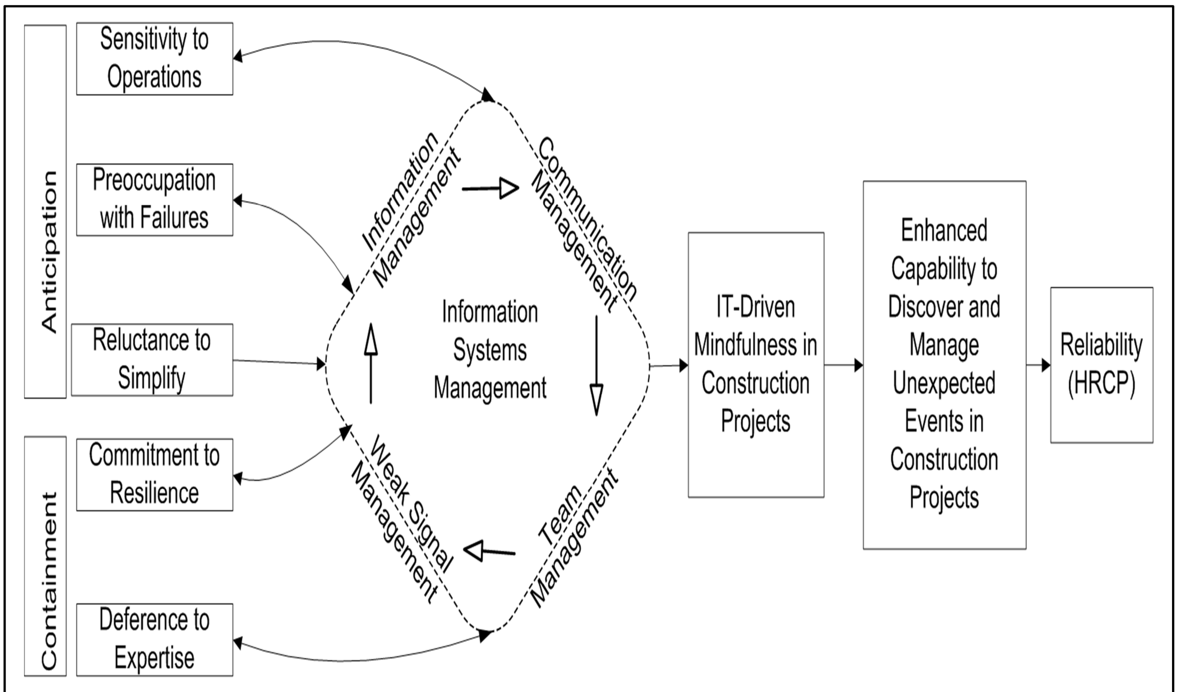


*Figure 4.* A mindful infrastructure for high reliability construction projects.
HRCP = High Reliability Construction Project
Adapted from Olde Scholtenhuis and Dorée (2013)

captures the essensce IT-driven mindfulness for driving high reliability in construction projects as shown in *Figure 4.* A mindful infrastructure for high reliability construction projects.

Consequently, a construction  project that meets the attributes identified on *Figure 4.* A mindful infrastructure for high reliability can be classified as a High Reliability Construction Project (HRCP). The framework in *Figure 4.* A mindful infrastructure for high reliability construction projects. modifies *Figure 1.* A mindful infrastructure for high reliability, which was adpted from Olde Scholtenhuis and Dorée (2013). In this concpetion, I define a *High Reliability Construction Project* (HRP) as one that combines the five cognitive processes of mindfulness, as revealed by High Relaibility Organizations (HROs), with Information Systems management (ISM) for early identification of failures to enhance interaction with fewer resources and greatest effectiveness in responding to them and the uncertainties that may result from them. My definition modifies the earlier definition of HRT following the insights of  Bourrier (2011) and Weick and Sutcliffe (2011), but added the element of Information Sytems Management (ISM).

**Summary of Key Findings**

Twenty-three out of 24 participants expressed that the use of IT-driven processes were essential to the management of unexpected events in Nigerian construction projects. Twenty-one out of the 23 participants who identified the need for IT-driven processes in the management of unexpected events suggested that combining ISM with mindfulness, as revealed by HRT, improved the ability to forecast, detect, and respond effectively to weak signals likely to cause an unexpected event. Participants also suggested combining ISM with mindfulness, as revealed by HRT, improved the ability to manage actual unexpected events that, inevitably, occurred during the execution phase of Nigerian construction project. Although the participants indicated that ISM have not been implemented effectively in Nigerian construction projects, participants suggested that the use of ISM improved the effective management of unexpected events in Nigerian construction projects

**Limitations of the Study**

The main purpose of this qualitative case study was to rich description of project experts' reality with respect to combining the five principles of mindfulness, as revealed by High Reliability Theory (HRT), with Information Systems Management (ISM) to facilitate and effective response to unexpected events during the execution phase of Nigerian construction projects. The intent of this exploratory case study was to gain an in-depth understanding of, and not to generalize about, unexpected events using HRT. The study had certain inherent limitations associated with participant selection requirement. First, the inclusion criteria for a project expert to participants required 1) a bachelor's degree, 2) minimum of 5 years post graduate experience, and 3) participation in project valued at US$3,000,000.00 and above. Specific knowledge of information systems management or high reliability theory was not a requirement. Second, all participants were determined to be working in the Abuja offices of their companies. Thus, excluding prospective participants who may have worked on the same project about which a participant gave perspective.

Indeed, excluding the knowledge of HRT in the inclusion criteria may have excluded participants who should have given deeper insights about the principles of HRT in construction projects. Besides, since all participants were knowledgeable in ISM (see

Table 4) setting the knowledge of HRT as an inclusion criteria should have improved the validity and reliability of the study as such participants could better understand how ISM and HRT should combine. Also, by focusing on participants who were working in Abuja, the study failed to account for those who may have worked on the same project, and who may have deeper insights that should have improved the study. Hence, a combination of the selection criteria and the location from which participants were selected for the study may have yielded participants who gave a limited perspective about the phenomenon under investigation.

## Recommendations

Findings from this study are of a preliminary character and, therefore, not intended as an attempt to draw definitive conclusions in presenting how HRO principles and ISM could be combined to facilitate an effective response to unexpected events during construction project execution. Generally, future studies need to examine construction's HRT lens in more detail. To this end, it might be necessary to investigate how more specific concepts of ISM management such as information security, attitude to IT, and learning can combine with HRT to improve an effective response to unexpected events in construction projects. Researchers should, therefore, place additional premium on refining, adapting, or extending the HRT lens for the management of construction projects. Such studies would require researchers to have a better understanding of both construction projects that are performing and those performing poorly.

As noted in the section, *Limitations of Study*, specific knowledge of ISM and HRT were not set as inclusion criteria for this study. Setting the knowledge of HRT as an inclusion criteria may have improved the validity and reliability of the study as such participants could better understand how ISM and HRT should combine. However, such a conclusion cannot be made without an empirical study. A future study could have a selection criteria that would yield a set of participants with knowledge in the use of both HRO principles and ISM.

Only 4 participants in this study had knowledge of the concept of HRT (see on Table 4). However, in responding to questions about unexpected events in construction projects, they all had a good grasp (though implicitly) of the concepts of HRT and have unconsciously applied the principles of HRT in their projects. A future study could investigate 1) the effect of an explicit knowledge of HRT on the performance of construction projects, 2) how the explicit knowledge of HRT facilitate an effective utilization of ISM with high reliability organization principles to facilitate an effective response to unexpected events during the execution phase of construction projects.

The data on Table 4 revealed that qualification and professional affiliation in Nigeria did to portend knowledge of HRT, neither did the size of a construction firm determine whether a Nigerian construction firm would make a conscious application of the principles of HRT. For instance, as indicated on Table 4, while company C have executed projects in 18 States of Nigeria, have been operating in the country for 20 years (at the time of this study), have executed projects between US$5.2 to US$12.3 Million, and was executing projects, the least of which had a value of US$28 Million, no participant from the company indicted having a knowledge of the concept of HRT. A future study could investigate the extent to which the use of the principles of mindfulness, as revealed by HRT, affects the performance of 1) construction projects, and 2) construction firms.

Nineteen participants (79%) recommended the need to encourage team members to apply their IT skills. They argued that encouraging the use of IT skills should improve the consistency of using IT for managing unexpected events. For instance, P5D/USuP argued, "Having a sophisticated information system in place, and training staff to use the system would yield minimal results if they are not encouraged to use the system." Also, , P2C/SuP surmised, "When the use of IT skills are encouraged, the people who use the solution become more at home with the system, and depend in large part on it to improve productivity. Future studies could focus on the specific factors that should improve attraction of team members to applying their IT skill for the management of unexpected events in construction project.

The requirement for effective risk management sufficed as an important theme revealed by 16 participant (67%) in this study. P4A/USuP noted, "lack of proper risk management is the reason why team members often propose simplistic explanations to minor errors, disregarding the possibility of other deep root causes of an event." P6C/USuP said, "A riskaware team would regard small, inconsequential errors or misses as a symptom that something is wrong, and that thing could have terrible, I mean very terrible consequences." Future research could focus on risk management strategies that combine IT and HRT in managing multilayered feedback during the execution phase of construction projects. Further studies could also consider the contributing factors to lax risk awareness in IT-driven management of unexpected events in construction projects.

Finally, I argued, based on my findings, that personal attitudes could influence the issues that clients, contractors, and consultants considered the most important factors that cause unexpected events (see *Figure 3.* Framework for analyzing the causes of unexpected events. Further studies could focus on the effects of different attitudes (e.g. corruption, greed, failure to follow rules, slow decision making, and unethical professional practices) on issues that were important to clients, contractors, and consultants such as funding, payment arrangements, contract management, – preparation and approval of drawings, decision making, learning, capacity to interpret emerging situations, and the ability to devise appropriate response strategies to emerging situations or unexpected events. Future studies in these areas could be cross-sectional longitudinal. Researchers may also conduct studies that use single or multiple regression models to test the relationship between the different attitudes of team members and the issues identified to be important to clients, contractors, and consultants.

## Implications

The primary purpose of qualitative studies is to obtain an understanding of social construction by examining and interpreting the views of participants (Gray, 2013; Maxwell, 2013; Patton, 2015). The findings of the study should contribute to the body of knowledge in the field of information systems management, project management, and the theory of High Reliability. Indeed, haven examined the relationship between the lived experiences of project actors such as architects, quantity surveyors, engineers, and project managers with respect to the use of information systems management and mindfulness, as revealed by HRT, the management of unexpected events during construction project execution becomes clearer. Findings from this study can be useful to several social dimensions: the individual project actor, the organization, and the society/policy. It can also have theoretical implications in the study of unexpected events in construction projects.

**Social Change: Individual**

The findings of this study could have positive social impact by providing individual project actors such as architects, quantity surveyors, engineers, and project managers knowledge that could improve their project management practices and the management of construction projects in general and the management of unexpected events during project execution in particular. A common theme that emerged from this study was the need for practitioners to pay close attention to team management. Participants noted that the way a team is managed affects the attitude of team members and their motivation to exercise personal discretion in response to problems, defer to expertise when confronted with either minor or complex problems, collaborate, and use information systems. Seventeen (17) participants (71%), identified team management as a key factor that affected collaboration and the use of IT in the management of unexpected events. P6B/USuP noted that even though the IT infrastructure was available, the attitude of the project leader for Project P9 "Did not help matters because she focused more on achieving milestones than ensuring that team members were actively engaged in IT-driven collaboration and whether minor issues that caused misunderstanding within the team were properly resolved." P6C/USuP explained, "There were restrictions on the use of IT tools in problem analysis, had limits on exercising personal discretion in times of emergency, and often did not have access to information about what happened in parts of the project that was not under their duties." P5D/USuP surmised, "Effective team management should not only focus increasingly on becoming agile and collaborative, but should also be data driven." In this context, the participants recommended the use of training and encouraged team members to apply their IT skills as a means to improving their ability to improving personal relationship skills, vigilance to errors, and the ability to identify and respond to unexpected events that occur during project execution.

