Interpreting the meaning of High Reliability Organisations in a healthcare context: A study of NHS Wales

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Abstract

Patient safety and providing a high quality of care are the prerequisite requirements for the effective and efficient operation of any healthcare organisation. However, alarming statistics of errors and adverse events continue to grow with effective organisational models to guide the reduction and control of error rates. The healthcare sector requires a major reform in current practices and the holistic approach known as High Reliability Organisation (HRO) offers potential utility when delivering error-free performance and reliable care and has evolved from studies of safety-critical environments, yet it has received little academic attention for the healthcare setting.

Despite more than two decades of HRO research, there is still a research gap in understanding how healthcare organisations can embrace the principles of HRO and what these principles mean. This research explores the meaning of HRO for healthcare professionals. As such, this doctoral research aims to *develop a HRO theoretical model to understand the concept of the HRO as it applied within the context of the Welsh NHS setting*. Two research questions were crafted for this study:

RQ1- *What are the perceived organisational features that enable higher reliability in the healthcare context?*

RQ2 - *How the perceived organisational features interact with each other to enable higher reliability in the healthcare context*?

The narrative literature review process allowed the synthesising of the HRO literature and identifying the key organisational features that can enable high reliability practices in the healthcare setting. The outcome of the literature review was a conceptual HRO model of six interrelated organisational features (forming eleven hypotheses). These concepts included the *mindful leader, training, communication, trust, reporting, and safety culture*. The study is framed using *'sensemaking'* and *'systems'* theories as explanators of the HRO healthcare model.

An online survey instrument was designed to test the HRO theoretical model in the Welsh NHS setting. Clinical and managerial workers from four Health Boards/Trusts (259 usable responses) participated. Structured Equation Modelling (SEM) was used to test the HRO model. The findings show that staff define HRO as the technical and socio-aspects for achieving high reliability performance; the revised HRO model identified that mindful leaders have a direct and significant impact on communication, training, and feedback. The mindful leader indirectly impacts safety culture through the mediation effect of communication, reporting, and trust. The training was found to have a direct impact on building trust and establishing good communication and reporting across the organisation. The revised HRO model, as a result of this study, provides a contextually specific (healthcare) understanding of HRO that differs greatly from other safety-critical contexts. The findings of the study have significant managerial and policy implications for the promotion and increased awareness of HRO amongst healthcare professionals and how to engage professional clinicians and professional managers who see HRO in similar but distinct forms. The contribution of the study is a healthcare specific description of HRO as a means of achieving higher system reliability.

Declaration and Statement

This work has not previously been accepted in substance for any degree and is not being concurrently submitted in candidature for any degree.

Signed .... Manisha Kumar................................. (candidate)

Date .... 22/03/2021...............................

STATEMENT 1

This thesis is the result of my own investigations, except where otherwise stated. Where correction services have been used, the extent and nature of the correction is clearly marked in a footnote(s).

Other sources are acknowledged by footnotes giving explicit references. A bibliography is appended.

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STATEMENT 2

I hereby give consent for my thesis, if accepted, to be available for photocopying and for inter-library loan, and for the title and summary to be made available to outside organisations.

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Table of Content

Contents

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List of Figures

List of Tables

Abbreviations

4Vs - Volume, Variety, Variation, and Visibility

A & E - Accident & Emergency

ACSNI - The Advisory Committee on the Safety of Nuclear Installations

AHA - Area Health Authorities

AHP - Allied Health Professions

AVE - Average Variance Extracted

CFA - Confirmatory Factor Analysis

CFI - Comparative Fit Index

CHC - Community Health Councils

CPD - Continuous Professional Development

CQC - Care Quality Commission

CUSP - Comprehensive Unit-based Safety Program

DHA - District Health Authorities

EFA - Exploratory Factor Analysis

ETTO - Efficiency-Thoroughness Trade-Off

FDA - Food and Drug Administration

FPC - Family Practitioner Committees

FRAM - Functional Resonance Analysis Method

FTE - Full-time Equivalents

GFI - Goodness of Fit Index

GIRFT - Get it right first time

GP - General Practitioners

HRO - Highly Reliable Organization

HSC - Health and Safety Commission

HSMS - Health and Safety Management System

IAEA - International Atomic Energy Agency

ICU - Intensive Care Unit

ISO - International Organisation for Standardisation

JHM - Johns Hopkins Medicine

LHB - Local Health Boards

MRI - Magnetic Resonance Imaging

NAT - Normal Accident Theory

NHS - National health Services

NLIAH - National Leadership and Innovation Agency for Healthcare

NPHS - The National Public Health Service

NPSA - National Patient Safety Agency

OM - Operations Management

ONS - Office of National Statistics

PCA - Principal Component Analysis

PICU - Paediatric Intensive Care Unit

R&D - Research and Development

RMSEA - Root Mean Square Error of Approximation

RRAILS - Rapid Response to Acute Illness

SC - Safety Culture

SEM - Structured Equation Modelling

SPSS - Statistical Package for the Social Sciences

TLI - Tucker-Lewis Index

TQM - Total Quality Management

UK - United Kingdom

WCH - The Wales Centre for Health

WHO - World Health Organisation

List of Publications

Journal Paper

- **Kumar, M.**, Rich, N., Kumar, M. and Liu, Y. (2020), "Creating highly reliable health care organisations through reverse exchanges", *Supply Chain Management: An International Journal* (ABS- 3*, Impact Factor- 4.7), https://doi.org/10.1108/SCM-03-2020-0123

Conference Papers

- **Kumar, M.**, Rich, N., 2019. Framework for achieving high reliability in healthcare, *POMS International Conference*, 13th – 14th December 2019, Mumbai, India,
- **Kumar, M.**, Rich, N., 2019. From experiential patient feedback to achieving highly reliable healthcare processes. *26th EUROMA Conference*, 15th -19th June 2019, Helsinki, Finland.
- **Kumar, M.**, Rich, N., 2018. Theoretical Framework for highly reliable healthcare organisations. *21st QMOD-ICQSS Conference*, 22nd -24th August 2018, Cardiff, UK.
- **Kumar, M.**, Rich, N., 2017. Healthcare and Highly Reliable Organisation: A dichotomy or harmony? *POMS Annual Conference*, 4th -7th May 2017, Texas, USA.

Chapter 1 Introduction

"The NHS will last as long as there are folk left with faith to fight for it"

Aneurin Bevan: Founder of the British National Health Services (NHS)

1.1 Introduction

The quote, above, from the originator of the British NHS, Aneurin Bevan (Member of Parliament), reflects the importance of the British NHS to the general population. Few organizations or industries enjoy such national and heart-felt loyalty of the public (despite being portrayed as underperforming by both the broadcast media and government statistics). To ensure that public confidence is maintained, effective patient care and the role of clinicians (including support staff) in delivering care must move away from processes that are broken and unsafe to systems of patient care that deliver high quality, safe, and timely care right first time every time. There can be no worthier intent than to help improve a process that supports patient care and to improve the lives of fellow human beings. Yet, as long ago as 1859, in a period that lacked widespread assistive healthcare technologies, the internet and global best practices, the British nurse Florence Nightingale was quoted as saying *"The very first requirement in a hospital is that it should do the sick no harm."* (1859). As such the need to get 'processes right' is now 160 years old. The GIRFT (get it right first time improvement program) initiative, launched by orthopaedic surgeon, Prof Tim Briggs, in 2012 highlights this lack of progress (https://www.gettingitrightfirsttime.co.uk/).

The GIRFT initiative focuses on treating customer safely and right first time offered the potential to reduce waste and release resources for the "cash strapped" NHS (Pym, 2017). The origin of GIRFT initiative itself could be traced back to the seminal publication of the US Institute of Medicine (1999) that highlighted compromises in the quality of patient care resulting in significant harm and deaths of patients. This report 'shook the world' and exposed care providers to startling evidence that the design and operation of care processes led to thousands of unnecessary deaths. The levels of patient harm can be seen through egregious instances of healthcare system failure highlighted in the report 'To Err is Human' by the US Institute of Medicine IOM (1999) and later by Francis (2010), Berwick (2013), and Keogh (2013) reporting on healthcare failures in the UK. These reports highlighted a significant decline in the quality of patient care and used evidenced statistics of avoidable errors committed by healthcare staff, resulting in the deaths of thousands of patients).

The IOM report (1999) shared shocking statistics of errors in the USA healthcare system (Kohn et al., 2000) and reignited interest in understanding how highly reliable organizational practices as well as combining lean ways of working/service improvement approaches could help overcome these system failings and harm. At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year because of medical errors that could have been prevented, according to estimates from two major studies (Kohn et al., 2000). Somewhere between 1.5 and 2.2 million people die annually because of healthcare errors in the U.S. Medical errors cost US providers approximately $37 billion each year, with roughly $18 billion of those costs associated with preventable errors, according to Kohn et al. (2000). In secondary care, it is claimed that approximately 10% of all inpatients are harmed during hospital treatment due to various adverse events, among which 50% of the errors can be prevented (Vries et al. 2017; WHO, 2019). These publications created a world-wide outrage and a 'call' to improve patient safety from governments, professional bodies and patient groups.

Medical errors (and other safety issues) costs billions of pounds/dollars each year to healthcare organisations that can be potentially avoided, according to Coleman et al., (2009) and a later study by Watson (2014). Hence moving towards a 'zero harm' healthcare system (or even an individual organization) seems to be slow and progress is questionable. The issue is not restricted to America though. In the UK, approximately 10% of all inpatients are harmed during hospital treatment, with reported adverse events costing the NHS approximately £3.5 billion per annum (Sari et al., 2007). In the recent UK National Audit Office report, an estimated cost of £1 billion was due to infections associated with healthcare errors alone. The Elliot et al. (2018) report on medication errors in the UK NHS also raises eyebrows in that 230 million medication errors occur in the UK NHS every year, though three out of four of those errors does not cause harm to patients. However, limited information is available on the severity and impact of the harm caused to patients due to such errors. In addition, the recent media coverage reporting the systemic and organization-wide malpractice at Mid Staffordshire NHS Trust further confirms the exposure of patients to risks and direct arm. The Mid Staffordshire NHS Foundation Trust attracted huge media attention because 1200 patients were involved in safety issues and the needless deaths of 670 patients (which was preventable) occurred; the cause of such a poor level of performance was attributed to an "over-focus on achieving efficiency targets" which compromised patient care and safety in the pursuit of efficiency (Francis Report, 2010).

Furthermore, the World Health Organisation (WHO), in their recent report (WHO, 2018) highlighted a figure of *"one in three hundred chances of patients getting harmed during a healthcare intervention"* and they contend this ratio is significantly higher than in other safety and risk critical industries such as aviation and nuclear power. Table 1.1 highlights the deteriorating conditions of patient safety in the healthcare system globally.

Facts on Patient Safety reported by WHO (2018)	Patient harm listed as 14th leading cause of the global disease burden
	Chance of one in ten patients getting harmed in the hospital
	Millions of patients affected by unsafe use of medication, which also cost in billions of dollars annually
	An astounding 15% of healthcare cost is wasted in dealing with adverse events
	14 out of every 100 patients admitted in the hospital is affected by hospital infections
	More than one million patients die annually due to surgical complications
	Administrative errors account for approximately 50% of all medical errors in primary care
	Inaccurate or delayed diagnosis causes harm to unacceptable number of patients.

Table 1.1: Patient Safety facts reported by WHO (Adapted from: WHO (2018))

Enhanced patient safety and high quality of care are the prerequisite requirement for the effective and efficient operation of any healthcare organisation. However, these requirements can also be considered as the biggest challenges currently facing the healthcare industry globally. The sector is in urgent need to reform current practices and explore alternatives to the provision of safer care and reduce preventable medical harm and errors.

Nearly two decades after the IOM report and ongoing research on making healthcare safer, many patients still suffer from preventable harm every day and no proper guide on how to deal with the current situation exists (Elliot et al., 2018; WHO, 2018). Other research contexts, such as commercial aviation and nuclear power, working under hazardous situations have more advanced models of organisational practices and concepts and have achieved high performance (reliability), yet the conceptualisation of the Highly Reliable Organization (HRO) for the healthcare context remains poorly defined and under-explored (Sutcliffe et al., 2017). There is a one in a million chance of a person getting harmed when flying compared to one in a three hundred chance of a patient being harmed during a healthcare intervention (WHO, 2019). A report published by WHO (2018) predicted that a comprehensive "systems approach" with correct strategies in Europe alone could prevent *"more than 750 000 harm-inflicting medical errors per year, leading in turn to over 3.2 million fewer days of hospitalization, 260 000 fewer incidents of permanent disability, and 95 000 fewer deaths per year"* (WHO, 2018).

The goal of a holistic approach to patient care and safety may be realised by application of HRO design principles (defined as *developing resilient and flexible processes and practices in an organisation to achieve and sustain highest levels of reliability for longer duration* – see Hopkins, 2007) but this has yet to be developed and tested effectively. These conditions set the background of this study. The application of HRO principles to the safety critical processes of patient care has yet to be developed and tested (Tolk et al., 2015; Hales and Chakravorty, 2016). As such, a study would need to develop and test the theory in this novel and people-centric context. In other safety contexts, the staff employed (and the equipment used) operate with standardised skills to process a relatively standardised material product. In the healthcare setting, the properties of industrial standard material flow are not the same as the flow of patients. Patients are complicated and may have comorbidities. It is often the case that patient routings and care pathways cannot easily be determined and therefore evolve. The need to restore broken healthcare systems and return to a capability to deliver care in a GIRFT manner is both an imperative for most governments and healthcare organisations and a major gap in the academic understanding of healthcare process management and the organisational practices that support safer ways of working. The latter is the context and theme of this study. This study, therefore, aims to contribute to a better understanding of how staff perceive safety and the concept of the high reliability organisation within the context of healthcare provision. In Chapter 3, the details of HRO principles and characteristics will be discussed to explain how organisations transition towards HRO. In this chapter, healthcare quality issues are highlighted, which justifies the need for HRO principles for the healthcare setting to minimise errors and harm to the patients.

1.2 Profiling Services and Safety

The term "healthcare process" covers a wide variety of actual practices and professions. To deliver the healthcare services more efficiently and effectively, one must have an understanding of 4Vs of operations management- Volume, Variety, Variation in Demand, and Visibility to customers (Slack et al., 2017) and such contingencies mean that customisation and translation of safety must be undertaken to exactly match the working environment within which safe care is practised (to result in greater efficiency, effectiveness and delivering services right first time). Understanding of 4Vs of the service operations (i.e. volume, variety, variation, and visibility) can help in profiling any services and thereafter develop strategies to manage it more efficiently and effectively (Johnston et al., 2012; Slack et al., 2017). Volume is defined as the number of products or services delivered either in mass with less customer interaction and more standardised process or when the output is low but with high interactions with the customer. Variety is defined as the flexibility to provide variety in services to the customer. They also include two further dimensions of variation and visibility. Variation is defined as when the operational process must be designed according to the demand fluctuation from the customer end and visibility is defined as customers' ability to see and experience the service in the operation process. Based on the understanding of volume and variety, any service can be classified into three categories: the mass service, the service shop, and the professional service (Slack et al., 2017).

Mass services are services with has greater customer transaction (volume), very little contact with the service provider (visibility) and very little customisation of services (variety and variability). For example, railway services and library services that perform mass operation daily, though most of those operations are standardised and require fewer customer interactions due to the increasing application of technology. In the **service shop,** the services are provided with more customer interaction using a mix of the front office and back-office resources to allow more degree of visibility to customers compared to mass services. For example, restaurants and car rental companies that have both front-office and back-office operations and require some level of interactions with the service user. **Professional services** require a higher level of customisation and frequent interaction with the customer. Such services are characterised by less volume and more variety, visibility, and variation in completion of a task that has a high level of complexities. For example, doctor's surgery, management consultancy etc, where every patient or project has unique requirements and requires customisation.

In short, service management can be defined as an effective and efficient way of process management which results in customer/ patient satisfaction (Johnston et al., 2012; Slack et al., 2017). Such a definition of service management is based upon calibration of volume versus variety, and these two concepts apply in a healthcare context. Examples of healthcare processes, see table 1.2, include accident & emergency, orthopaedics, neurology, maternity, Ear Nose and Throat ENT, and cancer.

The study of safety management in healthcare and non-healthcare operational and organisational settings has largely ignored such contexts but if these variations do exist then, it is feasible that a common understanding of the HRO will also have different interpretations. Very little support is provided by the extant operations management literature and service management, in general, is treated as largely a matter of customer experiences, recovery from failure and 'buying' customer loyalty. Except for the patient experience, these latter concepts do not translate into a healthcare professional service setting (Esain et al., 2016).

Healthcare Process/Service	Volume	Variety	Visibility	Variation
Accident and Emergency	Low	High	High	High
Orthopaedics	High	Relatively Low	High	Low
Neurology	Low	High	High	High
Maternity	High	Low	High	High
ENT	High	Low	High	Low
Cancer	Low	Low	High	High

Table 1.2: Profiling of Healthcare services across 4Vs of operations (Source: Researcher)

Within these service settings, most research has recently focused on pure services and their failure/recovery in terms of quality failures and the avoidance of reputational damage (Kumar and Kumar, 2016; Esain et al., 2016). However, when healthcare processes go wrong, the damage created affects the primary individual involved as well as staff and other stakeholders (carers and family etc.) and failure is measured in terms of safety and quality of care failures (Kumar et al., 2020; Burgess et al., 2016). Instead of providing 'vouchers' or other inducements for the customer not to complain the healthcare provider, who has provided a poor experience or caused patient harm/death, faces widespread media criticism and often claims litigation. As no public healthcare provider is insured because the insurance industry believes these organisations are unreliable and incapable of risk assessment, litigation claims must be paid from operating budgets. Moreover, other factors affecting the recovery process in healthcare could be litigation costs, damage to the reputation of staff and the organisation, and emotional damage (impacting on the memory of the organisation) (Esain et al., 2016). In the opinion of the researcher, the healthcare settings do not represent conditions where traditional call centre service recovery methods can be employed, and exploratory research in this area will mark a new contribution (Piercy and Rich, 2009; Kumar and Kumar, 2016). The researcher also believes that because safety represents a culture rather than a variable that can be controlled (as in manufacturing or most non-healthcare services), then a study of the attitudes of healthcare staff to the concept of the HRO is a worthy new avenue of research investigation.

The above characteristics of healthcare services, the specialisation of knowledge workers, the sensitivity of operations management to the ever-present dangers of harm, and the values of an organisation whose purpose is to care (and do no harm) means the current research into service recovery is inappropriate to that of the healthcare context. Studies, from an operations management perspective of damage to the quality of care (in the form of near-misses or actual harm reporting and incidents), do little to transform organisations into a higher level of reliability. Often learning from such events is hidden. The blame is attached to the individuals concerned with the incident and organisation fails to learn (as evidenced by the IOM report and others).

In the next section, the characteristics of healthcare operations are further explained and the link with HRO is justified.

1.3 Healthcare and Highly Reliable Organisations

It is important to understand the complex nature of the healthcare system before applying any change management initiatives to improve the performance and reliability of healthcare organisations because of the numerous tasks involved in providing patient care (Burgess et al., 2016; Smith, 2016). Harvey et al. (2016) called for moving beyond basic typologies founded on high variety workflows and high visibility operations to understand insightful issues of the process and contingent localisation of Operations and Service Management practices. They stopped short of identifying the need to understand safety as a precondition for patient flow and concluded the contextual factors affecting the outcomes of professional services (such as healthcare) are in contrast to more traditional manufacturing, “back-office” and general approaches undertaken by operations management (OM) researchers. The contingencies identified include the need to understand working practices and support infrastructures, HRM policies, performance management and reliability/safety in professional healthcare services (Lewis and Brown, 2012; Goodale et al., 2008). Healthcare has many attributes similar to other service industries such as heterogeneity, perishability, unique customer experience, the inseparability of customers with operations (Fitzsimmons, 2011; Grönross, 2007), but there are other characteristics of healthcare systems that would theoretically require further customisation to fully apply the concept of HRO for improving healthcare reliability (Kumar et al., 2020). The healthcare organisational setting is much harder to enact change, and it is a service operation where change cannot easily be imposed due to the diversity of staff involved, their different professions, their different reporting structures within a single organisation and other dysfunctional characteristics discussed below (Chassin and Loeb, 2013; Tolk et al., 2015; Burgess et al., 2016).

Achieving high reliability is essential for healthcare organisations but very difficult to achieve due to the nature of work laden with complexity, dynamism, interdependence, and time pressure (Carroll and Rudolph, 2006; Sutcliffe, 2011; Vogus, 2011; Christianson et al., 2011; Sutcliffe et al., 2017; Babyar, 2020; Kumar et al., 2020). Healthcare is a complex system as it requires a varying degree of technical knowledge for providing safer care. Also, complexity arises from having multiple inputs including patients, clinicians, managers, and other stakeholders that are processed through interrelated and complex processes resulting in favourable (i.e. right care and treatment) or unfavourable outcomes (harm to or death of a patient) for the patient or their families (Lindsay et al., 2020; Burgess et al., 2016). Healthcare complexity is also linked to interdependence as reliability is a measure of collective achievement rather than the sum of individual achievements, which is the current operation mode in the healthcare organisations, i.e. working in functional silos (Christianson et al., 2011; Smith, 2016).

Healthcare operates in a dynamic environment because the patient’s conditions are everchanging and evolving, team compositions also change quickly, and care provided by multiple professionals with different ways of communication, social status, power, and professional languages (Sutcliffe, 2011; Christianson et al., 2011; Lindsay et al., 2020). The time pressure created due to resource constraints in the healthcare system does not allow the organisation to operate in an error-free manner. The combination of process complexity, patient acuity, and time pressure results in slippage in quality of care for a given patient and limits care workers to adhere to checklists and procedures to minimise harm to patients (Naveh et al., 2005). This situation is further exacerbated by the blame and shame culture in organisations, which forces employees to remain quiet and silent when recognising danger or unsafe conditions (Blatt et al., 2006; Leape et al., 2012).

In addition, healthcare is a human actor-dependent, so translating HRO's tight-coupling assumption to this setting requires contextualisation (e.g. high-risk department such as trauma, ICU have more time-dependent pressure and cannot wait for a response compared to other units such as Geriatric which can be considered as a medium to low-risk unit). The tightly coupled system is defined as a system with more time-dependent pressures and requires a quick response and have reciprocal interdependence across many units and levels with variable sequencing (Roberts and Rousseau, 1989; Perrow, 1999). Unlike other tightly coupled systems like nuclear or oil and gas industry, in the healthcare setting, error in one patient does not always cascade through the entire department or hospital to affect every patient and the surrounding community (Tolk et al., 2015).

In the healthcare environment, the professionals or 'knowledge workers' are mostly located in customer-facing "front offices" and operate in a very different context to the back office of a bank or customer service centre (Smith, 2016). Front offices in the healthcare environment share little with manufacturing assembly lines even though they employ roughly the same number of people as a typical car assembly factory. Healthcare back-office operations also contain high levels of professional workers and thus treating professional services environment with the same methodology and intervention approach as traditional approaches to back-office improvement is inappropriate and insufficient to make productivity, quality and cost improvements (Harvey et al., 2016). Instead, to be successful, healthcare professionals must all have a high appreciation and awareness of safety management and high reliability if performance is to improve and as such, the attitude of workers to safety and the meaningful translation of a HRO concept and applied practices remains one of the least developed areas of service operations management (Tolk et al., 2015, Agwu et al. 2019; Cantu et al., 2020; Babyar, 2020). The gap in HRO application to the healthcare setting is supported by the following quote by Hales and Chakravorty (2016, pg. 2873) –

> *"While we understand what the aspects of HROs are, we lack the understanding of how to systematically create HROs and why they work to improve reliability."*

Therefore, a gap in the body of knowledge is framed as a poor understanding of the constituent parts of a model (and synergies) that combine to make a healthcare organisation safe.

1.4 The Research Gap in Summary

When the researcher started the PhD study in 2016, the majority of the HRO publications in the healthcare setting was conceptual, with limited publications going beyond 'what' to explain 'how' a healthcare organisation can embrace the characteristics exhibited by HROs (Tolk et al., 2015; Hales and Chakravorty et al., 2016; Vogus and Iacobucci, 2016). The few highly cited work on HRO in healthcare (Chassin and Loeb, 2013, Vogus and Sutcliffe, 2007a, b; Pronovost et al., 2006) uses a survey instrument but had only limited factors to measure HRO practice in the healthcare setting. Moreover, using those instruments in the future HRO study is not evidenced so far in the literature even in 2021. The two literature review papers on HRO published in 2020 (Cantu et al., 2020; Babyar, 2020) clearly evidenced the lack of progress in empirical research on how organisations can embrace HRO characteristics. This evidence supports and justifies the researcher's focus on developing an HRO theoretical model for the healthcare sector in doctoral research, which is discussed now.

The preceding synopsis of the stresses for healthcare organisations and professionals sets the scene for this study. In the healthcare operations management setting, the real issue is one of how a High Reliability Organisation and the right supporting culture is conceived by professionals as a precursor to the development of effective operations management processes, procedures, practices and cycles of learning that will develop to prevent harm and avoid healthcare service failures. The published literature has limited evidence of the HRO model applied to the healthcare setting and how the perceptions of staff impact the realisation of HRO tenets to improve patient safety and deliver high quality care to patients (Tolk et al., 2015; Hales and Chakravorty et al., 2016; Vogus and Iacobucci, 2016; Agwu et al., 2019; Cantu et al., 2020; Babyar, 2020).

The gap is expressed as a theory-building and testing approach to understand the tenets of High Reliability Organisations customised to the healthcare setting. The aim of the study is ***to develop a HRO theoretical model to understand the concept of the HRO as it applied within the context of the Welsh NHS setting.*** As discussed above, there is clearly a research gap in how organisations can exhibit HRO characteristics. This study attempts to address the research gap by answering the two research questions that are aligned with the aim of the study.

Research Question 1 (RQ1): ***What are the perceived organisational features that enable higher reliability in the healthcare context?***

Identifying the organisational features enabling high reliability practices will be achieved through a literature review, which will help the researcher identify the key organisational features most cited in the HRO healthcare literature. This will take a theory-building approach as there is no clearly developed model of HRO application in healthcare. The existing publications have focused on limited organisational features that enable high reliability in healthcare. Thus, it requires robust justification through theory-building to identify the perceived organisational features that fit the healthcare context from the review of secondary literature. Chapter 3 will provide a rationale on how the researcher has identified those organisational features that will form the part of the HRO theoretical model.

Research Question 2 (RQ2): ***How the perceived organisational features interact with each other to enable higher reliability in the healthcare context?***

Once the perceived organisational features are identified through the literature review process, the researcher will develop a HRO theoretical model that will showcase how the features are linked to each other. The secondary literature will support the theorising of X affecting Y in the model. The researcher will propose a range of hypotheses that aim to test the relationship between different organisational features that can guide healthcare organisations to transition towards HRO. The theoretical model will be tested by first developing a survey instrument, pilot testing it, and launching the survey in different health boards within Welsh NHS. The interactions between the organisational features enabling high reliability practices will be measured through a structured equation modelling (SEM) approach.

The result of the study will develop a theoretical model to understand the interpretation of the highly reliable organisation for the healthcare profession.

1.5 Personal Motivation for the Study

The researcher's personal interest in patient safety and quality of care derives from her personal interest in human resources and healthcare. The soft side of organisational management and how people and systems combine for high performance seemed at odds with the need for high reliability levels in the healthcare context. Service failures in financial services and other sectors resulted in token gifts and compensated for poor performance, but healthcare systems are more fragile and the costs of failure so high. The researcher's academic background of Masters in Business Administration (MBA) with specialisation in human resource and personal work experience of spending some time in secondary care, where she realised the importance of softer skills for providing consistently high-quality care and avoiding errors.

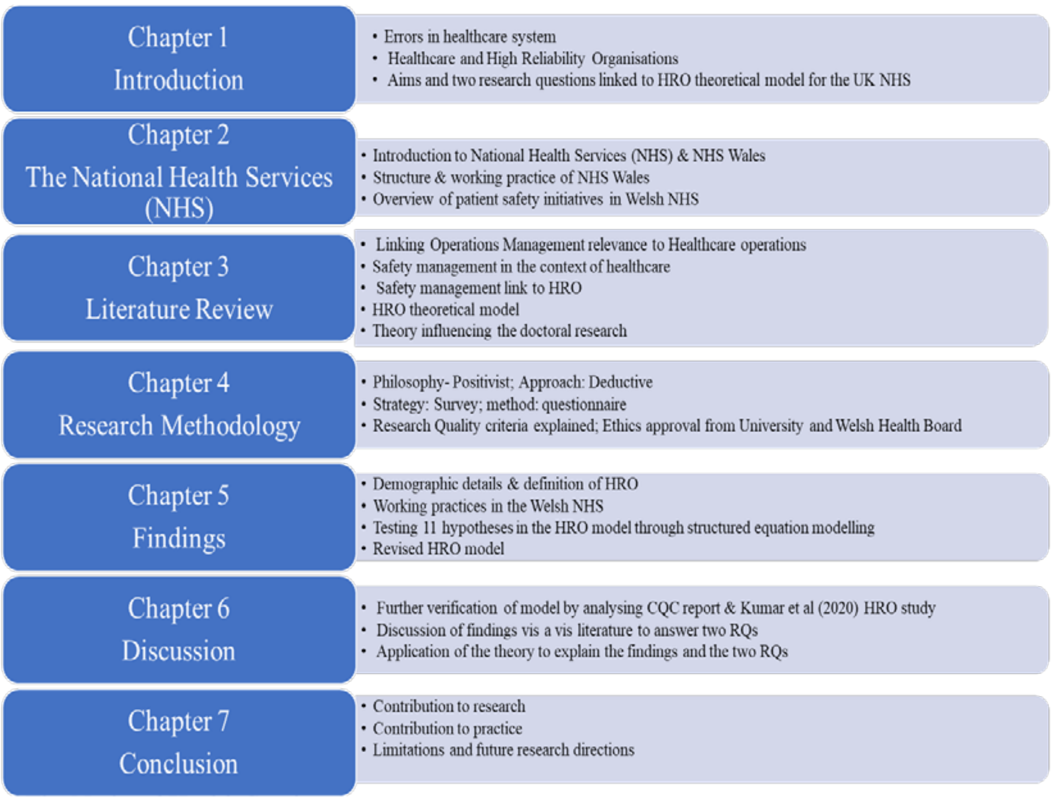
At the start of the doctoral study, the researcher was focused on understanding the importance of effective service recovery in the context of the healthcare setting. The researcher came across a special issue on Service recovery (Kumar et al., 2016), where few interesting articles focused on how service recovery can improve organisational learning and thereby have the capability to reduce errors and improve customer satisfaction (Kumar and Kumar, 2016; Esain et al., 2016). However, the focus on service recovery seemed like a reactive approach to resolving customer problem when errors have already occurred in the system and passed on to the customer. Given the statistics for the number of errors, near misses, and deaths in healthcare are astounding, a service recovery approach can only partially reduce the number of those incidents rather than address the problem from the systems perspective. This was when the researcher was exposed to the literature on HRO (which focuses on high reliability performance over a sustained time period in a high-risk industry setting). The concept of HRO seemed relevant and focused on developing a safety culture by making changes in organisational practices, especially soft practices such as leadership and communication. Doing initial horizon scanning of the HRO healthcare literature clearly showed a research gap in answering how organisations can transition towards HRO. This helped in narrowing down the focus to HRO healthcare study.

The researcher was also motivated by researching a meaningful and important gap in operations management, especially healthcare operations. The latter also reflects the researcher's altruistic intent and a way of giving back to society and her contribution to the world of knowledge.

1.6 The Thesis Logic and Structure

This thesis was designed such that the reader will follow a logical journey from the start of the research to its conclusions, see figure 1.1.

Figure 1.1: Structure of the thesis



Chapter One has set out the motivations and needs for this research. Chapter Two provides an introduction to the context of the study, which is the Welsh National Health Services (NHS)- the services provided, its structure and safety in Wales.

Chapter Three will present the focal literature and position this work within the main body of knowledge. This chapter will locate the study within a broader theoretical debate and focus on the use of *'sensemaking and system theories'* to explore high reliability organisational designs. The literature review chapter will outline the research gap and the need for a context-rich approach to any study of highly reliable organisations. Chapter Four will present and defend the designed research strategy and methodology that supports this study and will defend, from a philosophical perspective, the combined methods and phases of the research and its pedigree. Chapter Five will present the survey results in the Wales NHS and test the model for high reliability to establish a causal link between perceived organisational features included with the HRO theoretical model. This will be followed by the discussion (Chapter Six) where the findings of the two research questions will be compared against the extant literature to provide a contribution. The research and practical contribution of the study will be included in the conclusions Chapter Seven.

The next chapter will present an overview and context of Wales as the focal region for this study.

Chapter 2 The UK National Health Services

2.1 Introduction

National Health Services UK (NHS) is a comprehensive, publicly funded health care system provided in the United Kingdom (UK) for the UK population. The NHS was formed after the second world war on 5th of July 1948 and was the brainchild of the then Minister of Health (and Welshman), Aneurin Bevan (www.wales.nhs.uk). The origin of NHS was termed as "The Appointed Day" and marked a remarkable achievement in the history of the UK. In the last seven decades, the NHS has undergone several structural changes and reforms to keep its services relevant and address the challenges faced by the economic crisis, rising costs, ageing population, increasing demand, and increasing complexity in patient cases (Bartram and Dowling, 2013). Even though errors plague healthcare, the increasing reforms in the NHS have allowed keeping the focus on providing safe, efficient, and effective care (Gauld et al., 2014).

This chapter discusses the NHS, its structure, how NHS Wales has been functioning since its inception, the improvement initiatives undertaken for improving quality and safety in care delivery. The chapter provides the background context in which the empirical study is conducted to allow the reader to gain a contextual sensitisation to the NHS and its issues. Understanding the current structure and improvement initiatives undertaken in NHS Wales will help the researcher compare with the HRO theoretical model and how the principles of HRO aligns with some of the Welsh NHS initiatives, including 1000 Lives and Prudent Healthcare.

2.2 History of NHS

NHS was formed on 5th July 1948. It was the first time that the 'noble concept' of free healthcare for all (at the point of need) was implemented and was funded from general taxation. It was brought to the people with three main principles:

- That it meets the needs of everyone
- That it be free at the point of delivery

- That it be based on clinical need, not ability to pay

The aim of the newly established NHS in 1948 was *"The establishment of a comprehensive health service designed to secure improvement in the physical and mental health of the people of England and Wales and the prevention, diagnosis and treatment of illness"* (1946 NHS Act). Since the inception of NHS in 1948, it has gone through several changes over the decades, see figure 2.1.

In 1948 the NHS was divided into three parts: - *Primary Care, Community Service and Hospital Service*. This was also called the Tripartite System (www.wales.nhs.uk). Primary Care was a group of medical professionals including General Practitioners (GP), pharmacists, opticians etc., who were previously private contractors. Under the NHS system, they were not salaried but would be paid on the number of patients they had on "their list", or they would see. The local authorities controlled Community Services that would cover maternity services and child welfare, including vaccinations and immunisations of children. The Hospital Services included 14 regional hospitals and about 400 management committees that looked after their hospitals (www.wales.nhs.uk).

The NHS was overwhelmed with the people demanding its services. In only a few years, the NHS spending was enormous, and 1950's saw a rise in cost for NHS service provision. This resulted in the HM Treasury introducing charges on prescriptions, dental and optical care. In 1959, the Mental Healthcare Act was introduced as a relief for the patients of mental health conditions as it brought changes to the mental health rules and the grounds on which patients were kept in specialist hospitals. 1960's was the time when NHS grew to protect its staff and people (a period of rapid growth in the scale and scope of the NHS). Significant numbers of health centres were established. The minister of health, Enoch Powell, at the time published the "Hospital Plan for England and Wales", in which it was proposed to have more hospitals as the population was increasing and so was the demand. Later in the late 60s came the Salmon Report and Cogwheel Report, which brought forward the need and structure for nursing staff and also the need for speciality doctors in hospitals. (www.nhsggc.org.uk)

In 1974, the old Tripartite System came to an end and efforts were made to have all healthcare under "one boundaryless system". The hospital and community centres were then managed by the Area Health Authorities (AHAs) and all contracted health services (GP, Pharmacy, Optical) were taken care of by Family Practitioner Committees (FPCs). For the first time, a council was set up to represent the public's views called Community Health Councils (CHCs).

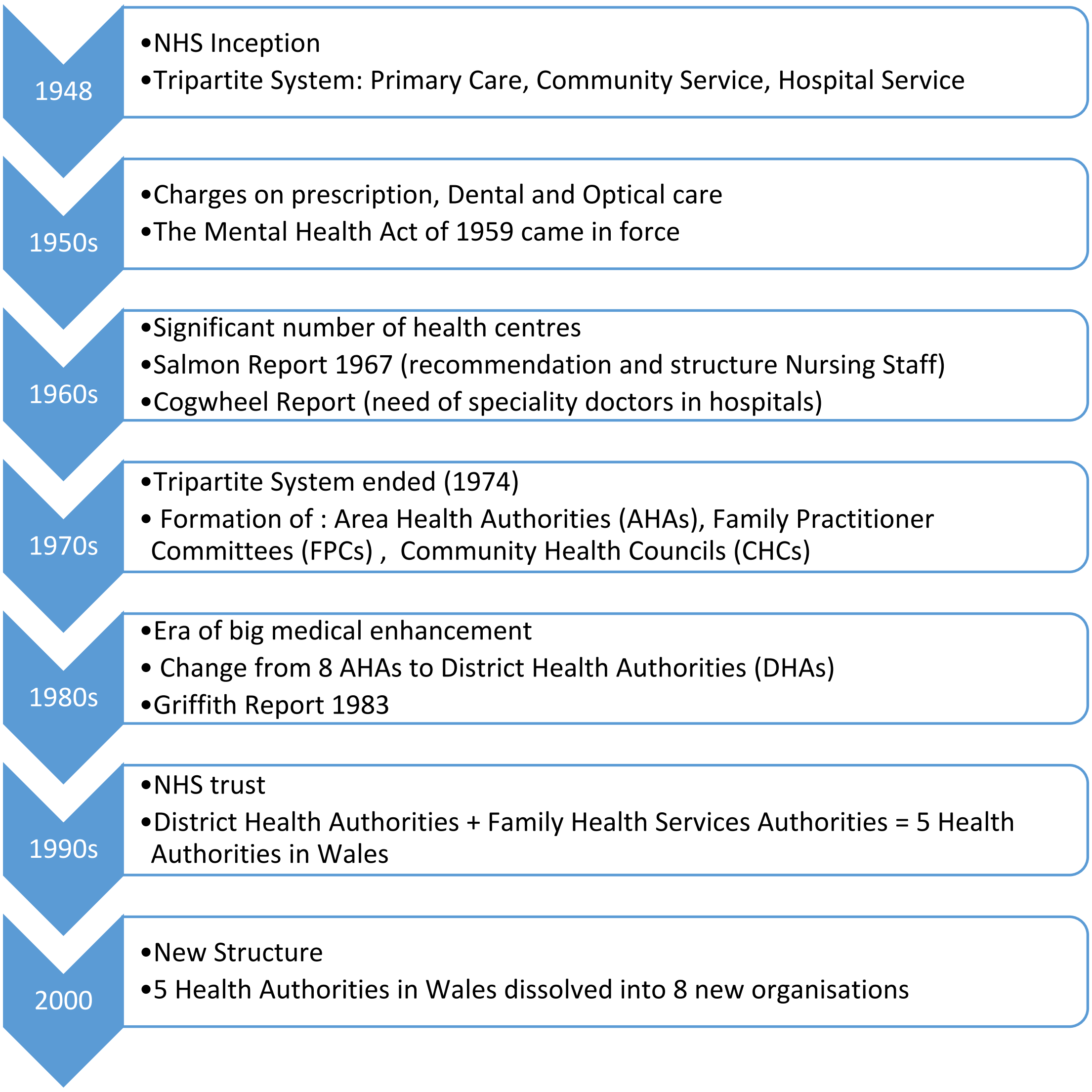
The 1980’s saw a significant leap in medical technologies and surgical procedures through the availability of MRI scanner innovations, keyhole surgery, mammography etc. Many medical advancements were made in this decade in combatting heart disease, mental illness, and learning disability. This was also when in Wales, 8 Area Health Authorities (AHAS) were changed from county focused organisations to District Health Authorities (DHAs). Based on the recommendations of the Griffiths Report, the DHAs were managed by General Managers who coordinated resources. The report also suggested clinicians should be part of the management team. In the 1990s, the NHS trust came into existence and even the concept of the internal market. During this time, GP and District Health Authorities (DHAs) were acting as service purchasers, and the Trusts were providers of healthcare services.

In 1997 under the dissolution referendum, the National Assembly of Wales came into being. Since then, NHS Wales is managed by the Welsh Government under the responsibility of the Welsh Cabinet Secretary for Health and Social Services. Another structural reform in the NHS led to the dissolution of five Health Authorities. The new structure has the following parts: -

1. The Health & Social Care Department
2. Regional Offices
3. National Leadership and Innovation Agency for Healthcare (NLIAH)
4. Health Commission Wales (Specialist Services)
5. The National Public Health Service (NPHS) and The Wales Centre for Health (WCH)
6. Local Health Boards (LHBs)
7. NHS Trusts
8. Community Health Council (CHCs)

NHS is now the fifth largest employer in the world, employing around 1.7 million people by the health services across the UK (Triggle, 2018). The budget spending for the NHS has grown at least 12 times since its conceptualisation in 1948. The proportion of public services budget spent on healthcare increased from 11.2% in 1955-56 to 30.1% in 2016-17. The statistics from the Office of National Statistics (ONS) shows an increase in life expectancy of the UK population (e.g. Male life expectancy had increased from 65.9 in 1948 to 79.5 in 2018; similarly, female life expectancy increased from 70.3 in 1948 to 83.1 in 2018), resulting in higher expenses for the NHS to cover the additional cost of healthcare for the growing ageing population.

Figure 2.1: History of NHS



(*Source: The researcher*)

2.3 NHS Wales

The new structure of NHS Wales came into existence in 2009. It looks after its population of 3.15 million people and promises better healthcare in the 21st century. It is also the biggest employer in the country, with approximately 99000 staff in more than 85000 full-time equivalents (FTE) post (https://gov.wales/staff-directly-employed-nhs-30-september-2020-html). The major funding of the NHS comes from the Wales government, which looks after the day to day functioning of healthcare. The allocated budget for Health and Social Services is £8.74 billion (https://gov.wales).

NHS Wales comprises of 7 Health Boards and 3 NHS Trusts, see figure 2.2. The seven Local Health Boards (LHBs) that plan and deliver healthcare support to the people of Wales are: -

1. **Aneurin Bevan University Health Board** was established on 1st October, 2009. It is responsible for NHS services in the area of Blaenau Gwent, Caerphilly, Monmouthshire, Newport, Torfaen and South Powys. It employs over 14000 staff (http://www.aneurinbevanprimarycare.co.uk/).

2. **Swansea Bay University Health Board** was established on April 1st, 2019. It looks after the population of Neath, Port Talbot and Swansea. The Health Board has three major hospitals: Morriston and Singleton in Swansea and Neath Port Talbot Hospital in Port Talbot. The Health Board has community hospitals and also provided specialists services in fertility, obesity, plastic surgery, to name a few service offerings. It employs over 12500 staff (https://sbuhb.nhs.wales/).

3. **Cardiff & Vale University Health Board** was established on 1st October 2009 and provides the healthcare services in Cardiff and Vale of Glamorgan. It also provides a range of specialities to a wider population across South and Mid Wales. It employs around 14500 staff (https://cavuhb.nhs.wales/)

4. **Hywel Dda Health Board** was established on 1st April 2008. It is responsible for NHS services in Carmarthenshire, Ceredigion and Pembrokeshire. It employs over 11,000 staff (20018/19). (http://www.wales.nhs.uk/)

5. **Cwm Taf Morgannwg University Health Board** was established on 1st April 2019. It provides primary, community, hospital and mental health services to

the people living in Bridgend, Merthyr Tydfil and Rhondda Cynon Taf. It employs around 12,000 staff (https://cwmtafmorgannwg.wales/).

6. **Betsi Cadwaladr University Health Board** was established on 1st October, 2009 and is the largest health board in Wales. It is responsible for NHS services in Anglesey, Gwynedd, Conwy, Denbighshire, Flintshire and Wrexham. It employs over 17,000 staff and provides primary, community, mental health and acute hospital services for the population of North Wales. (https://bcuhb.nhs.wales/)

7. **Powys Teaching Health Board** was established in 2003 and is responsible for NHS services in Powys. It employs around 12,000 staff.

Figure 2.2: Location of Health Boards in Wales

(Source: http://www.wales.nhs.uk/)

There are 3 NHS Trusts in Wales. These are the *Welsh Ambulance Services Trust* for emergency services, *Velindre NHS Trust*, offering specialist services in cancer across South East Wales. It also provides specialist blood services across Wales. The new *Public Health Wales* Trust is responsible for protecting and improving health and wellbeing and reducing health inequalities (https://gov.wales/nhs-wales).

The NHS workforce is faced with the challenge of evolving and innovating their service offerings to treat the growing number of the ageing population and a rising number of people with complex and chronic conditions (Welsh NHS Confederation, 2016). The organisation is also faced with the challenge of meeting the future needs of the population and developing innovative work practices to address expected shortfall in the future NHS staff for certain types of jobs and specific geography of Wales (Welsh NHS Confederation, 2017). Commenting on the important role played by the NHS workforce, and the Welsh Government, The Welsh NHS Confederation document (2017; pg.1) stated the following-

> *"It is important that Welsh Government policies support the ability of local NHS organisations to deploy staff in the best way to support high-quality and efficient patient care. Future demand for health and social care will not be met unless we plan, develop and use the health and social care workforce differently. The Welsh Government, through cross-party support, must help facilitate sustainable long-term workforce planning according to the needs of local communities."*

Amongst the key challenges facing health and care in Wales, the Welsh NHS Confederation (2016) stated the need for collaborative working and partnership across all public bodies to identify population needs. In addition, the report highlighted the need for the Health Boards to invest more in prevention-based activities and early interventions, which is aligned with anticipation principles of HRO.

2.4 Improvement Initiatives in NHS Wales

There have been consistent efforts for a better quality of care and patient safety in the Welsh healthcare setting since 1980's. The evidence can be seen from an initiative of implementing Total Quality Management (TQM) at Mid Glamorgan Health Authority in 1980's and the TQM initiative adapted by Bridgend and District NHS Wales (Bevan Commission, 2017). In 1990 the first director had put Quality initiatives in Wales as a part of the policies for better healthcare (Owen, 1990). All Health Boards across Wales have been consistent in their efforts, the progress has been slow, and there are many rooms for improvements (Addis et al., 2019). The progress has been visibly slower than the other high achieving non-healthcare organisation (Bevan Commission, 2017). In one further study involving English and Wales Hospitals, Lankshear et al. (2011)

found the inability of more than 50% of NHS Trusts to communicate effectively and reliably with junior doctors impacted on the medication safety outputs tool issued by the National Patient Safety Agency (NPSA). This highlights the need for a holistic approach to improving healthcare quality by integrating healthcare workers at all organisation levels.

There were several initiatives taken in Wales to improve patient safety and quality of care in Wales, which are discussed below.

2.4.1 1000 Lives - Improving Quality Together

The campaign was launched in April 2008 in Wales with the idea of improving patient safety and enhancing the quality of service in all Health Boards in Wales (www.1000livesplus.wales.nhs.uk). The aim was to save *1000 lives* and avoid up to 50,000 episodes of harm in Welsh healthcare in two years from the launch date (https://www.wales.nhs.uk/news/9630). All the Health Boards were committed to acting on the campaign. They were all working together to reduce any harm associated with healthcare, such as reducing infection, reducing surgical complications, and saving lives. This campaign was the first attempt to measure harm all across Wales. The impact from the two years of this campaign resulted in the prevention of 65869 episodes of harm and 1199 fewer deaths than the previous year (Cooper et al., 2015). The campaign had overachieved its target, and the campaign was further extended for four years and called *1000 Live Plus*. The campaign could have been even more successful if the approach was systematic and holistic in nature. All the Health Boards took their own approach to implementation, the training of most staff was on quality and not on the assessment of the quality of their processes.

2.4.2 Together for Wales (Wales Government 2011)

Together for Wales initiative was suggested by the Bevan Commission in one of its paper, *"Forging a better Future"* in 2011 and adapted by the Wales government for five years between 2011- 2016. The leading suggestions given for adaption in the next five years within NHS Wales were the following (www.bevancommission.org , http://www.wales.nhs.uk/) :

- Transparency in all kinds of performances, including the delivery of services available, the quality of service, patient experience and the cost involved. This will help NHS to have transparent processes aligned with patient requirements
- One system for all and the services would be around the requirements of people and not around the organisation.
- Efforts to make the people healthier and working on the reasons of inequalities of health in population.
- Investments in making world-class efficiency measure and a more integrated approach in providing care
- The co-production of services by involving local people in all stages of care delivery and accelerated pace of adoption of best practises.

2.4.3 Prudent Healthcare in NHS Wales

The Welsh NHS has been trying to look ahead in the future by overcoming its current ageing population, more complex health conditions, more engaged and increased patient expectations, and reduced budget and resources by introducing Wales to Prudent Healthcare (Bevan Commission, 2017). The work of the Bevan Commission underpinned the idea of the Prudent Healthcare initiative in Wales, an independent think-tank with the vision to bring the best healthcare practises to Wales from all around the world and still follow the principles of Aneurin Bevan (Bevan Commission, 2013; Welsh Government, 2016). The Prudent Healthcare principles were launched and supported by the Minister of Health and Social Services in January 2015.

The idea of Prudent Healthcare is making Wales healthier with the thought of how it will benefit the people of Wales by providing better care that enhances the experience of being cared for and improves everyone's health (Addis et al., 2019; Bradley et al., 2014). It is also how the services provided could cover the inequalities and provides social benefits for generations to come, and is more sustainable. Prudent Healthcare has the four main principles as working towards adding value to the service provided with sustainable improved outcomes (Addis et al., 2019; Bradley et al., 2014):

- Achieve health and wellbeing with the public, patients, and professionals as equal partners through co-production.
- Care for those with the greatest health needs first, making the most effective use of all skills and resources.
- Do only what is needed, no more, no less, and do no harm.
- Reduce inappropriate variation, using evidence-based practices consistently and transparently.

The Prudent healthcare concept has been spread all across the Welsh Health Boards. There were investments made so that primary care and secondary care could imbibe the principles of Prudent Healthcare. Healthcare professionals across Wales routinely receive information and guidance to adapt the principles of Prudent Healthcare. However, the limited research on the impact of this initiative indicates that there has been a gap in receiving the information and the implementation of the information (Addis et al., 2019). It further states that some clinicians felt that they were already doing things which aligned to the Prudent Healthcare principles and others thought that there was resistance to the new idea because of time pressures, high expectation of patients and the fear of getting pulled into litigations (Addis et al., 2019). Like 1000 Lives campaign, the idea lacks a more consistent approach in all Health Boards and the need to assure its employees that this bigger idea is to achieve more value and reduce all kinds of waste in NHS Wales.

Addis et al. (2019) also identified the issue of capacity caused due to staff shortage, lack of diagnostic services during the weekend, lack of resources within the community, which made it difficult for Hospitals to practice Prudent Healthcare principles. Lack of resources increases the burden on the healthcare workers and also increases the chance of errors or identifying weak signals in the system, as suggested by HRO researchers. Barker et al. (2016) further identified that for the success of initiatives like Prudent Healthcare, the clinicians require to showcase a behavioural change to physically and psychologically avail the opportunity provided by the initiative and show the desire to demonstrate that behaviour more than competing behaviours. Clinicians play a critical role in embracing, leading, and sustaining any change program in the NHS, and thus their buy-in and commitment are a must for the success of initiatives such as HRO (Babyar, 2020; Kumar et al., 2020; Lindsay et al., 2020).

Hancock (2015) reported a national quality and service improvement initiative in Wales, called the Rapid Response to Acute Illness (RRAILS) Programme, for reducing harm and death from sepsis. The participants of the study went through a learning set, and thereafter their performance was observed. The program helped Welsh clinicians change their behaviour and identify the need for reliable processes to improve outcome by early identification, escalation, and response to sepsis. This program bears a close resemblance to HRO as it also emphasises on the 'anticipation' principle to identify weak signals in the system before it changes to catastrophic failure.

Thus, some of the initiatives in the last decade in Wales point towards NHS Wales aspiration to achieve high reliability performance and deliver care aligned with the patient requirements.

2.5 Summary

This chapter has provided an introduction to the history of the NHS and how it has evolved in the last seven decades. Thereafter an introduction to NHS Wales and its structure was provided. A range of improvement initiatives, such as 1000 Lives and Prudent Healthcare, has been promoted by the Welsh Government and supported by an independent "think tank" like Bevan Commission to ensure safe, efficient, and effective care provision in Wales. A review of improvement initiatives has highlighted a need for a standardised approach across all Health Boards to maximise the benefits gained from implementing improvement initiatives. The review has also highlighted issues with clinicians behaviour in embracing change. The Bevan Commission and other healthcare researchers have recently suggested a joined-up approach involving patients and clinicians to drive the improvement effort, collect and monitor patient feedback to highlight areas for improvement, and achieve consistency in service delivery across Wales (Addis et al., 2019; Bevan Commission, 2017; Bradley et al., 2014). This is the context of the Welsh NHS and is provided to help the reader to position this research.

The next chapter will present and explore the background and focal literature that frames this theory-building study of safety management and the features of the HRO that are present or absent in the context of the global healthcare organisations.

Chapter 3 Literature Review

3.1 Introduction

The introduction chapter has identified a series of issues which affect the professional practice of healthcare management and distinguish it as a distinct and complicated context of operations management. The first chapter has provided evidence that there is a general trend, in the healthcare professions, to accept failure as inevitable but also presented the need for an awareness that greater reliability, at the process and organisational levels is needed if safe and high quality care is to be provided. To ground this research and locate it within existing academic knowledge, this chapter presents a narrative literature review conducted to present the key concepts and models of safer healthcare and present the gaps in the extant body of knowledge. Before entering a fieldwork stage of research, the in-depth review of the literature was considered necessary because this research seeks to build and test theory to explore the building blocks (i.e. perceived organisational features that build the HRO theoretical model) that enable high reliability practices in the healthcare organisations. The chapter presents the focal literature of the study and presents key theoretical lens through which organizational safety will be reviewed during the analysis of the research findings and discussion of the contribution of this study.

3.2 The Importance of Patient Safety

Patient safety simply means avoiding and reducing any forms of adverse outcomes or injuries or risks during healthcare provision and thus protecting patients from any forms of harm stemming from the healthcare processes (Vincent, 2010). If we investigate everyday news, we are often flooded with examples of failures in healthcare processes and the presentation of different kinds of harm through medical errors, mistakes (small or big), near misses and actual deaths resulting from poor practise or other forms of error. The sensitivity of professions and the public has been heightened by such reports and the frequency with which such matters happen.

The National Health Services (NHS) defines patient safety as *"The avoidance of unintended or unexpected harm to people during the provision of health care"* (NHS-improvements 2016). The World Health Organization (WHO) has named patient safety to be an epidemic concern (WHO website 2008) and a major priority for the many professions and organizations engaged in delivering healthcare on a global scale. The latter 'call to action' shows that patient safety and a lack of progress in achieving higher process reliability are systemic to all healthcare systems and are not reserved for the third world or mature and affluent societies.

The 'turning point' which identified the lapses and problems with healthcare systems, which formally reported what had been hidden or ignored for decades, was the 1999 report by Institute of Medicine (IOM) 'To Err is Human'. The report highlighted the frequency and extent of one form of error – medication errors. Despite the existence of laws and Acts and professional codes of conduct and licensing of professionals, issues with patient safety had not been tamed and controlled. As long ago as 1902, the biological Control Act was made to produce biological products to ensure consumers' safety. In 1938 came Food, Drug and Cosmetic Act vested authority to the U.S. Food and Drug Administration (FDA) to oversee the safety of food, drugs, medical devices, and cosmetics (National Institute of Health, website http://www.iom.edu.np/) and various other acts have provided control of certain parts of the healthcare system – the majority of which controlled and demanded compliance to standards for indirect products and activities that support the provision of healthcare. Over time, these Acts and interventions to standardize practices and support the delivery of safe care resulted in the control of equipment, including the Safe Medical Device Act (1996), which demanded that healthcare providers of countries must report and track all the undesirable events related to medical devices.

The patient safety report 'To Err is Human' was a pinnacle of safety awareness because it moved from addressing equipment and materials to directly questioning the competence of professionals and their ability to manage organizational processes to enable reliable and safe care (Kohn, 2000). Whist the report stops short of questioning 'the medical model' it does reject the proposal that wilful malpractice was endemic. The report highlighted the propensity for failures and errors despite almost 100 years of ongoing work on patient safety from the start of the 1900's. The IOM published three reports in total, and each presented a new insight into failure. To Err is Human

(1999), Crossing the Quality Chasm (2001) and Preventing Medication errors (Aspden et al., 2007) added more and more resolution to the primary issue of ensuring patient safety and each acknowledged that unsafe systems existed around the patient and that these were prone to failure (or required failure to be prevented by any individual professional practitioner by deliberately managing clinical processes). The importance of patient safety was reinforced when the report “To err is Human” demonstrated that between 44,000 to 98,000 people died, in the US, each year because of preventable medical errors. The report also estimated that between 1.5 and 2.2 million people die annually because of healthcare errors in the U.S. Medical errors cost US approximately $37 billion each year, with roughly $18 billion of those costs associated with preventable errors (IOM, 1999). Internationally, approximately 10% of all inpatients are harmed during hospital treatment (with a range of between 3.8% and 16.6%). Some of the most common errors reported were drug-related errors: wrong Medication or a wrong dose of medicine given, Diagnostic errors, Equipment failures, Blood transfusion-related injuries, misinterpretation of orders given for patients.

The Crossing the Quality Chasm (2001) was a follow-up of the “To Err is Human” report. It proposed changes and modifications to healthcare processes that were encapsulated in six aims for improvement: to provide safe, effective, patient-centred, timely, efficient, and equitable care. In Crossing the Quality Chasm, the Committee on Quality of Health Care focus is not on specific organizational approaches but rather on principles and guidance for redesign and represents fundamental changes in the way the system meets the needs of the people it serves (Wolfe, 2001). The report presented a conceptual means of framing the intent and outcomes sought from a healthcare process.

The “Preventing Medical Errors” report by the IOM in 2006 brought forward the concept of creating partnership collaborations with patients and healthcare providers. The first step was that the patient is taking more interest and accountability of their own medical care (Self-care concept). The hospital staff is communicating more to patients and educating the patients and themselves about medical care (interaction concept). The second step to reducing medical errors, it was argued, was to use information technology to prescribe medicines and to dispense. The intention was that all prescriptions be issued electronically and received electronically by pharmacists to erase all kinds of medicinal errors (IOM report 2006). These errors included transcription errors and administration errors that could be captured by better information technology. Classifying the types of medication errors, a study conducted in the UK by Elliott et al. (2018) highlighted that administration error and prescribing and transcribing error are still the two most prominent errors as highlighted in the IOM report (2006). Even after two decades of the first IOM report, healthcare organisations globally are struggling to reduce medication errors despite having access to high-tech technologies and investment in continuous improvement and safety initiatives such as Lean ways of working (Kumar et al., 2020).

The combined reports identified many other acknowledged errors, including the proposal that 1 in 10 patients was harmed during their hospital care because of a lapse of safety. Also, 1 in 5 suffers major injury or harm, and 1 in 30 die due to safety errors (Lawton et al., 2012). It has been argued that, in the UK, approximately 10% of all inpatients are harmed during hospital treatment, with reported adverse events costing the NHS approximately £3.5 billion per annum (Sari et al., 2007). In another report on medication errors published by Frontier Economics on 16th October 2014, it was highlighted that NHS wastes between £1billion - £2.5 billion due to improper medication use (Trojesen, 2014). Recent media coverage reported the malpractice at Mid Staffordshire NHS Trust further confirms the above-stated statistics. It was a complete system failure (at the organisational level) which ended up exacerbating patient harm and deaths. The Mid Staffordshire NHS Foundation Trust attracted huge media attention for all the wrong reasons by costing the lives of 1200 patients and causing the needless deaths of 670 patients (which was preventable) by an over-focus on achieving efficiency targets and in the process compromising patient care and safety (Francis Report, 2010).

In 2000, the UK Department of Health (NHS) published its report “An organisation with a memory”. The results showed about 850,000 adverse events per year (10% of hospital admissions). The statistics linked to adverse events in other European countries were similar - Spain (9.3%) (Aranaz Andrés et al., 2006) and Denmark (9%) (WHO, 2002). Recent statistics of medication errors from the USA show that at least one death every day and injury to approximately 1.3 million patients every year (Bennet, 2017). In the UK, NHS recently estimated that 237 million medication errors occur at some point in the medication process in England and costing NHS upwards of £98 million and more than 1700 lives every year (Elliott et al., 2018). However, 72% of those errors have little or no potential for harm. Moreover, most of these reports highlighted that nearly 50 per cent of the adverse events are considered preventable (WHO, 2019). Another report from the OECD highlighted that the annual cost of adverse events in England is comparable to 2000 GPs or 3500 hospital nurses (Slawomirski et al., 2017). The report also indicates that hospitals in the OECD countries incur 15% of the expenditure in treating safety failures.

All these reports imply that medical errors are latent failures in all the healthcare system across the globe and many of these errors are preventable. The biggest and most extreme harm caused is the loss of life, which is irrevocable, but apart from that, any nation will incur a significant “loss” because of errors in the health care system. These focal losses are the ‘tip of the iceberg’, and many hidden losses are incurred at the time when an error happens and harm results (Slawomirski et al., 2017; Elliott et al., 2018; WHO, 2019). These losses are: -

1. Lost capacity resulting in the overburden of the healthcare system
2. Financial losses to the institutes
3. Loss of trust in the healthcare systems
4. Loss of confidence of healthcare workers
5. No trust in the system
6. Lower health of the population

Two decades since the IOM published the first seminal report to expose unsafe healthcare, there have been changes made in the healthcare systems to counteract these weaknesses. Recent operations management authors have also conducted studies in improving healthcare process quality (Radnor and Bateman, 2016), but few have actually addressed the question of how to make healthcare processes highly reliable for enhancing patient safety (Cantu et al., 2020; Babyar, 2020; Tolk et al., 2015; Lekka, 2011). Instead operations management research has been restricted to small case studies of individual clinical or process-based teams. Despite global efforts to make healthcare safer, including new measures, laws, rules and practices put in place to achieve “zero harm”, healthcare progress is questionable and still processes result in errors and harm to patients (Cantu et al., 2020; Babyar, 2020; Kumar et al., 2020; Elliott et al., 2018). This background introduction has set the pessimistic scene for the reader, and the following section of the literature review will present the focal and background literature concerning patient safety and the high reliability organisation approach to healthcare systems design and management.

3.3 Operations Management Profiling and Link to Safety

Operations management is the body of knowledge used to design manufacturing and service systems. It has been associated with all stages of the evolution of manufacturing organizations (craft to mass and then to lean, agile, and industry 4.0) and it is the body of knowledge with important design considerations for the design of effective service organizations. This thesis will be defended from the basis and knowledge of operations management as a key field of study which underpins the design of effective organizations and processes.

3.3.1 Manufacturing and Service Operations

Most definitions of operations management ignore the presence of a service operation context and focus largely on operations as a manufacturing concern. A definition of services is presented by Gadrey et al. (1995) who observe that a service operation is executed by a provider or organisation which changes the customer's status instantaneously and 'on demand' and with the customer's collaboration. The definition is interesting and provides a good way of framing healthcare services. A service is, the authors contend, based on exploiting the knowledge of the provider's staff and satisfying the "service user's" needs by planning, and quality and control procedures. However, Gadrey et al., (1995) propose that services and their associated processes are based largely on the logic derived from the manufacturing sector designs. The authors do show that service operations, of any type, and professionals delivering services are increasingly concerned with the design and operation of high-quality processes and that professionals are engaged in learning how to improve – ironically, the learning models for service professionals are often imported models that have worked well in manufacturing operations but may not have been contextualised to the service setting and service user expectations. These models include the lean model and Bowen and Youngdahl (1998) identify "lean healthcare" as a target for such importation of better practices to improve performance. However, evidence of actual improvement resulting from such importation and emulation is emerging, but the sustainability of the Lean approach in the healthcare setting is still questionable (Burgess et al., 2016; Lindsay et al., 2020).

The generic label ‘service operation’ is itself a label that covers many different activities. These different contexts will be explored later in terms of the volume, variety, visibility of the consumer with the service process and variation in demand for a service process and the skills needed/errors that can be created by professionals in these contexts. Within service operations, two key differences can be determined. Some services are operated for a profit and driven by concepts of growth, and financial return and others are focused on cost minimisation (back-office operations) or have public sector budgets to work within (Osborne et al., 2015). The second dimension concerns the importance of safety and the impact of a failure on the service user. A service user is described in a variety of ways, including terms such as Customer, Consumer, Citizen (public sector and local government), Criminal (Justice system), Patient (the term used specifically for healthcare provision).

Of all the different classifications of the service user, only one type falls within the public sector, not for profit, and high safety requirements for healthcare. These contexts are important because, unlike private healthcare, public health systems are not motivated by growth and profit (and using residual profits to invest in safety) but are capacity constrained, funded by public budgets, have a focus on the cost of the service provision and greater altruism as an essential quality of the service provision as well (Osborne et al., 2015). Furthermore, patients in public systems tend to have their health needs met by primary and secondary care processes that are in the local vicinity and choice is therefore limited.

The general differences in service operations will now be explored.

3.3.2 Difference between Healthcare and other Public Services organisations

Four key service characteristics that differentiate service organisations from their manufacturing counterparts are (Grönross, 2007; Johnston and Clark, 2008; Fitzsimmons, 2011; Andrés-López et al., 2015):

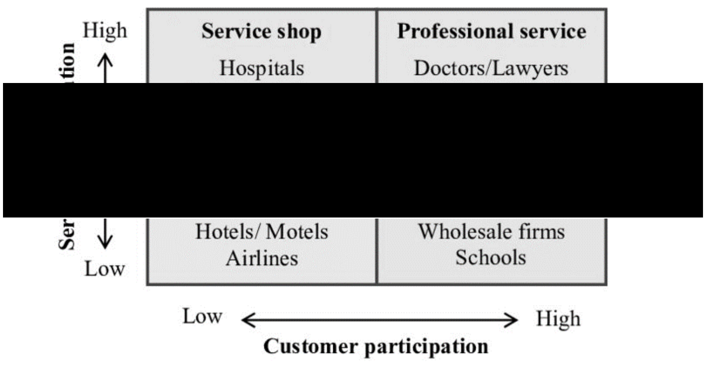
1. *Intangibility*: In service processes, the output can be intangible, i.e. the quality of the service provided is determined by the customers' feelings and expectations; there is lack of physical structure or tangible products received at the end of the service
2. *Inseparability*: The service production and consumption occur simultaneously, and in many cases, customer flowing through the process; this implies that the service provider must be ready when the demand arises.
3. *Variability (or heterogeneity)*: Every customer experience is unique and different from others, thus increasing the management complexity and requirement to provide customised services
4. *Perishability*: Services cannot be stored to be delivered at a later stage. If the service is not consumed at a given instance, capacity is lost and cannot be recovered. Thus, service providers need to be prompt and know effective methods to do capacity planning and demand management.

Within the service industry, public services such as the healthcare industry have unique characteristics and features that differentiate them from other service sectors (Berry and Bendapudi, 2007; Ahmed et al., 2013). In healthcare, we are dealing with sick, stressed, more emotional, demanding, sensitive, and dependent patients than they would normally be as a consumer (Berry and Bendapudi, 2007). The inseparable nature of services means that a service user and provider often co-design the service provided in the healthcare settings. An example includes the inpatient healthcare setting where the patient is immersed in the system for a few hours or days which may lead to changes in stress and emotional levels due to lack of contact, limited physical or mental stimulation opportunities, or due to feedback and response from care providers (Lillrank et al., 2011; O'Connor et al., 2000). A single error in the healthcare setting may lead to deaths that will have a devastating impact on patient families and the reputation of the provider (Reason, 1998).

The relationship between the public service user and public service organisations are not characterised by transactional or discrete relationship, as seen in most product or manufacturing cases (McLaughlin et al., 2009; Osborne, 2018; Osborne et al., 2015). Public sector organisations also tend to be not-for-profits and lack this commercial imperative to manage profits and cashflow. Such public organisations are designed to help citizens, patients and others who access services to improve their lives or comply with governmental regulations or requirements. Compared to other services, healthcare providers require patients to have a higher level of privacy disclosure to treat their symptoms. Unlike other sectors where people want to experience a service or buy a product, in this setting end-users need this service but do not necessarily want it (Berry and Bendapudi, 2007). From the provider perspective, clinicians in the healthcare setting have to equally deal with higher stress level and requires to be emotionally strong in dealing with complex cases or delivering bad news, and there is always a risk of medical malpractice claim (Berry and Bendapudi, 2007). Also, the use of tangible products by healthcare providers such as machine or technology are not 'public goods' in their own right – they only help in delivering the intangible and process-driven public services (Radnor and Bateman, 2016).

As discussed in Chapter 1 (section 1.2), healthcare belongs to professional services (PS) setting, exhibit several characteristics linked to 4Vs of OM- volume, variety, variation, and visibility (Slack et al., 2017), the understanding of which can help healthcare to improve the efficiency and effectiveness of their service delivery to patients. Based on the understanding of volume and variety, any service can be classified into four categories: the mass service, the service factory, the service shop, and the professional service (Schmenner, 1986; Verma and Boyer, 2000), see figure 3.1. As seen in figure 3.1, healthcare belongs to the professional services category, which requires a higher level of customization and frequent interaction with the customer (Daultani et al., 2015; Trinh and Kachitvichyanukul, 2013; Verma and Boyer, 2000).

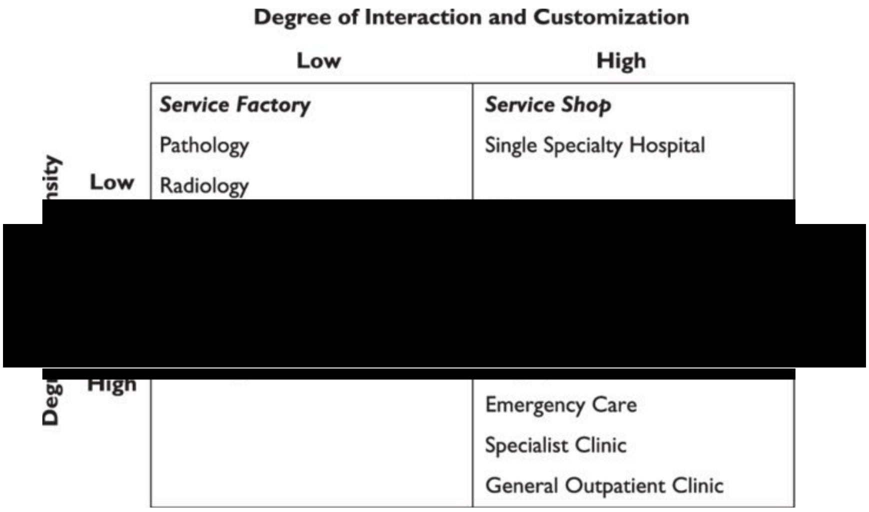
Figure 3.1: The classification of services



(Source: Trinh and Kachitvichyanukul, 2013)

Within the context of healthcare professional services, there can be a similar 2X2 matrix to classify different types of healthcare operations, see figure 2.2, based on customisation and customer participation (Daultani et al., 2015). There are examples of mass services (e.g. Pharmacy) and service factory (e.g. Pathology and Radiology) within the context of healthcare that is also characterised by high volume operations. On the other hand, there are operations with high variety, high customer visibility, and high degree of labour intensity (e.g. ICU, Emergency Care), which will require a different way of managing operations than those required by Service Factory or Mass Services.

Figure 3.2: Classification of Healthcare services



(Source: Daultani et al., 2015)

The purpose of explaining these different contexts is that the operations management literature recognizes different contexts but fails to address the issue of safety management in any meaningful way (or to suggest different approaches that are more contextually suited to a given form of service provision). Instead, derived decisions from these contexts tend to focus on manufacturing concepts of standardized work, equipment capacity and human skills needed to operate machinery and equipment/process layout. For healthcare settings and contexts, such derived decisions do not take enough account of safety rather than ‘flow’ of processes (Reason, 1998; Burgess et al., 2016). For healthcare contexts, the key inhibitor to patient flow is their condition and the safety of transferring care. The latter argument reinforces the need for safety first in designing new healthcare systems or adapting existing ones. Without being a high volume and low variety process with low variation then it is unlikely that a healthcare process could be standardized, and control activities introduced in the manner that such conditions would support a manufacturing environment (Kumar et al., 2020; Daultani et al., 2015). The reliance on process quality assurance for manufacturers and the ability to detect errors in a system (by tracking product variables) does not transfer to the healthcare setting were attributes can only be measured in imprecise terms (patient condition), and some variables exist (but they are insufficient to manage the processes supporting the patient and the patient's condition. As such, safety systems in healthcare processes tend to focus on organizational enablers and human factors for patients that are non-standardized in the care needed (Vogus, 2011; Reason, 1998).

For most models of manufacturing, value is derived through processing (value-added via physical conversion), but this concept is also difficult to transfer to a healthcare context where diagnosis (no actual physical conversion takes place), standardisation is less, patient (product) flow is slow as patients have a specific pathway designed for/selected for them and the patient moves between specialists that can help them manage their conditions as if moving between independent businesses that form a specific supply chain (Daultani et al., 2015; Burgess et al., 2016; Lindsay et al., 2020). The movement of the patient through the services they require, and the disjointed manner of service delivery coupled with the ever-present risks to patient safety, means this operations management context is one of the most difficult settings to design and manage. Unlike manufacturing, the responsibility for the process of care changes often, there is often poor communication between specialist departments and patient experiences vary widely (Christianson et al., 2011; Lindsay et al., 2020).