**Social Change: Organizational**

Organizations and project stakeholders that work in them could benefit from this study as findings from this study could have a positive social change impact by providing insights capable of facilitating organizational learning, expanding the knowledge stakeholders, and strengthening practices. Indeed, insights gained from this study could enable organizations engaged in both simple and complex projects to better understanding of the framework and tools that could enhance their ability to improve project efficiency. Operational efficiency can improve the number of projects delivered on schedule, and within budget. As noted by Cheung and Pang (2012) in the reviewed literature, an improvement in operational efficiency can boost the reputation of a construction firm and improve funding opportunities. Participants were also of the view that having an integrated IT infrastructure was relevant to structured data management, avoiding incessant data reentry and uncertainty in reporting events that affect the outcome of project activities. For instance, P4B/USuP noted, "When there is an appropriate IT infrastructure one can aggregate and extrapolate minor failures effectively." Several participants also discussed how combining ISM with mindfulness, as revealed by HRT, affected their projects. For instance, P4D/SuP argued:

> Relying on the analytic capacity of the human mind and his ability to sense problems, and combining such capabilities with information systems management as the primary drivers of failure analysis should motivate project teams to using IT consistently in failure analysis. It should also influence them to rely more on the views of experts, undertake significant failure analysis, and failure extrapolation. Persons with such mindset and who are dependent on data-driven analysis would not consider recovery from adverse events as a routine and are bound to be sensitive and react to events that are not going according to plan appropriately.

In this context, the participants recommended that organizations should 1) implement an appropriate IT infrastructure that account for weak signal management and information management, 2) subject team members to regular training that helps them to improve their relationship management skills, encourage them to apply acquired skills, and improve their ability to take advantage of existing IT solutions, and 3) implement a comprehensive risk management strategy that is geared towards continuous improvement of risk awareness, vigilance towards error, and responding adequately to unexpected events. Indeed, by providing insights that should enable organizations to combine ISM with mindfulness, as revealed by HRT, findings from this study should enable organizations to limit schedule and budget overruns, and make the best use of their resources, and improve performance in ways that should impact the 50% - 70% of

Nigerian construction projects which Ameh and Ogundare (2013) found to encounter some form of delay/ disruption due unexpected events.

**Social Change: Societal/Policy**

Findings from this study should have an impact on the society because a positive social impact on the individual project practitioner and the organization, should, by extension, have a positive impact on the society (see discussion on Social Change: Individual and Social Change: Organizational. Indeed, ideas that have positive impact on individuals and organizations often have been found to a positive impact on the society (Bornmann, 2015; Tay, Chan, & Diener, 2014). In this context, the society could benefit from this study because it features opportunities by which the society, governments, and policymakers view failure in construction projects, and improve their ability to formulate and implement better and more realistic policies that could reduce wastes in construction project. It is important to note that a large percentage of government's spending in developing countries such as Nigeria goes to providing infrastructure (Deloitte on Africa, 2014). By reducing wastes in construction projects, the society is bound to derive optimum benefits from public resources (taxpayers' money) committed to both small and mega construction projects.

Also, findings from this study can help individuals and organizations to exercise a proactive response to unexpected events thereby improving project performance could result in job creation and lower rates of unemployment. Findings from several studies show a correlation between improved performance and the willingness of organizations to hire. For instance, Naidenova and Parshakov (2013, p. 644) found that "retail companies try to hire new employees when their profits go up." Sleutjes and Schutjens (2012) found that an increase in sales precedes and other firm outcomes, such as profits encouraged firms to invest and hire new employees. Several studies have linked low levels of unemployment with lower levels of crime in the society (Baker, 2015; Phillips & Land, 2012), while studies reviewed in this study provided compelling evidence that employment levels is one of the key matrices for measuring social, economic, and political stability (Ashford et al., 2012; Leisink & Bach, 2014), and these are elements that contribute to positive social change.

**Social Change: Theory**

The knowledge gathered from this research could improve High Reliability theory defined in the conceptual framework and potentially improve the processes, tools, and methods needed to identify, avoid, predict, and respond to unexpected events in construction projects. Three findings of this study are critical to improving the theory of high reliability as revealed by the conduct of High Reliability Organization (HROs).

1. Health of team relationships: The importance of ensuring the health of team relationships and the cyclical relationship between unexpected events and relational effects (see *Figure 2.* Cyclical relationship between relational effects and unexpected events).
2. Effective identification and analysis of unexpected events: Based on the literature and participant's responses I proposed a new framework that should provide a bases for analyzing unexpected events from a new perspective. The new framework is focused on 5 dimensions: Financial

issues, Contractual issues, Project management issues, Learning issues, and attitudinal Issues (see *Figure 3.* Framework for analyzing the causes of unexpected events. .

3. Combining mindfulness, as revealed by HRT, with ISM: I modified the conceptual framework for high reliability to reflect the views of participants, which suggested the need to combine mindfulness, as revealed by HRT with ISM to improve the management of unexpected events in construction projects The study extended the theory of high reliability, as revealed by HRT, to include the principle Information Systems Management (ISM) to create a mindfulness infrastructure for High Reliability Construction Projects (see *Figure 4.* A mindful infrastructure for high reliability construction projects. In this conception, I renamed construction projects that incorporate all the principle identified in the new framework shown in *Figure 4.* A mindful infrastructure for high reliability construction projects. High Reliability Projects (HRP).

Consequently, this study can consolidate the theory of high reliability by providing evidence that support the conception that teams and organizations that combine mindful with ISM in the management of operational variations were likely to have reliable outcomes because of their improved ability to concentrate on identifying and mitigating failures. Indeed, Project Management Institute (PMI) endorses periodical reviews directed at improving knowledge areas, process, tools, and techniques in project management. Therefore, by combining expert perspectives and scholarly literature the study could strengthen the voice of researchers that evaluate and recommend changes for refining theories to improve the management of construction projects.

**Recommendations for Practice**

Recommendations that could enhance practitioners' ability to integrate Information Systems Management (ISM) with mindfulness, as revealed by HRT, are based on responses to the second research question. The second research question probed the factors that should enable project teams to combine mindfulness with information systems to facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects. The participants recommended the implementation of an appropriate IT infrastructure, regular training, and encouragement of team members to apply acquired IT skills as important to improving the use of information systems. P5D/USuP noted, "Implementing an organization-wide IT infrastructure should enhance data management and real-time trend analysis and reporting signals that may translate into unexpected events." P5D/USuP suggested, "Training should cover relationship management, leadership, communication, and the use of IT tools…and skills should be updated to align with system improvements." P2C/SuP surmised, "When the use of IT skills are encouraged, the people who use the solution become more at home with the system, and depend in large part on it to improve productivity." Beyond implementing an appropriate IT infrastructure, and training and encouraging practitioners to use the system in the management of unexpected events in construction projects, participants suggested the implementation of a comprehensive risk, team and communication management strategy that is IT-driven. The risk management strategy should be geared towards continuous improvement of the risk awareness of team members through clearly defined methods of managing inter– and intra–team feedback, and making the best use of lessons learned. It should also place premium on team relationships and institute defined procedure to minimizing team friction and adversarial relationships, and ensuring that lines of communication and unambiguous. In conclusion, the overall recommendation of the participants was to implement an IT-driven mindfulness infrastructure that is focused on enhancing the capability of team members to manage unexpected events through skills improvement, identification, avoidance, prediction and appropriate response.

**Personal Reflection**

The exploratory case study design of my study was to gain an in-depth understanding about how project teams can combine mindfulness, as revealed by HRT, with ISM to respond adequately to unexpected events during the execution phase of Nigerian construction projects. While it was clear, from the extant literature, that ISM and mindfulness could independently improve response to unexpected events, it was not clear whether combining ISM with mindfulness, as revealed by HROs, would improve the capacity of a construction team to respond to unexpected events during project execution. Also, if combining ISM with mindfulness can improve the capacity of a construction team to respond to unexpected events, it was also necessary to understand the strategies by which effecting such response could be done effectively. The experiences of 24 participants selected from 4 construction firms, and segregated to give perspectives on either a project considered successful or unsuccessful provided a number of reasons why combining ISM with mindfulness was essential to managing unexpected events during construction project execution. The participants also provided a number of strategies by which teams can combine ISM with mindfulness to untangle the complex dynamics of construction projects, initiate timely identification of weak signals that point to unexpected event, and take appropriate timely actions regarding such signals during the execution phase of construction projects. The findings from this study may encourage project practitioners, organizations, and other stakeholder adopt the an IT-driven mindfulness strategy in their future projects.

As a doctoral student, I am excited by the findings from this study and motivated to share the experiences of participants and the insights I gleaned from their perspectives. Through the research process, I reviewed, among others, several articles on project management, unexpected events, information systems management (ISM), weak signal management, high reliability theory (HRT), and high reliability organizations (HROs). This study offered me an opportunity to compare the extant literature to the experiences and suggestions shared by the participants. Going further, I would take steps to share my findings with individual project actors, professional organizations, the project management community, and government agencies.

## Conclusions

Construction projects' failures have attracted the attention of scholars for decades. Most projects that fail because of budget or schedule overrun have at some point during its lifecycle encountered some form of unexpected events. However, unexpected events do not just occur; rather they often provide weak signals that go unnoticed or undetected in the chaos of project activities. Besides, failures that often suffice as unexpected events were most likely to occur at the human interface. Indeed, an unconfirmed expectation could be a weak signal pointing to trouble, but a team could ignore the event if the human interface fails to interpret it in relation to other occurrences. Unfortunately, despite increased awareness, serious and widespread efforts, and improvement initiatives the outcomes of many construction projects continue to suffer preventable setbacks that cause them to exceed planned budget and schedule expectations. The exploratory case study design of this study was to learn something additional about unexpected events and how to forecast, detect, and respond effectively to weak signals likely to cause an unexpected event, with special focus on the execution phase of construction projects. In attempting to learn something additional, I adopted the high reliability theory (HRT), a technique that has been adopted successfully to stem unexpected events by organizations in the automobile, information, aviation, and health industries, etc. Specifically, this study explored how teams can combine mindfulness, as revealed by High Reliability Organizations (HROs), with Information Systems to respond adequately to unexpected events during the execution phase of Nigerian construction projects.

Twenty-four construction experts discussed the essence of combining mindfulness, as revealed by HRT, with ISM as a response strategy to mitigate unexpected events during the execution phase of construction project. Predominantly, the participants noted the importance adopting Information Systems Management (ISM) as a foundation for *mindful* response to unexpected events in construction projects. Combining mindfulness and ISM could reducing or completely eradicating reliance on human memory, which is often prone to errors, ensure direct and real-time access to project information need to respond adequately to weak signals that could cascade into an unexpected event, and facilitate an accurate analysis and extrapolation of data to predict the possible occurrence and impact of unexpected event. According to participants, how teams are managed, encouraged to use their skills, allowed timely access to information, and armed with an appropriate IT infrastructure should impact their ability to provide an appropriate response to weak signals that point to failure, and events that are not going according to plan.

Twenty-three out of 24 participants expressed that implementing an appropriate IT infrastructure was key to providing an appropriate response to unexpected events in construction project. Participants noted that an appropriate IT infrastructure could improve communication management, weak signal management, team management, and information management. While 15 (63%) of participants mentioned that the use of information of information system management was not sufficient, most participants suggested that regular training (88%) and encouragement to use IT skills (79%) should improve the use of IT in the management of unexpected events in construction projects. Indeed, the participants' experiences provided a positive reflection on the need to combine ISM and mindfulness, as revealed by HRT, for identifying, avoiding, forecasting, and providing an appropriate response to unexpected events which, by extension, should improve the performance of construction projects.

The findings of this study contributed to the body of knowledge by 1) identifying the cyclical relationship between unexpected events and relational effects, 2) proposing a framework for analyzing unexpected events, and 3) proposing a mindful infrastructure for high reliability construction projects (HRCP), which is a framework that could enhance the capability to discover and manage unexpected events in construction projects. Also, the findings of this study could affect positive social change in several dimensions: the individual, the organization, and the societal/policy through the effective utilization of resources, avoiding or responding adequately to events that are not going according to plan, and implementing policies that should motivate people to be more sensitive to unexpected events in construction projects.