The widespread recognition that many patients experience harm has also added a new dimension which is not well researched in healthcare and that is the recovery from service failures (Esain et al., 2016). In the operations management literature, such service failure events (in retail, banking, etc.) are treated with countermeasures of apologies, learning and often a financial inducement to remain as a loyal customer (discounts, vouchers, and such like). However, failures in a safety-critical context, such as healthcare, has dire consequences and often litigation (of much higher sums than a service failure recovery inducement used in the mainstream and non-healthcare service sectors (Esain et al., 2016; Kumar et al., 2020). As such, the value of a patient pathway is derived for effective care (not necessarily efficient care) and the patient experience is a far more complicated and prolonged interaction with the care provider.

In this setting, the outcome of patient experience is determined because of multiple interactions with the total range of healthcare professionals (Kumar et al., 2020) and the value creation occurs only at the end of the patient's treatment (Harvey, 2016). For most patients, there are protracted episodes of care involving multiple actors interacting across functional boundaries that may reside inside or external to the organisation in their supply chain. Also, most of the errors occurring in this setting are at the interprofessional interfaces involving the flow of professional work products (e.g. diagnoses, opinions), whose actual path is unpredictable and can vary dynamically (Harvey, 2016). This makes healthcare a complex system and different from other service settings. In addition, learning from the world of high performance services is equally difficult because of the lack of profit motivation for public health services, the lack of resources and tight budgets of a national 'free' service and various bottleneck operations that are determined by the 'actual' patient journey, difficult to apply quality control/quality assurance routines, and demand variations on a much greater scale (Osborne et al., 2015; Lindsay et al., 2020). Hence applying the principles of manufacturing, or services in general, without customising it to the healthcare settings or understanding the healthcare context may result in failure or sub-optimisation of the system (Radnor and Bateman, 2016; Smith, 2016; Christianson et al., 2011).

In this manner, even though healthcare providers may emulate high performing manufacturing (e.g. Virginia Mason Production System – see Burgess et al., 2016), the process tends to focus on quality systems improvement and patient flow rather than a full assessment and development of routines that enhance the reliability of care and protect the safety of the patient within a flow process.

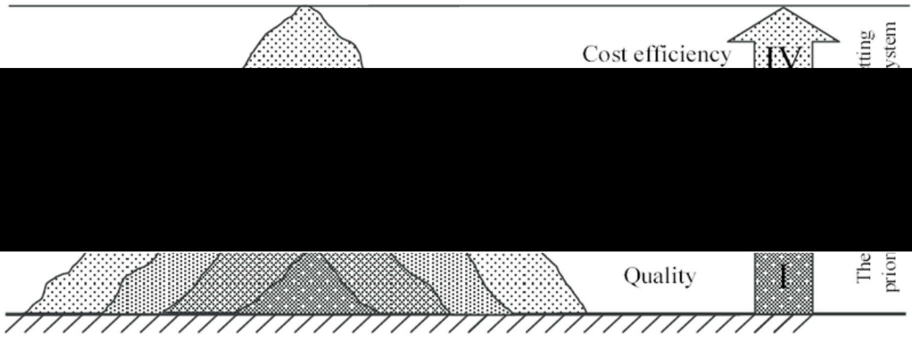
3.3.3 Operational Capabilities development: Lack of Safety Performance Objectives

Capability can be understood as a specific strength of the firm that they perform consistently better than its competitors or comparator companies (Wu et al., 2010). Peng et al.(2008) conceptualized operational capabilities as *'[…] the strength or* *proficiency of a bundle of interrelated routines for performing specific tasks'* (pg. 734). The definition clearly indicates that organizations need to pursue multiple interrelated routines to develop operational capabilities and it is the linkages of these activities, which form the ability to exploit the strength/capability. Such capabilities can be defined and measured in terms of quality, dependability, flexibility, speed, and cost (Skinner, 1969; Ferdows and DeMeyer, 1990). Such performance objectives, and their "mastery", focus on the design and operation of any manufacturing or service system. Most of the early OM literature focuses on the concept of a narrow performance during mass production, which cantered exclusively on cost management through the design of efficient systems that raised labour productivity (Skinner, 1969; Hayes and Wheelwright, 1984). Later, when additional performance objectives were demanded as part of a strategy to satisfy customers and owners, a "trade-off" concept emerged which meant that certain objectives would need to be prioritised at the expense of others (such as the belief that higher quality performance would lead to an increase in price).

Ferdows and DeMeyer (1990) first proposed a cumulative mastery of capabilities to gain competitive advantage, which began with the mastery of the process and organisational quality management (Quality control and quality assurance). The approach was in contrast to the trade-off concept or competitive capability concept, proposed by Skinner (1969) which proposed that organisation should focus and pursue developing capability on a single dimension based on either quality or delivery or flexibility or cost dimensions (Hayes and Wheelwright, 1984; Skinner, 1969). The trade-off concept assumes that no organization can be best at everything; thus, they need to design and align their effort to the dimensions they are good at and can excel and recognize their limitations. Researchers supporting trade-off concept (e.g. Boyer and Lewis, 2002; Corbett and Claridge, 2002; Pagell et al., 2000) suggested that organizations should only choose and focus on competitive priorities to develop its operational strategy rather than invest in all of them.

On the contrary, Ferdows and De Meyer (1990), supporting the cumulative capabilities concept, argue that in the dynamic market environment, the organisation will be disadvantaged if they only focus on developing one operational capability or one at a time (Skinner's (1969) trade-off concept). Instead, Ferdows and DeMeyer (1990) argued the need to cumulatively develop and build sequentially from one core capability, starting first with quality, then adding organisational and process dependability, speed, and then cost to sustain competitive advantage (see figure 3.3). The analogy used by the authors was cumulative capabilities that were mastered in their famous 'Sand cone Model' for improvement where organisations can build excellence on a common set of fundamental principles that can have lasting improvements in performance (Ferdows and De Meyer, 1990). Here, the word 'Sand' is analogous to management effort and resources and the core idea, of the Sand cone model, is to have a stronger and robust base that could be continuously widened to support the height. The model is now discussed below.

Figure 3.3: The Sand cone Model



[redacted]

(Source: Ferdows and De Meyer, 1990)

The first layer of improvement, a pre-condition to all lasting improvement, should focus on meeting minimum '*quality'* performance standard (i.e. doing things right first time or providing goods and services that are fit for purpose) (Slack and Brandon-Jones, 2018). Interestingly the authors did not focus on safety critical businesses but drew their model from case studies in food production. As such, the paramount importance of safety is not explicitly recognised. Once the quality process and performance objective are mastered and achieved, the organisation can start focusing on improving *dependability* dimension for operational improvement (i.e. doing things on-time and keeping to the promises made to the customer). At the same time, the organisation should strive to further improve on *quality* dimension in conjunction with *dependability*. In fact, improvement in *dependability* is only possible through improvement in *quality*. Once the organisation has achieved a critical level of *dependability* that can provide some stability in the operations, they are ready to improve the *speed* of the operations by delivering products and services to the customers at a faster pace and in-full (Ferdows and De Meyer, 1990) and at the same time continue to improve on the *quality* and *dependability* dimensions. The last layer of the Sand cone model is *cost* improvement, which is an ultimate consequence of resources and management efforts invested in the improvement of quality, dependability, and speed (Matthias and Buckle, 2016). This analogy is very similar to *Cost of Quality* concept proposed by Crosby (1979) who suggest that quality can be free in long-term when organisations are ready to invest upfront in prevention related costs resulting in a significant reduction in failure costs. Giving top priority to *quality* dimension can help to achieve the acceptable levels of other dimensions in the sand cone model.

The cumulative capabilities concept was further tested and support for the 'Sand cone' proposition were identified in the research work of Roth and Miller (1992), Noble (1995), White (1996), Menor et al. (2001), Rosenzweig and Roth (2004), and Avella et al. (2011). The explicit belief of the model is that any attempt to master a performance objective that follows any other route (not starting with quality) would end in disaster and chaos (the two scenarios that a health service cannot be subjected to).

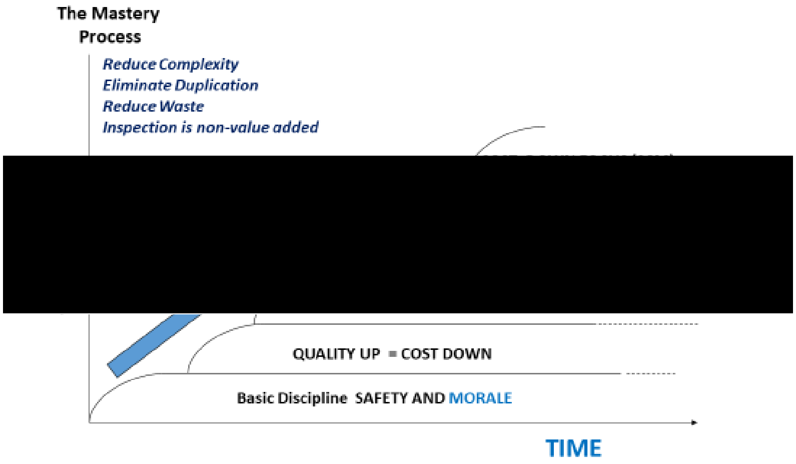
Other studies have found no evidence of cumulative capabilities progression logic (Bortolotti et al., 2015; Flynn and Flynn, 2004; Schroeder et al., 2010). These authors contest that the sequence of the cumulative development of capabilities is dependent on contextual contingencies, i.e. type of industry, size, geographic location, external environment. In the view of these authors, the operations strategies developed, and decisions taken, are affected by contingency factors, which reflects on their capability's choices (Flynn and Flynn, 2004; Schroeder et al., 2010). These authors provide some opportunity to identify safety as a core performance objective of equal or greater importance to quality but non elaborate further.

The majority of operational improvements studies in the British NHS is focused on a process of constantly seeking 'low hanging fruit' or simple improvements to gain efficiency savings (a cost-centric model which, in manufacturing leads to trade-offs) and also a care model that is focused on meeting centrally-set targets (Burgess et al., 2016; Lindsay et al., 2020). These latter objectives tend to prioritise the speedy delivery of care (through waiting time reductions and treatment times). Thus, the chances of long-term sustainability and lasting improvements through system-wide change in culture and mindset which is founded on a strong safety and quality objective, remains a fantasy according to Matthias and Buckle (2016) and later Bortolotti et al. (2018).

Several researchers argued that the “Sand cone” model application is contingent on the context being investigated and thus requires adaptation to provide any form of superior organisational performance (Bortolotti et al., 2015; Flynn and Flynn, 2004; Schroeder et al., 2010). There is a very limited operations management study that tests the relationship between one of the important dimensions in healthcare, i.e. safety with other dimensions of the Sand cone model, such as quality and speed (Rich et al., 2006, p29). Therefore, the role of safety is largely ignored by the literature and remains a gap in the body of knowledge (Reason, 1998; Vincent, 2010). Furthermore, to create a sand cone within a hospital and care setting would require the understanding and commitment of all the staff in a team, in a directorate, across an entire organisation and potentially to other organisations if high performance healthcare and better patient outcomes/experiences are to result. The latter would lead to a modified form of the sand cone model. The study of safety and quality as the primary objective of a healthcare system would be worthy. It would necessitate either a study of its application or the study of employee awareness and understanding. As the predominant focus of the health service is quality and delivery (speed), then a contingent model could therefore exist in this setting and would be worth studying in terms of the primary need to gain employee commitment and understanding of a safe service that is reliable (Bortolotti et al., 2018).

In summary, the Sand cone model, therefore, captures the essential logic of most manufacturing and service organisations and their comparatively less-safety exposed systems. The study of cases by Rich et al. (2006) therefore identifies the need to focus on improving the safety of processes and engaging staff to result in motivation (improved morale) by stabilising safe working then working on quality issues (see figure 3.4). However, Rich et al., (2006) do not go further to explore the exact characteristics of this initial foundation and how staff perceive the role of safety systems and how safety and just culture of recognising and learning from failures can be developed.

Figure 3.4: The modified Sand cone Model



(Source: Rich et al., 2006)

Despite the presentation of performance objectives that are more suited to a safety-critical and care context, application of the logic has been poor and mainly in the form of professional improvements to existing processes rather than a wholesale redesign of entire pathways and organisations (Harvey, 2016). However, the model does open some interesting debates in terms of the fundamental role and primary activity of developing a safety culture within healthcare organisations as a precursor for any form of service improvement. However, a major gap remains in the OM understanding of how public healthcare systems are designed or how healthcare services' existing design impacts patient safety and quality of care.

3.3.4 Safety Culture as a Foundation of Sand Cone Performance

Research on Safety culture (also known as organisational safety climate) have not figured highly in the operations management literature and this was recognised by Das et al., (2008). Brown (1996) was amongst the first OM researchers to call for research on workplace safety in operations management, but it has remained largely unanswered, especially in the context of healthcare. Of the few studies that exist, such a study has tended to test the relationship between safety and quality in the manufacturing environment and mostly focuses on employees' safety or the use of International ISO standards (Das et al., 2008; Brown et al., 2000; Brown, 1996). Such manufacturing workplaces operate with much greater standardisation of teams, technology, and material than the variety of patients seen in a healthcare setting. Such standardisation has been reinforced by the use and conformance of manufacturing businesses with audited international management standards such as the ISO45001 Health and Safety standard. Such standards do not exist or have not been adopted by healthcare organisations. The Das et al. (2008) study indicated safety does contribute to quality outcomes in the supply chain of a manufacturing system. This relationship has also been detected in studies of healthcare settings (Reason, 1998; Vogus, 2011). Many authors portray ‘safety’ as a basic need (like that of Abraham Maslow’s Theory of motivation – Maslow, 1954) and an organisation’s requirement to meet the employee's basic needs to be protected whilst at work. Das et al. (2008) argue that safety has a positive and direct impact on employee’s motivation to pursue organisational goals of quality improvement (Das et al., 2008). In this manner, the development of a common understanding and common mental model of what safety means for an organisation, especially those in healthcare contexts.

As part of the Lean improvement project, Marria et al. (2014) tested the importance of workplace safety and applied a modified 6S methodology. The 6S approach is a Japanese and lean working method of workplace discipline and control which usually consists of 5Ss (with each S being a stage of sorting, setting, shining, standardising, and sustaining improvement in the workplace) and the sixth S included by the authors was safety). The authors propose that it is necessary to include safety because workplace discipline reduces and eliminates human error sources (Reason, 1990). Marria et al. (2014) also assert that 5S and safety can be integrated to produce productivity and quality gains. The findings from the study showed a visible and tangible positive change in the workplace (i.e. in relation to productivity, efficiency, and quality) along with the creation of a safer work environment for employees and visitors. A similar application of the 6S tool tested in a healthcare environment by Nazarali et al. (2017) showed significant improvement in the productivity of an ophthalmology clinic. The study demonstrated a reduction in different forms of waste and, at the same time, many instances of the mitigated patient and resident safety risks. The authors claim that the initiative ultimately released extra time (saved through waste removal) and released many benefits for the resident clinician in terms of effective and efficient delivery of patient care. The improvement of the workplace and elimination of errors through the standardisation of the workplace does suggest that such improvements do assist in better system performance, although large scale (beyond single case studies) do not exist in the literature.

The link between safety and service quality is also absent from much of the Total Quality literature and the gurus in that field (Deming, 1986; Juran, 1988). Even definitions of quality and/or TQM rarely address the issue of safety management. Zeithaml and Bitner (2003, pg.85) propose that *"Service quality is a focused evaluation that reflects the customer's perception of specific dimensions of service namely reliability, responsiveness, assurance, empathy, tangibles"* but again miss the importance of safety. Most service quality authors highlight service reliability, service responsiveness, service assurance, customer empathy, tangibles, "word of mouth" recommendations, personal treatment, needs satisfaction, perceived quality of provider and service, meeting user expectations, past experience of such services and standards, and other descriptors but ironically a lack of attention to the explicit recognition of safety. The possible conclusion is that safety is an implicit belief for a service user and academics in the field of service management or that it has been largely missed by researchers. Whichever view is taken, the service sector and healthcare is a potential setting within which to explore how the staff engaged in delivering care conceptualise safety and reliability.

In the context of healthcare, patient safety comes first before any dimensions of the original Sand cone model and this priority objective (and calls for such a priority) have increased over the last 30 years. For example, the Institute of Medicine (IOM) report considers patient safety *"indistinguishable from the delivery of quality health care"* and defines patient safety as *"prevention of harm to patients"* (Aspden et al., 2007). The patient safety dimension focuses on the following aspects of care delivery (1) prevents errors; (2) promote learning from errors, and (3) build a safety culture by involving healthcare professionals, organizations, and patients. (Aspden et al., 2007; Clancy et al., 2005; Mitchell, 2008). The 2001 report from the IOM on 'crossing the quality chasm' conceptualised quality care as safe, effective, patient-centred, timely, efficient, and equitable. The report clearly rated safety as the foundation upon which all other aspects of quality care are built. Enhancement in patient safety in the long-term can have a knock-on impact on healthcare quality, dependability, speed, and cost of delivering healthcare services. Thus, it is important to focus on safety dimensions to make healthcare more reliable. Focusing on quality improvement projects may not help healthcare be highly reliable, given the wide range of processes, human factors, and length of treatment time/number of encounters in a typical patient journey.

3.4 Tackling Healthcare Challenges through Operations Management

Recent statistics from the World Health Organization (WHO) revealed that 8%-12% of hospitalized patients are a victim of an adverse incident (WHO, 2019) which has a correlation with statistics published in other parts of the world. These other statistics suggest that 10% of hospital admissions lead to adverse events in the NHS UK (NHS, 2000); 9.3% in Spain (ENEAS, 2005); 9% in Denmark (Schiøler et al., 2001); 16.6 % in Australia (WHO, 2002). In the USA, one type of healthcare error, i.e. medication errors, cause at least one death every day and injure approximately 1.3 million patients every year (WHO, 2018). These statistics are startling and show that adverse incidents have not declined in healthcare settings across the globe in the last two decades, even though there has been leap-frog jump in the healthcare management system for improving patient safety and getting things right first time. Another alarming statistic shared by WHO (2019) was that 90% of those adverse incidents are preventable. WHO (2019) also claimed that the risk of a patient dying in the healthcare setting due to preventable medical accident is 10000 times higher than when flying in an aircraft (1/300 against 1 over 3 million).

The statistics shared above reveal the quality and safety issues in high-income and developed countries of the world as opposed to developing nations which is startling. The finding supports the messages stated in ‘To Err is Human’ publication by Institute of Medicine (IoM)- *“the problem is not bad people in health care-- it is that good people are working in bad systems that need to be made safer”* (Kohn et al., 2000). This was among the first publication that highlighted the need for a safer and reliable healthcare system design. The report put forward several recommendations for improving patient safety including improvement in leadership, data collection, analysis, and reporting, safety culture, and development of an effective system with patient safety focus at the heart of designing such system. Since the publication of the IOM report, healthcare organisations started focusing on patient safety and quality improvement projects to deal with medical errors and its impact (Crump and Adil, 2009; Proudlove et al., 2008; Chassin and Loeb, 2013). There needs to be a fundamental change in the structure and design of healthcare services to enhance safety and reliability of care (Hopkins, 2007; Lekka, 2011; Ahmed et al., 2013; Kumar et al., 2020; Cantu et al., 2020). The switch in emphasis from harm towards and organizational and systems perspective to managing patient safety reflected a more general trend in the literature towards a focus on the organisation, rather than individual failures of commission or omission. Such an approach is related to the work of James Reason (1990) and his swiss cheese model of accident causation, which will be discussed later.

3.4.1 Speeding Up Processes and Increasing Safety Issues

Similarly, healthcare providers in the UK- National Health Services (NHS), face multiple challenges to provide a high quality of care amidst rising costs, a reduction in funding, increasing demand, and increasing complexity in patient cases which only add to the complexity of managing patient safety (Burgess et al., 2016; Lindsay, 2016; Klein, 2010). The call for efficient healthcare processes, increasing managerialism, target setting and meeting targets were introduced to the publicly funded British NHS commended during the Thatcher government in the UK and have persisted since the 1980s. Increased influence of such factors on healthcare providers has intensified and in parallel with a period of budget reductions, increasing costs of healthcare provision, and both which place additional pressure on government budgets and present significant sources of errors, trade-offs between speed and the quality of care (Hollnagel, 2009) and the ranges of latent process risks to the availability of timely care and safer patient treatment (Klein, 2010; Radnor and Bateman, 2016; Graban and Swartz, 2012).

This has led to increasing interest in the application of quality improvement methodologies such as Lean and Six Sigma, borrowed from the manufacturing sector, for quality improvement and learning best practices from manufacturing (Lindsay et al., 2020; Bortolotti et al., 2018; Chassin and Loeb, 2013; Crump and Adil, 2009). The rise in papers addressing the healthcare context was reviewed by the researcher and the ABS 2018 rated three-star and four-star journals have each published works in the areas of quality improvement, but these papers rarely address the safety management of processes and focus instead on the Leanness of quality improvement (Bortolotti et al., 2018; Lindsay et al., 2020).

Healthcare organisations in the Western world, the subject of much academic research into quality, started focusing on improving quality of care and patient safety post the year 2000 and resulted from learning from manufacturing organisations about operations management and improvement principles to match patient expectations, especially knowledge gained from the car producer Toyota and the adoption of Lean ways of working by private healthcare providers in the USA (Ahmed et al., 2013; Berry and Bendapudi, 2007; Matthias and Buckle, 2016; Lindsay, 2016).

3.4.2 Healthcare and Manufacturing Sector Emulation

In simplistic terms, operations management is concerned with efficient and effective management of inputs of people, processes, and resources through a transformation process model to provide an output to the end consumer that could be tangible or intangible (Slack et al., 2017). Such a rudimentary view of manufacturing operations has been used as the conduit as researchers have transitioned into the healthcare context and settings. There has been a growing recognition, in the literature, that healthcare providers need the expertise of operations management, operations improvement, human resources management and other discipline scholars to create efficient and effective healthcare system for delivering user-centred designed services (Robert et al., 2015). Given public services consumes a significant proportion of a nations GDP expenditure and experiences significant operational challenges in the face of funding cuts and resources constraints, there is no better time for OM scholars to research and develop new OM thinking and theory for public services (Osborne et al., 2015). In the same vein, the healthcare sector equally needs to adapt its practices to embrace OM thinking and theories for improving patient safety and quality of care and is reflected in the call made by Radnor and Bateman (2016).

Segel (2017) and many other operations management researchers have contested that borrowing principles and tools from operations management such as Lean and Agile methodologies to help healthcare overcome bureaucratic systems so that improvement and transparent processes (that characterizes many manufacturing operations) can be developed and nurtured (Upton, 2016; Matthias and Buckle, 2016;

Radnor and Osborne, 2013; Radnor et al., 2012; Fillingham, 2008). This shift in focus is a result of growing pressure on public services across the western world to focus on increased efficiency and meeting centrally set targets over the effectiveness and equity resulting in depreciation in the integrated care ethos (Radnor and Bateman, 2016; Currie and Suhomlinova, 2006). Radnor (2010) conducted a review on operations improvement methodologies used in the public sector and found 51% of the publications focused on Lean and 35% of those Lean papers were linked to healthcare. However, caution should be taken when implementing operations management techniques as they are context-specific and thus require adaptation to meet the requirements of healthcare operations rather than dismissing the context (Radnor and Osborne, 2013). Hence, Public services organisations should stay away from product-dominant public management theory and adhere to service management theory that recognises the context (Osborne et al., 2015; Johnston and Clark, 2008; Grönroos, 2007). A good application of service OM theories should lead to better and more appropriate services and experiences for patients, staff, and organisations (Johnston et al., 2012).

Despite the raised awareness and benefits of applying operations management methodologies such as Lean for healthcare service improvement, the rate of improvement across healthcare organisations including NHS is not consistent due to several reasons, including limited training to healthcare professionals and managers on quality improvement methodologies, high demand variability, lack of time for clinical teams to engage in improvement, and also the reluctance of healthcare professionals to engage in quality improvement (Lindsay et al., 2020; Wilkinson et al., 2011; Fillingham, 2008). Another reason for the lack of sustainability of Lean in the UK NHS is too much focus on efficiency improvement, reducing costs, and meeting targets (Seddon and Caulkin, 2007). These trends have resulted in inward-facing Lean initiatives that have led to short-term improvement in internal efficiency but fail to address the larger issue of re-designing healthcare services to meet the needs of the end-users and add value to their lives (Radnor and Bateman, 2016).

Operations strategy in healthcare is a set of bureaucratic policies and the complexities and difficulties of diffused responsibilities through committees resulting in undermined staff empowerment, slowing problem solving, produces parochialism (i.e. employees focusing more on internal matters than actual customer requirements), breeds inertia (i.e. left for catching up instead of leading), discouraging innovation, and diverts huge amounts of time into scheming and playing with the system (Segel, 2017; Hamel and Zanini, 2017). Such organisational contexts and the problems of a medical model of operations, high use of specialist professions, protection of specialist knowledge and inexperience with improvement processes and organisational safety processes (as opposed to safe-conduct for the licenced individual) creates a difficult organisational context in which to enhance the safety of the organisation and safety of processes that use multiple specialists (Sutcliffe, 2011; Christianson et al., 2011; Lindsay et al., 2020).

There are many issues that have impeded progress for healthcare staff when addressing safety and quality improvements and a high attachment of the individual clinician to their profession has combined to slow progress as well (Lindsay, 2016). Indeed, the low awareness of operations management knowledge and the fact that improvement and organizational safety are not typically offered to staff during their professional training means that the organization must supplement this knowledge.

The researcher, therefore, identifies significant gaps in the literature for operations management in healthcare (as opposed to safety-critical sectors) and the management of organizational systems to support patient safety. The next section of the literature review will focus on safety management before returning to the concept of the Highly Reliable Organization (HRO) and how this concept has relevance for theory building in operations management. To this point in the review, the operations management literature has been portrayed as explicitly focused on quality as a route to high performance whereas the high performance of a healthcare system is premised on a reliable set of processes that are focused on safety and quality of care provision to a far higher level of sensitivity and consequence of process/system failure.

The next section reviews the gap in the literature found during the review of safety-critical systems design.

3.5 Safety Management

“Safety” is a very generic word used in day-to-day lives, but the dictionary meaning is being in a state where you are not at risk or danger. To some authors, safety means being safe from any mishappening; to some, it means being in a state where you are protected from any undesirable outcomes; but in the industry, it means where all operations and employees are safe from any mishappening or events. Erik Hollnagel asserts that *"safety is the system property or quality that is necessary and sufficient to ensure that the number of events that could be harmful to workers, the public, or the environment is acceptably low"* (Hollnagel, 2015, pp. 1-2).

3.5.1 The Evolution of Safety and Organizational Management

Until the British industrial revolution, there were no large-scale organizations, and industrial safety laws were non-existent. After industrialization and the growth of trade unions, rules in the workplace, laws and pecuniary compensation schemes were introduced. In 1908 the Workmen Compensation Act stated that 'in effect, that regardless of fault, management would pay for injuries occurring on the job' (Petersen, 1978, p. 11). Over time, safety became even more of a management role. Safety management manages business activities and applies principles, framework, and processes to help prevent accidents and injuries and minimize other risks. Safety is a state of condition, and safety management is the process of being in that state of being safe. (Li and Guldenmund, 2018). Therefore, the role of organizational management was identified as having the authority to improve systems and the responsibility for safety in a workplace, including harm caused to people by the working environment, equipment operation, and other risks at work. The changes to the legal framework and identification of organizational responsibilities called for new procedures to control safety and to assure the employer was compliant with national standards. The latter gave rise to national systems for safety management and inspection as well as codes of conduct and systems for the management of organizational safety – known as Safety Management Systems (Evans and Parker, 2008).

One of the earliest safety models which exposed the need to manage organizational safety was Heinrich's safety pyramid. Heinrich was a loss adjuster and insurance employee who observed and then calculated hierarchical stages of safety accident that resulted in actual harm. His work derives from industrial accident claims submitted from manufacturing businesses and employees. In his 1931 book, "Industrial Accident Prevention: A Scientific Approach," Herbert William Heinrich calculated that 88 percent of accidents are caused by "unsafe acts of persons" (human errors) and calculated that, of a group of 330 accidents that he had investigated, 300 will result in no injuries, 29 will result in minor injuries and one will result in a major injury (see figure 3.5).

Figure 3.5: The Heinrich Pyramid

(Source: Adapted from Heinrich, 1931)

The statistical calculations of Heinrich revealed a systemic problem with organizations and their sensitivity to safety management. His work also showed that human error existed and that it caused significant injury as well as near misses that had the potential for actual harm. The limitations of his work concern the linear portrayal of harm by the pyramid approach. It also suggests that by concentrating on the lower levels of the pyramid, then accidents should decline. The model, therefore, suggests a reductionist approach where the root cause of any accident can be determined in retrospect, and therefore controls can be introduced. The model also implicitly assumes that humans will create errors and that humans are rational. There is little evidence to suggest that Heinrich's model was translated and adopted by healthcare organizations as no documented studies exist, but his model does show that safety was being embraced as an organizational concept. To improve safety and to reduce accidents then learning is needed and so too is awareness of staff to be sensitive to the potentials for failure. In effect, a greater understanding of the safety systems.

3.5.2 Safety Management System (SMS)

A safety management system is a systematic approach to managing safety, including organizational structures, accountabilities, policies, and procedures. An SMS is scalable so it can be tailored to the size and complexity of any organization. As defined by the Federal Aviation Administration (2020), "*SMS is the formal, top-down, organization-wide approach to managing safety risk and assuring the effectiveness of safety risk controls. It includes systematic procedures, practices, and policies for the management of safety risk." (Pg.8)*. Accepting this definition, safety represents a blend of organizational features and activities that are mutually supportive and prevent or limit accidents, reduce the potential for mishappening, losses and raises staff concern for "near misses". The organizational evolution to higher safety for its people, equipment, assets, and environment must engage with an SMS and introduce measures (including rules and regulations) to create an effective Safety Management System.

Such an approach is conducive with Heinrich's views where safety management means 'a systematic control of worker performance, machine performance, and the physical environment' (Heinrich et al., 1980, p. 4). The work of Heinrich began a process of understanding safety and systems for safety control. For this thesis, the elements of a Safety Management System (SMS) would comprise several components and activities. The universally accepted framework for SMS (Federal Aviation Administration, 2020) includes four main components and twelve elements, representing the minimum requirements for an SMS.

1. Safety policy and objectives
    - Management commitment and responsibility
    - Safety accountabilities
    - Appointment of key safety personnel
    - SMS implementation
    - Contractors/third party interfaces
    - Coordination of emergency response planning
    - SMS documentation
2. Safety risk management

- Hazard identification
- Risk assessment and mitigation

3. Safety assurance
   - Safety performance monitoring and measurement
   - Internal safety investigation
   - The management of change
   - Continuous improvement of the SMS
4. Safety promotion
   - Training and education
   - Safety communication

Expanding the SMS into a **health** and **safety management system** (HSMS) is the next stage in the evolution of an SMS. Such an evolution embraces more proactive approaches to maintaining the health of a system which is established, by an employer, to minimize the risk of injury and illness (HSE, 2013). It involves identifying, assessing, and controlling risks to workers in all workplace operations and addressing the bottom of Heinrich's pyramid. According to HSE (2013), the three components to effectively manage health and safety in any organization are: *leadership* and management of appropriate business processes; investing in *training* to develop a *skilled workforce*; creating an environment where *workers are trusted* and involved. In addition, the HSE report also highlighted the need for a sustained and systematic approach to HSMS, which can only be built by developing positive attitudes and behaviours among workers in the organization.

An effective HSMS is a key component of any business (HSE, 2013); its scope and complexity will vary according to the type of workplace and the nature of its operations. For both the development and implementation of an HSMS to be successful, effective, and efficient, it needs to be based on a formal structure of defined elements. A successful HSMS includes but is not limited to the following seven elements (HSE, 2013):

- Management involvement and commitment

- Hazard identification and assessment
- Hazard Control
- Training
- Emergency response
- Incident reporting and investigation
- Communications

Such systematized approaches, embodied in an HSMS and its compliant clauses (especially if an ISO standard such as ISO4500: 2018 – Occupational Health & Safety Management System, is being used), details good effective practices based on expert views of what companies should do represent controls of procedures but stop short of creating cultures that have moved to embed safety (rather than conform and comply with a standard). An embedded safety culture requires more features, especially those concerning learning, in addition to reporting and investigations. The latter also includes a bias towards the presentation of system failures that result in accidents to be ascribed to human error. It is a symptom of historical models of safety systems management – the system of blaming an individual for an accident rather than taking a synthesis and holistic approach to identifying failures in a system that allowed an individual to be hurt (Reason, 1990).

To this point, the discussion has centred on accidents and failure plus the countermeasures of using a HSMS to create a system to prevent (or heighten sensitivity) failures that lead to accidents. The history of safety model development, the theoretical approach to the management of safety, has had a few major landmark models and studies. These models have also changed over time since the initial conceptualization of an accident by Heinrich (1931). These evolutions in thinking commenced with the seminal work of Charles Perrow (1984).

The precedent for studies of safety/reliability can be traced to Perrow (1984) who studied post-accident behaviours and discovered multiple sources of failure exist in tightly coupled systems like the modern manufacturing organization and healthcare organizations. His work promoted the idea that organizational technology is not the problem for failures, but it is organizational practice. Reason (1990) continued this line of thought, from an aviation perspective, and later proposed the ‘Swiss Cheese

Model’ and Erik Hollnagel proposed his Safety I and Safety II model. Later these models catalysed Charles Vincent and Sydney Dekker to add to these models and to bring them into mainstream thinking concerning the management of safety in healthcare organizations. These authors will be discussed later.

3.5.2.1 Safety Models

Charles Perrow, a sociologist, published his book in1984 which provides a detailed analysis of the behaviour of complex systems (organisations) from a sociological perspective. This book is presented as a series of case studies of accidents. It was the first publication to propose a framework for characterizing complex technological systems and identified air traffic control, marine traffic management, chemical plants, hydro dams, and nuclear plants based on a calibration of their “riskiness".

Perrow (1984) contended that all organizations that operate in high risk and safety-critical sector with high-risk technologies would eventually and inevitably will have accidents. These accidents, he asserted, resulted from the complexity of technology and social settings and the interdependence of the two. Under these conditions, the sophistication and complexity of the technology employed were much greater than the human operator/managers ability to control it. His initial thoughts concerning safety and risk in organizations was a seminal work and stated that people or operators can make mistakes and even small problems (which are not identified or recognized by the human) can lead to major catastrophes for complex organizations. Perrow fatalistically believed that these features in safety-critical organizations made accidents inevitable. He also identified other features of the operating model of a safety-critical business that would accelerate and exacerbate the propensity for catastrophic failure, which included:

1. *Tight Coupling of the operating system* – which implies these safety-critical systems are underpinned by technologies that lack redundancy and are connected in such a way that they are highly interdependent and a failure can therefore be rapidly transferred from a point in the system to catastrophic failure of the entire system of people, equipment’s and processes.
2. *Interactive complexity* is Perrow’s second condition which states that safety critical systems contain unfamiliar, unplanned, or unexpected sequences that are not

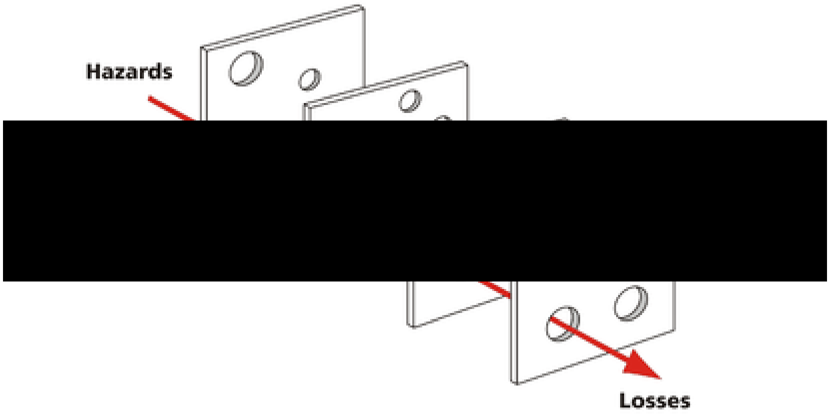
visible to humans and that interaction amongst the different components of the operating system is invisible and cannot be detected until failure is almost complete.

Inevitably, Perrow further classified systems into High-Risk and Low-Risk categories. The industries like aircraft operation, nuclear weaponry, and military systems were classified as High-Risk Systems and complex manufacturing plants (oil refineries, chemical plants) were calibrated in the Low-Risk category.

Perrow argues that multiple and unexpected failures are built into all of society's complex and tightly coupled systems. Such accidents are unavoidable and cannot be designed around nor easily eliminated. Perrow's argument, based on systemic features and human error, is that big accidents tend to escalate, and technology is not the problem, the organizations are. This revelation was the first fully codified attempt to change the focus of safety thinking towards a systemic management of organisational processes as well as how to learn from failures so that the small and insignificant signals of failure can be detected. Perrow firmly established the organisation (and not the individual) should be the key unit of analysis if safety was to be managed and improved (even though he stopped short of saying catastrophic failures can be eliminated altogether).

Professor James Reason accepted that there were latent pathogens and sources of system failure that are ever-present, His work draws from the aviation sector, but he refused to accept the view that failure was inevitable. His model is known as “The Swiss Cheese model” and was coined by Reason in 2000 (see figure 3.6). This model is one of the most used in risk management and widely cited in the world of contemporary patient safety management. The reference to ‘Swiss Cheese’ is deliberate and Reason likens these to defences, barriers, and safeguards (cheese blocks in the diagram) protect the victims and assets from local hazards and accidents. Swiss cheese, however, contains holes and these are weaknesses in the defences employed within an organization. Defences include training, mistake-proof devices, policies, well-maintained equipment, rules, and such like. Reason argues that when the holes in one layer of Swiss Cheese opens or multiple holes line up, then failure happens, and this can have a small consequence or end in catastrophe. The holes in a safety system are due to active failures and latent failures in the system itself and are ever-present when work is being conducted. The model is helpful in framing safety issues and how to build systems of robust defence, resilience and to push organizations to build-in redundancy into processes to compensate for when failure happens (and to reduce its impact).

Figure 3.6: The Swiss cheese Model



(Source: Reason, 2000)

In criticism of Reason's model, is that he stopped short of prescribing actions, routines and management systems that could be used to control the system and reduce failures. His work also did not claim to improve the reliability of an organization and its processes. Instead, Reason's model allowed safety to be framed from an organizational perspective. His acknowledgement of latent pathogens supported Perrow's view that failures are inevitable for any system, especially healthcare and an implicit belief that a Highly Reliable Organization (HRO) in the healthcare setting cannot exist or will exist for only a brief period. His view that every system has potentials for failure (holes) in the layers of defence in a process or pathway. The purpose of the layers of cheese slices represents levels of defence against errors and failures. In this manner, a slice would include training and the maintenance of staff training, so everyone is working to the latest best standard for an activity. Another slice may be equipment maintenance and calibration or check sheets etc., that mitigate the existence of a potential failure. His model was drawn from aviation but is increasingly adopted by healthcare professionals. His argument is that when holes line up, then significant accidents can happen at any stage of a process or that a patient who passes through a series of defences will be increasingly likely to have a significant accident. It would be fair to state the Reason's model has held the title of the dominant model since the 1990s. The layers of Swiss Cheese would also include policies, measures and many other aspects of management that could prevent errors in a process.

The work of Eric Hollnagel has championed the role of Resilience and safety engineering and has proposed several models, including FRAM (Functional Resonance Analysis Method), ETTO (Efficiency-Thoroughness Trade-Off) and Safety I and Safety II thinking. Hollnagel's Functional Resonance Analysis Method is a criticism of the traditional approach, which views humans as error-prone or as fallible. He rejected the use of accident investigations to find the "human error" that initiated failure and catastrophe. At the time of his research, in the 1990s, he had rejected human error as the primary trigger for accident causation and instead, Hollnagel began to explore the performance shaping factors or performance conditions that caused and "forced" employee to fail. He did not replace the concept of human error but supplemented it with interest in working conditions and work pressures. Hence the need to engage in resilience engineering as a means of reducing failures in systems by enhancing the factors that lead to the successful operation of an organisation. The FRAM (Hollnagel, 2004, 2012) provided a way to describe outcomes and to identify areas of resonance arising from the variability of everyday performance. From here, Hollnagel argued, it was possible to engineer dampening practices that reduce the impact of unwanted variability. The FRAM model consists of:

- Identifying the essential system functions of a system and characterising each function using the six basic characteristics (aspects).
- Checking the completeness / consistency of the safety model.
- Characterising potential variability of the functions in the model.
- Define the functional resonance based on dependencies/couplings among functions and the potential for functional variability. Resonance that leads to system failure due to dependencies in the organisation.
- Identify ways to monitor the development of resonance either to dampen variability that may lead to unwanted outcomes or to amplify variability that may lead to wanted outcomes.

So Hollnagel added again to the thesis that organizations create the conditions for failure and human error is permitted by such lapses in system design. Hollnagel continued his research to suggest that “Safety I” was an approach to finding out what went wrong and is the traditional approach (to apportion blame to an individual or the organization) whereas ‘Safety II’ is the study of how work practices go right and do not result in any form of failure. As such, Hollnagel added a proactive element and a different way of understanding how complex organizational systems work effectively. Such an approach rules out hindsight bias and the blame associated with human error. However, Hollnagel (2009) also proposed an ‘Efficiency-Thoroughness Trade Off’ (ETTO), which again focused on organizational and workplace conditions that create higher failure probability. He identified that the pursuit of efficiency (when staff are under pressure to deliver care or production requirements) would lead to a reduction in their attention, quality and the effectiveness of what they are doing. Such a trade-off, he argued, was inevitable and would lead to failure. He used this analysis to diagnose, in retrospect, catastrophic failures, including the case of the Deepwater Horizon oil rig failure. Hollnagel’s contribution is an important one and suggests that safety researchers should study what goes right and the collective meaning of safety for all employees, Again he is a modern author who believes organizations as systems are at fault through management or design in allowing accidents to happen to relatively innocent employees.

Charles Vincent has also added to the modern safety debate and is a British clinical professor from the UK NHS system. He is also critical of organizational designs and is cynical that importing best practices from non-healthcare settings has any value. His publications (2008, 2010) have each declared that healthcare is an environment that does not easily fit the previous generations of safety researcher and that the NHS remains in a blame (Safety I) mode of operation. Vincent’s contribution to safety models, mainly through his work with the British charity, The Health Foundation, covers many aspects of safety but typically focuses on the tasks, procedures and methods for better safety. His work “A Framework for Measuring and Monitoring Safety” (2014) includes the identification of five important dimensions for safety management and monitoring which promotes many organizational features and his views represent the need to move to a Safety II approach yet his research findings remain in the mode of preventing things from going wrong. His main arguments are that organizations must:

- Conduct ‘past harm’ reviews which should include the psychological and physical measures that will prevent reoccurrence.
- Enhancing Reliability in operations as defined as ‘failure free operation over time’ and applies to measures of behaviour, processes and systems.
- Enhance sensitivity to operations by increasing the availability of quality information and added capacity to monitor safety on an hourly or daily basis,
- Designing systems for the anticipation and preparedness for failure via the ability to anticipate, and be prepared for, problems.
- Finally, he calls for an Integration of learning so that the organisation can respond to, and improve from, safety information.

Once again, Vincent shows a renewed interest in the organization as the unit of analysis for any safety system. He acknowledges the inevitability of failure but suggests monitoring should be used for early detection of weak signals that failure is imminent. The focus of Vincent et al. (2014) and other works of The Health Foundation have tended to stop short of Safety II thinking and have instead attempted to improve existing practices as a means of gaining greater reliability. Such confusion in the literature is rife, and the field of study can be regarded as at a watershed point where there remains a division between Safety I and Safety II advocates. Even if a balanced approach is undertaken, the common unit of analysis is now human error within organizational systems that create the conditions where employees fail. Such failure in manufacturing results in defective production or no production; in mainstream services (such as personal banking) it results in service recovery and apologies; however, in healthcare, it can result in physical harm and actual mortality.

The pragmatic view alone suggests there is still much to learn, and a theory-building research study into this subject is timely and of significant importance. Most notably, modern healthcare is conducted and practised in a setting which is resource-constrained and where measures of efficiency and targets drive behaviours (Davis et al., 2008). This has resulted in a shift in organizational focus from patient-centred care and safety towards meeting individual/ward/hospital/Trust targets and goals, i.e. organizational culture moving from ‘patient-focused’ to ‘provider-focused’

(Rozenblum et al., 2013; Bismark et al., 2011). These conditions are associated with an increased likelihood of failure (Hollnagel, 2012).

Sydney Dekker is a contemporary Australian safety theorist and one who proposes that the ‘soft side’ of safety must be manipulated and designed for learning and the development of a just culture (Dekker and Breaky, 2016). Unlike other authors, Dekker does not enter the efficiency debate and the view that an efficiency focus will compromise safety. Instead, Dekker believes that Safety I and Safety II are distinguished by their cultural approach to safety. Dekker is one of the most cynical commentators on the field and takes an academic approach to study safety. His argument is and remains that organizations can and must develop a culture of safety. Culture should be based on a blame-free approach to human error, a systems approach to safety and organizations must learn to evolve and reduce system failure. He does not directly deny the inevitability of failure but suggests that culture will react in a more effective and timely manner than any other form of monitoring or intervention. He further emphasizes prioritizing and giving capabilities to your workforce, capable of critiquing and questioning safety practices. He advises that if you want to stop or prevent failure, stop looking for failure and start looking for what makes your organization successful.

Contrary to Dekker’s and other safety researchers' suggestion, another example of failure was the prioritizing department targets over patient safety measures in the NHS Mid Staffordshire Trust in the UK. The Mid Staffordshire NHS Foundation Trust attracted huge media attention for all the wrong reasons by costing the lives of 1200 patients and causing the needless deaths of 670 patients (which was preventable) by an over-focus on achieving efficiency targets and in the process compromising patient care and safety (Borland et al., 2013). This error led to a series of investigations, as discussed below.

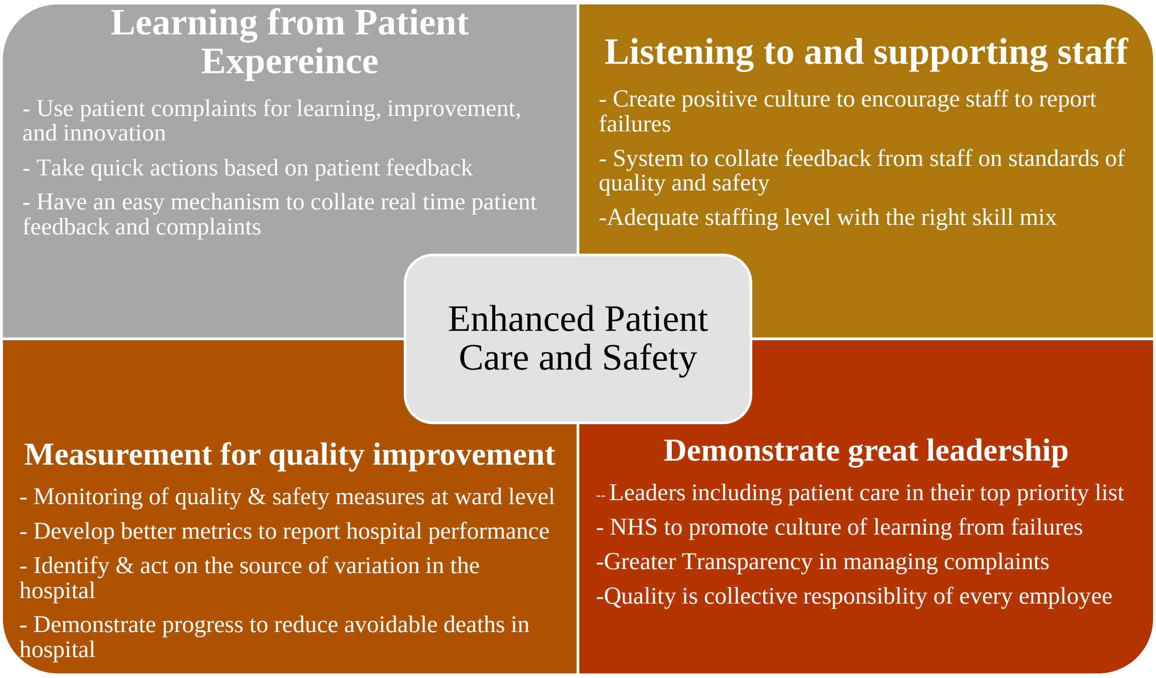
- **Francis report-** Based on Public enquiry lead by Robert Francis, investigating more than 1000 patient deaths over a decade in Mid Staffordshire NHS Foundation Trust (January 2005- March 2009); 290 recommendations for improvement across NHS suggested
- **Keogh report -** Professor Sir Bruce Keogh conducted review into the quality of care and treatment provided by 14 trusts with persistently high mortality

rates. The review identified some common challenges facing the wider NHS and Keogh identifies 8 ambitions for tackling some of the underlying causes of poor care.

- **Berwick report-** In August 2013 the national Advisory Group on the Safety of Patients in England published the results of their review of the Francis enquiry to distil the patient safety lessons learnt and specify the changes needed. This was led by Prof. Don Berwick

The three reports that emerged as a result of investigating the errors in this Trust, Francis (2010), Berwick (2013), and Keogh (2013) report, emphasized on four key dimensions to create a culture for providing enhanced patient care and safety in the healthcare setting. Figure 3.7 is developed by summarizing the key recommendation from the three reports.

Figure 3.7: Key recommendations from Keogh, Berwick, and Francis reports



(Source: The Researcher)

The recommendations from three reports were aligned with suggestions given by health and safety researchers globally including Perrow (1984), Reason (1998), Hollnagel (2004, 2012) and Dekker and Breaky (2016), which can help the organization to perform reliably over a longer time period –characteristics of HRO that can help healthcare organizations to overhaul their existing practices and focus more on achieving patient safety. The recommendations greatly emphasize learning from patient complaints and experience and accordingly improve the healthcare system.

At this point in the discussion and review, the trend towards an organizational approach to safety (either bureaucratic and a HSMS approach or a living systems approach to learning and culture) is firmly established. These authors stress the key concepts of teamwork and system leadership, including the implicit belief that an organization can be directly manipulated and designed for better safety performance by manipulating the enablers for greater reliability. Such manipulations require a holistic approach to the organization and a systems approach, as first outlined by Ackoff et al. (2006). The growing gap, therefore, remains how an organization can detect weak signals of failure, how staff can be engaged in this process of detection, how systems can be designed with redundancy and resilience and how learning from failures will result in a greater series of reliable processes.

Despite the continued evolution of safety research from a specialist perspective, a growing body of literature emerged to address the concept of the high reliability organisations which itself had an interest in managing safety. However, the two literature are treated almost independently yet share an interest in organizational design and reliability. These authors form a school known as the high reliability organisations school, which is discussed in the next section.

3.6 High Reliability Organizations (HRO)

From the late 1980s, in parallel with the rise in the literature concerning safety and quality in general, a body of knowledge emerged concerning the development of an organizational form and processes that could deliver high performance in safety critical sectors. This approach is generically known as the High Reliability Organization (HRO) approach. Organizations are run by people and mistakes are bound to happen is a common link to the safety literature and no organization will ever be “error-free”. The commonly used adage that Murphy's First Law states *“Anything that can go wrong will go wrong”* is implicit when studying error but the concept of the HRO entered management research in 1980 as a result of studies at the University of California, Berkeley by Todd LaPorte, Gene Rochlin, and Karlene Roberts. They observed that myriad of research had focused on organizations that have suffered disasters (See Perrow, 1984), but little has been studied and written about organizations whose operations are free from errors or disasters. These industries were the ones who had maintained records of high safety for a very long period. Unlike the safety theorists and their reviews of incidents, these HRO researchers adopted context-rich case study strategies and studied how organizational designs enabled greater system reliability and resilience.

LaPorte et al. (1989) studied three major organizations that are examples of disaster-free operations- Aircraft carriers (in partnership with Rear Admiral (ret.) Tom Mercer on the USS Carl Vinson), the Federal Aviation Administration's Air Traffic Control system (and commercial aviation more generally), and nuclear power operations (Pacific Gas and Electric's Diablo Canyon reactor). This led to the conceptualization of HRO. Carl Weick, one of the prominent and initial researchers of HRO states that *"Other people who had examined these organisations were stuck by their unique structural features. We saw something else: These organisations also think and act differently" (*Weick and Sutcliffe, 2001). It should be noted that this literature grew in parallel to the mainstream safety management literature but included organizational psychologists as the core mass of research staff.

HROs is defined as an organization's ability to sustain almost error-free performance over a long time period (Roberts, 1990, 1993). To further explain the HRO concept, Roberts (1990, p160) stated "… *One can identify this subset of organisations that have high safety records by answering the question, "how many times could this organization have failed resulting in catastrophic consequences that it did not?" If the answer is on the order of tens of thousands of times the organization is 'high reliability'"'* (Roberts, 1990, pg. 160- 176).

Rochlin (1993), an HRO researcher, argued that traditionally the safety researchers have relied on the number of accidents that happened and did not focus on the processes that enabled a failure to happen. He states, "*What distinguish reliability-enhancing organizations, is not their absolute error or accident rate, but their effective management of innately risky technologies through organizational control of both hazard and probability …*" (Rochlin 1993, pg.17). Despite using accident numbers to define HRO, some researchers have investigated the characteristics and technologies used by these organization to become error-free for a long period of time.

HRO can be defined as developing resilient and flexible processes and practices in an organization to achieve and sustain the highest levels of reliability (Hopkins, 2007). The definition of HRO has evolved significantly since its inception at the University of California, Berkeley in 1990. Researchers have argued that every organization need to identify and understand the characteristics and behaviours to create conditions to achieve highly reliable performance (Weick and Sutcliffe, 2007). The focus to define HRO shifted from accident statistics to more processes and characters, see table 3.1.

Definition of HRO	**Industry**	**References**
Within the set of hazardous organisations there is a subset which has enjoyed a record of high safety over long periods of time. One can identify this subset by answering the question, "how many times could this organisation have failed, resulting in catastrophic consequences, that it did not?" If the answer is on the order of tens of thousands of times the organisation is "highly reliable"	High-risk Industry such as Nuclear	Roberts, 1990: 160
"Those organisations characterised as HROs all show a positive engagement with the construction of operational safety that extends beyond controlling or mitigating untoward or unexpected events and seeks instead to anticipate and plan for them."	High-risk industry	Rochlin, 1993: 1549
HROs are organisations that function in a "nearly accident free performance"	High-risk industry	La Porte and Consolini, 1998: 848
HROs, such as naval aircraft carriers, nuclear power-generation stations, and air traffic control units, "operate in an unforgiving social and political environment, an environment rich with the potential for error, where the scale of consequence precludes learning through experimentation, and where to avoid failures in the face of shifting sources of vulnerability, complex processes are used to manage complex technology"	High-risk industries	Weick et al., 1999:83
"The signature of HRO is not that it is error-free, but that errors don't disable it"	High risk industries	Weick and Sutcliffe, 2001: 14

"HRO theory… states that organisations can handle complex and hazardous activities at acceptable levels of performance with the proper management of people, technology and processes"	Healthcare	Youngberg, 2004: 13
"…organisations that have not just avoided failure through good fortune or the vagaries of probability, but that have actively managed to control and reduce the risks of technical operations whose inherent hazards make them prone to catastrophic failure"	Nuclear & Offshore industry	Cox et al., 2006: 1125
Organisations that can manage and sustain almost error-free performance despite operating in hazardous conditions where the consequences of errors could be catastrophic.	High-risk industries	Lekka, 2011:
"consistent performance at high levels of safety over long periods of time"	Healthcare	Chassin and Loeb, 2011:563
"high reliability is not a state that an organization can ever fully achieve; rather, it is something the organization seeks or continually aspires to. Second, reliability is fundamentally a dynamic set of properties, activities, and responses."	Healthcare	Christianson et al., 2011:315
HROs are organisations that engage in cognitive processes and actions directed at actively avoiding seemingly inevitable organisational holdups and containing errors.	Construction	Olde Scholtenhuis & Doree., 2014:658
High reliability organizing has its roots in studies of organizations across many industries where failure has drastic consequences and coordinated efforts are needed to ensure safe outcomes (e.g., commercial aviation, nuclear power, and naval aircraft carrier operations). It demands that people coordinate their attention and action to continually improve the functioning of the organization, while acknowledging that there is always room for further improvement.	Healthcare	Ghaferi et al.,2016;

Table 3.1: Definition of HRO (Source: Researcher)

Despite being complex, operating in a dynamic and interdependent environment, facing the challenge of time and other resource constraints, *'mindful'* organisations put a collective effort in establishing features that can enable healthcare to be highly reliable and operate in an error-free way over a sustained period (Sutcliffe, 2011; Vogus and Sutcliffe, 2007a,b; Vogus, 2011). HROs believe in mindful organising to increase the quality of attention across the organisation, thereby developing collective capabilities across the organisation to understand the context for dealing with unexpected events, detecting and correcting errors or near misses (Weick et al., 1999; Sutcliffe, 2011). Mindful organising raises people awareness and makes them alert to detect subtle changes in their local context and take a contingent approach in responding to those subtle changes or weak signals in the process (Vogus and Sutcliffe, 2007b; Sutcliffe, 2011). Here, a collective understanding of context implies sustained attention to the operational challenges to develop and deepen the knowledge of the context and further update a shared understanding of the context to act upon objectively (Weick et al., 1999; Levinthal and Rerup, 2006; Vogus, 2011). The capacity to act collectively can be enabled by channelising resources to provide tailored responses to an unexpected event.

Weick and Sutcliffe (2001) identified the five principles that make an organization transition to HRO is learning and the development of a "Mindful organization". They propose that organizational frameworks cannot be developed and instead, a pattern of behaviours can be determined through the five principles of HRO discussed below.

3.6.1 Preoccupation with failure rather than successes

The organizations which have a long history of safety records (and continue to maintain their safety standards) possess the character of identifying early warning signs. These organizations have a preoccupation with any form of failure that might come in future. Weick and Sutcliffe (2001, 2007) argued that these organizations are alert and ready to pick any early warning signs identified from the processes. They argue that such organizations have developed their processes so that any kind of 'near miss' or any small failures can be identified, reported and acted on. They are always ready to face the unexpected in their processes and act to avert a disaster. The limitation of the approach is finding those early warning signs (weak signals) from the background noises that are generated by the process.

The critics of HRO contest that it's impossible to find these early warning signs and can only be identified when looked upon a situation retrospectively (hindsight bias) and this follows Perrow's original arguments that, *"Signals are simply viewed as background noise until their meaning is disclosed by an accident"* (1982, pg.175). The author further argued that in 1979 at Three Mile Island nuclear power station, there were warning signs before the near disaster, it was not possible in any way to identify the signal from the noise (Perrow,1982). Weick and Sutcliffe (2001), in response, had said that there are so many background noises going on or there are an infinite number of weak signals and the technology is not capable of picking up the warning signs. They criticized the Three Mile Island Nuclear power incident did not have a weak signal; instead, they were ignored because of the organizational inefficiency (Hopkins, 2007). Mindfulness is to give a strong response to weak signals emerging in the organization and relies upon trained skills and experience-based intuitive behaviours. (Weick and Sutcliffe, 2001:3-4)

The important conclusion is that any warning signs or failures that emerged are symbolic of some problem in the organisation's processes. These failures, even small ones, should be dealt with so that the risks to bigger issues are mitigated. Such a view reinforces the belief that 'sharp end' staff – those who work on the process as opposed to 'blunt end' staff (Reason, 1990) – are those who should be able to stop the process before failure is inevitable. To enact such a system, it is important that training and a common framework of high reliability are shared. Each staff member always has heightened sensitivity and situational awareness of the process. Such enablers have yet to be tested in the healthcare sector beyond a small series of cases in parts of healthcare systems.

In practice, such sensitivity levels mean that every employee in the organization realizes that there can be lapses or breakdowns and must be prepared to face any near misses or errors. Unlike the lean operations management school that relies on visual management practices and a systematic approach to workplace design/management (including the 5S system), these authors do not propose how such weak signals, errors and variation/resonance can be detected effectively and in a timely manner. The HRO authors leave such artefacts and rituals to the company concerned and propose there are no universal methods that should be adopted. The advocates of HRO propose HROs are learning organizations and the employees must be trained and supported to keep a very close eye on the day to day operations and deal with any small error with adequate countermeasures to avert future catastrophes. Learning to identify the mistakes and act upon them is, therefore, an organizational competence. The key lessons from the HRO literature is the implicit advocation of a common mental model for safety (in a similar vein to that of the models proposed for organizational learning by Senge, 1993). The gap being expressed here is the need to understand how employees would interpret what high reliability means for them and what component parts of such a safety culture would include.

3.6.2 Reluctance to simplify

Weick and Sutcliffe (2001) argue that HRO organizations operate with the mindset that simplifying data or information can lead to loss of data or knowledge. Such a view reinforces that of Vincent (2010) in terms of the importance of measuring. HRO advocates propose that the simplification of data or information to make decisions for catastrophe avoidance has been a common management practice. In the process of simplification, an organization can lose the detail in the information that they consider as unimportant but hide weak signals of failure. This could be harmful to the organization and a situational loss of knowledge can lead to disaster. "*Simplification increases the likelihood of eventful surprise*" according to Weick and Sutcliffe (2001, pg.94). It should be noted that data sensitivity concerns the process of a failure rather than the organizational characteristics and practices that enable better and more effective control of the organization.

HRO organizations also encourage employees to review data and have employees that specifically conduct this activity. Theoretically, they will see and analyse the smallest problem and deal with them before it becomes a disaster or difficult for other staff to handle. Such an investment in an organizational position separates data management from operational staff. It is quite common in the monitoring of transportation systems. But such a divorce of data in healthcare management would be unfeasible if applied to the patient's level and could only be applied to technology, universal processes of standardized patient needs or bed management (Ghaferi et al, 2016). As such, this HRO requirement is very difficult to apply in the healthcare setting.

The ability to identify and deal with a subtle threat can make the difference between early and late recognition of failure and is a feature of HRO organizations, but case studies of healthcare providers do not show how these systems can be applied in healthcare. Threats to patient safety can be difficult to identify and complex in nature at the level of the patient, the process, the pathway, and the organization, so the richness of data is multi-dimensional and hard to apply (Chassin and Loeb, 2013)

3.6.3 Sensitivity to operations

Frontline or 'sharp-end' staff are the most "aware" of the processes and variations in the current state of its operation. They are the staff that enact the common mental model for safety and know the most about the functioning of processes/equipment and are the most skilled staff in detecting signals that a process is about to fail. Front line staff are the most informed and aware employees. They can predict the near misses and failures much easier than others even if they lack the academic qualifications of more specialist staff. They are the employees who may know the solution to the failures and therefore need only a mechanism to connect their learning to improvement (Weick and Sutcliffe, 2001). The managers of an organization ('blunt end staff') must encourage front end workers to be vigilant and situationally aware of deviations in performance and to report errors of commission/omission in a context where staff do not fear such reporting (such a call for a fearless organization is associated with the systems approach undertaken by the quality Guru W. Edwards Deming (1986)).

Weick and Sutcliffe (2001) argue that managers are supposed to inspire the employees to share and report their experiences to all in an organization as a means of learning. Such sharing is in sharp contrast to organizations that follow "Silo" thinking and protect knowledge or apportion blame to individuals when things go wrong (Safety I thinking). A culture of such silo thinking has been responsible for many organizational accidents due to the inability to share information and views (Hopkins, 2007). The latter feature of an HRO is particularly relevant to the healthcare setting where many specialists combine to treat a patient over a prolonged period, and each specialist uses their own language and reports to a directorate of fellow professionals.

Such artificial boundaries slow learning and the responsiveness of the organization to changes and resonance (Hollnagel, 2012). The management of early warning signs are generally small, so changes identified by sharp end workers is important and is encouraged under HRO (Chassin and Loeb, 2013).

3.6.4 Commitment to resilience

Advocates of HRO propose that errors will happen and implicitly accept the normal accident theory of Perrow (1984). The call for organizations to be more resilient is an important addition to the learning systems that have been advocated by Weick and Sutcliffe (2001, 2007) thus far. Even organizations with long records of safety and reliability are still fragile unless organizational routines and practices are introduced that enhance resilience. Resilience is the capability of an organization to identify the problem and act upon it before it escalates to a bigger problem (Chassin and Loeb, 2013) and builds upon Weick and Sutcliffe's view that *"the signature of an HRO is not error free, but that error doesn't disable it"* (2001, pg.14). This organizational capability closes a commitment to learning and results in practices introduced to buffer the impact of a failure and prevent failures from happening. Such a strategy also results in redundant equipment and processes to ensure that the organization can still function even if a key asset is lost or an accident occurs. This characteristic is linked to the previous one of preoccupation with failures, but this dimension adds action to create more robust processes, staff, and equipment. Unlike the safety authors, discussed previously, the HRO authors translate Hollnagel's resonance into procedures that limit and contain such unhealthy deviations.

3.6.5 Deference to expertise

Drawing from Weick et al. (1999) experience of major catastrophic failures, they proposed that, in difficult situations, the decision making should be escalated to staff and professionals with more diagnostic expertise (expert knowledge) or to people who are more aware of the situation (command management). Even if such staff are at the sharp end of this bottom-up approach to decisions is enacted, all staff must be aware of the time that such decisions should be escalated and to whom. Herein lies a contradiction in the HRO model; the model is inclusive, and team-based but an elite also exists within it. The frontline staff must be trained in accordance with the decision's in difficult times can be taken and must defer to expertise during a potential crisis. The situation in which either a shutdown is required, or major safety issues has appeared, and immediate decisions must be taken, a similar approach to the medical model used by healthcare organizations – defer to more senior staff. However, the speed at which this can be conducted differs in terms of the workplace and availability of senior staff as well as the time in the day because experts tend not to be available during the night shifts. Table 3.2 summarises the five principles of HRO.

Adhering to the first three principles of HRO – preoccupation with failure, sensitivity to operations, and reluctance to simplify, can help organisations to *'anticipate failure'* or unexpected events and thereby take proactive measures to prevent those errors from happening. The last two principles of commitment to resilience and deference to expertise can help organisations to respond quickly to *'contain failure'* or unexpected events. This shows organisational resilience in quickly controlling unexpected events or errors or adverse events when it occurs. The principles of HRO can help organizations identify failures at an early stage, learn from failure, and develop a robust system to prevent failures (Weick and Sutcliffe, 2001).

HRO characteristics	**Description of characteristics**	**HRO role**	**Challenges to achieve HRO characteristics**
Pre-occupation with failure rather than success	Organizations need to identify early warning signs or signals, analyse them and act on them	Manage the unexpected in future	Finding signals from noise
Reluctance to simplify	Organization need to simplify data to take better decisions; simplification may sometime lead to ignorance or loss of data	HRO have specialized people or department to pick warning sounds from background noise	Cost cutting organization regard such dept./people as redundant and redundancy is enemy of efficiency
Sensitivity to operations	The front-line operators are most	Managers must encourage to report the experiences	People refusing to speak the reality due to fear culture- this results in loss of

	aware of current state of operations		rich data that remains as a tacit knowledge
Commitment to resilience	HRO is not error free but that error doesn't disable it	Commitment to learn from failures	Lack of integrated system to identify failures, learn quickly from it, and share across the organization
Deference to expertise	In difficult situations, bottom-up decision making is required	Highly trained people at low hierarchy to take quick and informed decisions	At low hierarchy, employees are sometimes unaware of implications of their decisions

Table 3.2: Principles of HRO and Challenges (*Adapted from: Hopkins, 2007*)

The core narrative, drawn from the literature thus far, is that all modern organizations will create failures and accidents, but these accidents must result in learning and the integration of all staff with a common mental model of a safe organization so that learning leads to improvement and a lower incidence of failure or greater sensitivity to the early signs of failure. To increase resilience and to reduce resonance, all staff but especially the sharp end staff must have greater sensitivity to the sources and weak signals that an organizational system is starting to fail. In parallel, measures are needed to show the prevalence of failure and data derived from accidents to make better decisions and to identify where to improve within a tightly coupled system. To parallel an increased speed of detection, an increased speed of reaction is needed. Such reaction speed is a function of knowing what to do or access expert advice or to allow system monitoring staff to intervene directly.

The central theme of driving out the fear of reporting is important for all staff, especially those at the sharp end, and this would imply that the HRO safety model is founded on much greater communication, training and improvement/learning processes. These fundamental principles seem at odds with the portrayed state of healthcare worldwide and patient safety. The parallel literature based on what makes organizations function without an incident for long periods is interesting and offers new insight into the principles of HRO for healthcare organizations. In the following sections, the researcher will discuss the need for HRO model and what organisational features define HRO model that will enable organisations to practice five principles of HRO over a sustained period.

3.7 HRO in Healthcare: Research Gaps and Research Questions

Failure in organizations, such as Healthcare, is unacceptable (IOM, 1999) as no organization should operate without policies and practices that protect vulnerable patients from harm. Healthcare organizations need to operate at, as manufacturers and the total quality movement would propose “zero defect” levels (Crosby, 1979). In contrary though, statistics linked to healthcare errors are shocking as reported in many studies such as ‘To Err is Human’ report from Institute of Medicine (1999), Francis report (2010), Berwick report (2013), and Keogh report (2013). This itself justifies the need to further develop research study in the field of HRO and healthcare.

The close relationship between the HRO literature and general organizational management and safety literature shows a lack of cross-over and even the mainstream operations management fields of study have no studies of HRO as a model of service operations (with the exception of the researcher’s recent publication - Kumar et al., 2020). Instead, the service failure literature is dominated by Lean and quality management approach, which fails to provide a holistic perspective or framework to embed patient safety culture in the healthcare setting (Lindsay et al., 2020; Esain et al., 2016; Burgess et al., 2016).

The concept of HRO has entered the literature concerning the most effective form of healthcare management as a point of discussion rather than as a practical application, in the form of case studies or a more general acceptance of the approach and its application in practice. This lack of applied examples and longitudinal studies of enablers and inhibitors to HRO is a gap identified by this literature review. Indeed, during the literature review, the researchers could not find a single study of HRO in the British and public-funded provision of healthcare and any such cases were limited or presented with significant bias rather than as a peer-reviewed item of professional research. The literature review shows a need for theory building and to test the collective perception of HRO as a form of organizational development by a range of NHS employees rather than as a specialist, a managerial or simply an improvement technique. Of equal importance would be to investigate the common understanding of what is HRO in the minds of employees.

The literature review shows a clear lack of empirical evidence with which to describe the application, enablers of HRO as a dominant (or supporting) model to organizational performance and whether the approach suits this context rather than the simpler and variable-based contexts of air traffic control, forestry safety and the contexts within which Weick and Sutcliffe (2001, 2007) have developed this model. The current operations management research still ignores HRO in favour of studies of leanness and quality, which is a major omission in that quicker care could be at the trade-off with safe working (Hollnagel, 2012). Furthermore, there have been many studies that show certain NHS specialists do not readily accept interventions to lean or improve quality and have not been previously trained to do this type of intervention (Radnor and Bateman, 2016; Lindsay et al., 2020). The lack of acceptance of HRO, even by a minority of staff, will severely limit the utility of the approach and its key principles. Despite identifying exemplar organizations, most organizations still struggling to implement the concept of HRO (Cantu et al., 2020; Babyar, 2020). As such, the conditions for HRO, despite the benefits of the approach, may not actually be appropriate. These conditions have yet to be tested robustly, and this presents the research gaps and aim of this thesis. The biggest identified problem is to characterize HRO and the associated framework/model that could help its implementation in healthcare sectors. The gap is, therefore, in the understanding of organisational features that enable high reliability practices by employees of the NHS'.

3.7.1 Justification for HRO theoretical model

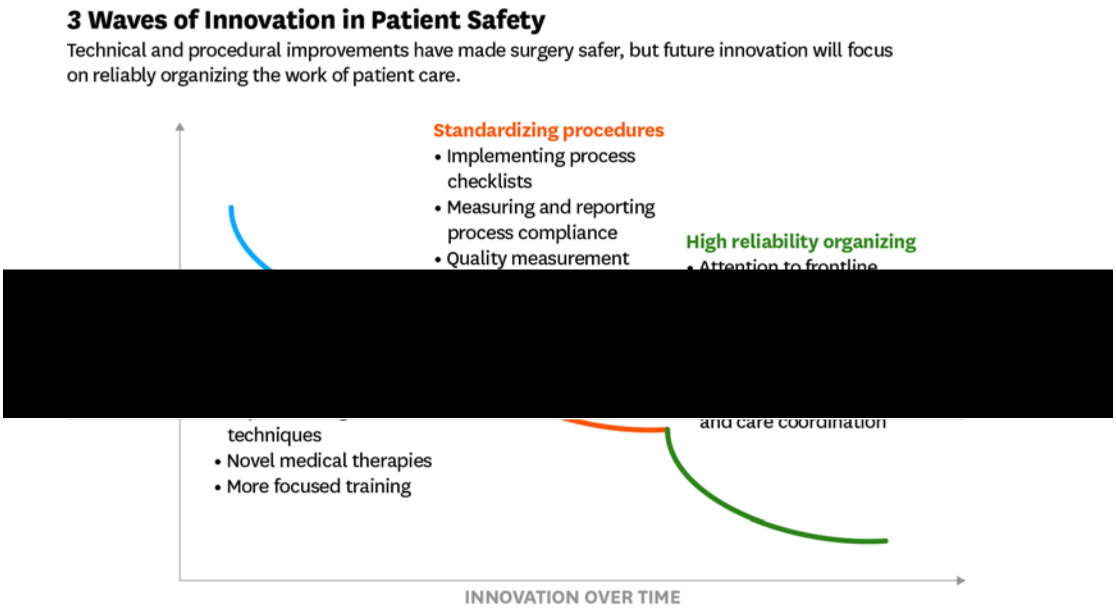
There is a lack of a clear framework for *'mindful organising'* that can help healthcare organisations evaluate their patient safety efforts (Pronovost et al., 2006; Tolk et al., 2015). Currently, the publicly reported performance measures are more focused on efficiency-related metrics, as witnessed from IOM report and Mid-Staffordshire NHS Trust reported organisational failure and are insufficient for healthcare providers to evaluate safety (Babyar, 2020; Pronovost et al., 2006; Jha et al., 2005). Though reliability and safety are not necessarily the same as they two pull in opposite directions (Hopkins, 2007; Lekka, 2011); yet HRO theorists have attempted to classify organisations as HRO or non-HRO mostly based on the reliability statistics defined by error per unit of measurement or use of complex, tightly-coupled technology, which does not help to understand if those organisations were also operating safely. In support of the above argument, Rochlin (1993, pg.17) stated

> *"What distinguishes reliability enhancing organisations is not their absolute error or accident rate, but their effective management of innately risky technologies through organisational control of both hazard and probability … There is, therefore, no a priori way to evaluate. The mathematical or statistical performance of the organisation... relative to any theoretical optimal conditions."*

Another group of HRO researchers (e.g. Weick and Roberts, 1993; Weick and Sutcliffe, 2001; Pronovost et al., 2006; Hopkins, 2007; Lekka, 2011) suggested shifting the focus from reliability statistics or nature of technologies used to examine the organisational factors enabling these organisations to manages its risk and be highly reliable. Weick and Roberts (1993) argue that high reliability can be achieved by creating or 'engineering' a positive safety culture underpinned by safety-related behaviours and attitudes. A balance between the socio- and technical- elements in the socio-technical system is important to embed HRO characteristics in an organisation operating under hazardous conditions (Lekka, 2011). Going beyond metrics to report highly reliable performance, organisations need to focus on strong learning orientation, continuous training, prioritisation of safety over other goals, and having established processes for checks and controlling variation, which can contribute to impeccable safety records in HROs (LaPorte and Consolini, 1991; Lekka, 2011; Ghaferi et al., 2016).