References

Aapaoja, A., Herrala, M., Pekuri, A., & Haapasalo, H. (2013). The characteristics of and cornerstones for creating integrated teams. *International Journal of Managing Projects in Business*, *6*(4), 695-713. doi:10.1108/IJMPB-09-2012-0056

Abanda, F. H., Vidalakis, C., Oti, A. H., & Tah, J. H. M. (2015). A critical analysis of building information modeling systems used in construction projects. *Advances in Engineering Software*, *90*, 183-201. doi:10.1016/j.advengsoft.2015.08.009

Abdul Rahman, I., Memon, A. H., Karim, A., & Tarmizi, A. (2013). Significant factors causing cost overruns in large construction projects in Malaysia. *Journal of Applied Science*, *13*(2), 286-293. doi:10.3923/jas.2013.286.293

Abubakar, I. R. (2014). Abuja city profile. *Cities*, *41*, 81-91. doi:10.1016/j.cities.2014.05.008

AJehn, K. A, & Techakesari, P. (2014). High reliability teams: new directions for disaster management and conflict. *International Journal of Conflict Management*, *25*(4), 407-430. doi:10.1108/IJCMA-02-2014-0019

Akinsiku, O. E., & Akinsulire, A. (2012). Stakeholders' perception of the causes and effects of construction delays on project delivery. *Journal of Construction Engineering and Project Management*, *2*(4), 25-31. doi:10.6106/JCEPM.2012.2.4.025

Al-Khalil, M. I., & Al-Ghafly, M. A. (1999). Important causes of delay in public utility projects in Saudi Arabia. *Construction Management & Economics*, *17*(5), 647-655. doi:10.1080/014461999371259

Al-Sabah, R., Menassa, C. C., & Hanna, A. (2014). Evaluating impact of construction risks in the Arabian Gulf Region from perspective of multinational architecture, engineering and construction firms. *Construction Management and Economics*, *32*(4), 382-402. doi: 10.1080/01446193.2014.884281

Aleithawe, I., Sinno, R. R., & McAnally, W. H. (2011). Right-of-way acquisition duration prediction model for highway construction projects. *Journal of Construction Engineering and Management*, *138*(4), 540-544. doi:10.1061/(ASCE)CO.1943-7862.0000450

AlSehaimi, A., Koskela, L., & Tzortzopoulos, P. (2012). Need for alternative research approaches in construction management: Case of delay studies. *Journal of Management in Engineering*, *29*(4), 407-413. doi:10.1061/(ASCE)ME.1943-5479.0000148

Alzahrani, J. I., & Emsley, M. W. (2013). The impact of contractors' attributes on construction project success: A post construction evaluation. *International Journal of Project Management*, *31*(2), 313-322. doi:10.1016/j.ijproman.2012.06.006

Ameh, O. J., & Ogundare, O. (2013). Impact of due process policy on construction projects delivery in Nigeria. *Journal of Building Performance*, *4*(1), 13-23. Retrieved from http://spaj.ukm.my/jsb/index.php/jbp/article/view/82

Aminbakhsh, S., Gunduz, M., & Sonmez, R. (2013). Safety risk assessment using analytic hierarchy process (AHP) during planning and budgeting of construction projects. *Journal of safety research*, *46*, 99-105. doi:10.1016/j.jsr.2013.05.003

Amoatey, C. T., Ameyaw, Y. A., Adaku, E., & Famiyeh, S. (2015). Analysing delay causes and effects in Ghanaian state housing construction projects. *International Journal of Managing Projects in Business*, *8*(1), 198-214. doi:10.1108/IJMPB-04-2014-0035

*Ansoff, H. I., & McDonnell, E. J. (1990). Implanting strategic management (Vol. 2). New York: Prentice Hall.*

Aoki, M., & Rothwell, G. (2013). A comparative institutional analysis of the Fukushima nuclear disaster: Lessons and policy implications. *Energy Policy*, *53*, 240-247. doi: 10.1016/j.enpol.2012.10.058

Arif, M., Bendi, D., Toma-Sabbagh, T., & Sutrisna, M. (2012). Construction waste management in India: An exploratory study. *Construction Innovation*, *12*(2), 133-155. doi:10.1108/14714171211215912

Ashford, N. A., Hall, R. P., & Ashford, R. H. (2012). The crisis in employment and consumer demand: Reconciliation with environmental sustainability. *Environmental Innovation and Societal Transitions*, *2*, 1-22. doi:10.1016/j.eist.2012.01.002

Assis, E. M., Borges, E. P., Vieira de Melo, S. A., & Schnitman, L. (2015). Modeling failure rate of a robotic welding station using generalized q-distributions. *International Journal of Quality & Reliability Management*, *32*(2), 156-166. doi: 10.1108/IJQRM-11-2012-0151

Aven, T., & Krohn, B. S. (2014). A new perspective on how to understand, assess and manage risk and the unforeseen. *Reliability Engineering & System Safety*, *121*, 1-10. doi:10.1016/j.ress.2013.07.005

Aziz, R. F., & Hafez, S. M. (2013). Applying lean thinking in construction and performance improvement. *Alexandria Engineering Journal*, *52*(4), 679-695. doi:10.1016/j.aej.2013.04.008

Babatunde, O. K., & Low, S. P. (2013). Chinese construction firms in the Nigerian construction industry. *Habitat International*, *40*, 18-24. doi:10.1016/j.habitatint.2013.01.002

Baker, S. R. (2015). Effects of immigrant legalization on crime. *The American Economic Review*, *105*(5), 210-213. doi:10.1257/aer.p20151041

Ballesteros-Pérez, P., del Campo-Hitschfeld, M. L., González-Naranjo, M. A., & González-Cruz, M. C. (2015). Climate and construction delays: Case study in Chile. *Engineering, Construction and Architectural Management*, *22*(6), 596-621. doi:10.1108/ECAM-02-2015-0024

Banaitiene, N., & Banaitis, A. (2012). *Risk management in construction projects*. INTECH Open Access Publisher. Doi: 10.5772/51460

Bartsch, V., Ebers, M., & Maurer, I. (2013). Learning in project-based organizations: The role of project teams' social capital for overcoming barriers to learning. *International Journal of Project Management*, *31*(2), 239-251. doi: 10.1016/j.ijproman.2012.06.009

Bemelmans, J., Voordijk, H., & Vos, B. (2012). Supplier-contractor collaboration in the construction industry: A taxonomic approach to the literature of the 2000-2009 decade. *Engineering, Construction and Architectural Management*, *19*(4), 342-368. doi:10.1108/09699981211237085

Bloomberg, L. D., & Volpe, M. (2012). *Completing your qualitative dissertation: A road map from beginning to end*. Sage.

Bluhm, D. J., Harman, W., Lee, T. W., & Mitchell, T. R. (2011). Qualitative research in management: A decade of progress. *Journal of Management Studies*, *48*(8), 1866-1891. doi:10.1111/j.1467-6486.2010.00972.x

Boardman, C., & Ponomariov, B. (2014). Management knowledge and the organization of team science in university research centers. *The Journal of Technology Transfer,* 39(1), 75-92. doi:10.1007/s10961-012-9271-x

Boin, A., & Schulman, P. (2008). Assessing NASA's safety culture: The limits and possibilities of high-reliability theory. *Public Administration Review,* 68(6), 1050-1062. doi. 10.1111/j.1540-6210.2008.00954.x

Bootz, J. P., Lievre, P., & Schenk, E. (2015). Solicitation of experts in an undetermined environment: The case of a polar exploration. *Journal of Knowledge Management*, *19*(5), 900-91. doi:10.1108/JKM-02-2015-0061

Borger, E. (2012). Approaches to modeling business processes: A critical analysis of BPMN, workflow patterns and YAWL. *Software & Systems Modeling*, *11*(3), 305-318. doi:10.1007/s10270-011-0214-z

Bornmann, L. (2015). Alternative metrics in scientometrics: A meta-analysis of research into three altmetrics. *Scientometrics*, *103*(3), 1123-1144. doi:/10.1007/s11192-015-1565-y

Bourrier, M. (2011). *The legacy of the theory of high reliability organizations: An ethnographic endeavor* (No. 6). University of Geneva Working Paper. doi:10.2139/ssrn.1797008

Brady, T., & Davies, A. (2014). Managing structural and dynamic complexity: A tale of two projects. *Project Management Journal*, *45*(4), 21-38. doi:10.1002/pmj.21434

Braglia, M., & Frosolini, M. (2014). An integrated approach to implement project management information systems within the extended enterprise. *International Journal of Project Management*, *32*(1), 18-29. doi:10.1016/j.ijproman.2012.12.003

Brawn, D. (2012). Extensions of time and liquidated damages in construction contracts in England and Wales. *International Journal of Law in the Built Environment*, *4*(1), 75-90. doi:10.1108/17561451211211750

Breevaart, K., Bakker, A. B., & Demerouti, E. (2014). Daily self-management and employee work engagement. *Journal of Vocational Behavior*, *84*(1), 31-38. doi:10.1016/j.jvb.2013.11.002

Bryde, D., Broquetas, M., & Volm, J. M. (2013). The project benefits of building information modelling (BIM). *International Journal of Project Management*, *31*(7), 971-980. doi:10.1016/j.ijproman.2012.12.001

Bryman, A. (2012). *Social research methods*. Oxford, NY: Oxford

Bucknall, R. L. (2016). *Global construction 2020: A global forecast of the construction industry over the next decade to 2020, (*2010). Bradwall, London: Global Construction Perspective & Oxford Economics. Retrieved from http://rlb.com/articles/global-construction-2020/

Caniëls, M. C., & Bakens, R. J. (2012). The effects of project management information systems on decision making in a multi-project environment. *International Journal of Project Management*, *30*(2), 162-175. doi:10.1016/j.ijproman.2011.05.005

Carlo, J. L., Lyytinen, K., & Boland Jr, R. J. (2012). Dialectics of collective minding: Contradictory appropriations of information technology in a high-risk project. *MIS Quarterly*, *36*(4), 1081-1108. Retrieved from http://sfxhosted.exlibrisgroup.com/waldenu

Castro, N., & James, L. E. (2014). Differences between young and older adults' spoken language production in descriptions of negative versus neutral pictures. *Aging, Neuropsychology, and Cognition, 21*(2), 222-238. doi:10.1080/13825585.2013.804902

Che Ibrahim, C. K. I., Costello, S. B., & Wilkinson, S. (2013). Development of a conceptual team integration performance index for alliance projects. *Construction Management and Economics*, *31*(11), 1128-1143. doi:10.1080/01446193.2013.854399

Che Ibrahim, C. K. I., Costello, S. B., & Wilkinson, S. (2015). Key indicators influencing the management of team integration in construction projects. *International*

*Journal of Managing Projects in Business*, *8*(2), 300-323. doi:10.1108/IJMPB-04-2014-0028

Cheng, M. Y., Tran, D. H., & Wu, Y. W. (2014). Using a fuzzy clustering chaotic-based differential evolution with serial method to solve resource-constrained project scheduling problems. *Automation in Construction*, *37*, 88-97. doi:10.1016/j.autcon.2013.10.002

Cheng, T., & Teizer, J. (2013). Real-time resource location data collection and visualization technology for construction safety and activity monitoring applications. *Automation in Construction*, *34*, 3-15. doi:10.1016/j.autcon.2012.10.017

Cheung, S. O., & Pang, K. H. Y. (2012). Anatomy of construction disputes. *Journal of Construction Engineering and Management*, *139*(1), 15-23. doi:10.1061/(ASCE)CO.1943-7862.0000532

Chipulu, M., Ojiako, U., Gardiner, P., Williams, T., Mota, C., Maguire, S., ... & Marshall, A. (2014). Exploring the impact of cultural values on project performance: The effects of cultural values, age and gender on the perceived importance of project success/failure factors. *International Journal of Operations & Production Management*, *34*(3), 364-389. doi:10.1108/IJOPM-04-2012-0156

Chou, J. S., & Lin, C. (2012). Predicting disputes in public-private partnership projects: Classification and ensemble models. *Journal of Computing in Civil Engineering*, *27*(1), 51-60. doi:10.1061/(ASCE)CP.1943-5487.0000197

Costin, A., Pradhananga, N., & Teizer, J. (2012). Leveraging passive RFID technology for construction resource field mobility and status monitoring in a high-rise renovation project. *Automation in Construction*, *24*, 1-15. doi:10.1016/j.autcon.2012.02.015

Cronin, C. (2014). Using case study research as a rigorous form of inquiry. *Nurse researcher*, *21*(5), 19-27. doi:10.7748/nr.21.5.19.e1240