Despite technical advancement and standardising procedure, there were reported 200000 deaths out of 65 million surgical operations performed in the USA in 2015 (Ghaferi et al., 2016). The authors emphasised moving beyond technical and procedural innovations to create a highly reliable patient safety culture that balances between people, process, and practices (see figure 3.8). Ghaferi et al. (2016) contend that healthcare can now gain only incremental improvement in surgical procedures through technical innovations (e.g. minimally invasive techniques such as laparoscopic surgery) which seem to have reached a flattening of the patient mortality curve. The largest gain may already be made through these innovative technical surgery procedures, thereby having less impact on improving safety. Focusing on the second wave of innovation in patient safety after the 'To Err is Human' report by IOM in 1999, hospitals introduced standardised procedures such as using checklists to minimise variations and dictate one way of operating to improve quality of care. The authors further argue that there is a diminishing utility of these structural improvements methods in enhancing patient safety. Recent research has reported that increased adherence to protocol is not commensurate with the improvement in patient safety outcomes (Ghaferi et al., 2016).

Figure 3.8: Three waves of innovation in Patient Safety



(Source: Ghaferi et al., 2016)

Ghaferi et al. (2016) call for high reliability organising, building on the first two waves of innovation in technology and standardised procedure, to understand and improve how healthcare providers organise themselves for highly reliable performance over a longer duration. Similar to the viewpoint of other HRO researchers such as Weick and Sutcliffe (2001, 2007), Ghaferi et al. (2016) accentuated the importance of high reliability organising by paying attention to how individuals interact and communicate with one another and organise their daily work under trying conditions. HROs have capabilities to flex themselves between standardisation and customisation to meet every patient need and attempts to understand actual behaviours, practices, and interactions that unfold between healthcare workers for managing the complex and dynamic environment. In the words of Atul Gawande (2012) – *"This is what distinguished the great from the mediocre. They didn't fail less. They rescued more"*. The ability of a healthcare organisation to identify the weak signals, and act on it before it leads to catastrophic failure (Reason, 1997) is what distinguishes hospitals with low and high mortality for the same level of clinical complications (Ghaferi et al., 2016; Gawande, 2012). The ability to identify and act upon weak signals can be achieved through better organising, which represents a significant opportunity for improving patient safety and avoids ‘failure to rescue’ incidents which result from post-surgery complications or errors (Gawande, 2012).

Such organisation, classified as *‘mindful’* organisation by Weick and Sutcliffe (2001), exhibit a collective state of mindfulness through five characteristics or hallmark of HRO: 1) preoccupation with failure; 2) reluctance to simplify; 3) sensitivity to operations; 4) commitment to resilience; and 5) deference to expertise. The first three characteristics enable organisations to identify the weak signals and give strong responses to weak signals (i.e. conducting interpretative work) by analysing their impact and acting on the analysis (Reason, 1990; Weick and Sutcliffe, 2001). The last two characteristics give the capability to the organisation to react quickly and bounce back (i.e. contain the problem) if a disaster strikes the organisation. Despite three decades of HRO research, organisations still struggle to distinguish weak signals from noise and determine which of these signals are symptoms of deeper and potentially disastrous problems (Hopkins, 2007; Chassin and Loeb, 2013; Babyar, 2020).

The ability to identify weak signals from noises is also dependant on the organisational slack or redundancy in the form of patient safety or quality improvement teams who can dedicate time and resources to identify and act upon weak signals (Lawson, 2001; Weick and Sutcliffe, 2001; Hopkins, 2007). Such characteristics are exhibited by learning organisations where time for learning is considered a vital ingredient and embedded as an essential part of the organisation design (Tolk et al., 2015; Agwu et al., 2019; Babyar, 2020).

Pronovost et al. (2006) adapted Donabedian’s model (1966) for measuring quality and patient safety which includes *structure* (how care is organised) and *process* (what we do) that can influence *patient outcomes* (the results achieved), and added the fourth element to capture *organisational culture* (the context in which care is delivered). This socio-technical approach to measuring patient safety is more comprehensive than the traditional focus on efficiency-based metrics focused on reporting errors and defects. The proposed framework was used across 100 intensive care units (ICUs) in Michigan to improve organisational culture and minimise errors in healthcare delivery. The model was targeted against three groups- senior leaders, team leaders, and front-line staff, to see how engagement, education, execution, and evaluation for planned interventions are done. The result demonstrated that the safety framework helped improve the organisational culture and eliminate catheter-related bloodstream infections across 100 ICUs. Further use or empirical validation of the framework was not evidenced in the literature review process; thus, the practical application of the framework to assess safety culture in future research still needs to be validated.

Another empirical research on HRO application in the healthcare setting was conducted by Vogus and Sutcliffe (2007a, b) whose focus was registered nurses and their managers in 125 nursing units across 13 hospitals spread across the six states of USA. The first survey study (Vogus and Sutcliffe, 2007a) highlighted the self-reported safety organising scale (9 items across the five HRO's principle) positively impacted safety culture and was negatively associated with reported medication errors and patient falls. However, the study was focused on the unit level and included only one nursing profession; future study needs to focus on the application of safety organising scale (SOS) to doctors and other professionals in the healthcare setting. Extending this research further, Vogus and Sutcliffe (2007b) bundled the SOS with other factors including leadership (trust in manager) and design (use of care pathways) to measure its impact on medication errors in 78 units across 10 acute care hospitals in the five US states. The result statistically confirmed that SOS impact on reducing medication error in the hospital nursing unit is augmented when paired with a high level of nursing manager trusts or the extensive use of care pathways. The two studies help in advancing the understanding of how healthcare organisations can transition towards HRO practices, though both studies only included limited organisational factors impacting medication errors.

Further advancing the understating of patient safety culture and its underlying tenets to demonstrate reliable performance over time, Steyrer et al. (2011) compare the performance, via a survey, a low-risk unit (Geriatric unit) and high-risk units (ICU, Surgery, Trauma Surgery) against the sub-dimensions of the patient safety culture. The low-risk and high-risk classification is based on Charles's Perrow two factors influencing high reliability: interactive complexity, and tight coupling. The geriatric unit is characterised by a lower level of complexity and coupling than ICU and Trauma surgery which has a higher level of interactive complexity and tight coupling. Thus, the context plays an important role in the healthcare setting when evaluating patient safety culture. The geriatric units reported enhanced safety by more social influences from their management team, proactive attitudes and sense of oneness amongst care workers, and having a more holistic view of a patient. These enabled members of the geriatric unit to be more sensitive to patient's need and take a systems perspective to achieve a higher standard of safety culture. On the contrary, the dynamic and emergent nature of ICUs and trauma units coupled with a narrow focus, working with cross-functional team, and having a higher level of complexity and interactions results in a lower standard of safety culture compared to the geriatric unit. However, the study struggled to quantify the differences in safety culture dimensions between acute geriatric setting and other high-risk settings. The study highlighted the need to understand the context in which reliability or patient safety study is conducted. Also, the study failed to indicate how an organisation can transition towards high reliability.

Due to an increasing focus on HRO theory and its application in the healthcare setting by Joint Commission[1], there is a surge in safety culture assessment and HRO healthcare research published in the last decade. Chassin and Loeb (2013), representing the Joint Commission that has accredited or certified more than 20000 US hospitals, presents a practical framework to evaluate organisation's readiness and maturity against the three key criteria of leadership, safety culture, and robust process improvement that can enable the organisation to progress towards high reliability. However, there is limited evidence of applying the proposed framework and its validity in assessing an organisation readiness for developing a culture to promote high reliability (Tolk et al., 2015).

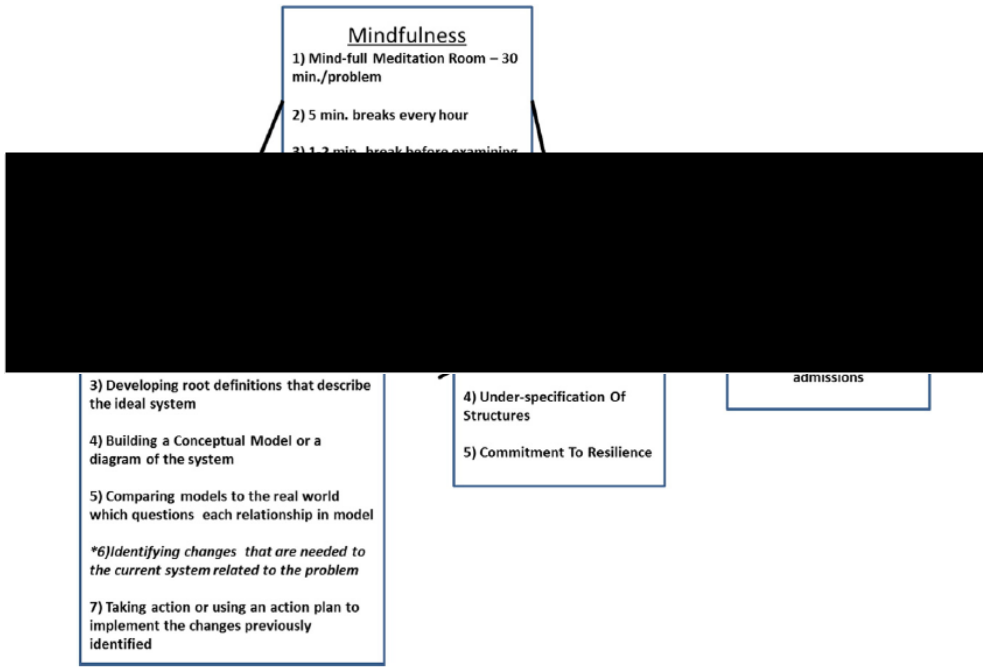
Another interesting study by Vogus and Iacobucci (2016) involving 1,685 nurses across 95 units in 10 hospitals highlighted the importance of socio-factors in enhancing high reliability work practices in hospitals leading to reduced medication errors and patient falls in that unit. The authors identified bundles of reliability - enhancing work practices including interpersonal skills of nurses, the discretion given to them to take decisions, training in enhancing communication impact on affective commitment, respectful interaction, which further impact mindful organising and

[1] It is a non-profit accreditation agency for over 20000 healthcare organisations in the USA. They launched the Joint Commission Centre for Transforming Health Care in 2009 with an objective *"To transform health care into a high-reliability industry by developing highly effective, durable solutions to health care's critical safety and quality problems in collaboration with health care organizations, by disseminating the solutions widely, and by facilitating their adoption."*

organisational citizenship behaviour respectively. These practices enable healthcare organisations to reduce medication errors and transition to becoming HRO. However, the study identified the negative effect of organisational citizenship behaviour on the reduction in medication errors. Other hypotheses were supported, highlighting how selecting for and building interpersonal skills and trusting relations and creating an environment to use those skills (e.g. affective commitment, respectful interaction) play a crucial role in transitioning towards HRO. This is among very few studies that provided evidence of which organisational practices can enable healthcare organisations to become HRO. However, this study only included nurses in their sample and the working practices included were directly focused on the frontline staff. A holistic picture of how different hierarchy in the organisation embraces reliability-enhancing work practices may advance further the study of Vogus and Iacobucci (2016).

In an attempt to understand the impact of five HRO principles, mindfulness training, and soft system methodology on improving the reliability processes and practices within a critical care unit of a US hospital, Hales and Chakravorty (2016) study showed how training on mindfulness and practising it every day before treating a patient could help in the reduction of errors and identification of weak signals by care workers. The authors showed the effectiveness of HRO and soft system methodology in addressing a problem and identifying a solution to improve patient safety (see figure 3.9).

Figure 3.9: A framework to improve healthcare reliability



(*Source: Hales and Chakravorty, 2016*)

However, in a complex healthcare system where time to treat a patient is scarce due to a limited capacity available to service the demand, it is not feasible for nurses and doctors to do yoga or mediation before treating any patient. The likelihood of applying Hales and Chakravorty (2016) framework in a healthcare setting plagued by lack of resources, which resembles the NHS and many other healthcare organisations globally, is slim. There is no further evidence of using their framework in improving the reliability of the healthcare process. Moreover, the study itself showed no significant improvement in performance during the post-implementation stage of the framework suggested by the authors.

The majority of published HRO work mostly focuses on specific elements of the HRO rather than presenting a holistic perspective of HRO practices and processes in any depth (Lekka, 2011; Chassin and Loeb, 2013). Some of the authors have offered tools, frameworks, rating scales, to assess the extent to which organisations are behaving like an HRO (Weick and Sutcliffe, 2007; Pronovost et al., 2006; Vogus and Sutcliffe, 2007a,b; Chassin and Loeb, 2013) or demonstrate institutional resilience (Carthey et al., 2001). However, most of the offerings are still struggling to explain how to embed and achieve the characteristics of HRO or resilient engineering. There is limited evidence so far on how to elevate low-reliability organisations or industry into an HRO and sustain that performance over time (Babyar, 2020; Cantu et al., 2020; Tolk et al., 2015; Chassin and Loeb, 2013; Lekka, 2011). In the UK, the NHS Institute for Innovation and Improvement planned to conduct specific tests on reliability theories, but so far, there is limited evidence of progressing the planned research (HSE, 2011).

HRO research is limited to specific contexts, and its application in a more mainstream organisational context is limited (Lekka, 2011; Agwu et al., 2019). Even the empirical literature on HRO is very descriptive and does not lend any clear theoretical framework to facilitate understanding of how HROs develop and maintain certain organisational factors such as mindful leadership or safety culture to operate in an error-free environment over a long-term (Hopkins, 2007; Lekka, 2011; HSE, 2011; Chassin and Loeb, 2013; Tolk et al., 2015; Hales and Chakravorty, 2016; Agwu et al., 2019).

The following quote from Goldenhar et al. (2013) validates the above statement – *"While several HRO frameworks specific to health care have emerged, transformation remains elusive, improvements remain modest and patient harm continues to be pervasive"* (pg.900). Similar findings were reported by Hales and Chakravorty (2016) - *"While we understand what the aspects of HROs are, we lack the understanding of how to systematically create HROs and why they work to improve reliability."* (pg.2873). For example, Chassin and Loeb (2013) developed an HRO framework for healthcare which included three key factors enabling high reliability practices – leadership, safety culture, and robust process improvement. The framework can measure stages of organisation's maturity across the three factors. There is limited evidence of usage of this maturity tool or field testing of its psychometric properties. Some of the barriers identified by researchers that inhibit healthcare organisations from being HRO are blame and intimidation culture, low expectations among employees, accepting errors as part of the system, lack of deference to expertise practice during unexpected events, issues with interprofessional collaboration, and threats of litigation (Mckeon et al., 2006; Chassin and Loeb, 2013; Babyar, 2020). Although high reliability performance remains elusive to the healthcare setting, developing the foundation to build a high reliability culture has been initiated (Sutcliffe et al., 2017; Babyar, 2020).

In a recent empirical study conducted by Agwu et al. (2019) in eight organisations across three industries (oil and gas, beverage manufacturing, restaurant chain), the authors highlighted a lack of a clear model to help organisations show increased maturity in demonstrating HRO traits or characteristics. Given the researcher started her doctoral research in 2016 and there were no clear model to enable organisation to exhibit HRO characteristics or adhere to five hallmarks of HRO (Tolk et al., 2015; Vogus and Iacobucci, 2016; Chassin and Loeb, 2013), it is encouraging to see the findings from Agwu et al. (2019), which further justifies the need for developing a theoretical model to enable organisations transition towards HRO.

The following quote extracted from Agwu et al. (2019: pg. 298) supports the researcher's justification to develop a HRO model – "*This paper recognised the numerous researches in HRO theory, but noticed the unavailability of a harmonised measurable framework that could be standardised and applied across diverse organisations*." The authors also make a case that the application of HRO should not be limited to high-risk industries as the five principles of HRO are equally applicable and beneficial to other types and size of organisation in medium to low-risk categories. The need for more empirically focused research on HRO was further highlighted in the two literature review papers published in 2020, respectively by Babyar (2020) and Cantu et al. (2020).

"HRO theory within the published literature has not significantly evolved past the original characteristics and hallmarks" (Cantu et al., 2020: pg.5)

"High reliability in healthcare organisations remains opaque, with varied structures to recommendations, despite continued interest and accreditation focus. Advancing high-reliability science for healthcare has remained elusive." (Babyar, 2020: pg.89)

The two literature review papers on HRO published in 2020 (Cantu et al., 2020; Babyar, 2020) clearly evidenced the lack of progress in empirical research on how organisations can embrace HRO characteristics. This evidence supports the researcher's focus on developing an HRO theoretical model for the healthcare sector in this doctoral research. The empirical study conducted by a limited number of authors on HRO application in the healthcare setting (Vogus and Iacobucci, 2016; Hales and Chakravorty, 2016; Chassin and Loeb, 2013; Steyrer et al., 2011; Weick and Sutcliffe, 2007, 2015; Vogus and Sutcliffe, 2007 a, b; Pronovost et al., 2006, 2015) has influenced the researcher's understanding of organisational factors enabling high reliability practices. This has helped the researcher propose a conceptual model for this doctoral research, discussed in section 3.8 of the chapter.

3.7.2 The research aim and research questions

Based on the literature gap discussed above and in Chapter 1, the aim of the study is ***to develop a HRO theoretical model to understand the concept of the HRO as it applied within the context of the Welsh NHS setting***. To achieve the aim of the study and understand what constitutes HRO model, the following two research questions are proposed that have emerged from the gap in the literature.

Research Question 1 (RQ1): What are the perceived organisational features that enable higher reliability in the healthcare context?

Research Question 2 (RQ2): How the perceived organisational features interact with each other to enable higher reliability in the healthcare context?

The first research question focuses on organisational features that can help organisations to transition towards HRO and the second research question will answer how organisations, by having better understanding of interactions between the organisational features, can achieve high reliability. Thus, the next section of the chapter will focus on identifying the organisational features and the relationship between them through the critical review of existing literature. This will enable the researcher to develop the HRO theoretical model that will be tested in the empirical phase of the study.

3.8 Development of a HRO Theoretical Model

As discussed in the last section, healthcare aspires to be HRO but have struggled to embrace the principles of HRO due to a lack of a clearly defined model or organisational factors that can enable them to achieve the hallmarks of HRO (Frankel et al., 2006; Goldenhar et al., 2013; Tolk et al., 2015; Hales and Chakravorty, 2016; Sutcliffe et al., 2017; Agwu et al., 2019; Babyar, 2020; Cantu et al., 2020). There is a lack of understanding about the bundles of organisational factors that can enable healthcare to exhibit highly reliable performance over a sustained period and thereby systematically create HRO. Inspired by the existing gap in the literature, this section brings together these bundles of the organisational factors in the form of an HRO theoretical model which the doctoral research will test and validate through survey-based study. The question of which organisational factors enable mindful behaviour to act and respond to unforeseen events and achieve the characteristics of HRO is answered through this doctoral research.

More than 200 articles were reviewed on HRO focused research in the healthcare setting between 2005 and 2020. Snowballing method was also used to identify either seminal literature or articles directly related to the two research questions posed in this doctoral research. As identified by some of the highly cited authors in the field (Sutcliffe et al., 2017; Chassin and Loeb, 2013; and Tolk et al., 2015), HRO application in healthcare still remains elusive, and there are only a handful of articles that go beyond what is HRO to explain a range of factors that can help organisations to achieve HRO. The majority of the published HRO study in the healthcare setting is either theory-based synthesis with a focus on 2-3 factors enabling HRO practice, commentary or viewpoint or literature review.

The researcher was interested in shortlisting articles based on applied research in the healthcare setting or other industrial settings but directly relevant to answering the two research questions. Narrowing down the focus to articles that used a survey to assess high reliability performance of healthcare unit or hospital (e.g. Pronovost et al., 2006; Vogus and Sutcliffe, 2007a,b; Steyrer et al., 2011; Chassin and Loeb, 2013) or viewpoint and theory based synthesis articles that identified factors enabling high reliability practice (e.g. Ghaferi et al., 2016; Lekka, 2011; Reason 2000; Weick and Sutcliffe, 2001, 2007). Articles outside the healthcare setting were also selected through a snowballing method as they were directly informing the development of a theoretical model (Cox et al., 2006; Sutcliffe et al., 1999). In the literature review paper by Tolk et al. (2015), the authors highlighted that there are only 23 papers on HRO that are based on empirical research and 25 case study articles that focused on high reliability cultures in different industries. These statistics, which includes papers from all sectors (including healthcare), show the lack of empirical research on how organisations can embrace HRO characteristics and particularly in the healthcare sector.

In table 3.3, the researcher has selected key articles that focused on explaining how organisations can exhibit five hallmarks of HRO or how an organisation can transition towards HRO. The majority of the articles included in table 3.3 have a high citation (especially the one published before 2010), are from the healthcare sector, and applied in nature (i.e. have used survey instrument or conducted case studies or shared commentary based on their observation of the healthcare setting). Table 3.4 is used to identify the most frequently cited organisational factors that can enable organisations to exhibit HRO characteristics over a sustained period.

Authors (Year)	**Sector**	**Citations**
Pronovost et al. (2006)	Healthcare	244
Weick and Sutcliffe (2001)	High-risk industries	4476
Vogus and Sutcliffe (2007a)	Healthcare	416
Vogus and Sutcliffe (2007b)	Healthcare	303
Reason (2000)	Healthcare	7196
Reason (2005)	Healthcare	366
Roberts et al. (2005)	Healthcare	132
Madsen et al. (2006)	Healthcare	122
Cox et al. (2006)	High-risk industries	143
Frankel et al. (2006)	Healthcare	170
Lekka (2011)	Healthcare and other industries	79
Steyrer et al. (2011)	Healthcare	10
Chassin and Loeb (2013)	Healthcare	590

Ghaferi et al. (2016)	Healthcare	17
Vogus and Iacobucci (2016)	Healthcare	50
Hales and Chakravorty (2016)	Healthcare	43

Table 3.3: Citation of selected articles linked to a HRO theoretical model *(Source: Researcher)*

Organisational Factors ⬇	Pronovost et al., 2006, 2015	Weick & Sutcliffe, 2001, 2007	Reason, 2000,2005	Roberts et al., 2005	Madsen et al., 2006	Cox et al,. 2006	Frankel et al. 2008	Vogus & Sutcliffe, 2007a,b	Lekka, 2011	Steyrer et al., 2011	Chassin & Loeb, 2013	Ghaferi et al. 2016	Vogus & Iacobucci, 2016	Hales & Chakravorty, 2016	Cantu et al., 2020
Mindful Leadership	X	X	X				X	X	X	X	X	X		X	X
Communication		X		X	X	X	X	X	X	X		X	X	X	X
Trust		X	X	X	X	X		X			X	X	X		
Reporting	X	X	X	X	X	X		X	X	X		X	X	X	
Training	X	X	X	X	X		X		X		X	X	X	X	X
Robust Process Improvement	X			X	X						X			X	
Safety Culture	X	X	X	X	X	X	X	X	X	X	X	X	X		X
Learning Orientation	X		X	X	X				X	X		X		X	X
Teamwork							X					X	X		
Accountability	X									X			X		X
Information Technology	X			X	X					X	X	X			

Standard Processes	X			X	X					X		X			
Reward system				X	X										
Governance Structure	X														

Table 3.4: Organisational factors enabling high reliability practices (*Source: Researcher*)

The most frequently cited factors were chosen to develop the theoretical model based on table 3.4 and also draw from a review of more than 200 articles which identified the following key HRO concepts: *Leadership / Mindful Leadership, communication, reporting, trust, training, and safety culture*. Some of the other factors such a learning orientation, accountability, and process improvement overlap with features of safety culture, reporting and training and thus briefly discussed when providing a detailed overview of those factors. The researcher now provides an overview of the most frequently cited factors and proposes hypotheses tested using a survey instrument. This section will present the key organisational features, identified from table 3.4, that can enable healthcare organisations to develop collective capabilities to be HROs.

3.8.1 Safety culture

The term 'safety culture' was identified in the International Atomic Energy Agency (IAEA) report following the Chernobyl nuclear accident (IAEA, 1986). Thereafter, safety culture received prominence and was mentioned in all subsequent investigation of major accident inquiries such as Piper Alpha oil platform explosion in the North Sea (1988), Ladbroke Grove rail disaster in London (1999), and Space Shuttle Columbia disintegration when re-entering the space (2003), whereby the cause of the accident was attributed to poor safety culture in those organisations (Cox et al., 2006). There are several definitions of safety culture, but the one provided by The Advisory Committee on the Safety of Nuclear Installations (ACSNI) Human Factors Study Group (1993) under the umbrella of Health and Safety Commission (HSC), encapsulates key characteristics of safety culture

"The safety culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies, and patterns of behaviour that determine the commitment to, and the style and proficiency of, an organisation's health and safety management. Organisations with a positive safety culture are characterised by <u>*communications*</u> *founded on* <u>*mutual trust*</u>*, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures"*

Defining safety culture in the context of the healthcare organisation, Sutcliffe (2011), stated that safety culture is a part of organisational culture and encompasses *"what is valued, beliefs about how things work and behavioural norms that determine the degree to which all organisational members direct their attention and actions towards minimising patient harm during delivery of care. Furthermore, safety culture entails an ongoing struggle to detect and correct misidentifications, misspecifications and misunderstandings that pose threats to safety (*p.141)*"*. Thus, safety culture is the combination of values, beliefs, and behaviours embraced by all organisational members towards minimising patient harm when delivering care and regularly using practices and controls to act upon the weak signals that pose a threat to safety (Schulman, 2004; Sutcliffe, 2011). The definition shows the importance of collective mindfulness or mindful organising to enact a safety culture in healthcare organisations (Weick and Sutcliffe, 2007).

One of the key researchers in the field of safety, James Reason (1997, 2000), suggested that to transition organisation from average safety culture to excellent one, organisations can work towards creating a socially engineered culture, termed as a just culture - *"an informed culture can only be built upon a reporting culture; and this in turn depends upon establishing a just culture"* (Reason, 2000, p. 12). Reason (1997) describe just culture as reporting culture where employees are prepared to report unsafe conditions, near misses, errors, inappropriate procedures or any other safety concerns to their line manager or senior leaders in the workplace. Contrary to safe practice, unsafe behaviour or practice from workers include errors, near misses, not following protocols or standards, risk-taking, rule violation, and not reporting safety incidents (Flin and Yule, 2004). Such negative behaviour can lead to adverse events (e.g. medication error) and injuries to healthcare workers (Reason, 2005).

When care workers take responsibility and support transparent and **open communication**, it helps in the development of a safety culture (Frankel et al., 2008). In a series of studies conducted by Robert and colleagues, particularly in the health care setting (Robert et al., 2005; Madsen et al., 2006), they showed strong evidence of a reduction in errors in the paediatric intensive care unit due to mindful organising and just culture. This was enabled by giving care workers specific skills, accountability, and empowerment to enact a safety culture. Supporting findings from Robert and colleagues, Vogus and Sutcliffe (2007a, 2007b) focused on nurses in the healthcare setting and stated that a higher level of mindful organising by nurses and team in the unit could be associated with fewer medication errors and patient falls over time.

It is important not only to create a culture of **open reporting** of weak signals but also analysing their significance and act on the analysis, termed as interpretative work (Reason, 1990). Individuals are encouraged to halt their work if it compromises with the safety without the fear of getting penalised by the line manager. This practice can only be enabled in a 'blame-free' organisational culture where employees openly report adverse events and mistakes to learn from the failure and prevent it from happening in the future (Provera et al., 2010). However, Reason (2000, 2005) also suggest that there should a balance between supporting the reporting of near misses and errors by employees on the one hand and not tolerating unacceptable behaviours that require disciplinary actions on the other.

Trust plays an important role in giving employees the confidence to report the incidents to their line manager or senior management (Reason, 2000; Cox et al., 2006; Chassin and Loeb, 2013). Safety culture builds on trust between employees will improve accountability among employees for adhering to safety protocols and procedures, reporting of unsafe practices by employees, and allow them to question their seniors for unsafe practices (Frankel et al., 2008; Weick and Sutcliffe, 2007; Vogus and Singer, 2013; Chassin and Loeb, 2013). Giving accountability to employees to adhere to safe practices is an important part of a safety culture. HROs create a blame-free culture in the organisation by reporting small errors and learning from those errors to avoid in the future (Marx, 2001; Frankel et al., 2008). At the same time, HROs ensure that blameworthy act is also recognised and dealt appropriately as this forms an important part of safety culture and helps maintain trust among employees (Chassin and Loeb, 2013). Accountability is also driven by the implementation of standards for invoking disciplinary procedures against any staff or team responsible for reckless actions, irrespective of their professional hierarchy or credentials (Chassin and Loeb, 2013).

Individuals can be empowered to make decisions without waiting for their senior leaders' approval and increases decision-making speed. Empowerment is a concept that aligns with the 'deference to expertise' characteristics of HROs (Madsen et al., 2006; Lekka, 2011). Decentralised decision-making by nurses working at the front line and carrying out regular debriefings with their teams have shown to improve response times, quality of care, and reduced mortality rates (Madsen et al., 2006).

3.8.2 Mindful Leader

Hopkins (2009), inspired by Weick and Sutcliffe (2001) work on 'mindful' organising, call such a leadership style as *'mindful leadership'* that incorporates the following qualities:

- Encourage employees to voice their concerns and viewpoints and to use this bottom-up **communication** approach to help promote safety practices within the organisation.
- Provide resources in the form of time, **training**, and space for conducting quality improvement or patient safety related tasks.
- Proactively involved in quality improvement or safety related projects to lead by examples and inspire others to get involved in such continuous improvement initiatives (Chassin and Loeb, 2013; Jha and Epstein, 2010)
- Benchmark their performance against other organisations or learn from accidents in other organisations to diagnose their own weaknesses and act upon them (Sutcliffe, 2011)

Mindful leaders will attempt to develop a collective vision and mission for patient safety across the organisations by shaping the social and relational infrastructure across the organisation (Hopkins, 2007; Vogus and Sutcliffe, 2007b; Christianson and Sutcliffe, 2009; Vogus, 2011). They contribute to establishing an interrelated set of practices and processes that enhance the organisations' overall safety culture (Vogus et al., 2010; Weick and Sutcliffe, 2007). Mindful leadership enables establishing a single vision of patient safety and eliminating harms to the patient across the clinical hierarchy including a board of trustees or directors, senior management, consultants, and senior nurse (Chassin and Loeb, 2013). Leaders can enable mindful organising by prioritising safety and creating an environment for employees where they feel safe to speak up and act in a way that improves patient safety (Yun et al., 2005; Vogus, 2011). Yun et al. (2005), reporting findings from a low-to-moderate severity trauma unit, highlighted the importance of leaders in empowering their workforce to make decisions (i.e. deference to expertise), and thereby improving learning by team members without compromising on patient safety.

Leaders play an important role in emphasising that safety is paramount and equally important as other business objectives and such message from leaders helps in driving safety-related values, behaviours, and culture among management and employees down the hierarchy (Madsen et al., 2006; Frankel et al., 2006; Lekka, 2011; Vogus, 2011; Tolk et al., 2015; Babyar, 2020). Highlighting the importance of leadership in the clinical setting, Madsen et al., (2006) stated that organisation often goes back to their normal way of working in the absence of their leader that promotes and embed high reliability processes. Giving the example of an ICU, where practices of decentralised decision making and holding regular debriefings stopped after the clinical leader left the organisation (Madsen et al., 2006).

The ability of senior leaders to listen and act on concerns raised by the staff can also influence patient safety (Pronovost et al., 2006). When reporting findings from 100 ICUs in Michigan, Pronovost et al. (2006) stated the important role of senior leaders in allocating sufficient resources, providing incentives, and removing barriers for the employees involved in delivering high quality of care. However, half of the respondents participating in the study reported a lack of support and insufficient time dedicated by senior leaders significantly deterred their project progress (Pronovost et al., 2006). The leader plays an important role in identifying the weaknesses in the operations of the organisation, take a systems perspective in identifying a solution to address the weaknesses, as well as encourage employees to learn from previous errors and apply the knowledge to improve risk management (Lekka, 2011; Weick and Sutcliffe, 2007).

Leaders play an important role in eliminating intimidation within the workplace by encouraging and rewarding workers to **report errors** and unsafe conditions. In this way, Leaders can build and **enhance trust** relations with their employees in an organisation (Whitener et al., 1998; Shamir and Lapidot, 2003; Chassin and Loeb, 2013). The leader's or manager's actions and behaviours have an important influence on the development of trust and as such, provide a foundation for trust relations (Whitener et al.,1998). Vogus and Sutcliffe (2007b) showed how the impact of safety organising scale on reducing medication error in the hospital's nursing units is augmented by trusting their leaders, i.e. if the nurse has **more trust** in their manager, the impact on the reduction in medication errors is amplified. This is aligned with other findings that have highlighted effective and committed hospital-level leadership impacting other organisation practices to influence safety culture (IOM, 1999; Singer et al., 2003).

Senior managers can influence safety culture in organisations by continuously demonstrating their visible commitment to safety initiatives in organisations which is best indicated by the amount of time they dedicate to quality or safety matter in organisations (Flin and Yule, 2004). Leaders can engage with their employees in collaborative sense-making through participation in patient safety or quality improvement projects that help improve trust, communication and produce a more elaborate set of behaviours to enact (Vogus, 2011; Hofmann et al., 2003). Leaders encouraging reporting of safety concerns will foster open and constructive communication about near misses, error, or unexpected events (Hofmann and Morgeson, 1999; Hofmann et al., 2003).

Leaders at levels in the organisations, i.e. senior managers, middle managers, and supervisors, take different roles and responsibilities to influence employees' behaviours towards safety outcomes. Still, it is the senior leader who has a greater level of influence on the workers’ safety behaviour than line supervisors (Flin and Yule, 2004). Even though line supervisors play a decisive role in the safety behaviour of the worker, it is the leader who sets the supervisor’s goals, objectives, and priorities. Mindful leaders encourage employees and managers to subscribe to the organisational goals and objectives over their immediate personal gains (Donaldson, 2001; HSC, 1993). If the leaders don’t act when something goes wrong or do not encourage employees to search for and **report** errors, it is likely that the safety performance will decline. Thus, it is very important in healthcare or any other settings to identify the right person for the senior leadership position and accordingly provide required training to demonstrate the behaviour and action directed towards improving the current level of patient safety to higher levels (Donaldson, 2001).

The leadership team at the Johns Hopkins Medicine Board of Trustees (a healthcare provider in the United States) provided the required infrastructure to manage quality and safety efforts across the five hospitals/medical centres (Pronovost et al., 2015). They established a governance structure to ensure the five hospitals interacted with each other and at the same time had the independence to make local changes but following the same seven measures of inpatient process-of-care and were expected to achieve the target of 96% compliance. Over two years, it helped all the participating hospitals consistently achieve targets in six out of seven inpatient process-of-care measures. The success was attributed to the leadership team, giving accountability to each hospital and their workers, providing resources for skills and capabilities development, building a culture of patient safety and continuous improvement based on teamwork, constant monitoring against performance measures, and use of robust process improvement methods such as Lean Six Sigma (Pronovost et al., 2015).

3.8.3 Communication

The commitment to ongoing resilience and deference to expertise characteristics are required when responding to unexpected events, and in such scenarios, effective communication channels between hierarchical levels can help the organisation to have access to expertise and communicate the "big-picture" mental model of how the organisation should work to everyone (Lekka, 2011). Effective communication between individuals or teams will enable employees to collate, analyse, and synthesise a systems' picture of current operations and devise methods and procedures to contain and prevent potential failures in future effectively (Roberts and Bea, 2001; Weick and Sutcliffe, 2007; Hopkins, 2007). Effective communication enables to embrace safety-related values and behaviours among clinical staff such as staff are encouraged to speak freely about incidents, communicate their viewpoints to other co-workers or senior management, and they feel comfortable in giving individual-feedback to one another (Jones and Cox, 2005; Cox et al., 2006). Poor communication is a leading contributing factor in all types of adverse events or medical errors, which is often occurring between two groups of caregivers – consultants/physicians and nurses (Sexton et al., 2000; Chassin and Loeb, 2013; Tolk et al., 2015; Cantu et al., 2020; Babyar, 2020). Retrospective investigation of all major accidents and adverse events have highlighted that organisations often fail to systematically identify weak signals and communicate them to the relevant individual or team in the organisations, particularly senior management, who can act quickly to put in place effective control measures to mitigate the impact of unexpected events (Cooke and Rohleder, 2006; Hopkins, 2007; Lekka, 2011).

Communication between different stakeholders in the healthcare setting responsible for enacting a safety culture and improving the quality of care is vital for maintaining safety performance (Carson-Stevens et al., 2016). The use of a standardised tool such as the WHO surgical checklist before an operation can act as a useful communication tool between stakeholders involved in surgery to ensure standards are followed (Leonard et al., 2004). Miscommunication or lack of communication is considered as a common cause of inadvertent patient harm as evidenced from a large dataset study in the primary care setting by Carson-Stevens et al. (2015), stating 21% of patients incident reports can be attributed to communication problems. The communication problems can happen to due barriers to accessing clinical services, errors in information exchange between healthcare workers, availability and accuracy of patient records, delayed referrals, and miscommunication between patient and healthcare workers or between healthcare workers (Carson-Stevens et al., 2015).

Summarising the key points linked to communication, the literature review highlights the important role of the leaders in establishing effective communication between and across the professional hierarchy. It was also evidenced from safety culture and mindful leader discussion on how effective communication leads to the development of safety culture in the workplace. This leads to the proposition of two hypotheses, which will influence the development and testing of the HRO theoretical model.

Hypothesis 3 (H3): Mindful leaders positively impact in establishing effective communication with employees in organisations aspiring to be HROs.

Hypothesis 10 (H10): Effective communication among employees positively impact on development and maintenance of a safety culture.

3.8.4 Training

The organisations aspiring to be HRO, invest more in training to teach employees how to recognise and respond to anomalies or unexpected events to minimise errors, and share and learn from those incidents to have fewer accidents in future (Babyar, 2020). Continuous technical training and re-training of staff are critical to keep their skills up to date and give them capabilities to identify weak signals and conduct interventions to identify the root causes of problems (Roberts and Rousseau, 1989; Weick and Sutcliffe, 2007; Lekka, 2011). Allocation of resources, in terms of time and space available to enhance workers' technical and social skills and enable them to anticipate and respond to unexpected events, will allow organisations to embed HRO characteristics of preoccupation with failure, sensitivity to operations, and deference to expertise (Hales and Chakravorty, 2016). Training can enable organisations to instil safety-related values and behaviours among clinical staff to enable them to assess and evaluate how things can go wrong (Lekka, 2011).

Simulating catastrophic events and conducting accident investigations can help employees understand systemic causes of failure, the potential impact of failures, evaluate each failure scenario, and develop capabilities to respond when such adverse events occur (Weick and Sutcliffe, 2007, 2015; Sutcliffe et al., 2017). Individual and teams should be trained in situational awareness, standardised **communication**, closed-loop communication, and shared mental models to mitigate and manage errors and sustain reliable performance over time (Riley et al., 2010). In addition, teams can also be cross-trained on team coordination, perceptual contrast, analysing different scenarios, self-correction, and guided error training programs for collective demonstration of HRO principles (Wilson et al., 2005). All the training can help individual and teams to **build trust**, **improve communication**, **improve reporting and feedback**, and have skills and capabilities to consistently aspire to operate error-free (Babyar, 2020).

The opportunity to use the learning from the training in practice on real problems, termed as learning by doing (Hays et al., 1988), is important to develop care workers' capabilities and give them the confidence to deal with uncertain situations (Hales and Chakravorty, 2016). The effectiveness of this approach was tested by Hales and Chakravorty (2016) in a critical care unit of a US hospital treating 4000 patients annually, where care +45workers were trained in mindfulness, five principles of HRO, and soft system methodology and were asked to follow the approach before and during treatment of a patient. The result of the study showed that **resources allocated by the leadership** team for frontline staff to train and practice mindfulness, five HRO principles, and soft system methodology helped in **improving process reliability**, but the results were not statistically significant for the improvement achieved between benchmark period and post-implementation period.

Training plays an important role in implementing effective teamwork and communication in the healthcare setting (Frankel et al., 2008). Training in effective **communication**, **reporting**, structured language, standards and checklists, effective assertion, and effective leadership will give healthcare workers skills and capabilities to embed a **safety culture**. Similarly, the use of medical simulation to learn and practice such skills will help healthcare workers to upskill and reskill themselves to adhere to safer practices and deliver patient care systematically (Ghaferi et al., 2016). Ghaferi et al. (2016) suggested using high-fidelity patient simulators and surgical skills labs to enable less-skilled surgeons to refine and upskill their technical knowledge with less risk to patients. An example of an improvement in patient safety outcomes through training is provided by Ghaferi et al. (2016), where the authors suggested that development of a safety program (called comprehensive unit-based safety program [CUSP], developed by the team at John Hopkins Medicine and Armstrong Institute) and training on CUSP helped clinicians to improve communication, teamwork, knowledge sharing, and learning, thereby resulting in 33% reduction in surgical infections among colorectal surgery team. Delivering effective training programs in teamwork and communication strategies will improve quality and safety, thereby decreasing the reported cases of patient harm, potential malpractice suits, and improved patient satisfaction.

HROs can embrace reliability enhancing work practices by training and mentoring frontline workers in developing their interpersonal skills which act as a foundation to **build trust** among interdependent colleagues (Schulman, 1993), **improve communication** between teams and individuals during adverse events (Weick and Sutcliffe, 2007; Vogus and Iacobucci, 2016), and **create a safety-enhancing culture** (Vogus and Iacobucci, 2016). By giving frontline workers the required training, HROs enable them to develop their knowledge and skills for real-time adaptation when facing adverse circumstances, errors, or unexpected events (Roe and Schulman 2008; Gordon et al. 2013).

In another HRO focused research in the paediatric intensive care unit (PICU) by Robert and colleagues (Robert et al., 2005; Madsen et al., 2006), authors identified the application of five hallmarks/characteristics of HROs by healthcare workers in the PICU. The constant in-service training allowed caregivers to identify weak signals in the system and act upon it; work as a team to get the holistic picture of care given to the patient and identify potential safety threats for each patient; conduct team huddles or post-event debriefings to learn from the event and prepare to recover from unexpected future events quickly; and decision making migrating to bedside caregivers who have more knowledge and experience of giving care to a specific patient. The mindful organising through a collective effort from individual and team working for PICU helped reduce errors in the unit that receives complex and fragile patients and thereby **improving the safety culture of the unit** (Robert et al., 2005; Madsen et al., 2006).

The discussion above on leaders allocating resources to impart a range of theoretical and simulation-based training helps caregivers improve trust and communication within a team and between teams, improve employee's capabilities to identify and report unsafe practices, and enhance the safety culture of the organisation. This helps in establishing the following hypotheses to be tested in the next phase of the study.

Hypothesis 2 (H2): Mindful leaders positively impact in establishing effective training programs for employees in organisations aspiring to be HROs.

Hypothesis 5 (H5): Effective training programs for employees positively impact the development of reporting culture in organisations aspiring to be HROs.

Hypothesis 6 (H6): Effective training programs for employees positively impact in establishing effective communication across the organisations aspiring to be HROs.

Hypothesis 7 (H7): Effective training program for employees positively impact on building trust among employees in organisations aspiring to be HROs.

Hypothesis 8 (H8): Effective training program for employees positively impact on development and maintenance of safety culture.

3.8.5 Reporting

Reporting using mechanisms such as checklists, incident reports, and huddles contribute to the **building of safety culture** in organisations (Sutcliffe et al., 2017). Reporting facilitates balancing information flow between hierarchies and teams to learn from safety incidents (McKeon et al., 2006). De-briefing and reporting facilitated by huddles can help in the open transfer and sharing of information, have a meaningful conversation about incidents and good practices, do collective problem solving, and promote learning, which aids to the creation of a safety culture based on transparency (Provost et al., 2015; Sutcliffe et al., 2017).

Staff at lower hierarchical levels are encouraged and feel comfortable reporting adverse events or weak signals to their senior members in the hierarchical ranks (Pronovost et al., 2002; 2006). Research has shown that healthcare workers often fail to report near misses or unsafe practices to their line manager, who is well placed to address the problems and close the loop (Chassin and Loeb, 2013**). Open reporting plays an important role in building a safety culture**, which can **only be supported by a mindful leadership style** (Lekka, 2011). The ability of the healthcare workers to identify and report weak signals and unsafe conditions combined with creating capacity in the organisation to act on those reports and eliminate the risks they represent is critical for enhancing safety culture within organisations (Reason, 1997, 2000; Chassin and Loeb, 2013).

As said by Reason (2000) - *"an **informed culture** can only be built **upon a reporting culture**; and this in turn depends upon establishing a just culture"* (pg. 12). An open reporting culture will encourage care workers to collect, analyse, and disseminate information about errors and near misses, which further help them learn about the potential root causes or do proactive checks to identify the weak signals (Vogus and Sutcliffe, 2007a; Reason, 1997). In addition to senior management at the organisational level communicating the importance of safety culture, leaders at the hospital's unit level also enhance the effect of safety organising on patient safety by fostering trust and creating an open environment to discuss and *report errors* and near misses (Edmondson, 1996, 1999; Blatt et al., 2006; Vogus and Sutcliffe, 2007b). **Leaders play an important** role **in fostering open reporting** of mistakes and errors to learn from those incidents and improve the safety culture of the unit or the hospital (Reason, 2000; Weick and Sutcliffe, 2007; Pronovost et al., 2015).

To make Johns Hopkins Medicine (JHM) highly reliable, the five hospitals under JHM were connected by the real-time dashboard reporting seven inpatient process-of-care measures with an expectation to achieve 96% compliance across all seven measures. The visibility of the performance board across the JHM made each hospital have established processes for accountability and sustainability of performance, build capacity to undertake improvement and invest in Lean Six Sigma training to improve and sustain performance measures (Pronovost et al., 2015). The improvement in reporting and communication across the five hospitals and within each hospital was achieved through a robust governance structure **developed by the leadership team** at JHM.

The above discussion demonstrates how leaders help build an open reporting culture which further influences the development of safety culture across the organisation over the longer-term. This leads to another set of two hypotheses, which will affect the development of the HRO theoretical model for this doctoral research.

Hypothesis 1 (H1): Mindful leaders positively impact establishing reporting culture in organisations aspiring to be HROs.

Hypothesis 9 (H9): Open reporting across the organisational hierarchy positively impact on development and maintenance of safety culture.

3.8.6 Trust

Trust plays a vital role in the coordination of employee's expectations and interactions to maintain successful organisational relations (Lane and Bachmann, 1998; Reason, 1998; Kramer, 1999; Cox et al., 2006) and thereby contribute towards **establishing safety culture** over an extended period in organisations (Cox et al., 2006; Chassin and Loeb, 2013). Mutual trust among employees or stakeholders is an important facilitator or barriers to establishing a good safety culture in an organisation and its supply chain (Reason, 1998; Hale, 2000; Cox et al., 2006). At the micro-level, trust between medical colleagues fosters collaboration, enables expanded communication on patient's status during hand-off, improves decision-making abilities due to transparency in reporting and communication, and thereby strengthens positive outcomes (Philibert, 2009; Babyar, 2020). Trust between employees is enhanced if the organisation eliminates intimidating behaviour and promotes reporting and fixing the problem by workers (Chassin and Loeb, 2013). A worker, who reports a problem, should also be communicated with the improvement made regarding reporting, which will further enhance trust across the organisational hierarchy. At the macro-level, lack of trust is considered the primary reason for partnership failure between healthcare stakeholders (e.g. primary and secondary care or secondary care and social care) to achieve outcomes intended to benefit the community health (Prybil et al., 2014).

Leaders play an important role in building trust across the organisational hierarchy and within each level of the hierarchy -senior, middle, and frontline levels (Vogus and Sutcliffe, 2007b; Weick and Sutcliffe, 2015). A study involving 1033 nurses and 78 nurse managers in 78 units in 10 acute-care hospitals identified that nurses having trust in their nurse manager (i.e. leadership team) drive the organisational safety culture and improve safety-related metrics (Vogus and Sutcliffe, 2007b). The **healthcare leaders** create policies, structures, practices, and control measures to build trust among caregivers to promote and practice mindful organising. Leaders' act helps build trust that will eventually drive the organisation towards a higher level of HRO maturity (Vogus and Sutcliffe, 2007b).

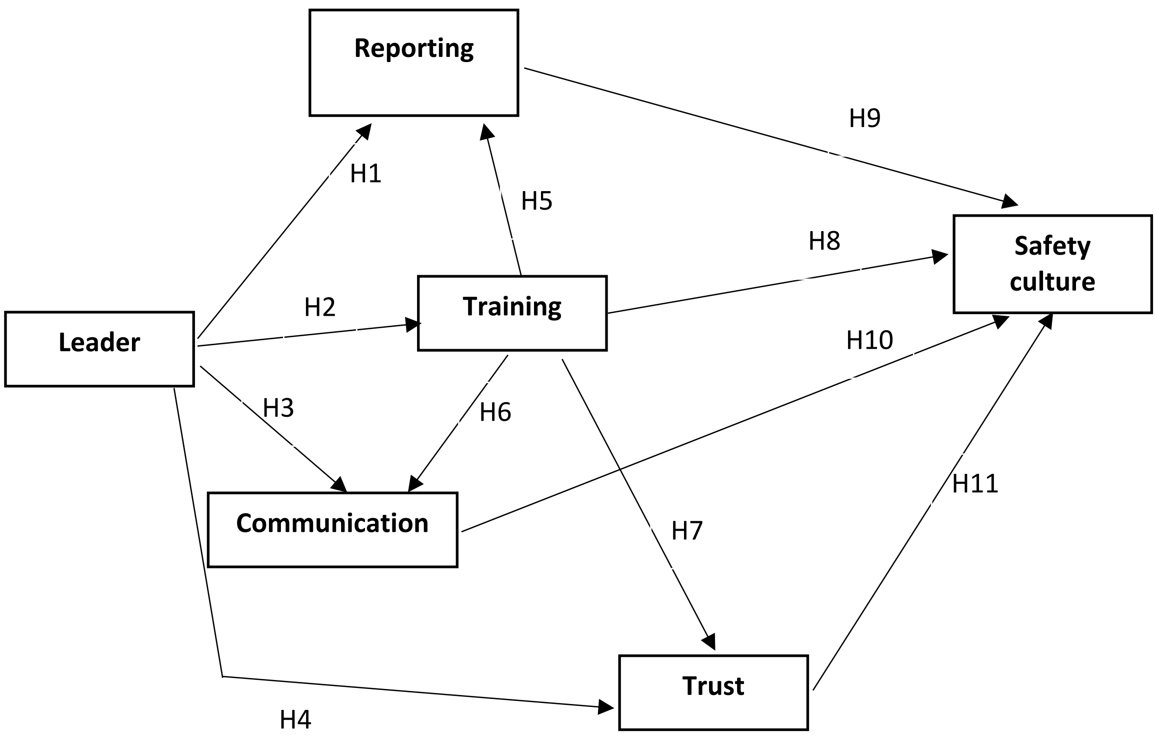
Increasing the trust levels can improve spontaneous sociability in the workplace where employees will openly discuss safety issues, self-report errors and near misses, help and cooperate to deal with the problematic situation at work, work towards a common goal, and share information across organisational hierarchy (Kramer, 1999; Cox et al., 2006). Similarly, if there is a low level of trust between employees or employees and managers, this will have a negative impact on the development and maintenance of effective safety culture (Cox et al., 2006). In a case study conducted in the nuclear industry, Cox et al. (2006) reported that the presence of trust at the case study site encouraged employees to take ownership of safety practices within the organisation and also report or question team members if an unsafe practice is identified. This helps in the development of open and honest questioning and challenging culture. Similarly, a low level of trust between key stakeholders can result in the development of blame culture and hiding of safety-related incidents (Reason, 1997; Turner and Pidgeon, 1997; Cox et al., 2006). Despite the importance of trust in establishing a safety culture, there is limited evidence of research on how trusts can facilitate firms to be HROs (Cox et al., 2006). However, the review of the relationship between trust and safety culture, as reported above, leads to the following hypotheses to be tested in the empirical phase of the study.

Hypothesis 4 (H4): Mindful leaders positively impact establishing trust relations with employees in organisations aspiring to be HROs.

Hypothesis 11 (H11): Trust relations among employees positively impact on development and maintenance of a safety culture.

The eleven hypotheses proposed in the above section, based on the identified organisational factors that explain how organisations can transition towards HRO, are combined in an HRO theoretical model that was developed by the research and will be tested in the empirical stage of the doctoral research. The development of an overarching theoretical model to explain how the organisation can embrace HRO characteristics is a contribution to doctoral research and helps in developing the HRO body of knowledge. The model proposed below (see figure 3.10) was inspired by past literature, and in particular from the following work - Vogus and Iacobucci, 2016; Hales and Chakravorty, 2016; Chassin and Loeb, 2013; Steyrer et al., 2011; Weick and Sutcliffe, 2007, 2015; Vogus and Sutcliffe, 2007 a, b; Pronovost et al., 2006, 2015.

Figure 3.10: HRO theoretical model for the doctoral research



3.9 Theoretical Underpinning

Every doctoral study must be founded on a theoretical base and approach. Such theories provide a lens to any study and can be used to explain how systems function and to make sense of the relationships. The chosen primary underpinning theory for this study is the Sensemaking perspective that is also one of the popular theories applied to explain the HRO research. The secondary theory that complements the sensemaking perspective and aligned with the researcher's HRO model is the Systems Theory. Both theories are fit for purpose and help explain the development of the theoretical model, the interrelationship between features in the HRO model, and the findings reported by the Doctoral research.

3.9.1 Applying Sensemaking perspective to explain the HRO theoretical model

Sensemaking is a cognitive process that requires human actors, working in the safety-critical operations, to assess the complex situations and search for resolutions in the embedded socio-technical system consisting of organisation, human factors, and technology (Borgesl and Goncalo, 2010; Kilskar et al., 2017). Sensemaking started emerging in the organisational literature in 1960s but received attention from the Karl Weick seminal work published in 1995 – Sensemaking in Organisations. Sensemaking is defined as *"a sequence in which people concerned with identity in the social context of other actors engage ongoing circumstances from which they extract cues and make plausible sense retrospectively, while enacting more or less order into those ongoing circumstances"* (Weick et al., 2005, pg. 409). It can be seen as a process of making sense of complex social dynamic situations by individuals, constructing their own roles and stories within their organisations, influencing and shaping organisational behaviour, and deciding actions to be made (Mamykina et al., 2015). The definition of sensemaking is aligned with anticipation (first three principles of HRO) and containment (last two principles of HRO) principles of HRO, where social actors embedded in the socio-technical system plays an important role in either acting on the weak signals or acting quickly to contain complex situations and learn from those situations.

Weick et al. (2005) contend that the first attribute of sensemaking is that it *organises flux*. It means when an individual encounters complex situations or experiences or events that do not meet their existing set of action scripts or that challenge their sense of meaning, they will stop their routine activities and flux of momentary thoughts and reactions takes its place (Mamykina et al., 2015). The occurrence of unexpected events organises flux, leading to noticing, bracketing, and labelling the unexpected event or situation into an understandable form. The noticing and bracketing phase is influenced by the mental model in the minds of individuals that they have acquired through their work experience or training. The bracketing phase starts when an individual attempts to find an answer or response to a situation which is different from routine or normality (Mamykina et al., 2015; Weick et al., 2005). After bracketing the event, individual or team try to impose labels on independent events to suggest plausible acts of managing, coordinating and classifying them into functional categories, each of which can be associated with a possible treatment or series of actions (Weick, 1995; Weick et al., 2005). Labelling attempts individuals to move from unordered to an ordered domain by offering meaning and explaining root causes for complex situations or errors. For example, a nurse taking care of a premature baby in the neonatal unit of the hospital suddenly sees deterioration in the baby's health. The nurse starts seeing symptoms which is different from normality and it organises flux in the mind of the nurse. The flux makes sense of what abnormal condition has suddenly triggered the baby and why it has happened. The nurse may attempt first to make sense of the symptom and try to bracket and label the symptoms to an established root cause or possible set of treatment for that condition.

The above example also forces the nurse to reflect on the flow of events prior to this complex situation to understand its cause. Here, individuals try to formulate the meaning of situations only after completing their involvement and reflecting on the outcomes (Weick, 1995; Weick et al., 2005). Thus, the *sensemaking process can be triggered retrospectively* by reflecting on chaos or complex situations and how individuals and organisations responded to the condition of ambiguity (too many possible correct interpretations) or uncertainty (absences of possible correct interpretations) (Mamykina et al., 2015; Saint-Charles and Mongeau, 2009). This can facilitate extracting specific cues by understanding and unravelling the potential antecedents of the event and creating meaning for the event retrospectively. The cues can either be extracted and unravelled by the individual or socially constructed by working in a team to create meaning and learning through interpretations and actions (Lundberg et al., 2012; Maitlis and Christianson, 2014).

In sensemaking, individuals will look for *plausible explanations rather than accuracy* and involves specific action for each situation by assuming a set of conceivable hypotheses (Weick et al., 2005). It means the individual will test their hunches or hypotheses by presuming the character of the complex situation or event and adapt the plausible understanding of the situations through progressive estimates and feedbacks. This individual sensemaking is based on their own understanding of the event and the opinions shared by others (Mamykina et al., 2015). The individual is embedded in a social structure that allows sharing and streaming of meanings, which means organisational sensemaking is *social and systemic*. Attempting to unravel ambiguity or uncertain situations require going beyond an individual and involving other social actors to develop a plausible understanding of the situations. The outcome is dependent on the stronger or weaker coordination and information distribution among the interdependent workers (Weick et al., 2005). However, the sensemaking process can only start when an individual or team have the capabilities and skills to identify the discrepancies that do not match their expectations. These expectations are shaped by the experience of an individual, *the socio- system they are associated with at work*, training received, and their own attitude to quality and safety and how much it aligns with group norms or organisational culture (Kilskar et al., 2017).

Another important pillar of sensemaking is the next *set of actions* after understanding the complex situation and the context in which that situation has occurred (Weick et al., 2005). After bracketing and labelling the event, it allows the individual to act accordingly to the new meaning. Actions help to test the hunches or hypotheses, which was developed in the mind of the individual. Embedded in the socio-technical system, individuals may take actions by first *communicating* with others in the team and formulate and exchange opinions before and after actions have been taken (Weick et al., 2005). *Communication* plays an important part in sensemaking as it allows to lift the equivocal knowledge out of the tacit, private, complex, and past to make it explicit, ordered, and relevant to the situation encountered by the individual (Weick et al., 2005).

In summary, sensemaking is triggered by flux, which forces the individual to test their presumption by communicating with others in the socio-technical system to develop a plausible explanation of the uncertain situation by bracketing and labelling the events and selecting the assigned actions for the particular type of event. However, the labelling happened on an almost completed act, which means that retrospectively the individual try to understand the flow of events that lead to an uncertain or complex situation.

The next subsection justifies the use of Systems Theory as the secondary theory to explain how high reliability practices can be enabled by better understanding the interrelationship between organisational features required for the transition towards HRO.

3.9.2 Applying Systems Theory to the proposed HRO model

Systems theory is one of the oldest management theories and dates to the 1930s when the General Systems Theory emerged from the biological sciences approach (Von Bertalanffy, 1969). The systems theory approach is a means of synthesising rather than a reductionist approach to understanding how a system works and what it is. The systems approach states that the system is greater than its parts (Ackoff, 1994), and relationships and interactions between parts of the system create the performance of the system in total.

Systems theory argues that systems, especially organisations, must fit their environment/ surrounding conditions and must also evolve as the environment evolves or face demise. It suggests that there should be alignment between organisational strategy, structure, human resources, incentives, and information and decision-support systems to maximise the benefits for all stakeholders (Golden and Martin, 2004). The functional silo nature of working in most organisations results in misalignment of focus across the categories, resulting in sub-optimal solutions or outcomes. The relevance of systems theory in understanding the influence of surrounding conditions is beautifully explained by the following statement from Anderson (2016, pg.593):

> *"Although many of us spend considerable time siloed, focusing on the functionings of individual organs, our jobs necessitate that we think about how each intricate organ system influences, and is influenced by, its environment. We think about how renal function is influenced by the squeeze of the cardiac muscles, and simultaneously by the medications a patient is taking, the sepsis his or her body is fighting, and the pre-existing renal disease with which he or she came."*

Healthcare is a complex system due to the nature of work laden with dynamism, interdependence, time pressure, and multiple inputs that do not allow healthcare to operate in an error-free manner (Christianson et al., 2011; Sutcliffe, 2011; Smith, 2016). The healthcare setting will benefit from the system theory approach that has the primary purpose of providing safe and high-quality care, as evidenced in the 'To Err is Human' report from IOM (Kohn et al. 2000). The IOM report accentuated to move away from the blame culture (Characteristics of Safety I organisations where individuals are blamed for errors). It advocated that quality improvement focus should be on the healthcare system as a whole.

The assumption behind system theory is that most individuals in the organisation strive to do good work, but they are acted upon by diverse influences which are outside their control and focus (Petula, 2005; Anderson, 2016)- a typical characteristic exhibited by healthcare organisations globally (as explained by the above quote from Anderson (2016)). Anderson (2016) and Petula (2005) strongly support systems theory to reduce adverse events, improve the quality of patient care provision, and promote health. Systems theorists move away from linear root cause analysis when failure happens and state that analysis should shift the focus from individual failings to surrounding conditions that allowed such events to occur. This will enable problem-solving team to devise outcomes and solutions after conducting synthesis and retrospective analysis of common patterns and behaviours across time that may have influenced the event occurrence.

Systems theory also promotes the view that employees must be engaged in business and continually learn to ensure a stable patient flow process (input-process-output cycle). To maintain a stable flow, staff must measure any information in feedback about deviations in performance or safety and react in a timely manner to variations that are deemed unacceptable or likely to lead to system failure (Hollnagel, 2012). This is where sensemaking complements the systems approach. It emphasises bracketing and labelling the errors and conducting retrospective analysis to establish an understanding of the chain of events prior to the error (Mamykina et al., 2015; Weick et al., 2005). The systems approach also states that a system must be viable in terms of performing to ensure the system is performing well against its function and designed intention.

The quality improvement and the HRO literature clearly state that complex healthcare systems operate safely, in most cases and conditions, because of the healthcare workers who are socialised to care and put the patient first (Golden and Martin, 2004; Petula, 2005; Sutcliffe, 2011; Babyar, 2020). These members of staff, working on the “front line” or “sharp end”, tend to make small adjustments in practice to negate the potentially detrimental outcomes of problems by reacting to weak signals that the process or system is about to fail. However, the care providers are continually juggling balancing targets versus the effectiveness of care, lack of resources, poor communication and reporting, ineffective IT and decision-support system, misalignment of strategy, and leadership issues. The misalignment and complexities of the healthcare system can undermine the healthcare workers' effort to promote their patients' well-being and provide high-quality care (Petula 2005). In the word of Golden and Martin (2004, pg. 42) – “ the goodwill afforded the system by these caring professionals has eroded as good people are asked to do heroic things in organisations and systems that often are misaligned, and therefore not supportive”.

In summary, Systems Theory has the capability to improve the reliability of healthcare processes as it allows healthcare workers to visualise the entire system and recognise the interrelationship between systems components to address the pressing issues of preventable harm and errors (Petula 2005; Anderson, 2016; Sutcliffe, 2011; Babyar, 2020; Kumar et al., 2020). The researcher’s HRO theoretical model is also influenced by systems theory. The researcher argued that understanding the interrelationship between organisational features that promote high reliability practices can help healthcare transition towards HRO. The sensemaking and systems theoretical perspectives provide the foundation of this study and upon which the findings of the study will be reviewed.

This doctoral research aims– “*to develop a HRO theoretical model to understand the concept of the HRO as it applied within the context of the Welsh NHS setting*”. As identified from the literature review process, there is no clearly defined HRO model that explains how an organisation can transition towards HRO; it forces the researcher to start making sense of the existing HRO literature and retrospectively identifies the key organisational features that can explain how organisation achieve high reliability. The existing literature influences the researcher in the field, which has no definite answer to developing HRO theoretical model. The research needs to synthesise the literature to develop the HRO theoretical model based on certain presumptions and test those presumptions embedded in the HRO model (i.e. 11 hypotheses) by conducting an empirical study within the Welsh NHS setting. The HRO model is inspired by Systems theory as it goes beyond individual focus to understand how the six organisational features of HRO can enable healthcare to be HRO. The researcher will test her presumption by gathering viewpoints about the proposed HRO model from clinicians and managers in the Welsh healthcare setting and conducting quantitative analysis to test if the presumptions hold or require further actions and refining the model. The unit of analysis chosen for this study is the organisation, which aligns with the Systems theory perspective.

As part of the theory building process, the researcher has developed the conceptual model by first bracketing and labelling the key constructs (i.e. organisational features that affect high reliability practices in the healthcare setting; linked to RQ1 & RQ2) in the form of an HRO theoretical model. The directionality and relationship between the organisational features are influenced by the researcher’s sensemaking of the existing HRO literature and understanding of how these features can enhance high reliability practices in the healthcare setting.

Apart from the direct relevance of sensemaking and systems theory to the process of conducting Doctoral study and testing the HRO theoretical model, both theories also helps in explaining the results (as part of theory testing process) derived from the empirical phase of the study to explain the Welsh NHS context, understanding of the term HRO by the clinicians and managers working in the healthcare setting, capturing the opinion and viewpoints of each respondent of the survey based on their experience of tackling uncertain situations in their ward/department/ hospital or health board. The respondents' viewpoint will help test the proposed HRO theoretical model and how the organisational features interact to support high reliability practices in the healthcare setting.

3.10 Chapter Conclusions

This chapter has presented the key focal literature concerning the organizational management of safety and has identified many gaps in the literature. Most notably, there is a lack of understanding of how employees define and understand the concept of the high reliability organization and what it means to them. Such a gap is an important area of academic study to understand. More sophisticated safety models and improvement models cannot hope to embed unless such an awareness and understanding is present because, without such an understanding, learning cannot occur to enhance reliability, resilience and performance will not improve. Such an understanding is important if the HRO model is to be transferred to the context of healthcare and from other service contexts that are safety-critical and more like healthcare provision than manufacturing. The context of healthcare is an extreme operations management operating model. Unlike most manufacturing or service typologies, it can contain all the variants of the service operation models from low volume and high variety to high volume and low variety of patients, diagnoses, tests, scans, and specialities. As such, without a guiding mass of former research in this area, a theory building approach is needed to explore the actual understanding of employees and whether they see the utility in a HRO approach to safer healthcare. The current OM models of understanding tend to focus on lean, quality improvement and certain safety models which have often been emulated and copied from other sectors or contexts that are far removed from the vagaries of health care and the safety-critical nature of the practice of care. The HRO theoretical model was designed following the narrative literature review process. This model is the basis of testing Welsh NHS employee’s understanding of HRO and how the organisational features that enable high reliability practices interact with each other. The researcher has chosen the sensemaking and systems theories to frame and address the aim of the study.

The next chapter will present and defend the research philosophy, approach, strategy and methodology undertaken to answer the guiding research questions of this study.

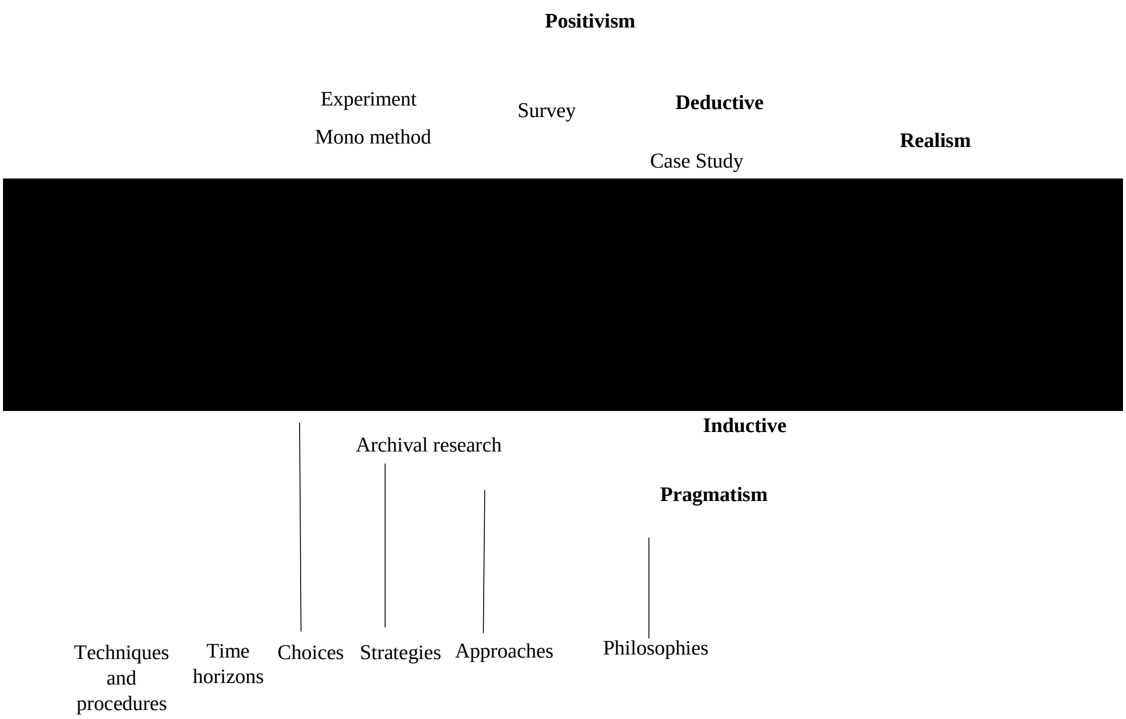
Chapter 4 Research Design

4.1 Introduction

An understanding of the philosophy that underpins effective academic research is important when determining the most appropriate research approach, strategy and methods. A limited understanding of the philosophical approaches to the design of management research can seriously impact on the quality of management research and the outcomes that the study generates (Easterby-Smith et al., 2012). It is without doubt that different and less-than-ideal data collection methods that are adopted to answer the key research questions will lead to some outcome but the outcome of the research will be questioned if a researcher had not carefully thought through the philosophical aspect that affects the study. Every research project, theory building or theory testing, is influenced by philosophical choices, a formalised research approach, the research strategy, and data collection methods (Bryman and Bell, 2015; Saunders et al., 2016). Guba and Lincoln (1994:105) contend, *"Questions of method is secondary to questions of paradigm"*. A paradigm is associated with assumptions, rules, and perceptions that people have about the world and how it influences the nature of knowledge generated when following those assumptions (Collis and Hussey, 2009; Gummesson, 2000). In this manner, it is important to be clear which philosophical paradigm is being used and the research traditions associated with that paradigm.

The word 'paradigm' is often used interchangeably with 'philosophy' and is an explanation of a basic set of beliefs about the world that is held by the researcher. Thus, this chapter will first reflect on the philosophies and approaches to research design before discussing the methodological choices used for this study. The author will adopt the Saunders et al. (2016) "research onion" framework (Figure 4.1) to navigate and explain the research design adopted for this study and use it to justify the choices undertaken at each level of research onion.

Figure 4.1: Research Design



(Source: Saunders et al., 2016)

Any research design requires clarity regarding the purpose of the study to help develop focused research aims and research questions. The purpose of a research study can be descriptive (discover), exploratory (understand), or explanatory (develop causality) (Yin, 2018; Marshall and Rossman, 1999). Descriptive research is focused on reporting and recording elements of events, situations, or person, and thereby attempts to answer 'what', 'who', and 'where' questions (Meredith et al., 1989). E*xploratory research* focuses on 'what' questions but goes into more detail than a descriptive study to pursue a new insight and ask more detailed levels of description concerning the subject of interest. The *explanatory research* goes beyond 'what' question to focus on 'how' and 'why' questions to understand causal links between variables of the research study (Saunders et al., 2016; Yin, 2018).

This doctoral **research aims** '*to understand the concept of High Reliability Organisations (HRO) as it applied within the context of Welsh National Health Services (NHS) setting'*. The determined output of this research is to develop a practical model that encapsulates the organisational features enabling high reliability practices within the NHS setting. Researchers have argued that every organisation needs to identify and understand the characteristics and behaviours of the highly reliable organisation to improve its reliability and safety performance (Weick and Sutcliffe, 2007; Martin et al., 2015). To understand those characteristics and behaviours that enable organisations to become highly reliable, the big research question posed by this *explanatory research study* is ***"How do organisations support or inhibit high reliability healthcare processes?".*** To answer the 'big question', the following set of sub-questions are proposed:

RQ1: What are the perceived organisational features that enable higher reliability in the healthcare context?

RQ2: How the perceived organisational features interact with each other to enable higher reliability in the healthcare context?