Davies, A., & Mackenzie, I. (2014). Project complexity and systems integration: Constructing the London 2012 Olympics and Paralympics Games. *International Journal of Project Management*, *32*(5), 773-790. doi:10.1016/j.ijproman.2013.10.004

Davies, R., & Harty, C. (2013). Implementing 'Site BIM': A case study of ICT innovation on a large hospital project. *Automation in Construction*, *30*, 15-24. doi:10.1016/j.autcon.2012.11.024

Deloiitte on Africa (2014). Deloitte African Construction Trends report. Retrieved from https://www2.deloitte.com/content/dam/Deloitte/za/Documents/manufacturing/za_africa_construction_trends_2015_10032015.pdf

Dimitriou, H. T., Ward, E. J., & Wright, P. G. (2013). Mega transport projects—Beyond the 'iron triangle': Findings from the OMEGA research programme. *Progress in planning*, *86*, 1-43. doi:10.1016/j.progress.2013.03.001

Dixon-Woods, M., Agarwal, S., Jones, D., Young, B., & Sutton, A. (2005). Synthesising qualitative and quantitative evidence: A review of possible methods. *Journal of*

*Health Services Research & Policy*, *10*(1), 45-53B. doi:10.1258/1355819052801804

Doloi, H., Sawhney, A., & Iyer, K. C. (2012). Structural equation model for investigating factors affecting delay in Indian construction projects. *Construction Management and Economics*, *30*(10), 869-884. doi:10.1080/01446193.2012.717705

Doloi, H., Sawhney, A., Iyer, K. C., & Rentala, S. (2012). Analysing factors affecting delays in Indian construction projects. *International Journal of Project Management*, *30*(4), 479-489. doi:10.1016/j.ijproman.2011.10.004

Dominic, A. D., & D. Smith, S. (2014). Rethinking construction cost overruns: Cognition, learning and estimation. *Journal of Financial Management of Property and Construction*, *19*(1), 38-54. doi:10.1108/JFMPC-06-2013-0027

Dresser, R. (2012). Research ethics. Aligning regulations and ethics in human research. *Science (New York, NY)*, *337*(6094), 527-528. doi:10.1126/science.1218323

Eadie, R., Browne, M., Odeyinka, H., McKeown, C., & McNiff, S. (2013). BIM implementation throughout the UK construction project lifecycle: An analysis. *Automation in Construction*, *36*, 145-151. doi:10.1016/j.autcon.2013.09.001

Ellegaard, C., & Koch, C. (2014). A model of functional integration and conflict: The case of purchasing-production in a construction company. *International Journal of Operations & Production Management*, *34*(3), 325-346. doi:10.1108/IJOPM-03-2012-0108

Etikan, I, Musa, S. A., Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics. 5*(1), 1-4. doi: 10.11648/j.ajtas.20160501.11

Fallahnejad, M. H. (2013). Delay causes in Iran gas pipeline projects. *International Journal of Project Management*, *31*(1), 136-146. doi:10.1016/j.ijproman.2012.06.003

Fang, D., & Wu, H. (2013). Development of a safety culture interaction (SCI) model for construction projects. *Safety science*, *57*, 138-149. doi:10.1016/j.ssci.2013.02.003

Farrington, T., & Crews, C. (2013). Research-on-research: The IRI 2038 Scenarios: Four views of the future. *Research-Technology Management*, *56*(6), 23-32. doi:10.5437/08956308X5606192

Fellows, R., & Liu, A. M. (2012). Managing organizational interfaces in engineering construction projects: Addressing fragmentation and boundary issues across multiple interfaces. *Construction Management and Economics*, *30*(8), 653-671. doi:10.1080/01446193.2012.668199

Forcher, B., Agne, S., Dengel, A., Gillmann, M., & Roth-Berghofer, T. (2012, March). Towards understandable explanations for document analysis systems. In *Document Analysis Systems (DAS), 2012 10th IAPR International Workshop on* (pp. 6-10). IEEE. doi:10.1109/das.2012.92

Fulford, R., & Standing, C. (2014). Construction industry productivity and the potential for collaborative practice. *International Journal of Project Management*, *32*(2), 315-326. doi:10.1016/j.ijproman.2013.05.007

Gärtner, C. (2013). Enhancing readiness for change by enhancing mindfulness. *Journal of Change Management*, *13*(1), 52-68. doi:10.1080/14697017.2013.768433

Gerson, K., & Horowitz, R. (2002). Observation and interviewing: Options and choices. In T. May (Ed.), *Qualitative Research in Action.* London: Sage Publications.

Ghoddousi, P., & Hosseini, M. R. (2012). A survey of the factors affecting the productivity of construction projects in Iran. *Technological and Economic Development of Economy,* 18(1), 99-116. doi:10.3846/20294913.2012.661203

Ghoddousi, P., Eshtehardian, E., Jooybanpour, S., & Javanmardi, A. (2013). Multi-mode resource-constrained discrete time–cost-resource optimization in project scheduling using non-dominated sorting genetic algorithm. *Automation in construction*, *30*, 216-227. doi:10.1016/j.autcon.2012.11.014

Giezen, M. (2012). Keeping it simple? A case study into the advantages and disadvantages of reducing complexity in mega project planning. *International Journal of Project Management*, *30*(7), 781-790. doi:10.1016/j.ijproman.2012.01.010

Gilbert, L. S., Jackson, K., & di Gregorio, S. (2014). Tools for analyzing qualitative data: The history and relevance of qualitative data analysis software. In *Handbook of research on educational communications and technology* (pp. 221-236). Springer New York. doi:10.1007/978-1-4614-3185-5_18

Goldenhar, L. M., Brady, P. W., Sutcliffe, K. M., & Muething, S. E. (2013). Huddling for high reliability and situation awareness. *BMJ Quality & Safety*, *22*(11), 899-906. doi:10.1136/bmjqs-2012-001467

Gray, D. E. (2013). Doing research in the real world. Thousand Oaks, CA: Sage.

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of Qualitative Research*, *2*, 163-194).

Gudiene, N., Banaitis, A., & Banaitiene, N. (2013). Evaluation of critical success factors for construction projects–an empirical study in Lithuania. *International Journal of Strategic Property Management*, *17*(1), 21-31. doi:10.3846/1648715X.2013.787128

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field methods*, *18*(1), 59-82. doi: 10.1177/1525822X05279903

Gunduz, M., Nielsen, Y., & Ozdemir, M. (2012). Quantification of delay factors using the relative importance index method for construction projects in Turkey. *Journal of Management in Engineering*, *29*(2), 133-139. doi:10.1061/(ASCE)ME.1943-5479.0000129

Guo, F., Chang-Richards, Y., Wilkinson, S., & Li, T. C. (2014). Effects of project governance structures on the management of risks in major infrastructure projects: A comparative analysis. *International Journal of Project Management*, *32*(5), 815-826. doi:10.1016/j.ijproman.2013.10.001

Han, S. H., Park, H. K., Yeom, S. M., & Chae, M. J. (2014). Risk-integrated cash flow forecasting for overseas construction projects. *KSCE Journal of Civil Engineering*, *18*(4), 875-886. doi:10.1007/s12205-014-0464-8

Hartmann, T., Van Meerveld, H., Vossebeld, N., & Adriaanse, A. (2012). Aligning building information model tools and construction management methods. *Automation in Construction*, *22*, 605-613. doi:10.1016/j.autcon.2011.12.011

He, Q., Luo, L., Hu, Y., & Chan, A. P. (2015). Measuring the complexity of mega construction projects in China—A fuzzy analytic network process analysis. *International Journal of Project Management*, *33*(3), 549-563. doi:10.1016/j.ijproman.2014.07.009

Herroelen, W. (2013). Discussion of "probabilistic estimation and allocation of project time contingency" by Gabriel A. Barraza. *Journal of Construction Engineering and Management*, *139*(2), 253-255. doi:10.1061/(ASCE)CO.1943-7862.0000466

High Reliability Organizing (2013). Models of HRO. Retrieved July 18, 2015, from http://high-reliability.org/HRO-model-overview.

Holopainen, M., & Toivonen, M. (2012). Weak signals: Ansoff today. *Futures*, *44*(3), 198-205. doi:10.1016/j.futures.2011.10.002

Hosseini, R., Chileshe, N., Zou, J., & Baroudi, B. (2013, February). Approaches of implementing ICT technologies within the construction industry. In *Australasian Journal of Construction Economics and Building-Conference Series* (Vol. 1, No. 2, pp. 1-12). doi:10.11591/ijaas.v2i1.1321

Hwang, B. G., & Ng, W. J. (2013). Project management knowledge and skills for green construction: Overcoming challenges. *International Journal of Project Management*, *31*(2), 272-284. doi:10.1016/j.ijproman.2012.05.004

Idoro, G. I. (2012). Sustainability of mechanisation in the Nigerian construction industry. *Journal of Civil Engineering and Management*, *18*(1), 91-105. doi:10.3846/13923730.2011.604541

Ijigah, E. A., Oloruntoba, K., & Mohd, H. R. (2012). Towards accomplishing millennium development goals (MDGs) in Abuja FCT Nigeria: The project management consultants roles, *International Journal of Research in Management & Technology*, 414-424. Retrieved from http://www.iracst.org/ijrmt/papers/vol2no42012/9vol2no4.pdf

Imoudu, E. C. (2012). The impact of foreign direct investment on Nigeria's economic growth; 1980-2009: Evidence from the Johansen's co-integration approach. *International Journal of Business and Social Science*, *3*(6), 122-134. Retrieved from http://ijbssnet.com/journals/Vol_3_No_6_Special_Issue_March_2012/16.pdf

Irani, Z., & Kamal, M. M. (2014). Intelligent systems research in the construction industry. *Expert Systems with Applications*, *41*(4), 934-950. doi:10.1016/j.eswa.2013.06.061

Irfan, M., Khurshid, M. B., Anastasopoulos, P., Labi, S., & Moavenzadeh, F. (2011). Planning-stage estimation of highway project duration on the basis of anticipated project cost, project type, and contract type. *International Journal of Project Management*, *29*(1), 78-92. doi:10.1016/j.ijproman.2010.01.001

Irvine, A., Drew, P., & Sainsbury, R. (2013). 'Am I not answering your questions properly?'Clarification, adequacy and responsiveness in semi-structured telephone and face-to-face interviews. *Qualitative Research, 13*(1), 87-106. doi:10.1177/1468794112439086

Izam Ibrahim, K., Costello, S. B., & Wilkinson, S. (2013). Key practice indicators of team integration in construction projects: A review. *Team Performance Management: An International Journal*, *19*(3/4), 132-152. doi:10.1108/TPM-10-2012-0033

Jacob, U. N. (2013). *Project delays in the Niger Delta Region, Nigeria: Significant causes, effects and solutions* (Doctoral dissertation). Retrieved from http://hdl.handle.net/10539/12808

Jafari, A., & Rodchua, S. (2014). Survey research on quality costs and problems in the construction environment. *Total Quality Management & Business Excellence*, *25*(3-4), 222-234. doi. 10.1080/14783363.2013.824715

Jiang, H., Xu, Y., & Liu, C. (2013). Construction price prediction using vector error correction models. *Journal of Construction Engineering & Management*, *139*(11), 1-11. doi:10.1061/(ASCE)CO.1943-7862.0000729

Kaivo-oja, J. (2012). Weak signals analysis, knowledge management theory and systemic socio-cultural transitions. *Futures*, *44*(3), 206-217. doi:10.1016/j.futures.2011.10.003

Karlaftis, M. G., Easa, S. M., Jha, M. K., & Vlahogianni, E. I. (2012). Design and construction of transportation infrastructure. *Artificial Intelligence Applications to Critical Transportation Issues*, 121-133. Retrieved from http://onlinepubs.trb.org/onlinepubs/circulars/ec168.pdf#page=129

Kazaz, A., Ulubeyli, S., & Tuncbilekli, N. A. (2012). Causes of delays in construction projects in Turkey. *Journal of Civil Engineering and Management*, *18*(3), 426-435. doi:10.3846/13923730.2012.698913

Kerzner, H. R. (2013). *Project management: A systems approach to planning, scheduling, and controlling*. John Wiley & Sons.