The first research question is a 'what' question that is aligned with the exploratory research to understand the organisational features that can enable the organisation to adhere to principles of high reliability (RQ1). However, the focus of this research is to go beyond 'what' question to explain 'how' the perceived organisational features interact with each other to enable high reliability practices in the healthcare setting (RQ2). This is aligned with the big research question which also focuses on answering 'how' in addition to 'what', thereby resulting in adopting *explanatory* research design (Marshall and Rossman, 1999; Yin, 2018). The next section will discuss the choice of research philosophy that will enable to address the two research questions of this study.

4.2 Research Philosophy

It is imperative for researchers in the social sciences (and other fields of study) must initially understand the relevance of research philosophy and how it influences the design and data collection methods. The term research philosophy refers to the development of valid knowledge in answering the questions related to the phenomenon under investigation (Saunders et al., 2016). The selection of an appropriate research paradigm implies reflection by the researcher on the important assumptions about the way they "see the world" and view the relationship between knowledge and the process by which knowledge is created and developed. To understand research philosophy, one needs to first understand researcher's assumptions about the ontology (nature of reality) before enquiring about the reality in the best possible way (epistemology), and the extent to which researcher's values influences the research process or axiology (Guba and Lincoln, 1994; Creswell, 2014).

Ontology refers to assumptions held by the researcher on how the world operates, i.e. the nature of reality (Saunders et al., 2016; Easterby-Smith et al., 2012). It varies between two extremes of a continuum of *objectivism* and *subjectivism* (Collis and Hussey, 2009). An *Objective ontology* refers to the existence of social entities independent of the viewpoints or assumptions held by a social actor (and derives from the field of natural sciences). The approach implies that there is a universal truth that is unaffected by contextual factors or dependant/biased by the researchers' viewpoint. *Subjectivism* is closely associated with how the social actor perceives reality and interpret it. The approach is derived from the social sciences. Here, the subjectivist researcher attaches their own meanings to the research phenomenon they are investigating and the way they think they should interpret the phenomenon under investigation. For a subjectivist ontology, social actors will construct reality (Saunders et al., 2016). The subjectivist researcher's role is to interpret the differences in understanding of social actors when they perceive different situations in varying ways and draw diverse viewpoints from those events.

Ontological assumptions have an influence on researcher's ***epistemological assumptions.*** Epistemological assumptions concern with an acceptable approach to knowledge generation and the relationship between researcher and what is being researched (Easterby-Smith et al., 2012; Collis and Hussey, 2009). Epistemology is concerned with how to collect acceptable knowledge in the traditions of a discipline and how a researcher can communicate that knowledge to others (Bryman and Bell, 2015). The researcher can communicate the knowledge objectively by remaining independent of the subject being researched (Objectivist), or they can immerse themselves with those being studied to socially construct the knowledge as is the case for the subjectivist (Mason, 2002; Easterby-Smith et al., 2013).

The ontological and epistemological choices of researchers influence their association with those being researched, i.e. whether they conduct research in a value-free way objectivist or value-laden subjectivist way. The choice of these positions determines another branch of philosophy called *axiology* (Saunders et al., 2016). **Axiology** refers to how the feelings and personal beliefs of the researcher are affecting the outcome of the study and thereby questioning the credibility and generalisability of the research findings (Bryman and Bell, 2015). In the natural science field, researchers are expected to be value-free and objectives in their research to minimise biases in the result. On the contrary, in the social science field, such assumptions are less convincing as the focus is more on understanding people perceptions and how they interpret the reality of their social world (Collis and Hussey, 2009).

The researcher's decisions concerning ontology, epistemology, and axiology will determine the suitability of these approaches when designing their research. There are many underlying philosophies described in the management research ranging from post-positivist, to positivist, critical realism, pragmatism, and interpretivism. In this section, the author will discuss the two most popular philosophies adopted in operations management research, i.e. positivism and interpretivism (Lindsay, 2016). These two philosophies can be considered as two ends of a philosophical continuum with critical realism and pragmatism positioned in between these two philosophies.

4.2.1 Positivism versus Interpretivism Philosophy

Researchers adopting a **positivist philosophy** believe that reality is external, objective, and exists independent of social actors (Saunders et al., 2016; Easterby-Smith et al., 2013). The researcher’s belief, views, and personality must not influence or interfere with the result or outcome of the study. The positivist philosophy demand researcher objectivity (ontological stance of objectivism). The positivist researcher will collect observable phenomena to provide credible data and facts to understand what constitutes the reality (i.e. epistemological stance of being independent to that being researched) (Saunders et al., 2016; Bryman and Bell, 2015; Collis and Hussey, 2009). Here research rigour is established through precision and objectivity by replacing the intuitive hunches of the researcher (Meredith et al., 1989; Collis and Hussey, 2009).

Positivist researchers start with an understanding of the background of the theoretical problem and the studies linked to the theoretical problem, that has been previously undertaken. The approach helps the researcher identify the main variables affecting the theoretical problem and understand how they relate to one another (Easterby-Smith et al., 2013). Positivist researchers, therefore, employ methods including experiments and surveys to uncover the truths, facts, and relationships between variables by analysing large samples of data drawn from distinct populations. The use of quantitative methods for analysing large datasets with established statistical methods adds to the claims and confidence claim that the results drawn from the selected samples can be generalised to a wider population or other settings (Easterby-Smith et al., 2013).

On the contrary, the **interpretivism philosophy** opposes the positivist philosophy, which means that ontological, epistemological and axiological assumptions will be opposite to those followed by positivist researchers. Interpretivist researchers follow a subjective ontology, believing that there are multiple realities and the understanding of reality is subjective and socially constructed by participants involved in the Study (Easterby-Smith et al., 2013; Saunders et al., 2016). Their epistemological stance is that the researcher is part of what is observed or researched. Unlike positivist philosophy, here, the researcher is not divorced from the research process. Burrell and Morgan (1982, pg.28), define the interpretivist paradigm as "*informed by a concern to understand the world as it is, to understand the fundamental nature of the social world at the level of subjective experience. It seeks explanation within the realm of individual consciousness and subjectivity, within the frame of reference of the participant as opposed to the observer of action.*" Based on the definition, the axiology of this philosophy is value-laden and biased due to the outcome being influenced by the interaction between the subject of the study and the researcher conducting the study (Saunders et al., 2016).

In the interpretivist philosophy, the goal is to understand the significance people attach to social reality and their motivations and intentions in showcasing those behaviours (Saunders et al., 2016). Interpretivist research provides an in-depth understanding of the phenomena under investigation, and the researcher uses a sense-making perspective to move between data and theory to interpret the socially constructed reality (Easterby- Smith et al., 2013). The qualitative methods employed to conduct interpretivist research includes interviews, observation, ethnography studies, to name a few methods that are preferred choices under this philosophy (Collis and Hussey, 2009; Crotty, 2015). The sample size is smaller in comparison to positivist philosophy, and the qualitative method employed for analysis is to make sense of different perspectives in the selected sample. The focus is not on generalising the result to the population but contextualising it to the setting being researched.

The differences between the two philosophies are summarised in table 4.1. After reviewing the philosophies, the author mapped both philosophies against the research questions set at the outset of this study.

Factors to compare two philosophies	Positivist	Interpretivist
Ontology	Objective; Reality is external and objective.	Subjective; Reality is multiple, subjective and socially constructed by observers in a study
Epistemology	Researcher is independent from that being researched	Researcher is part of what is observed or researched
Axiology	Value-free and unbiased as researcher does not influence the outcome	Value-laden and biased due to outcome being influenced by the interaction between the subject of the study and the researcher conducting the study
Research goal	Discover and explain the structure of reality	Understand the significations people attach to social reality, and their motivations and intentions
Nature of Research Problem	Examination of the facts	Development of an inside understanding of a phenomenon
Origin of the research problem	Identification of theoretical inadequacies for explaining or predicting reality	Immersion in the phenomenon studied
Research position	Prescriptive, causal, deductive, theory testing	Descriptive, Inductive, theory building
Starting points	Formulation of explicit hypothesis	Meaning/ research questions
Associated methods	Experiments, survey, simulation	Interviews, observations, ethnography
Sample size	Large	Very Small
Analysis / Interpretation	Verification /falsification	Sense-making

Type of data analysis	Statistical/ quantitative methods to test for cause-effect relations	Non-statistical / qualitative methods; cause-effect relationship is not a focus
Outcomes	Causality	Understanding
Generalisability	Generalise results to population	Generalise results to settings
Judgement of research quality	External validity and reliability are critical	Credibility, transferability, dependability, and confirmability

Table 4.1: Comparison of Positivist and Interpretivist Philosophies (Adapted from Saunders et al., 2016; Collis and Hussey, 2009; Easterby-Smith et al., 2013)

The author is interested in understanding the organisational features that enable healthcare organisations to achieve high reliability and how those organisational features interact with each other and impact the safety culture in the NHS setting. The **two research questions can be best answered** by **embracing positivist philosophy** which will enable the author to quantitatively test the cause-effect relationships between organisational features affecting reliability. Here the author will be relying on the secondary data, i.e. literature and other secondary sources, to develop the hypotheses for testing the relationship between variables involved in this healthcare study. The author takes the role of an independent researcher to make detached interpretations of factors enabling high reliability in the healthcare setting by collecting data in a value-free manner (Saunders et al., 2016; Easterby- Smith et al., 2013).

4.3 Research Approaches: Deductive versus Inductive

The choice of research philosophy influences the researcher’s choice of research approach they take to answer their research questions. The research approaches can vary from deductive to inductive, or a mix of both (i.e. Abductive) depending upon the type of research questions posed and researcher’s philosophical stance for the Study (Denzin and Lincoln, 2000; Ghauri and Grønhaug, 2002). The purpose of any research study is to either build theory, extend theory, or test theory. The deductive research aligns with positivist philosophy, where the researcher delves into literature and theory to develop and test hypotheses. Whereas, the inductive researcher relies on data to generate theory because of their data analysis (Saunders et al., 2016).

The **deductive approach** is a dominant research approach in the natural sciences where the established laws in the field form the basis for developing the hypotheses, anticipating and predicting their occurrences in the sample data collected and thereby accept or falsify the hypotheses (Collis and Hussey, 2009; Ghauri and Grønhaug, 2002). The hypotheses of the study are derived from general principles and existing theories in the established field of research. In the deductive approach, the researcher is independent of what is being observed, but they have capabilities to designs controls to allow the testing of hypotheses, as often happens in the experimentation process. The research follows a structured approach to enhance the chances of a replication study in other settings (Gill and Johnson, 2002) and thereby improving the generalisability of the findings to a larger population (Easterby- Smith et al., 2013).

On the contrary, **inductive research** involves researcher's immersing themselves into the subject of the investigation to collect data, gather information, develop interpretations and thereafter formulate a theory based on their interpretation of the data (Saunders et al., 2016). With the emergence of the field of social sciences in the 20^{th} century, researchers started questioning the deductive approach that emphasises on developing causal links between variables without understanding how humans interpret their social world. The inductive researchers would avoid adhering to rigid methodologies that inhibits capturing alternative explanations to the phenomenon being studied (Creswell, 2008).

The inductive research process relies mostly on qualitative methods such as interviews, observations, grounded theory, that takes longer time and effort predominantly to collect data and conduct qualitative analysis to develop a meaningful interpretation of the data (Collis and Hussey, 2009; Ghauri and Grønhaug, 2002). The inductive researcher takes a flexible approach to data collection that will allow them to capture beliefs, behaviours, and practices of the subject. The researcher is part of the research process to develop theory from the data collected. The major differences between the two approaches are discussed in table 3.2. Combining both inductive and deductive approaches, termed as an abductive approach, is becoming popular in social sciences research (Creswell and Clark, 2007). The use of mixed approaches to research is preferred over a single approach as it adds more reliability and validity to the research process and it addresses the limitations inherent in any of the mono-method used for conducting research (Creswell and Clark, 2007; Collis and Hussey, 2003; Denzin and Lincoln, 2000).

Criteria	Deductive	Inductive
Predominant Field of Study	Natural Sciences	Social Sciences
Researcher Role	Independent	Part of the research process to have close understanding of the research context
Starting point	Theory	Data
Direction of travel	Theory > Hypothesis > Observations > Confirmation/falsification	Observation > Pattern > Tentative hypothesis > Theory
Outcomes	Establish Cause-Effect relationship	In-depth understanding of phenomena under investigation
Method	Quantitative	Qualitative
Approach	A highly Structured / rigid approach	Flexible structure to accommodate any changes required as research progresses
Generalisability	Collect large sample to generalise conclusion	Not focused on generalisability

Table 4.2: Comparing Deductive and Inductive Research Approaches

(Adapted from Saunders et al., 2016; Easterby-Smith et al., 2013)

In this research study, the researcher has embraced positivist philosophy to unravel the two research questions. The deductive approach to research is aligned with the positivist philosophy. Hence, the author has chosen a deductive research approach to test the relationship between different variables in the theoretical model developed for this study in Chapter 3. The HRO model for healthcare proposed in Chapter 3 establishes a range of hypotheses to test the relationship between the variables (leadership, communication, trust, training, feedback, and safety culture) and how they interact with each other. The aim and the research questions established for this study aligns with the deductive approach criteria discussed in table 4.2. The next section of the chapter focuses on the research strategy adopted by the study to test the inter-relationship between different variables of the theoretical model.

4.4 Research Strategy

The research strategy is a systematic way of defining the approach taken by the researcher to collect and analyse the data to answer their specific research questions (Bryman and Bell, 2015). The choice of the research strategy is governed by multiple factors including the research questions posed in the study, the understanding and the theoretical development of the knowledge domain, the amount of time and resources required to conduct the research and your own philosophical underpinning (Saunders et al., 2016). In section 4.1, the three different types of research were discussed-descriptive, exploratory, and explanatory. All three research types can be conducted following a deductive or inductive approach (Yin, 2018; Saunders et al., 2016). Similarly, all three types of research can be conducted using a range of qualitative or quantitative research strategies available for conducting management research including experiments, survey, case studies, action research, ethnography, and archival research (Bryman and Bell, 2015; Saunders et al., 2016; Easterby-Smith et al., 2013). Each of the research strategies can adopt qualitative or quantitative or mixed method approaches to answer the research questions. The key differences between qualitative and quantitative research strategies are presented in table 4.3.

Process of Research	Qualitative	Quantitative
Focus	Understand & interpret	Describe, explain, and predict
Primary theoretical orientation	Inductive; generation of theory	Deductive; testing of theory
Role of Literature	Minor role; justify problem	Major role to justify problem; identify

		questions and hypothesis
Researcher Involvement	High- researchers is participant & catalyst	Limited; controlled to prevent bias
Sample Size; design	Small; Non-probability/ purposive	Large; Probability
Data Type	Verbal or pictorial description; non-numerical data	Mainly numerical data
Data Analysis	Descriptive analysis by interpretation of data	Statistical techniques
Data Validation	Rely on the participants, the researcher , or the reader	Rely on external standards such as judges, past research, statistics
Output	Knowledge constructed	Knowledge discovered
Generalisation	Analytical	Statistical
Research question seeks	Patterns of unanticipated as well as expected relationship	A relationship between a small number of variables

Table 4.3: Key differences between Qualitative and Quantitative research

(Adapted from Creswell and Clark, 2007:29; Cooper and Schindler, 2006:199; Bryman and Bell, 2015:27; Kumar, 2010)

In this research, a quantitative research strategy involving a survey is applied as the two research questions (RQ1 and RQ2) emphasises understanding the causal links between the organisational features that can only be achieved by conducting quantitative statistical analysis. Both the exploratory (RQ1) and explanatory (RQ2) questions will require some statistical analysis test to answer the big research question or address the aim of the study.

When research strategies are further cascaded to the next level, the author decided to choose a survey research strategy over other strategies available in conducting operations management and healthcare research. The reason for selecting survey strategy is influenced by the research questions posed for this study and the choices made when selecting philosophy (positivist), approach (deductive), and research strategy (quantitative). More details of the survey strategy are provided in the section below.

4.4.1 Survey

Survey research is mostly associated with a deductive approach and positivist philosophical stance (Saunders et al., 2016). It is a common research strategy used in business and management research in general (Saunders et al., 2016) and one of the most preferred strategies in the operations management field for the last three decades (Flynn et al., 1990; Voss, 1995; Forza, 2002; Rungtusanatham et al., 2003). Bryman and Bell (2015, pg. 54) define survey research as: *"cross-sectional design in relation to which data are collected predominantly by questionnaire or structured interview on more than one case (usually quite a lot more than one) and at a single point in time in order to collect a body of quantitative or quantifiable data in connection with two or more variables (usually more than two), which are then examined to detect patterns of association."* Another reason that makes the survey a popular strategy is in its ability to capture a large amount of data, in a short period, in a highly economical way (Bryman and Bell, 2015).

The strategy has helped in advancing the field of operations management by greatly contributing to the understating of unstructured organisational problems and establishing the causality between OM theoretical constructs and organisational performance (Flynn et al., 1997; Schroeder and Flynn, 2001; Caniato et al., 2017). Survey research can be conducted by designing and administering a questionnaire for efficient distribution to a broader population using face-to-face, telephone, postal, or online methods (Easterby-Smith et al., 2013; Floyd and Fowler, 2013; Saunders *et al*., 2016).

The research field of HRO is predominantly represented by conceptual, theoretical and case studies literature (Cantu et al., 2020; Babyar, 2020; Tolk et al., 2015). Empirical research to test interdependence between factors creating the high reliability culture in the healthcare setting is limited and an acknowledged gap in the literature (Gaba et al., 2003; Hudson, 2003; Katz-Navon et al., 2005; Pronovost et al., 2006;

Vogus and Sutcliffe, 2007; Norden-Hagg et al., 2010; Riley et al., 2010; Singer et al., 2010; Vogus et al., 2010; Freeth et al., 2012; Goldenhar et al., 2013; Singer and Vogus, 2013). The researcher found many issues with the state of current knowledge for HRO organisations. Most of the articles in the field use survey methodology to test an HRO culture, and these were insightful but lacked suggestions on the interventions required to achieve high reliability, or studies lacked recommendations for clinicians and professional managers. The researcher believed that, given these shortcomings and the intent to theory build, it was imperative that a survey was conducted to understand the relationship between HRO related themes and how they impact the safety culture of the healthcare professions. Such research would significantly impact clinicians and managers in healthcare settings and build theory beyond the current preoccupation with air transportation, nuclear facilities, and other safety-critical operating contexts.

4.4.1.1 Types of Survey research

The three types of research (section 3.1) apply when conducting survey research to generate theory, to test theory, or to refine an existing theory (Forza, 2002). The *exploratory survey* study is focused on developing preliminary insight into a topic that has not been widely researched and/or identify new possibilities and dimensions of interest. It may help in determining the concepts that represent underlying latent variables to measure the subject under investigation (Malhotra and Grover, 1998). The *descriptive survey* research, as the name suggests, presents the descriptive statistics to understand the subject of investigation, thereby helping in ascertaining facts about the subject. The method is mostly used for theory building and refinement (Malhotra and Grover, 1998; Forza, 2002). The last category of *explanatory survey* is used for theory testing, where the proposed hypotheses and relationship between the theoretical constructs in a framework or model is statistically tested to ascertain causality between the theoretical constructs. The explanatory study is conducted when there exists pre-defined concepts, propositions, and models for the subject under investigation so that relevant literature could be used to generate hypotheses for establishing causal links between constructs (Saunders et al., 2016; Forza, 2002). The differences and similarities between the three types of survey research are presented in table 3.4.

Survey Type Element/Dimensions	Exploratory	Descriptive	Explanatory
Unit (s) of analysis	Clearly defined	Clearly defined	Clearly defined
Respondents	Representative of the unit of analysis	Representative of the unit of analysis	Representative of the unit of analysis
Research Hypothesis	Not necessary	Questions clearly stated	Hypotheses theoretically derived from focal literature and clearly stated
Representativeness of the sample	Not a criterion as attempt is to develop understanding of a topic	Sampling method can range from systematic, to purposive or random selection	Sampling method can range from systematic, to purposive or random selection
Sample size	Sufficient to include the range of the interest phenomena	Sufficient to represent the population and conduct statistical analysis	Sufficient to test categories in the theoretical framework with statistical power

Table 4.4: Comparing the three types of survey research

(Adapted from Forza, 2002)

In this doctoral study, *explanatory survey research* was determined to be the most appropriate strategy and was conducted to test the causal links between the theoretical constructs of the HRO model (discussed in Chapter 3). The choice of the *explanatory survey* is aligned with the type of research questions posed for this study. More details of questionnaire development and pilot testing, sampling strategy, and unit of analysis are provided in the sections that follow. The choice of the survey over other research strategies such as case study, ethnography study, and action research has been briefly explained in the introduction to the survey (section 4.4.1). Given the focus of this study on establishing causality between the constructs of the theoretical model choosing a case study methodology, ethnography or action research approach would not have yielded the desired result. The researcher wanted to capture the response and viewpoints of clinicians and managers working in the Welsh healthcare setting on HRO themes and how they interact with each other, the survey seems the most appropriate research strategy to statistically test the HRO theoretical model based on the response from a wider population. Moreover, due to the time constraint of healthcare workers, the author, and ethics approval process involved in using other research strategies, favoured the choice of the survey over other strategies.

4.4.2 Data Collection method

The most popular data collection method used for survey research strategy is a questionnaire (Caniato et al., 2018; Saunders et al., 2016; Forza, 2002). A survey can be administered using various methods, including in-person, online, and postal method. However, before discussing different methods of administering the survey, it is first important to discuss the development of survey instrument, i.e. questionnaire, followed by focusing on pilot testing, administration of survey, sampling strategy, unit of analysis, quality criteria and ethical considerations when conducting survey research. The next sub-section will provide information on the questionnaire development process to administer the survey.

4.4.2.1 Sample Frame and Unit of Analysis

One of the important criteria to define at the outset of the survey research is the sample which will be responding to the survey and the unit of analysis used (Forza, 2002). Understanding the sample composition (who will participate in the research study) is imperative as their response will define the outcome and validity of the survey (Fowler, 2002; Floyd and Fowler, 2013). As discussed in table 4.4, conducting explanatory survey research encompasses a range of sampling strategies available to choose from – random sampling, stratified sampling, or purposive sampling based on convenience. The choice of sampling strategy is dependent on a range of factors including time available for the researcher, cost constraints, turnaround time, response rate, avoiding biases in the data collection process, to name a few factors affecting sampling strategy (Forza, 2002; Floyd and Fowler, 2013; Saunders et al., 2016).

Conducting research in the healthcare setting is challenging as it requires a lengthy process of ethical approval by the researcher's University and the NHS Board involved in the survey that may take up too few months for the approval process. Moreover, access to respondents could be further challenging due to work pressure and time constraints faced by the employees in an already resource-constrained environment of NHS Wales (Welsh NHS Confederation, 2016). The details of the ethics approval process and sample organisations approached to participate in the study is provided in section 4.4.4.

The focus of this doctoral study was the seven Welsh Health Boards and their respective hospitals (secondary care) - Aneurin Bevan Health Board; Swansea Bay University Health Board; Cardiff & Vale University Health Board; Hywel Dda Health Board; Cwm Taf Morgannwg Health Board; Betsi Cadwaladr University Health Board; and Powys Teaching Health Board. Apart from the seven Health Boards, Velindre NHS Trust was also approached who provided specialist services in cancer care and a range of national support services in Wales. The researcher approached the research and development (R&D) departments of seven Health Boards and one NHS Trust to negotiate access to hospitals in each Health Board/ Trust for distribution of survey instrument. Access was only granted at the three Health Boards (Aneurin Bevan Health Board, Cardiff & Vale University Health Board, Cwm Taf Morgannwg Health Board) and Velindre NHS Trust. The R&D team agreed to distribute the questionnaire through their intra-newsletter and other communication media. In the cover letter and the information sheet shared with each Health Board/Trust explained who the target respondent for this research is. Any clinicians or managers that directly interact with patients were eligible to participate in this study.

The sampling strategy used in this research has two variants. At the first level, the purposive sampling strategy was used as the focus was only on Welsh NHS, including the seven Health Boards and one NHS Trust. These healthcare organisations were equivalent to any others operating in Wales or other parts of the UK. This helps in addressing the issue of non-response bias as the selected Health Boards are representative of other NHS Boards and Trusts in Wales and the rest of the UK. It is accepted in the literature that slow-responder (those who responds after the reminder is sent) is considered as representative of those who have not responded to the survey and can be used to conduct non-response bias test. More information about non-response bias test is provided in Chapter 5.

At the second level, a random sampling strategy was adopted (though not by choice) as the R&D team in the Health Boards/Trust agreed to circulate the questionnaire via their intranet to clinicians and managers responsible for enhancing patient safety. The responses received from each Health Board depends upon who reads the newsletter and who has time to fill the questionnaire.

The appropriate *'unit of analysis'* is influenced by the type of research questions and the choice of research strategy. The understanding of the 'unit of analysis' is fundamental and conducted before the design and launch of the survey instrument (Forza, 2002; Malhotra and Grover, 1998; Floyd and Fowler, 2013). Design decisions include whether the questionnaire is going to focus on the supply chain or network, organisation, department, individual? Answering this question is important as it will affect the questionnaire design and content (Floyd and Fowler, 2013). As this doctoral research is interested in understanding the organisational features that facilitate or inhibits high reliability practices in the healthcare setting, the focus is on understanding organisational practices through responses from individuals working for a hospital or Health Board/Trust is a valuable source of insight. The survey instrument was targeted at Executive/Medical Director, Consultants, AHP/ Nurses, Medical Doctor, Specialist, Clinical Governance Manager, Patient Safety Officer, Manager, and any other individual directly interacting with patients. Most of the items included in the questionnaire focused on 'organisational level' information and thus the 'organisation' was determined to be the unit of analysis for this study. Choosing the 'organisation' as a unit of analysis is further supported by safety researchers such as Charles Perrow (1984) and Charles Vincent (2010, 2014) who also suggested to study the organisation level rather than use the individual as a unit of analysis upon which to base insights into the safety of an organisational system.

4.4.2.2 Questionnaire Design, Development, and Operationalisation

In this section, the researcher will discuss the choice of the most effective method for administering the survey and thereafter discuss the details of the questionnaire design and its development. A survey can be conducted using a range of methods including postal, drop-off, and online survey and interviews either face to face or through telephone interaction (Floyd and Fowler, 2013; Fowler, 2002; Saunders et al., 2016). The key characteristics and issues faced when adopting any form of data collection method are summarised in table 4.5 below. For this study, the researcher decided to use an online questionnaire to distribute the survey to appropriate clinicians and managers in the Welsh NHS setting. The reasons for choosing this form of data collection approach is many folds: it is low cost; quick turnaround compared to postal or telephonic or interview; gives access to wider population; gives time to respondents to fill the answer in their spare time. As the R & D team was going to distribute the questionnaire through the intranet, an online questionnaire with a survey link will be the quickest way to embed the link in the newsletter and get it distributed across 1000s of employees in three health boards and one NHS Trust.

Issues	**Questionnaire**			**Interview**	
	Post	*Drop-off*	*Online*	*Personal*	*Phone*
Are Visual Presentations Possible?	Yes	Yes	Yes	Yes	No
Are Long Response Categories Possible?	Yes	Yes	Yes	???	No
Is Privacy A Feature?	Yes	No	No	Yes	???
Is the Method Flexible?	No	No	No	Yes	Yes
Are Open-ended Questions Feasible?	L*	No	L*	Yes	Yes
Can You Judge Quality of Response?	No	???	No	Yes	???
Are High Response Rates Likely?	No	Yes	No	Yes	No
Can You Explain Study in Person?	No	Yes	No	Yes	No
Is It Low Cost?	Yes	No	Yes	No	No
Are Staff & Facilities Needs Low?	Yes	No	Yes	No	No
Does It Give Access to Dispersed Samples?	Yes	No	Yes	No	No
Does Respondent Have Time to Formulate Answers?	Yes	L*	Yes	L*	L*

Is A Long Survey Feasible?	Yes	No	L*	Yes	No
Is There Quick Turnaround?	Yes	No	Yes	No	Yes

**L= Limited*

Table 4.5: Data collection methods for survey research

(Adapted from Kumar et al., 2010)

The traditional literature review, when combined with "backward snowballing" methods helped to identify the relevant concepts from the literature, including the frameworks and models in the field of HRO and patient safety. The synthesis of literature allowed to develop the HRO theoretical model, which included the following organisational features or the latent variables that enable high reliability in the healthcare setting:

- **Mindful Leader** - is one of the core concepts and most identified themes for achieving high reliability or enhancing patient safety in the healthcare setting (Clarke et al., 2007; McFadden et al., 2009; Squires et al., 2010; Vogus et al., 2010; Sutcliffe, 2011; Singer and Vogus, 2013). The engaged leaders in the healthcare setting, which include both clinicians and managers holding management position, drives the culture by designing strategy and the building structure that guide safety processes and outcomes (Yates et al., 2005; Chassin and Loeb, 2013; Moller, 2013; Singer and Vogus, 2013). There is no one answer on how to make the leader stronger and engaging. Still, they need to be educated on the science of patient safety, quality improvement methodologies and providing visible support and infrastructure for managing and improving patient safety outcomes (Blake et al., 2006; McFadden et al., 2009; Moller, 2013).
- **Communication** - is an integral part of improving patient safety in the healthcare environment (Blake et al., 2006; Cox et al., 2006; Lekka, 2011). Different forms of communication play a major role in setting the safety environment. Assertive languages such as "I need clarity" (Weinstock, 2007) and structured languages could play a critical role in communicating in healthcare. Frankel et al. (2003) and Leonard et al. (2004) suggest the implementation of briefing before every procedure can go a long way in the

process of safety. A debriefing happens again at the end to consider the review process. Creating an environment where all forms of communication are welcomed and encouraged from all hierarchy (Hopkins, 2007; Carson-Stevens et al., 2016).

- **Trust** - Trust in the healthcare setting among employees is necessary to achieve patient safety objectives, openly discuss safety issues, deal with problematic situations at work, and work with a cross-functional team (Cox et al., 2006; Chassin and Loeb, 2013). It also helps in improving accountability and greater self-reporting of error and near misses (LaPorte, 1996; Roberts and Rosseau, 1989). Trust can only be built up by improvement in top-down and bottom-up communication (Cox et al., 2006).
- **Training** - at all levels is critical in the healthcare profession to enhance the safety standards and keep the clinical and managerial team abreast of the latest knowledge in the field (Hales and Chakravorty, 2016; McKeon et al., 2006; Wilson et al., 2005). Training in patient safety or quality improvement initiatives can help healthcare workers to improve efficiency and effectiveness of service delivery and minimising errors (White et al., 2012; Frankel et al., 2008; McKeon et al., 2006).
- **Reporting** - The culture of fear-free reporting at all levels of organisational hierarchy and getting constructive feedback creates a blame-free culture (Chassin and Loeb, 2013; Jones et al., 2010; McKeon et al., 2006; Pronovost et al., 2006; Hobgood et al., 2004). The open reporting of errors will help in promoting learning cultures, thereby promoting root-cause analysis to investigate medical errors and near misses (Apold et al.,2006; Hobgood et al., 2004). Giving feedback for building trust and openness are important properties of patient safety (Frankel et al., 2003; Van Rite, 2009).
- **Safety Culture** - is considered an indicator of high reliability in the healthcare setting (Babyar, 2020). Safety culture is built on trustworthiness, where candid reporting of errors and mistakes are promoted for learning purposes to avoid such mistakes in the future (Weick and Sutcliffe, 2007; Singer et al., 2007; Singer and Vogus, 2013; Vogus and Sutcliffe, 2007 a, b). Personal accountability for safety and empowering staff to abandon work on safety

grounds are vital features of safety culture (Weick and Sutcliffe, 2007; Singer and Vogus, 2013).

The literature clearly showed a void in the understanding of the interrelationship between all the organisational features that support high reliability in the healthcare setting. No previous HRO study has brought the six organisational features together to create a holistic approach to HRO and to test the causal links between the factors that have been cited as enabling high reliability in the extant literature (see table 3.3 and table 3.4). Synthesising the literature (see section 3.8) allowed the items used to measure each organisational HRO feature to be established. The factors and their respective items are reported in table 4.6. The 42-item scale formed the central part of the survey study and was included in *section 2 of the survey instrument*.

All the survey items were linked to current practices that may or may not be present in their department of work or organisation and respondents were asked to rate those items on a Likert scale of 1-5, where *1- Never practised; 2- rarely practised; 3- Sometimes practised; 4- often practised; and 5- practised all the time*. The Likert Scale of '1-5' is a commonly used rating scale in the operations management (Forza, 2002; Caniato et al., 2018) or healthcare research (Norden-Hagg et al., 2010).

One of the criticisms of 5 point Likert Scale method is that it allows respondents to go for neutral or mid-option responses if they are not sure about the item or how to score it (Forza, 2002; Floyd and Fowler, 2013; Saunders et al., 2016). To avoid respondents choosing the rating scale 3 or the neutral score, it was decided to have the five-point Likert scale without any neutral option. The option 3 in the adopted Likert scale states that the practice is adopted *'sometimes'* in the department/organisation.

The first section of the survey instrument included demographic questions on the respondent *'role in the organisation (clinical or managerial)'*; their 'gender', *'age group'*, and *'work experience' in the current hospital or the unit.* Given the focus of section 2 was on high reliability and patient safety, it was important that respondents were directly involved in interacting or contacting the patient. A question was asked if the *respondent role involved direct interaction with the patient* (YES/NO options were given for this question). Respondents were also asked to *define the terminology 'Highly Reliable Organisation'*. It will help the author to capture different definitions or perception of respondents about the term 'HRO'. The three keywords used in HRO are self-explanatory, and thus the intention was to provide a new definition of HRO based on combining the responses from respondents who have heard the terminology or have not heard the terminology. The last two questions of the section asked the respondent to rate the current performance of their organisation and the department they work in on a Likert Scale of 1-5, with 1 being ‘very poor’, 2- poor, 3- average, 4- good, and 5 -very good. This ends the first section of the survey instrument.

Latent Variables	Items measuring the latent variables	Reference list
Leader (7)	**Lead1:** Clinicians/Managers in leadership positions, at all levels of the organisation, have a shared vision for patient safety **; Lead2:** Clinicians/Managers in leadership positions, at all levels of the organisation, align policies and activities to support patient safety; **Lead3:** Clinicians/Managers in leadership positions participate in the quality improvement activities; **Lead4:** Clinicians/Managers in leadership positions promote quality improvement activities; **Lead5**: Clinicians / Managers in leadership positions promote discussion about patient safety concerns; **Lead6:** Clinicians / Managers in leadership positions have visible and consistent involvement in patient safety activities; **Lead7:** Clinicians / Managers in leadership positions make it easy for employees to voice concerns linked to adverse events	Clarke et al., 2007; McFadden et al., 2009; Squires et al., 2010; Vogus et al., 2010; Singer and Vogus, 2013; Yates et al., 2005; Moller, 2013; Blake et al., 2006; McFadden et al., 2009; Sutcliffe, 2011
Trust (7)	**Trust1**: Trust amongst all employees is necessary for effective safety improvement ; **Trust2**: Trust amongst employees helps to deal with problematic situation at work ; **Trust3**: Involvement of teams in the process improvement will lead to increased trust and commitment to achieve patient safety objectives ; **Trust4**: Trust between employees is enhanced by improvement in top-down and bottom-up open communication; **Trust5**: Trust between employees is enhanced due to open discussion of safety issues; **Trust6:** Trust amongst employees leads to improved accountability; **Trust7**: Trust amongst employees leads to greater self-reporting of error and near misses	Cox et al., 2006; LaPorte, 1996; Roberts and Rosseau, 1989
Communication (5)	**Com1:** Individual encouraged to freely speak their views; **Com2**: The use of easy to understand structured communication so all team members can participate in safety management practices ;	Blake et al., 2006; Weinstock, 2007; Frankel

	Com3: Good communication flow exists up and down the chain of command ; **Com4**: Co-workers feel comfortable giving individual feedback to each other ; **Com5**: The team feel comfortable communicating their viewpoints periodically with senior management.	et.al., 2003; Leonard et al., 2004
Training (6)	**Train1**: Training and simulation are used improve the practical skills of staff ; **Train2**: Practicing for emergency situations helps the team to cope with such events when they happen ; **Train3**: Multidisciplinary team training provided for working more effectively; **Train4**: Multidisciplinary team training provided for working more efficiently; **Train5**: Regular investment in knowledge and skills development of employees; **Train6**: Resource Management training provided to help in better decision making behaviour	McKeon et al., 2006; Wilson et al., 2005; White et al., 2011
Reporting (7)	**Report 1:** Team reports mistakes and near misses for mistake-proofing; **Report2**: Staff are informed about errors that have happened; **Report3**: Transparency in reporting enables greater improvement of patient safety ; **Report4**: Staff are given feedback about changes enacted as a result of event/error reporting ; **Report5**: Staff discuss ways to prevent errors from happening ; **Report6**: Safety reporting measured to track failure frequency**; Report7**: Staff at lower hierarchical levels of clinical competence are encouraged to report errors.	Jones et al., 2010; Hobgood et al., 2004; Apold et al.,2006; Frankel et al.,2003; Van Rite, 2009
Safety Culture (10)	**SC1:** Safety culture supported by enhancing Trust among employees; **SC2:** Open reporting of incidents among team members for SC; **SC3:** Improving clinical practices to support SC; **SC4:** Reliability of processes is maintained by formally assessing SC; **SC5:** Prompt actions due to SC audit supports effective reliability; **SC6**: Staff comfortably reports unsafe practice to enhance patient safety; **SC7**: Staff can question higher authority for unsafe practices**; SC8:** Formal briefings used to reduce errors in the complex process; **SC9**:Checklists are used to formally	Goldenhar et al., 2013; Chassin and Loeb, 2013; Weick and Sutcliffe, 2007; Singer and Vogus, 2013

	assess whether a process can be undertaken safely; **SC10**: Frontline staff have high levels of empowered accountability for enhancing patient safety	

Table 4.6: Items measuring the organisational features in the HRO model

A new section 3 concerning the theme of 'working context' was added in the survey instrument after receiving feedback and comments from the experts participating in the pilot study (please see next sub-section 4.4.2.3). The experts suggested having YES and NO types question that managed to capture the working context of hospitals in NHS Wales. Section 3 of the questionnaire included items that captured the working context of NHS Wales in terms of how the respondents perceive about *managing their department, managing patient, managing resources, safer care environment, and learning from the failure*. All the 25 items included in the section was developed by reviewing literature linked to the NHS in general and NHS Wales (see Chapter 2). Out of 25 items under five categories, three items were dropped (one from managing patient and two from a safer care environment) after receiving feedback from the experts in the pilot study. The final 22 items included in section 3 is discussed below.