Keung, C. C., & Shen, L. Y. (2012). Measuring the networking performance for contractors in practicing construction management. *Journal of Management in Engineering*, *29*(4), 400-406. doi:10.1061/(ASCE)ME.1943-5479.0000156

Kim, C., Son, H., & Kim, C. (2013). Automated construction progress measurement using a 4D building information model and 3D data. *Automation in Construction*, *31*, 75-82. doi:10.1016/j.autcon.2012.11.041

Koh, T. Y., & Rowlinson, S. (2014). Project team social capital, safety behaviors, and performance: A Multi-level Conceptual Framework. *Procedia Engineering*, *85*, 311-318. doi:10.1016/j.proeng.2014.10.556

KPMG International (2015). *Global Construction Survey 2015*. Retrieved from https://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/global-construction-survey/Documents/global-construction-survey-2015.pdf

Labaka, L., Hernantes, J., & Sarriegi, J. M. (2015). Resilience framework for critical infrastructures. *International Journal of Disaster Resilience in the Built Environment*, *6*(4). 409-423. doi:10.1108/IJDRBE-07-2014-0048

Labaka, L., Hernantes, J., Rich, E., & Sarriegi, J. M. (2013). Resilience building policies and their influence in crisis prevention, absorption and recovery. *Journal of*

*Homeland Security and Emergency Management*, *10*(1), 289-317. doi:10.1515/jhsem-2012-0089

Langer, E. J. (1989). *Mindfulness*. Reading, MA: Perseus Books

Lee, S. K., & Yu, J. H. (2012). Success model of project management information system in construction. *Automation in Construction*, *25*, 82-93. doi:10.1016/j.autcon.2012.04.015

Lee, S., Mortara, L., Kerr, C., Phaal, R., & Probert, D. (2012). Analysis of document-mining techniques and tools for technology intelligence: Discovering knowledge from technical documents. *International Journal of Technology Management*, *60*, 130-156. doi:10.1504/IJTM.2012.049102

Leech, N. L., & Onwuegbuzie, A. J. (2011). Beyond constant comparison qualitative data analysis: Using NVivo. *School Psychology Quarterly*, *26*(1), 70. doi:10.1037/a0022711

Leisink, P., & Bach, S. (2014). Economic crisis and municipal public service employment: Comparing developments in seven EU Member States. *Transfer: European Review of Labour and Research*, *20*(3), 327-342.

Levy, N., Render, M., & Benenson, I. (2015). Spatially explicit modeling of parking search as a tool for urban parking facilities and policy assessment. *Transport Policy*, *39*, 9-20. doi: 10.1016/j.tranpol.2015.01.004

Li, T. H., Ng, S. T., & Skitmore, M. (2012a). Conflict or consensus: An investigation of stakeholder concerns during the participation process of major infrastructure and construction projects in Hong Kong. *Habitat International*, *36*(2), 333-342. doi:10.1016/j.habitatint.2011.10.012

Li, T. H., Ng, S. T., & Skitmore, M. (2012b). Public participation in infrastructure and construction projects in China: From an EIA-based to a whole-cycle process. *Habitat International*, *36*(1), 47-56. doi:10.1016/j.habitatint.2011.05.006

Liu, Y., Chen, C., & Cui, C. (2012). Study on a Web-based project integrated management information system in A/E/C industry. *Journal of Software*, *7*(8), 1713-1720. doi:10.4304/jsw.7.8.1713-1720

Locatelli, G., Mancini, M., & Romano, E. (2014). Systems engineering to improve the governance in complex project environments. *International Journal of Project Management,* 32(8), 1395-1410. doi:10.1016/j.ijproman.2013.10.007

Love, P. E., Wang, X., Sing, C. P., & Tiong, R. L. (2012). Determining the probability of project cost overruns. *Journal of Construction Engineering and Management*, *139*(3), 321-330. doi:10.1061/(ASCE)CO.1943-7862.0000575

Mahdavi Mazdeh, M., & Hesamamiri, R. (2014). Knowledge management reliability and its impact on organizational performance: An empirical study. *Program: Electronic library and information systems*, *48*(2), 102-126. doi:10.1108/PROG-01-2013-0001

Marques, R. C., & Berg, S. (2011). Risks, contracts, and private-sector participation in infrastructure. *Journal of Construction Engineering and Management*, *137*(11), 925-932. doi:10.1061/(ASCE)CO.1943-7862.0000347

Marshall, B., Cardon, P., Poddar, A., & Fontenot, R. (2013). Does sample size matter in qualitative research? A review of qualitative interviews in IS research. *Journal of Computer Information Systems*, *54*(1), 11-22. Retrieved from http://iacis.org/jcis/articles/JCIS54-2.pdf

Marshall, N. (2014). Thinking, saying and doing in collaborative projects: What can we learn from theories of practice? *Engineering Project Organization Journal*, *4*(2-3), 107-122. doi:10.1080/21573727.2014.916689

Marzouk, M. M., & El-Rasas, T. I. (2014). Analyzing delay causes in Egyptian construction projects. *Journal of Advanced Research*, *5*(1), 49-55. doi:10.1016/j.jare.2012.11.005

Maxwell, J. A. (2013). *Qualitative research design: An interactive approach* (3rd ed.). Thousand Oaks, CA: Sage.

Memarian, B., & Mitropoulos, P. (2014). Production system design for speed and reliability: A case study in concrete construction. *International Journal of Construction Education and Research*, *10*(3), 181-200. doi:10.1080/15578771.2013.872735

Miles, M. B., Huberman, A. M. & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Thousand Oaks, CA: Sage.

Mir, F. A., & Pinnington, A. H. (2014). Exploring the value of project management: Linking project management performance and project success. *International Journal of Project Management*, *32*(2), 202-217. doi:10.1016/j.ijproman.2013.05.012

Mitropoulos, P., & Memarian, B. (2012). Team processes and safety of workers: Cognitive, affective, and behavioral processes of construction crews. *Journal of Construction Engineering and Management*, *138*(10), 1181-1191. doi:10.1061/(ASCE)CO.1943-7862.0000527

Naidenova, I., & Parshakov, P. (2013). Intellectual capital investments: evidence from panel VAR analysis. *Journal of Intellectual Capital*, *14*(4), 634-660. doi :10.1108/JIC-01-2013-0011

National Waterways Foundation (2012). *Cost of Project Delays.* Retrieved from http://www.nationalwaterwaysfoundation.org/study/HDRstudy.pdf

Nawi, M. N. M., Lee, A., Kamar, K. A. M., & Hamid, Z. A. (2012). Critical success factors for improving team integration in industrialised building system (IBS) construction projects: The Malaysian case. *Malaysian Construction Research Journal*, *10*, 44-62. Retrieved from http://faculty.cbu.ca/pifinedo/NAH.pdf

Newman, I., Ridenour, C. S., Newman, C., & DeMarco, G. M. P. (2003). A typology of research purposes and its relationship to mixed methods. In A. Tashakkori & C. Teddlie (Eds.), *Handbook of mixed methods in social and behavioral research* (pp. 167-188). Thousand Oaks, CA: Sage Publications.

Nigeria Bureau of Statistics (2014). Gross domestic product. Retrieved January 7, 2015, from http://www.nigerianstat.gov.ng/nbslibrary/economic-statistics/gross-domestic-product.

Nikakhtar, A., Hosseini, A. A., Wong, K. Y., & Zavichi, A. (2015). Application of lean construction principles to reduce construction process waste using computer simulation: A case study. *International Journal of Services and Operations Management*, *20*(4), 461-480. doi:10.1504/IJSOM.2015.068528

Olalusi, O. C., & Jesuloluwa, O. (2013). The impact of information technology on Nigerian construction industry. *International Journal of Engineering and Innovative Technology (IJEIT), 2*(9), 1-5. Retrived from http://www.ijeit.com/vol%202/Issue%209/IJEIT1412201303_01.pdf

Olawale, Y., & Sun, M. (2015). Construction project control in the UK: Current practice, existing problems and recommendations for future improvement. *International Journal of Project Management*, *33*(3), 623-637. doi:10.1016/j.ijproman.2014.10.003

Olde Scholtenhuis, L. L., & Dorée, A. G. (2013). *Welcoming high reliability organising in construction management.* Paper presented at the twenty-ninth Annual ARCOM Conference, 02-09-2013 - 04-09-2013, Reading, UK. Retrieved from www.arcom.ac.uk

Opawole, A., Jagboro, G. O., Babalola, O., & Babatunde, S. O. (2012). Evaluation of the contribution of construction professionals in budgeting for infrastructure development in Nigeria. *International Journal of Sustainable Construction Engineering and Technology*, *3*(2), 83-95. Retrieved from http://penerbit.uthm.edu.my/ojs/index.php/IJSCET/article/viewFile/453/368

Oppong, S. H. (2013). The problem of sampling in qualitative research. *Asian Journal of Management Sciences and Education*, *2*(2), 202-210. Retrieved from www.ajmse.leena-luna.co.jp

Osipova, E., & Eriksson, P. E. (2013). Balancing control and flexibility in joint risk management: Lessons learned from two construction projects. *International Journal of Project Management*, *31*(3), 391-399. doi:10.1016/j.ijproman.2012.09.007

Park, C. S., Lee, D. Y., Kwon, O. S., & Wang, X. (2013). A framework for proactive construction defect management using BIM, augmented reality and ontology-based data collection template. *Automation in Construction*, *33*, 61-71. doi:10.1016/j.autcon.2012.09.010

Park, Y. I., & Papadopoulou, T. C. (2012). Causes of cost overruns in transport infrastructure projects in Asia: Their significance and relationship with project size. *Built Environment Project and Asset Management*, *2*(2), 195-216. doi:10.1108/20441241211280873

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). Thousand Oaks, CA: Sage.

Peh, L. C., & Low, S. P. (2013). Research design and methodology. in organization design for international construction business (pp. 133-147). Springer Berlin Heidelberg. doi:10.1007/978-3-642-35164-8

Pentland, B. T., & Hærem, T. (2015). Organizational routines as patterns of action: Implications for organizational behavior. *Annu. Rev. Organ. Psychol. Organ. Behav.*, *2*(1), 465-487. doi:10.1146/annurev-orgpsych-032414-111412

Perrow, C. (2011). *Normal accidents: Living with high risk technologies*. Princeton University Press.

Phillips, J., & Land, K. C. (2012). The link between unemployment and crime rate fluctuations: An analysis at the county, state, and national levels. *Social Science Research*, *41*(3), 681-694. doi: 10.1016/j.ssresearch.2012.01.001

Pickavance, K. (2005). *Delay and disruption in construction contracts* (3rd ed.). London: LLP Reference Publishing.

Pinto, J. K. (2014). Project management, governance, and the normalization of deviance. *International Journal of Project Management*, *32*(3), 376-387. doi:10.1016/j.ijproman.2013.06.004

Piperca, S., & Floricel, S. (2012). A typology of unexpected events in complex projects. *International Journal of Managing Projects in Business*, *5*(2), 248-265. doi:10.1108/17538371211214932

Porwal, A., & Hewage, K. N. (2013). Building information modeling (BIM) partnering framework for public construction projects. *Automation in Construction*, *31*, 204-214. doi:10.1016/j.autcon.2012.12.004

Pourrostam, T., & Ismail, A. (2012). Causes and effects of delay in Iranian construction projects. *International Journal of Engineering and Technology*, *4*(5), 5-8. doi:10.7763/IJET.2012.V4.441

Project Management Institute (PMI, 2012). *A Guide to the Project Management Body of Knowledge (5th ed.).* Newtown Sqare, PA: Project Management Institute.

Rademaker, L. L., Grace, E. J., & Curda, S. K. (2012). Using computer-assisted qualitative data analysis software (CAQDAS) to re-examine traditionally analyzed data: Expanding our understanding of the data and of ourselves as scholars. *The Qualitative Report*, *17*(22), 1-11. Retrieved from http://nsuworks.nova.edu/cgi/viewcontent.cgi?article=1765&context=tqr

Ren, Z., Anumba, C. J., & Yang, F. (2013). Development of CDPM matrix for the measurement of collaborative design performance in construction. *Automation in Construction*, *32*, 14-23. doi:10.1016/j.autcon.2012.11.019

Rossel, P. (2012). Early detection, warnings, weak signals and seeds of change: A turbulent domain of futures studies. *Futures*, *44*(3), 229-239. doi:10.1016/j.futures.2011.10.005

Sacks, R., & Pikas, E. (2013). Building information modeling education for construction engineering and management. I: Industry requirements, state of the art, and gap analysis. *Journal of Construction Engineering and Management*, *139*(11), 04013016. doi:10.1061/(ASCE)CO.1943-7862.0000759

Salas, E., & Rosen, M. A. (2013). Building high reliability teams: Progress and some reflections on teamwork training. *BMJ quality & safety*, *22*(5), 369-373. doi:10.1136/bmjqs-2013-002015

Saldana, J. (2012). *The coding manual for qualitative researchers* (No. 14). Sage Publications.

Salet, W., Bertolini, L., & Giezen, M. (2013). Complexity and uncertainty: Problem or asset in decision making of mega infrastructure projects? *International Journal of Urban and Regional Research*, *37*(6), 1984-2000. doi:10.1111/j.1468-2427.2012.01133.x

Saunders, M. N., Saunders, M., Lewis, P., & Thornhill, A. (2011). *Research methods for business students,* (5th Ed. Pearson Education India.

Schoemaker, P. J., Day, G. S., & Snyder, S. A. (2013). Integrating organizational networks, weak signals, strategic radars and scenario planning. *Technological Forecasting and Social Change*, *80*(4), 815-824. doi:10.1016/j.techfore.2012.10.020

Schweber, L. (2013). The effect of BREEAM on clients and construction professionals. *Building Research & Information*, *41*(2), 129-145. doi:10.1080/09613218.2013.768495

Shebob, A., Dawood, N., & Shah, R. K. (2012). Development of a methodology for analysing and quantifying the impact of delay factors affecting construction projects. *Journal of Construction Engineering and Project Management*, *2*(3), 17-29. doi:10.6106/JCEPM.2012.2.3.017

Shehu, Z., R. Endut, I., & Akintoye, A. (2014). Factors contributing to project time and hence cost overrun in the Malaysian construction industry. *Journal of Financial Management of Property and Construction*, *19*(1), 55-75. doi:10.1108/JFMPC-04-2013-0009

Shepherd, D. A., Patzelt, H., & Wolfe, M. (2011). Moving forward from project failure: Negative emotions, affective commitment, and learning from the experience. *Academy of Management Journal*, *54*(6), 1229-1259. doi:10.5465/amj.2010.0102

Shi, Q., Zuo, J., & Zillante, G. (2012). Exploring the management of sustainable construction at the programme level: A Chinese case study. *Construction*

*Management and Economics*, *30*(6), 425-440. doi:10.1080/01446193.2012.683200

Sleutjes, B., & Schutjens, V. (2012). The Added Value of Neighborhood-Based Support Networks to Local Firm Growth. *Entrepreneurship Research Journal*, *2*(2), 1-29. doi: 10.1515/2157-5665.1047

Song, L., & Eldin, N. N. (2012). Adaptive real-time tracking and simulation of heavy construction operations for look-ahead scheduling. *Automation in Construction*, *27*, 32-39. doi:10.1016/j.autcon.2012.05.007

Špačková, O., Šejnoha, J., & Straub, D. (2013). Probabilistic assessment of tunnel construction performance based on data. *Tunnelling and Underground Space Technology*, *37*, 62-78. doi:10.1016/j.tust.2013.02.006

Stewart, G. L., Courtright, S. H., & Barrick, M. R. (2012). Peer-based control in self-managing teams: Linking rational and normative influence with individual and group performance. *Journal of Applied Psychology*, *97*(2), 435-447. doi:10.1037/a0025303

Sutcliffe, K. M., & Vogus, T. J. (2012). Organizing for mindfulness. *The Wiley Blackwell Handbook of Mindfulness*, 407-423. Retrieved from https://gnssn.iaea.org/NSNI/SC/TMMtU/Presentations/Ms%20Sutcliffe's%20Presentation%202.pdf

Sweis, G. J., Sweis, R. J., Al-Shboul, M. A., & Al-Dweik, G. A. (2015). The Impact of Information Technology (IT) adoption on the quality of construction projects: The case of Jordan. *International Journal of Information Technology Project Management (IJITPM)*, *6*(3), 26-40. doi: 10.4018/IJITPM.2015070102

Talmaki, S., Kamat, V. R., & Saidi, K. (2015). Feasibility of real-time graphical simulation for active monitoring of visibility-constrained construction processes. *Engineering with Computers*, *31*(1), 29-49. doi: 10.1007/s00366-013-0323-0

Taroun, A. (2014). Towards a better modelling and assessment of construction risk: Insights from a literature review. *International Journal of Project Management*, *32*(1), 101-115. doi:10.1016/j.ijproman.2013.03.004

Tay, L., Chan, D., & Diener, E. (2014). The metrics of societal happiness. *Social Indicators Research*, *117*(2), 577-600. doi:10.1007/s11205-013-0356-1

Turner, R., & Zolin, R. (2012). Forecasting success on large projects: Developing reliable scales to predict multiple perspectives by multiple stakeholders over multiple time frames. *Project Management Journal*, *43*(5), 87-99. doi:10.1002/pmj.21289

Turskis, Z., Gajzler, M., & Dziadosz, A. (2012). Reliability, risk management, and contingency of construction processes and projects. *Journal of Civil Engineering and Management*, *18*(2), 290-298. doi:10.3846/13923730.2012.672931

Udawatta, N., Zuo, J., Chiveralls, K., & Zillante, G. (2015). Improving waste management in construction projects: An Australian study. *Resources, Conservation and Recycling*, *101*, 73-83. doi:10.1016/j.resconrec.2015.05.003

Valdes-Vasquez, R., & Klotz, L. E. (2012). Social sustainability considerations during planning and design: Framework of processes for construction projects. *Journal* *of construction engineering and management*, *139*(1), 80-89. doi:10.1061/(ASCE)CO.1943-7862.0000566

Vanguard (2014). 2015 Budget: Experts urge FG to focus on critical infrastructure. Retrieved January 7, 2015, from http://www.vanguardngr.com/2014/12/2015-budget-experts-urge-fg-focus-critical-infrastructure

Vogt, W. P., & Johnson, R. B. (2011). *Dictionary of statistics & methodology: A nontechnical guide for the social sciences*. Sage.

Vogus, T. J., & Sutcliffe, K. M. (2012). Organizational mindfulness and mindful organizing: A reconciliation and path forward. *Academy of Management Learning & Education*, *11*(4), 722-735. doi:10.5465/amle.2011.0002C

Walker, D. H., & Shen, Y. J. (2002). Project understanding, planning, flexibility of management action and construction time performance: Two Australian case studies. *Construction Management & Economics*, *20*(1), 31-44. doi:10.1080/01446190110089691

Wang, X., Love, P. E., Kim, M. J., Park, C. S., Sing, C. P., & Hou, L. (2013). A conceptual framework for integrating building information modeling with augmented reality. *Automation in Construction*, *34*, 37-44. doi:10.1016/j.autcon.2012.10.012

Wasif, I., Josephson, P. E., & Styhre, A. (2012). Individual learning in construction projects: Professions and their approaches. *Construction Economics and Building*, *8*(2), 50-60. doi:10.5130/ajceb.v8i2.3006

Waziri, A. Y., Ali, K. N., & Aliagha, G. U. (2015). The influence of transformational leadership style on ICT adoption in the Nigerian construction industry. *Asian Social Science*, *11*(18), 123-133. doi:10.5539/ass.v11n18p123

Waziri, A. Y., Ali, K. N., Aliagha, G. U., & Majid, M. Z. A. (2015). Environment variables on IT adoption: A case of Nigerian construction organizations. *Journal Teknologi*, *74*(4), 105-112. doi:10.11113/jt.v74.4617

Weick, K. E., & Sutcliffe, K. M. (2011). Managing the unexpected: Resilient performance in an age of uncertainty. Hoboken, NJ: John Wiley & Sons.

Weick, K. E., & Sutcliffe, K. M. (2015). *Managing the unexpected: Sustained performance in a complex world*. Hoboken, NJ: John Wiley & Sons. doi:10.1002/9781119175834

Wendler, R. (2012). Human subjects protection: A source for ethical service-learning practice. *Michigan Journal of Community Service Learning*, *18*(2), 29-39. Retrieved from http://files.eric.ed.gov/fulltext/EJ988318.pdf

White, L. K., Suway, J. G., Pine, D. S., Bar-Haim, Y., & Fox, N. A. (2011). Cascading effects: The influence of attention bias to threat on the interpretation of ambiguous information. *Behaviour Research and Therapy,* 49(4), 244-251. doi:10.1016/j.brat.2011.01.004

Williams, T., Jonny Klakegg, O., Walker, D. H., Andersen, B., & Morten Magnussen, O. (2012). Identifying and acting on early warning signs in complex projects. *Project Management Journal*, *43*(2), 37-53. doi: 10.1002/pmj.21259

Winch, G. M. (2010). *Managing construction projects* ($2^{nd}$ Ed.). West Sussex, UK: Blackwell Publishing Limited.

Wong, P. S., Cheung, S. O., Yiu, R. L., & Hardie, M. (2012). The unlearning dimension of organizational learning in construction projects. *International Journal of Project Management*, *30*(1), 94-104. doi:10.1016/j.ijproman.2011.04.001

Xia, B., & Chan, A. P. (2012). Measuring complexity for building projects: A Delphi study. *Engineering, Construction and Architectural Management*, *19*(1), 7-24. doi:10.1108/09699981211192544

Yang, J. B., & Kao, C. K. (2012). Critical path effect based delay analysis method for construction projects. *International Journal of Project Management*, *30*(3), 385-397. doi:10.1016/j.ijproman.2011.06.003

Yang, J. B., Chu, M. Y., & Huang, K. M. (2013). An empirical study of schedule delay causes based on Taiwan's litigation cases. *Project Management Journal*, *44*(3), 21-31. doi:10.1002/pmj.21337

Yang, J. B., Huang, K. M., Lee, C. H., & Chiu, C. T. (2014). Incorporating lost productivity calculation into delay analysis for construction projects. *KSCE Journal of Civil Engineering*, *18*(2), 380-388. doi:10.1007/s12205-014-0128-8

Yang, L. R., Chen, J. H., & Wang, H. W. (2012). Assessing impacts of information technology on project success through knowledge management practice. *Automation in Construction*, *22*, 182-191. doi:10.1016/j.autcon.2011.06.016

Yean Yng Ling, F., & Song Anh Nguyen, D. (2013). Strategies for construction waste management in Ho Chi Minh City, Vietnam. *Built Environment Project and Asset Management*, *3*(1), 141-156. doi:10.1108/BEPAM-08-2012-0045

Yeheyis, M., Hewage, K., Alam, M. S., Eskicioglu, C., & Sadiq, R. (2013). An overview of construction and demolition waste management in Canada: A lifecycle analysis approach to sustainability. *Clean Technologies and Environmental Policy*, *15*(1), 81-91. doi:10.1007/s10098-012-0481-6

Yin, R. K. (2014). *Case study research: Design and methods*. Thousand Oaks, CA: Sage.

Yoke-Lian, L., Hassim, S., Muniandy, R., & Mee-Ling, T. (2012). The assessment of applications for extension of time claims in Malaysian construction industry. *International Journal of Engineering & Technology (0975-4024)*, *4*(4), 446-450. doi:10.7763/IJET.2012.V4.407

Zegordi, S. H., & Davarzani, H. (2012). Developing a supply chain disruption analysis model: Application of colored Petri-nets. *Expert Systems with Applications*, *39*(2), 2102-2111. doi:10.1016/j.eswa.2011.07.137

Zeng, Z., Kang, R., Wen, M., & Chen, Y. (2015). Measuring reliability during product development considering aleatory and epistemic uncertainty. In *Reliability and Maintainability Symposium (RAMS), 2015 Annual* (pp. 1-6). IEEE. doi: 10.1109/rams.2015.7105067

Zhang, L., He, J., & Zhou, S. (2012). Sharing tacit knowledge for integrated project team flexibility: Case study of integrated project delivery. *Journal of Construction*

*Engineering and Management*, *139*(7), 795-804. doi:10.1061/(ASCE)CO.1943-7862.0000645

Zhang, P., & Fai Ng, F. (2012). Attitude toward knowledge sharing in construction teams. *Industrial Management & Data Systems*, *112*(9), 1326-1347. doi:10.1108/02635571211278956

Zhang, S., Teizer, J., Lee, J. K., Eastman, C. M., & Venugopal, M. (2013). Building information modeling (BIM) and safety: Automatic safety checking of construction models and schedules. *Automation in Construction*, *29*, 183-195. doi:10.1016/j.autcon.2012.05.006

Zhao, D., McCoy, A. P., Bulbul, T., Fiori, C., & Nikkhoo, P. (2015). Building collaborative construction skills through BIM-integrated learning environment. *International Journal of Construction Education and Research*, *11*(2), 97-120. doi:10.1080/15578771.2014.986251

Zhao, X., Hwang, B. G., & Yu, G. S. (2013). Identifying the critical risks in underground rail international construction joint ventures: Case study of Singapore. *International Journal of Project Management*, *31*(4), 554-566. doi:10.1016/j.ijproman.2012.10.014

Zhou, K. Z., & Li, C. B. (2012). How knowledge affects radical innovation: Knowledge base, market knowledge acquisition, and internal knowledge sharing. *Strategic Management Journal,* 33(9), 1090-1102. doi:10.1002/smj.1959

Zhou, W., Whyte, J., & Sacks, R. (2012). Construction safety and digital design: A review. *Automation in Construction*, *22*, 102-111. doi:10.1016/j.autcon.2011.07.005

Zou, W., Kumaraswamy, M., Chung, J., & Wong, J. (2014). Identifying the critical success factors for relationship management in PPP projects. *International Journal of Project Management*, *32*(2), 265-274. doi:10.1016/j.ijproman.2013.05.004

# Appendix A: Literature Search Terms

+ case study +construction project research

+construction projects +bounded reality

+construction projects +incomplete information

+Construction projects +unexpected event

+exploratory case study +construction projects

+Failure prediction +construction projects

+high reliability +construction Projects

+Information systems +construction project team

+information systems +projects team

+information technology +projects team

+mindfulness +construction project team

+mindfulness +projects team

+semi-structured interviews +construction project research

construction projects AND unexpected events

early warning signs AND complex projects

effective group work in construction project

failure prediction in construction projects

high reliability teams

high reliability teams AND mindful construction projects

Mindfulness AND information sharing

Mindfulness AND integration

Mindfulness AND team

Mindfulness AND weak signals

teams and project activities

Time and cost overruns in Construction projects

Weak signals AND construction failure

+construction projects +activity relationships

+construction projects +failure

+construction projects +multiple stakeholders

+early warning signs +complex projects

+Failure prediction +construction projects

+high reliability +construction project team

+high reliability +projects team

+Information systems +mindfulness

+information technology +construction teams

+interviews +construction project research

+mindfulness +information systems

+openended questions +construction project research

Failure in Nigeria Constructions Projects

weak signals AND construction failure

high reliability project team

effective teamwork in construction projects

Mindfulness AND communication

team* in construction projects

Mindfulness AND information tools

Mindfulness AND reliability

Mindfulness AND unexpected events

mindfulness in Nigeria Constructions Projects

construction projects failure

Time and cost overruns in Construction projects

construction projects teams,

Appendix B: Sample Letter of Cooperation

Community Research Partner Name
Contact Information

Date

My Contact Information

Dear *Name of Researcher*

***Letter of Cooperation from a Research Partner***
***Re: Unexpected Events in Nigeria Construction Projects: A Case of Four Construction Companies***

Dear Gabriel Baritulem Pidomson,

Based on my review of your research proposal, I give permission for you to conduct the study entitled *Unexpected Events in Nigeria Construction Projects: A Case of Four Construction Companies* within *Name of Community Research Partner*. As part of this study, I, on behalf of this company, authorize you to interview staff of my company, analyze their perspectives, and use the results in your dissertation. Individuals' participation will be voluntary and at their discretion.

We understand that our organization's responsibilities include: Allowing access to project personnel and non-sensitive documents that would aid your inquiry. Non-sensitive documents that this company will share would include proposals for projects or programs, progress reports, and clippings from the mass media that the company had preserved. This organization reserves the right to withdraw from the study at any time if our circumstances change.

I confirm that I am authorized to approve research in this setting and that this plan complies with the organization's policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student's supervising faculty/staff without permission from the Walden University IRB.

Sincerely,

Authorization Official
Contact Information

# Appendix C: Consent Form

CONSENT FORM

______________________

_____________________

____________________

Dear Sir,

You are invited to take part in a research study about the management of unexpected events in Nigerian construction projects. The researcher is inviting project experts such as architects, quantity surveyors, civil engineers, and project managers to be in the study. These experts will be divided into two categories: Those who would provide insights to successful projects, and those who would provide insights to unsuccessful projects they have participated in. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

This study is being conducted by a researcher named Gabriel Baritulem Pidomson, who is a doctoral student at Walden University.

**Background Information:**
The purpose of this qualitative exploratory case study is to gain an in-depth understanding of how project teams can combine mindfulness as revealed by High Reliability Organizations (HROs) with information systems (IS) to effectively respond to unexpected events during the execution phase of Nigerian construction projects.

**Procedures:**
If you agree to be in this study, you will be asked to:

- Take part in a recorded interview that will last between 1 hour and 1 hour 30 minutes,
- Take part in crosschecking the transcript of your interview that will last not more than 30 minutes; the purpose of which is to ensure that the interview transcript is an accurate representation of your views

Here are some sample questions:

- What is your qualification?
- What do you think are the reasons for unexpected events (tasks and activity failures) in Nigerian construction projects?
- How sufficient is the use of information systems by team members in facilitating the management of unexpected events during the execution phase of a project (successful/unsuccessful) on which you have worked?
- Assess how members of your team regard close calls and near misses of planned activity or task completion.

**Voluntary Nature of the Study:**
This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at Walden University or your firm will treat you differently if you decide not to be in

the study. If you decide to join the study now, you can still change your mind later. You may stop at any time.

**Risks and Benefits of Being in the Study:**
Being in this type of research involves some risk of the minor discomforts that can be encountered in daily life, such as fatigue, tiredness, or becoming upset during the interview. Being in this study would not pose a risk to your safety or wellbeing.

While there may be no direct personal benefits to you as an individual, the study would have the following benefits:

- Equip project experts with the knowledge, framework, and tools that could enhance their ability to improve efficiency in the management of unexpected events that cause delays and disruptions in construction projects
- Present useful suggestions for changing the way the society, governments, policymakers, practitioners, and even clients view failure in construction projects.
- Present useful suggestions that would inform how governments and policymakers formulate and implement better and more realistic policies aimed at reducing wastes
- Improve project performance and inadvertently lead to more job creation – reducing unemployment, and social stability

**Payment:**
Kindly note that there will be no form of payment or reimbursement for participating in this study; however, findings from this study can be made available to you on request, at no cost to you.
**Privacy:**
Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. Also, the researcher will not include your name or anything else that could identify you in the study reports. Data will be kept secure by securing the raw data in digital format, and saved with passwords. Codes would be used in place of names, and transcripts edited to remove any references likely to reveal your identity. Data will be kept for at least five years, as required by the university.

**Contacts and Questions:**
You may ask any questions you have now. Alternatively, if you have questions later, you may contact the researcher via the telephone number, +xxx-xxxx-xxxx-xxxx, or via email addresses: xxxxxxxx.xxxxxxxxx@waldenu.edu. If you want to talk privately about your rights as a participant, you can call Dr. Xxxxxx xxxxxx. She is the Walden University representative who can discuss this with you. Her phone number is +x-xxx-xxx-xxxx. Walden University's approval number for this study is **09-14-16-0384801** and it expires on **September 13, 2017.**

The researcher will give you a copy of this form to keep.

**Obtaining Your Consent**

If you feel you understand the study well enough to make a decision about it, please indicate your consent by responding to this email with the words **'I Consent.'** By replying to the email with the words 'I Consent' you are agreeing to participate and would not need to sign any other documents.

I look forward to your kind response

Name of Researcher

# Appendix D: Sample Interview Protocol

**Project Topic:** *Unexpected Events in Nigeria Construction Projects: A Case of Four Construction Companies*

**Time of interview:** At the convenience of the participant

**Date:** At the convenience of the participant – (September – October 2016)

**Place / Method:** Place most suitable to the participant/ face-to-face

**Interviewer:** Gabriel Pidomson

Interviewee: Participant Code [P1D/SuP]

**Brief Description of the study:**

The purpose of this qualitative exploratory case study is to gain an in-depth understanding on how project teams can combine mindfulness, as revealed by High Reliability Organizations (HROs), with information systems (IS) to respond effectively to unexpected events during the execution phase of Nigerian construction projects. The questions outlined below are intended to be answered by middle to upper-level construction project team members such as architects, quantity surveyors, civil engineers, builders, and project managers, involved in Nigerian construction projects. Kindly note that the answers you provide will be treated as confidential information, and will at no time be shared except you expressly elect to waive this condition. To this end, any answers provided will be used exclusively in this research

## Preliminaries

**General Comments**

- Welcome participant, and get him/her relaxed
- This interview will be recorded if it is convenient to you, but if it is recorded it would enable us to concentrate on issues. However, if you do not feel comfortable, it will not be recorded.

- This research is strictly for academic purposes and is being undertaken as part of a program of academic study at Walden University. This research will be written up as a Ph.D. dissertation, and will be available for further viewing on request.
- From your response to the letter sent to you, you elected to participate in this interview, are there any concerns you may wish to raise about this interview?
- You also understand that if at any point you feel uncomfortable about any question you may choose not to answer such questions.

**Participant Profile**

1. What is your highest qualification?
2. How long have your been working in the construction industry?
3. How long have you been working in the present company?
4. Are you giving perspectives for a project considered unsuccessful/successful?
    - Why was the project considered unsuccessful (If perspective is for an unsuccessful project)
5. What is the value of project for which you are giving perspective
6. Are you familiar with the principles of High Reliability Organizations?
7. Are you familiar with the use of Information Systems Management (ISM) in construction projects?

**Core Questions**

**Unexpected events**

1. What are the types of unexpected events that you have experienced on your projects?
2. What do you think are the effects of unexpected events (tasks and activity failures) in Nigerian construction projects?
    - What do you think are the reasons that trigger activity failures in Nigerian Construction Projects?

**Information Systems**

3. How sufficient is the use of information systems by team members in facilitating the management of unexpected events during the execution phase of a project (successful/unsuccessful) on which you have worked?
    - If sufficient, what specific strategies were most effective?
    - If not sufficient, what kinds of improvement are needed?

**HRT – Dimensions of Mindfulness**

***Preoccupation with Failure***

4. Assess how members of your team regard close calls and near misses of planned activity or task completion.
    - How would you assess the interest of your team members in using information systems to analyzing near misses of planned activity or task completion?

***Reluctance to Simplify***

5. How do members of your team capture (and report) information necessary to inform decisions that impact the timely execution of project activities?
    - Which is given greater priority and more time when an unexpected event occurs – using information systems to analyze events or advocating the views of member?

***Sensitivity to Operations***

6. Assess the attitude of your team members towards gathering feedbacks on things that are not going according to plan?
    - What is the role of information systems in collecting and reporting such feedbacks?
7. How would you assess the access of your team to resources about an unexpected event?

***Commitment to Resilience***

8. How much training has your team had with regards building risk awareness?
9. How much discretion does your team have to resolve unexpected problems?

- How much leverage is allowed for team members to exercise discretion in their use of information technology skills in the management of unexpected events?

***Deference to Expertise***

10. How would you assess the respect of team members for professional expertise?
    - How often does your team defer to information technology expertise when there is a problem?

**Other Questions**

1. Any additional ideas on using information systems management to facilitate the management of unexpected events in construction projects
2. Are there any additional comments you would like to make?
3. Do you have any questions for me, relating to this study?
4. Would it be convenient if I contact you for further clarification where necessary, or send you a transcript of this interview for review?

---

The interview ends here. The section below is for the researcher to complete.

**Field notes**

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________

Appendix E: Sample Study Leaflet

**STUDY LEAFLET**

**Institution:** Walden University, 100 Washington Avenue South, Minneapolis, MN 55401, USA.

**Committee Chair/ Mentor:** Dr. xxxxxxx xxxxxx
Email address: xxxxxxx.xxxxxx@waldenu.edu
Work phone: xxx. xxx. xxxx prefer 10:30 to 3:30

**Walden University representative:** Dr. xxxxxxx xxxxxxxxx
+1- xxx - xxx - xxx.

**Topic of Study:** *Unexpected Events in Nigeria Construction Projects: A Case of Four Construction Companies*

**Purpose of Study:**

The purpose of this qualitative exploratory case study is to gain an in-depth understanding on how project teams can combine mindfulness, as revealed by High Reliability Organizations (HROs) with information systems (IS), to effectively respond to unexpected events during the execution phase of Nigeria construction Projects.

**Objectives of the Study:**

1. To explore the causes and consequences unexpected events – delays and disruptions – occur in Nigerian construction projects.
2. To explore the need and use of information systems in the management of unexpected events in Nigerian construction projects.
3. To explore how team mindfulness can be used to facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects.
4. To explore how combining team mindfulness with Information Systems can facilitate an effective response to unexpected events during the execution phase of Nigerian construction projects.

# Appendix F: Sample Request for Research Partnership

My Contact Information
Date

Community Research Partner Name
Contact Information

Sir,
**Request for Research Partnership with Your Company**
**Re: Unexpected Events in Nigeria Construction Projects: A Case of Four Construction Companies**

Kindly permit me to partner with your company to undertake a research study about the management of unexpected events in Nigerian construction projects. I am a doctoral student at the Walden University in the United States. The purpose of this qualitative exploratory case study is to gain an in-depth understanding of how project teams can combine mindfulness as revealed by High Reliability Organizations (HROs) with information systems (IS) to effectively respond to unexpected events during the execution phase of Nigerian construction projects.

If this application is approved, I would wish to have access to project personnel and non-sensitive documents that would aid my inquiry. Project personnel that would be invited to take part in an interview that would last approximately one hour are project experts such as architects, quantity surveyors, civil engineers, and project managers from your organization. These experts will be divided into two categories: Those who would provide insights to *successful projects,* and those who would provide insights to *unsuccessful projects* they have participated in. Non-sensitive documents that I would expect your company to share with me would include proposals for projects or programs, progress reports, and clippings from the mass media that the company had preserved.

If you have any questions you may contact the researcher via the telephone number, xxxxxxxx, or via email addresses: xxxxxxxxx. If you want to talk privately about your rights or your organization or that of participants, you can call xxxxxxxxx. She is the Walden University representative who can discuss this with you. Her phone number is xxxxxxxxxx.

Kindly find attached, (1) a consent form for prospective participants, (2) a sample interview protocol, (3) study leaflet, and (4) a format for *Letter of Consent* approved by Walden University for organizations that accept to partner with me to undertake this study. Appending your signature to item (4) will suffice.

Note that your organization reserves the right to withdraw from the study at any time if your circumstances change. Also, I wish to assure you that all information are for research purposes, would be kept confidential, and the identity of your company or that of participants will not be disclosed to any person apart for the school. Codes would be used in place of names, and transcripts edited to remove any references likely to reveal the identity of your organization or that of participants. However, data will be kept for at least five years, as required by the university.

I would be most grateful if you kindly approve this application.

Yours sincerely,
Signature and Name of Researcher

# Appendix G: Data for Research Question 1: Themes by Participant Response

| | | | Interview question 1 | | | Interview question 2 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Unexpected events | | | Effects of unexpected | | Reasons for unexpected events | | | |
| Company | Participant | Project | Failures | Near misses | Surprises | Operational effects | Relational effects | Environmental Instability | Lapses in Organizational Management | Attitude/behavior of team members | Lapsing in plans and benchmarks |
| A | P1A/ SuP | P1 | X | | X | X | X | X | X | X | |
| | P2A/SuP | P1 | X | | | | | X | X | X | X |
| | P3A/SuP | P2 | X | X | X | X | X | X | | | X |
| | P4A/USuP | P3 | X | X | X | X | X | | X | X | X |
| | P5A/USuP | P3 | X | X | | | X | X | X | X | X |
| | P6A/USuP | P4 | X | X | X | X | | X | X | X | |
| | P7A/USuP | P5 | X | X | X | X | X | X | X | X | X |
| B | P1B/SuP | P6 | X | | X | X | X | X | X | X | X |
| | P2B/SuP | P6 | X | X | X | X | X | X | X | X | X |
| | P3B/SuP | P6 | X | X | X | X | X | X | X | X | |
| | P4B/USuP | P7 | X | X | X | X | X | X | X | X | |
| | P5B/USuP | P8 | X | | | | | | X | X | |
| | P6B/USuP | P9 | X | | X | X | X | X | X | X | X |
| C | P1C/SuP | P10 | X | | X | X | X | X | X | X | X |
| | P2C/SuP | P10 | X | X | | | X | X | | X | |
| | P3C/USuP | P11 | X | X | X | X | | X | X | X | X |
| | P4C/USuP | P12 | X | X | X | X | X | X | X | | X |
| | P5C/USuP | P13 | X | X | X | X | | X | X | X | X |
| D | P1D/SuP | P14 | X | X | X | X | X | X | X | X | X |
| | P2D/SuP | P14 | X | | X | X | X | X | X | X | |
| | P3D/SuP | P15 | X | X | | | X | X | | X | |
| | P4D/SuP | P15 | X | X | X | X | | | X | X | X |
| | P5D/USuP | P16 | X | | | | | X | X | X | X |
| | P6D/USuP | P17 | X | | X | X | X | X | X | X | X |
| Number | 24 | 17 | 24 | 15 | 18 | 17 | 18 | 21 | 21 | 22 | 16 |
| Percentage | | | 100% | 63% | 75% | 71% | 75% | 88% | 88% | 92% | 67% |

# Appendix H: Response Themes for Interview Question 3

| | | | Sufficiency of ISM | | | | Effective strategy used | | Recommendation for improvement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Company | Participant | Project | Sufficient | Needs improvement | Insufficient | Attitude of team members | Open communication | Implementation of defined procedure | Implementation of appropriate IT infrastructure | Regular training | Encouragement to apply IT skills |
| A | P1A/ SuP | P1 | | | X | X | | | X | X | X |
| | P2A/SuP | P1 | X | X | | X | X | X | X | X | X |
| | P3A/SuP | P2 | | | X | X | | X | X | | |
| | P4A/USuP | P3 | | | X | | X | | X | X | X |
| | P5A/USuP | P3 | X | | | X | X | X | X | X | X |
| | P6A/USuP | P4 | | | X | X | | X | X | X | X |
| | P7A/USuP | P5 | | | X | | X | X | X | X | X |
| B | P1B/SuP | P6 | X | | | X | | X | X | X | X |
| | P2B/SuP | P6 | | | X | X | | X | X | X | X |
| | P3B/SuP | P6 | | | X | X | X | X | X | X | |
| | P4B/USuP | P7 | X | | X | X | X | X | X | X | X |
| | P5B/USuP | P8 | | | | | X | X | | X | X |
| | P6B/USuP | P9 | X | | | X | | X | X | X | X |
| C | P1C/SuP | P10 | | | | X | X | X | X | X | X |
| | P2C/SuP | P10 | | X | X | X | | X | X | | X |
| | P3C/USuP | P11 | | | X | X | X | X | X | X | X |
| | P4C/USuP | P12 | | | X | X | | X | X | X | |
| | P5C/USuP | P13 | X | | X | | X | | X | X | X |

*(table continues)*

*table continued*

| | | | Sufficiency of ISM | | | | Effective Strategy used | | Recommendation for improvement | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Company | Participant | Project | Sufficient | Needs improvement | Insufficient | Attitude of team members | Open communication | Implementation of defined procedure | Implementation of appropriate IT infrastructure | Regular training | Encouragement to apply IT skills |
| D | | | | | | | | | | | |
| | P1D/SuP | P14 | X | | | X | | X | X | X | |
| | P2D/SuP | P14 | | X | X | | X | X | X | X | X |
| | P3C/SuP | P15 | X | X | | X | | X | X | | X |
| | P4D/SuP | P15 | | | X | | | X | X | X | |
| | P5D/USuP | P16 | | | X | X | X | X | X | X | X |
| | P6D/USuP | P17 | X | X | | X | X | X | X | X | X |
| Total | 24 | 17 | 9 | 5 | 15 | 18 | 13 | 22 | 23 | 21 | 19 |
| % Total | | | 37% | 21% | 63% | 75% | 54% | 92% | 96% | 88% | 79% |
| SuP | | 6 | 4 | 4 | 8 | 10 | 4 | 11 | 12 | 9 | 9 |
| % SuP | | 34% | 44% | 80% | 53% | 56% | 31% | 50% | 52% | 43% | 47% |
| USuP | | 11 | 5 | 1 | 7 | 8 | 9 | 11 | 11 | 12 | 10 |
| % USuP | | 56% | 56% | 20% | 47% | 44% | 69% | 50% | 48% | 57% | 53% |

*Note.* SuP = successful projects; % SuP = percentage of successful projects; USuP = unsuccessful projects; % USuP = percentage of unsuccessful projects.

# Appendix I: Response Themes for Interview Question 4-10

| | | | Use of HRO Principles | | | | | Combining mindfulness and information systems management (ISM) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Company | Participant | Project | Attitude of team members | Risk management | Team management | Communication | Training and use of skills | Weak signals management | Information management | Communication management | Team management |
| A | P1A/ SuP | P1 | X | X | X | X | X | X | X | X | X |
| | P2A/SuP | P1 | X | | | X | X | X | X | X | |
| | P3A/SuP | P2 | | X | X | | X | X | X | | X |
| | P4A/USuP | P3 | X | X | X | X | X | X | X | X | X |
| | P5A/USuP | P3 | X | | | X | X | X | X | | X |
| | P6A/USuP | P4 | | X | X | | X | X | | X | |
| | P7A/USuP | P5 | X | X | X | | X | X | X | X | X |
| B | P1B/SuP | P6 | X | | | X | X | X | | X | X |
| | P2B/SuP | P6 | | X | X | X | | X | X | X | |
| | P3B/SuP | P6 | X | X | X | X | X | X | X | X | X |
| | P4B/USuP | P7 | X | | X | X | X | X | X | X | X |
| | P5B/USuP | P8 | | X | | X | | X | X | X | |
| | P6B/USuP | P9 | X | X | | | X | X | | X | X |
| C | P1C/SuP | P10 | X | X | X | X | X | X | X | X | X |
| | P2C/SuP | P10 | X | | X | X | | X | X | X | X |
| | P3C/USuP | P11 | X | X | X | X | X | X | X | X | |
| | P4C/USuP | P12 | X | | X | | X | X | X | | X |
| | P5C/USuP | P13 | X | X | | X | | X | X | X | X |

*(table continues)*

*table continued*

| Company | Participant | Project | Use of HRO Principles | | | | | Combining mindfulness and information systems management (ISM) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Attitude of team members | Risk management | Team management | Communication | Training and use of skills | Weak signals management | Information management | Communication management | Team management |
| D | P1D/SuP | P14 | X | | | | X | X | X | X | X |
| | P2D/SuP | P14 | | X | X | X | | X | X | | |
| | P3C/SuP | P15 | X | | | | X | X | X | X | |
| | P4D/SuP | P15 | | X | X | X | X | X | X | X | X |
| | P5D/USuP | P16 | X | X | X | X | X | X | X | X | X |
| | P6D/USuP | P17 | X | X | | X | X | X | X | | X |
| Total Number | 24 | 17 | 17 | 16 | 15 | 17 | 19 | 24 | 21 | 19 | 17 |
| Total Percentage | | | 71% | 67% | 63% | 71% | 79% | 100% | 88% | 79% | 71% |
| Number (SuP) | | 6 | 8 | 7 | 8 | 9 | 9 | 12 | 11 | 10 | 8 |
| Percentage (SuP) | | 35% | 47% | 44% | 53% | 53% | 47% | 50% | 52% | 53% | 47% |
| Number (USuP) | | 11 | 9 | 9 | 7 | 8 | 10 | 12 | 10 | 9 | 9 |
| Percentage (USuP) | | 65% | 53% | 56% | 47% | 47% | 53% | 50% | 48% | 47% | 53% |