The '*Managing department'* category included four items to get the respondents' perspective about their departmental working practices – *staff turnover, work pressure, standardised processes, and handovers managed systematically*. There were six items linked to *managing patient* category, including *volume and variety of patients seen each week, sharing and managing information about the patient, complaints from patient, and clearly defined patient safety strategy*. The '*Managing resource'* category included three items focused on *the right number and right skills of employees and they receive on-going training for improving quality of care*. The category of a '*safer care environment'* included seven items linked to *reporting incidents, avoiding errors and mistakes, ease of detecting errors, reassuring investigation process, reporting safety performance, and good safety culture*. The two items under the '*learning'* category focused on *staff learning from mistakes and staff learn best practices from other organisations*.

The last section of the instrument asked for the respondent's contact details if they were interested in receiving the executive summary of the survey findings. The survey instrument is included in Appendix I.

4.4.2.3 Pilot Study

The pilot study was conducted between 18th May till 8th June 2018 to test the survey instrument. In the pilot phase, sixteen academics and practitioners from Welsh Universities and Welsh NHS were approached who had prior experience of conducting Patient Safety research. They gave their consent to participate in the pilot study and agreed to feedback on the online questionnaire developed to further improve the survey instrument. After receiving the consent, an email with the survey link was sent to 16 experts involved in patient safety research or practice. Only eight of the sixteen participants responded to the pilot questionnaire. Three responses were from academics (from two Welsh Universities), and the remaining five were managers or clinicians in the NHS Wales. All eight respondents provided constructive feedback and suggestions on how to improve the questionnaire design and content.

The bulk of the feedback received was linked to the layout and visual presentation of the questionnaire. There were no comments from any of the eight respondents regarding the demographic questions in section 1 of the questionnaire. When reviewing section 2 of the questionnaire, which included all items linked to HRO themes, three respondents commented on refining the wording of the Likert Scale used and provide an introductory statement to the section. Two respondents explicitly suggested having an introductory statement that asked the respondent to answer based on the current practices in their workplace and not the ideal state. Seven out of eight respondents also suggested having sub-sections in Section 2 as it feels too long to respond to items in that section. Having a smaller sub-section can help respondents to be engaged and focused on their response.

For the first few items at the start of Section 2, three respondents suggested that the focus should be on clinical leaders and managerial leaders. Accordingly, changes were made in seven items of the Leadership variable. Other changes were conducted because of feedback from the experts and these included rewording two items of the *'Reporting'* section and three items of *'Safety Culture'* section. There were a few comments linked to minimising grammatical errors. Proof-reading of the questionnaire was done to minimise the grammatical errors as a result.

Six out of eight respondents commented that the specific Welsh context needed to be introduced in the questionnaire, which will help to understand the working practices of the hospitals in Wales. This was a very valid point made by the experts and led the author to conduct a review of secondary documents to understand the NHS Welsh context and some issues faced by different Health Boards in Wales (see Chapter 2). Based on the expert's comments and review of NHS Wales documents, section 3 in the survey instrument was introduced that had 25 items linked to the working context. The new section was reviewed by six out of eight experts, and they were happy with the YES/NO types of questions linked to the working context of NHS Wales. The experts suggested dropping three items from the list of working practices, as discussed in the last sub-section.

Six out of eight respondents suggested the redesign of the online questionnaire using Survey Monkey software as that was an accepted method for conducting online surveys in NHS Wales. The respondents stated that any outside email might get blocked or considered as SPAM if the NHS server categorises the sender email as untrusted. In order to avoid such a situation, the author was suggested to contact the R & D team in each NHS Board in Wales and get the online survey link circulated to the wider population through them (after the ethics approval and service evaluation process was completed). Information about ethics approval and how ethical best practice has been followed in conducting this research is discussed in section 4.4.4.

The researcher also got feedback about the HRO theoretical model and the survey instrument from the academics attending the Production and Operations Management Conference in May 2017 (Texas, USA) and Quality Management conference (QMOD) in August 2018 (Cardiff University, UK). The researcher presented the theoretical model to more than 30 healthcare academics from across the Europe in the QMOD conference and received excellent feedback about the theoretical model developed for the main study. The researcher got feedback on the 11 hypotheses within the HRO model from QMOD attendees with some further advise on how to strengthen the causal relationship between orgnisational features in the HRO model.

4.4.3 Quality criteria consideration for survey research

To ensure the research study was an accurate representation of reality, it was imperative to measure the reliability and validity of the instrument used and the findings reported. For any research study, reliability and validity tests are conducted to check the robustness of measurement instruments and confidently claim that the yielded result is accurate and believable (Saunders et al., 2016; Easterby- Smith et al., 2013). The research design process followed by establishing the performance of the methodology using four quality criteria, namely content/internal validity, construct validity, external/criterion validity, and reliability – see table 4.7 (Miles and Huberman, 1994; Meredith, 1998; Voss et al., 2002; Easterby- Smith et al., 2013; Saunders et al., 2016; Yin, 2018).

The literature review conducted helped in the development of the survey instrument and ensure through the pilot study that the instrument has been calibrated such that respondents can understand the meaning of the concepts employed and answer in an effective manner (i.e. addressing *content validity* issue). The research instrument was administered in a systematic manner and the literature review was used to derive the areas of questioning. The pilot testing with professionals also ensured that the questionnaire instrument was effective when it was deployed to the clinicians and managers employed in the region of Wales.

Quality Criteria	Definition	How are the criteria addressed in this research?
Content/Internal Validity	The extent to which the items included in the summated scale is a fair representation of the concept the test seeks to measure	- Developing items and concept based on a literature review - Conduct a pilot study and refine the items based on the feedback received from experts
Construct Validity	The extent to which the measurement items in the scale measures the same construct and is used actually to test the theory or hypothesis what it sets out to measure.	- Unidimensionality test using exploratory factor analysis to validate the items truly representing the construct - Confirmatory factor analysis test to check for the convergence between measures of the same construct (convergent validity) and separation between measures of different constructs (discriminant validity).

External/Criterion Validity	The extent to which the scale representing latent variables are related to measures of the dependent variable	- Structured Equation modelling result shows the model fit
Reliability	The extent to which the results can be reproduced when the research is repeated under the same conditions.	- Cronbach's alpha values for each latent variable has value above the threshold of 0.7 - Adapting validated instruments from literature

Table 4.7: Summary of quality criteria in the survey research

(*Adapted from: Forza, 2002; Malhotra and Grover, 1998; Easterby- Smith et al., 2013; Saunders et al., 2016*)

The *construct validity* test (Chapter 5) ensured the scale measured the construct or latent variable it was intended to measure. Exploratory and confirmatory factor analysis were conducted (Chapter 5) to check for the unidimensionality, convergent validity and discriminant validity. The *criterion related validity* is tested through the Structured Equation Modelling (SEM) test that helps to validate and test the theoretical model. The model-fit indices generated from SEM analysis established the causal links between latent variables and the robustness of the validated HRO framework. The research design conforms to the good practice of social science research which deals with the study of professional practice and interpretation of an organisational phenomenon, i.e. HRO model, through the perceptions of managers and clinicians. The means of generalisation of this study are based on the prediction that similar results will be attained from similar professionals working in clinical and managerial roles in the UK and NHS (not for profit) healthcare processes.

The *reliability test* was also conducted (presented in Chapter 5) and tested the internal consistency of the instrument. The reliability of the scale item is estimated by Cronbach's α- value of 0.7 or higher (Cronbach, 1951; Nunnally and Bernstein, 1994) to confidently state that the scale items are dependable, consistent, and explains the majority of the variation in the construct. The quality criteria and two additional measures of quality, i.e. contribution to theory and practice, are revisited in Chapter 7 to comment on how the research has addressed all the quality criteria to make a valid contribution to the HRO body of knowledge.

4.4.4 Ethical consideration

Ethics in research is the system or code of morals that are designed and followed during the research process (Karlsson, 2016). Ethics for researchers refer to the communication a researcher has during the research journey and the rules and risk involved with it. Researchers are expected to follow the rules and regulations which lead to a result and with social responsibility (Saunders et al., 2016; Easterby- Smith et al., 2013). Ethics, in the context of the survey, refer to demonstrating and following appropriate behaviour by the researcher (to ensure the rights of the subject under investigation or the respondents) are explicitly stated, clearly defined, and the subject is not affected by it (Saunders et al., 2016). The researcher attained ethical approval from Swansea University before conducting any field research. The major considerations will now be outlined.

The research has to be carried with honesty in all scientific communications, with the set objective to achieve, having the integrity of the commitments done, confidentiality promised, carefulness of any error or negligence, non-discrimination on the basis of age, sex or race, knowing the legality and the rules to follow and also have social responsibility to do no harm during the research process (Kalsson,2016). The main ethical issues that are considered before taking any research forward are (Adapted from Bryman & Bell, 2015) : -

1. To check with the requirements of doing the research in any institute
2. To check that there is no prospect of harm to any participants
3. The participants are informed clearly what the research is about, their nature of involvement in the research, the time involved of the participants, their rights to withdraw from the research at any time and what will the done with the data (information's asked) taken from them.
4. The privacy is followed as promised
5. The confidentiality would be followed
6. The data is compiled in accordance to the data-protection legislations
7. Once the research is finished the obligation of submitting report or synopsis to the organisations promised are done.

This research has been conducted in accordance with the Swansea University Ethics Code of Practice. In the first stage of the approval process, a “light touch” Ethical approval was taken to conduct the pilot study. The approval allowed the researcher to contact the participants for the pilot study of the questionnaire. Participation in the study was entirely voluntary, and participants could withdraw from the study at any time without giving a reason. Participants could also ask questions at any time and discuss any concerns with the researcher or the supervisor. Participants could request information and feedback about the purpose and results of the study. All this information were provided in the cover sheet of the survey instrument.

The results from the pilot study were reflected upon and were then used to conduct the main study with seven Health Boards and one NHS Trusts in Wales. For the main study, full Ethical approval from Swansea University was taken that allowed the author to contact different Health Boards of Wales. After the University Ethics approval, the researcher got in touch with the Research and Development department of the different Health Boards in Wales.

The study was determined to be a service evaluation by the Health boards and did not require to go through the NHS full ethical process. The Health Boards were promised that the information provided would be held anonymously so that it will not be possible to trace information or comments back to individual contributors. Information will be stored in accordance with the current Data Protection Act. The study was determined to be a service review because it did not include actual patients.

The participants were all employed by the NHS or are third Party employee working for the NHS and directly involved in the interaction with the patient. The privacy and anonymity of all participants and the Health Board were maintained throughout the research and in any other publications related to the study. Four Health Boards eventually declined to participate or did not respond to the email asking for participation in the study. Only three Health Boards and one NHS Trust agreed to participate in the study (see table 4.8). The process of getting the approval was different in all four Health Boards/Trust and sometimes the instruction was not very clear to follow. The author struggled to get the right people involved and the right forms to fill, which took considerable time to get approval. Some of the approvals obtained took much longer than anticipated because of either the internal changes happening in the Health Boards, no standard procedures were in place or unavailability of people who deal with the request of ethics approval. Once the approval was obtained, the Research and Development departments helped in collecting the data from different Health Boards. Table 4.8 below shows the timescale associated with applying and getting ethical approval from the Health Boards. All the work was done in accordance with the university code of practice and data has been handled in accordance to the data protection act. The letter of approval granted by the University, Health Boards and Trust are held in Appendix II.

Institute	**Date Applied**	**Date Received**	**Approval No.**
Swansea University (Light Touch Ethical form for Pilot Study)	19-04-2018	19-04-2018	Copy of the approval attached
Swansea University (Full Ethical Form for the main study)	16-07-2018	13-08-2018	Copy of the approval attached
Cwm Taf Morgannwg University Health Board R&D Department.	26-11-2018	25-10-2019	CT/1072/19
Velindre Cancer Centre	26-11-2018	10-04-2019	1920MISC0021
Aneurin Bevan University Health Board	26-11-2018	04-02-2019	SA 953/19
Cardiff &Vale University Health Board	28-02-2019	01-07-2019	Copy of the approval attached

Table 4.8: Service Evaluation and Ethics approval process

4.4.5 Limitations

Any research study design involves decisions and trade-offs, and this study is no exception. The researcher, therefore, acknowledges that the study is subject to the limitations of:

- It is limited to the region of Wales in the United Kingdom

- It is conducted in time period of resource scarcity

- The methods collect perceptions of staff rather than a longitudinal account of perceptions and how they change over time

- The Study has been subject to the time constraints of a doctoral study and the finite financial and travel resources that are implied by a doctoral study.

4.4.7 Summary

This chapter has presented, outlined and defended the main design considerations when undertaking this study. The chapter has shown how the approach to the study has been founded in a research ontology and epistemology, which supports the use of a questionnaire-based methodology used for theory building in an under-researched area of organisational practice. The intention of the study is to inform professional practice and to create a model that better understands the concept of the HRO within the context of safety-critical healthcare process management.

Chapter 5 Survey Findings

5.1 Introduction to Chapter

This chapter presents the survey findings from 259 respondents (from NHS Wales hospitals). The chapter is structured to first present the demographic details of the survey instrument, including types of respondent based on Gender, Role, Age, Year of experience, and Engagement with patients, were presented. The chapter will then present the views of the respondents. The respondents were asked to define HRO and comment on the working practices within their organisation or department that support such an approach to managing safely. In this stage of the research, the hypothesized theoretical model (proposed in Chapter 3) was tested using SPSS 25.0 and AMOS 25 software. Structured Equation Modelling (SEM) was conducted to analyse the data and to test the causal links between the organisational features of HRO including how they impact the Safety Culture practice in NHS Wales. The SEM analysis was used to identify the “best fit” model to explain the relationship between the six organisational features included within the HRO model.

5.2 Demographic Details

In the valid sample of 259 respondents (see table 5.1) the top five categories of employee that the responded to the instrument were: AHP/Nurse (75), Consultant (51), Manager (30), Patient Safety Officer (27), and Medical Doctor (25). Given the focus of the study is to understand what constitutes HRO practices and how the tenets of HRO interact and affect the safety culture in a healthcare setting. The representative samples of clinicians and managers that form the respondent population was considered an important feature of this study because it allows the similarities and differences in the viewpoints of the two groups to be captured with respect to HRO tenets and applied working practices. The data also shows that different professionals in clinical positions have also responded to the survey with Nurses dominating the response rate (28.8%) followed by clinical Consultants (19.6%). The respondents in other categories that contributed to the study included employees from the administration, pharmacy or other support functions. These support functions directly or indirectly affect the treatment of patients and provide services to allow 'patient facing' staff to be effective.

Role in organisation	Frequency	Percent
Executive/Director	9	3.5
Specialist	11	4.2
Clinical Governance Manager	12	4.6
Medical Doctor	25	9.6
Patient Safety Officer	27	10.4
Manager	30	11.5
Consultant	51	19.6
AHP/Nurse	75	28.8
Others	19	7.3
Total	**259**	**100.0**

Table 5.1: Role of respondents in the organisation

A re-coding of the "Role of the respondent" was conducted to create two groups of informants based on their clinical or managerial role types. The 'clinical' group included Specialists, Medical Doctors, Consultants, and AHP/Nurse were clustered together. The second group classified as 'managerial' included respondents who had managerial responsibility (they may be clinical background but currently in the Role of management or manager). The latter included the job roles of Executive/Director, Clinical Governance Manager, Patient Safety Officer, Manager, and Others. A cross-tabulation was conducted using the 'gender' of the respondents, see table 5.2, under two categories- managerial and clinical. 37.5% of the respondents belong to the 'managerial' category, and 62.5% belong to 'clinical' category.

A chi-square test was conducted to check the degree of association between 'gender' and 'role'. The p-value (0.591) is greater than the threshold value of 0.05, which means there is no association between gender and roles, i.e. the two categories linked to the Role was not affected by the gender of the respondent. The result assures the researcher that there is less bias in this study.

Managerial-Clinical * Gender Cross-tabulation					
Count		**Gender**		**Total**	**Pearson Chi-Square**
		Male	Female		
Managerial-Clinical	Managerial	41	56	**97 (37.5%)**	**0.591** *(Asymptotic Significance (2-sided)*
	Clinical	63	99	**162 (62.5%)**	
Total		**104**	**155**	259	

Table 5.2: Reclassification of Role of respondents by Gender

In terms of gender, more than 55% of the respondents are female (155, 59.8%), and 40.2% are male respondents (104). Gender, as a control variable, was used to compare the differences in perceptions of male and female respondents on the application of HRO principles in the healthcare setting. Two other control variables were included in the analysis of the data and these were the age of respondents and years of experience of the individual (working in a particular hospital) when the survey was conducted.

More than 77% of the respondents belong to age group of either 35-44 years or higher categories (see table 5.3). In terms of work experience, 75% (the majority of the respondents) have less than 10 years of experience in their current hospital setting. Approximately 49% of the respondents have less than 5 years of work experience in their current job. These two time periods were sufficient experience for the respondents to be familiar with the implemented and essential systems at their place of employment.

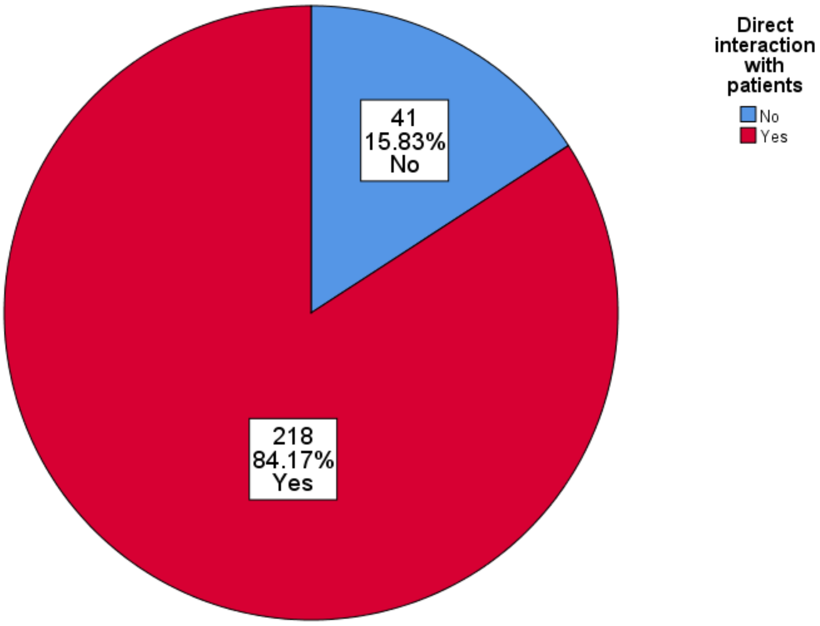
Gender * Age group Cross-tabulation							
Count							
		Age group					**Total**
		18-24	**25-34**	**35-44**	**45-54**	**55-64**	
Gender	Male	1	15	33	38	17	**104**
	Female	8	33	45	47	22	**155**
Total		**9**	**48**	**78**	**85**	**39**	**259**

Gender * How long worked in this hospital Cross-tabulation								
Count								
		How long worked in this hospital						**Total**
		< 1	**1-5**	**6-10**	**11-15**	**16-20**	**21+**	
Gender	Male	17	37	38	7	2	3	**104**
	Female	19	56	29	18	16	17	**155**
Total		**36**	**93**	**67**	**25**	**18**	**20**	**259**

Table 5.3: Gender, Age Group, and years of experience data

Most of the respondents were also found to directly interact with patients (218, 84.2%) as figure 5.1 demonstrates. The respondents - who said they did not interact with patients - mostly belong to governance teams, support service management, or work in administrative teams. The higher percentage of respondents interacting with patients adds more validity to the results as many items in the questionnaire are linked to practices within wards or hospitals that directly or indirectly impact safety culture. The bias is, therefore, in favour of greater insight from frontline staff or those at the ‘sharp end’ of care.

Figure 5.1: Respondents interacting with patients



These general demographic figures provide confidence that the population of respondents provide the greatest insight into operational practices and systems. The next section of this chapter will present the views of the respondents.

5.3 Definition and rating for Highly Reliable Organisation

An open-ended question was asked to capture the respondents understanding of the term “HRO”. Respondents were asked to define High Reliability Organisations as they understood it. Many of the respondents provided a short description of HRO which showed their interpretation of the concept. The researcher used ‘content analysis’ to explore and analyse the freely used text to define HRO, and to draw out different themes that could be identified based on the definitions provided by the respondents. A few common themes, highlighted in the definitions, concerned the concepts of zero errors/accidents/patient harm, safety culture, high quality care, better processes/system/practices, patient-centric culture, and committed staff, to name the main themes.

The ‘wordle’ proprietary software was used to refine the responses of the qualitative perceptions and comments of respondents. The software provides a summary of how the respondents perceive HRO (see figure 5.2). Given the fact that the majority of the respondents were in direct contact/touch with patients (see figure 5.1), it is unsurprising that the majority of the themes emerging from the content analysis of HRO definitions reflected patient-related measures such as no accidents, zero harm, safety, high quality of care.

Figure 5.2: Understanding of term 'HRO' by respondents

A similar 'wordle' exercise was created (figure 5.3) for the two control variables – gender (male and female), and the Role held by the individual in the organisation (clinical and managerial). The wordle for gender showed less variation in the keywords used by male and female respondents when defining HRO. The keywords that were frequently used in the definition by male and female respondents were 'harm', 'care', 'zero', 'staff', 'safe' and 'safety'. Males used the keyword 'processes' more often than females in defining HRO, whereas female usage of keyword was biased towards outcomes and 'accidents' in defining HRO which is an interesting finding that distinguishes the two subgroups. There was variation in the usage of keywords 'processes', 'accidents', and 'safety' when comparing the definitions of clinical and managerial respondents. Clinical staff used the keyword 'accidents' more often than managerial staff, whereas the usage of keywords 'processes' and 'safety' were more prominent in managerial staff definitions of HRO. Such a finding may be attributed to the nature of the managerial Role- focused more on improving processes and safety including an indirect relationship with the patient. Clinical staff may assume safety as part of their role, but they do not emphasize that word when defining HRO.

Figure 5.3: ‘HRO’ Wordle based on gender and role in the organisation

There were two groups of respondents that defined HRO - one group who had heard about HRO and understood the terminology and another group that had not heard about HRO but have attempted to interpret the meaning based on the three keywords of highly, reliable, and organization. A selection of quotes from the two groups was presented below. The quotes from both groups imply that the majority of the respondents have interpreted the concept correctly when compared with the literature and this definition aligns closely with the actual definition of HRO provided in the literature (Weick and Sutcliffe, 2007). The overall perception of the respondents about HRO was it, as a system and collection of practices, leads to no harm, zero accidents or errors, creation of patient-centric culture where staff are empowered to deliver services that meet patient expectations. Some of the respondents also identified HRO as a means of creating a continuous improvement culture. The belief is that this form of HRO improvement shares many common features with the Total Quality movement and the promotion of empowerment, open feedback, good communication that is all required to deliver high quality of care in the healthcare setting.

It was equally important to identify respondents who don't understand the term HRO and whether their limited understanding impacted on how they have responded to the questionnaire. From the quotes below, it clearly implies that those who have not heard the keyword 'HRO' also interpreted it in a similar way as those who understood the terminology. This evidence further adds to the reliability and validity of results that are discussed in the next few sections of this chapter.

Definition Samples: Respondents who have heard the term 'HRO'

"Zero deaths, incidents, near misses. Perfect safety over a long time."

"A trusting, efficient, knowledgeable and fully skilled organisation"

"Delivering prudent health care, reducing waste harm and variation"

"Making our daily work tailored to the patient demographics and also possessing the skills needed to carry out the work to a high standard"

"An organisation that avoids catastrophe despite being at high risk of adverse events"

"Consistent in its dealings, provides the best available care/ service within current knowledge, an accountable and open organisation that deals sympathetically and comprehensively with failures in service."

"An organisation able to deliver the best care, consistently to service users with all team members taking some ownership for providing an excellent service"

"An organisation that consistently performs to the highest standards of patient care and fiscal responsibility, while always striving for continuous improvement"

"Organisation has a high level of accountability; Management tier is seamless enabling adverse situations to be managed effectively; Organisation is built on the ethos of proactive management opposed to reactive management of situations"

Definition Samples: Respondents not heard 'HRO' but interpreted it correctly

"I haven't heard of the term but assume it would be about ensuring reliability to the highest levels, in an organisation. This would also suggest that they may be more efficient and that others may have a higher level of trust in that organisation"

"I am unfamiliar with this term - I speculate it means an organisation which ensures that its staff are trained appropriately that the results and standard of care are consistent and of a high standard"

"Only slightly familiar with the term in regard to it being an organisation that manages their known risks successfully"

"I have never heard this term. I would expect it to mean an organisation run efficiently and effectively with good expected outcomes from its processes"

"It's not a term I'd previously heard but in terms of healthcare I imagine that it's an establishment with excellent quality patient focused care, underpinned by governance and procedures with an aim to treat patients as per recommended National Guidelines"

"I can't say that I have ever heard of this term. I assume it means that the organisation will be consistent and dependable in terms of how members of staff within each team are managed, how the team as a whole functions etc. Also, that patients will be treated with equity and fairness, by ensuring that the organisation has robust, evidence-based care pathways"

A text analyser tool (https://www.online-utility.org/) was then employed to identify the most frequently cited words by respondents in their definition of HRO. The most cited keywords in the definition provided by respondents were: *zero, safety, staff, patient, care, open, organisation, best, quality, consistent, accountable, high, and improvement*.

Using the most cited keywords, **the researcher attempt to define the term 'HRO'**: *" An open and learning organisation that consistently performs to the highest standards of patient care, has a high level of accountability, deals sympathetically and comprehensively with failures, while always striving for continuous improvement to achieve the goal of patient safety over a long time with close to zero deaths, or errors."*

The reflection on the researcher's definition and how it compares with the existing definition in the literature and how it aligns with the theoretical underpinning of this study will be presented in Chapter 6.

After defining HRO, the respondents were asked to rate their employing organisation or departmental performance from an HRO perspective. The rating was based on a 1-5 Likert scale, where a score of 1 stands for 'very poor' performance to score of 5 meaning 'very good' performance. The descriptive statistics (mean and standard deviation values) of respondents are shown in table 5.4 and this result offers two inferences. Firstly, the respondents have rated their department performance higher than their organisation's performance (a proximity effect through closeness to the operating practices employed). The average score for department performance, as perceived by respondents, is close to 4 (i.e. good performance). The perceptions of respondents of the organisation performance level are close to 3 (i.e. average performance). The value of standard deviation (close to 0.9 for organisation and 0.8 for department responses) indicate reasonable variation in the respondent's perception about how their department or organisation is performing.

Descriptive Statistics					
	N	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
HRO performance in Organisation	259	1	5	3.33	.889
HRO performance in Department	259	1	5	3.86	.808

Table 5.4: HRO rating across organisation and department

A crosstab analysis was conducted to identify if the demographic of gender has any impact on how HRO performance was reported across the department and organisation. The results from crosstab, presented in table 5.5 and the chi-square test (table 5.6) shows an association between gender and performance reported for their department (p-value < 0.05, see table 5.6).

Crosstab								
Gender			HRO performance in Organisation					Total
			Very Poor	Poor	Average	Good	Very Good	
	Male	Count	0	18	37	39	10	104
		%	0.0%	17.3%	35.6%	37.5%	9.6%	100.0%
	Female	Count	5	20	66	54	10	155
		%	3.2%	12.9%	42.6%	34.8%	6.5%	100.0%
Total		Count	5	38	103	93	20	259
		%	1.9%	14.7%	39.8%	35.9%	7.7%	100.0%

Crosstab								
Gender			HRO performance in Department					Total
			Very Poor	Poor	Average	Good	Very Good	
	Male	Count	0	2	16	61	25	104
		% within Gender	0.0%	1.9%	15.4%	58.7%	24.0%	100.0%
	Female	Count	3	6	46	73	27	155
		% within Gender	1.9%	3.9%	29.7%	47.1%	17.4%	100.0%
Total		Count	3	8	62	134	52	259
		% within Gender	1.2%	3.1%	23.9%	51.7%	20.1%	100.0%

Table 5.5: Gender vs HRO performance reported across organisation and department

Male and female respondents do not differ significantly in the rating of their organisation (p-value >0.05, see table 5.6) but do differ in their perception about the performance of their department. 82% of the male respondents feel their performance in the department is either good or very good compared to only 64% of the female respondents (see table 5.5).

Chi-Square Test: Organisation				**Chi-Square Test: Department**		
	Value	df	Asymptotic Sig. (2-sided)	Value	df	Asymptotic Sig. (2-sided)
Pearson Chi-Square	5.875	4	**.209**	11.054	4	**.026**
Likelihood Ratio	7.635	4	.106	12.440	4	.014
Linear-by-Linear Association	.963	1	.326	8.944	1	.003
N of Valid Cases	259			259		

Table 5.6: Chi-Square Test between Gender and HRO performance

5.4 Understanding Working Context within NHS

The next section of the questionnaire was designed to understand the working context of the NHS in terms of how the respondents perceive their department to be managed, managing patient, managing resources, safer care environment, and learning from the failure. Twenty-two binary YES/NO type statements were included in the section and respondents were asked to comment YES or NO if they agree or disagree with the statement. This section was deliberately designed so that it was not directly linked to the relationships previously established that describe the HRO tenets. The section was designed to help understand the level of confidence or trust the respondents have in their ward/department when delivering care to the patients. The respondents rated their perception for the 22 statements and a Chi-Square test was conducted to statistically determine the perception of the respondents for each statement.

The researcher then tested for gender differences to test to see if Male and Female respondents perceive a statement in the same way or have a difference in opinion between them. A Chi-Square test was designed to help test perception differences with respect to control variables such as Gender and Role in the organisation (Clinical and Managerial). For example, the working context 1 statement is ‘My department has a lot of staff turnover’.

H0 (Null Hypothesis): Male and Female groups agree that the department has more staff turnover

H1 (Alternate Hypothesis): Male and Female groups differ in their perception about more staff turnover in their department

If the p-value generated by Chi-Square test is less than 0.05 (testing done at 5% significance level) then the researcher must reject the null hypothesis and accept the alternate hypothesis. Similarly, if the p-value is greater than 0.05, the null hypothesis is accepted. In the same way, all 22 statements were tested using the two control variables - Gender (Male vs Female), Role in the organisation (Clinical vs Managerial). Table 5.7 and table 5.8 present the results of the Chi-Square test for Gender and Role respectively. The results are reported in table 5.7 and are followed by the analysis which is shown in table 5.8.

Working Practices		**Male**		**Female**		**p-value**
	N	**Yes**	**No**	**Yes**	**No**	
About the Department						
1.High Staff Turnover	259	72	32	106	49	0.712
2.Workplace very pressured	259	67	37	107	48	0.569
3.Lots of Standardized procedures	259	81	23	136	19	0.097**
4.Handovers between teams are managed systematically	257	102	2	151	2	0.502
Managing Patient						
5.Have High volume of patients each week	259	58	46	87	68	0.094**
6.Have High variety of patients each week	259	45	59	104	51	0.000*
7.Patient often complain about treatment	259	21	83	56	99	0.004*

8.Staff experience lack of information of patients	259	73	31	99	56	0.056**
9.Staff spend time with patient sorting missing information	259	86	18	137	18	0.081**
10.Written strategy of Patient Safety (PS) improvements	259	102	2	152	3	0.100
Managing Resources						
11.Right amount of staff to improve PS	259	63	41	88	67	0.173
12.Right skill-mix to improve PS	259	63	41	88	67	0.329
13.Team has necessary on-going training	259	41	63	84	71	0.066**
Safer Care Environment						
14.Too many reported incidents	259	35	69	70	85	0.175
15.Staff bother to report incidents	259	71	33	86	69	0.086**
16.Our mistakes and errors are avoidable	259	83	21	128	27	0.853
17.Easy to detect error	259	50	54	60	95	0.299
18.Safety investigation procedure is reassuring	259	56	48	63	92	0.037*
19.Good Safety Culture	259	67	37	133	22	0.000*
20.Dedicated area in the workplace that measures and promote safety performances	259	104	0	155	0	0.064**
Learning						
21.Staff learn from mistakes	259	76	28	134	21	0.012*
22.Staff know to find best practices from another organisation	259	89	15	131	24	0.901

**5% significance level; **10% significance level*

Table 5.7: Chi-Square Test between Gender and Working practices

Only one item linked to *'managing department'* was found to have a gender-based perception difference between male and female respondents (at the 10% significance level test). These include statement no.3, which concerned the standardisation of processes ("Lots of Standardized procedures"). The majority of the female respondents agreed to statement 3 compared to their male counterparts. For three other statements (Statement 1, 2, and 4), the male and female respondents hold a similar and positive perception, (i.e. they agreed with the statement). The response implies that employees find the work environment very pressurised (statement 2), and there is a high turnover of staff (statement 1) with an obvious link between these two views that pressure leads to staff leaving. Both male and female groups agreed that the handover process between teams (a significant safety issue that was identified in the literature and in professional reports) are managed systematically and in a controlled manner (statement 4).

In the category of *‘managing the patient’*, there were perception differences between the two groups for five out of six statements in this category. Statement 6 (we have a high variety of patients each week) and statement 7 (patient often complain about the treatment) were statistically significant at 5% significance level, i.e. Male respondents feel that they see less variety of patients whereas female perceives that they see a high variety of patients each week. Similarly, the male group had a higher number of respondents that disagreed with the statement -patients often complain about their treatment, compared to their female counterpart and hence the group varies in their opinion (p-value <0.05). For the other three statements, 5,8 and 9, the two groups vary in their perception at 10% significance level. Both groups response was in favour of Statement 8 and 9, indicating that there is some issue in managing patient or their files as either patient complaint about their treatment or the staff spend time looking for missing patient information. Lack of management of the patient or their file can have a significant impact on the quality of care delivered to the patient. Both groups agreed to statement 11 that they have a written strategy for patient safety improvement.

For the *‘managing resources’* category, the two groups only had differences in perception for statement 13 (the team has necessary on-going training), which was significant at 10% significance level. Majority of the female perceived that they receive necessary on-going training. In contrast, the majority of male disagreed with the statement, i.e. they felt that they were not receiving sufficient on-going training at the workplace. Both groups agreed that they have the right number of staff (statement 11) with good skills-mix (statement 12) to improve patient safety. For the learning environment category, both groups agreed that they know to find the best practices from other organisations. For statement 21 (staff learn from their mistakes), the result was statistically significant in a positive way, i.e. the percentage of female agreeing to this statement was more than the percentage of males. Overall, both groups agreed more to this statement than had a disagreement for this statement.

The category, *‘safer care environment’*, included seven statements (statement 14-20). Statement 18 (Safety investigation procedure is reassuring) and statement 19 (Good Safety Culture) were significant at 5% level, whereas statement 15 (staff bother to report incidents) and statement 20 (Dedicated area in the workplace that measures and promote safety performances) was significant at 10% level. For statement 18, the majority of the female respondents disagreed with the statement, whereas the majority of male respondents agreed with the statement. It is an indication that the female group doubted the safety investigation procedure used in their work environment. For statement 19, both groups had a higher percentage of respondent agreeing to the statement that their organisation has good safety culture, though the percentage of female agreeing to this statement was higher than their male counterpart. There was a difference in perception between the two groups when it comes to reporting incidents when it occurs (statement 15). The majority of the male respondents agreed with this statement, whereas the percentage agreement from the female counterpart was on the lower side compared to the male group. For statement 20, both groups unanimously agreed with the statement, though the number of females responding YES to the statement exceeded the male group and hence significant at 10% significance level. For statements 14, 16, and 17, both groups were in consensus (i.e. the majority of them either jointly agreed or disagreed with the statement). The number of reported incidents in their organisation is on the lower side as approved by both groups (statement 14), given majority of respondents in both groups disagreed with this statement. Both groups perceived that it is not easy to detect error when it occurs in the work processes (Statement 17), which is alarming and worrying from a safer care perspective. The groups agreed that their mistakes were avoidable (statement 16), which is an encouraging and positive response for providing safer care.

Table 5.8 shows the results, based on the role of the respondent in the organisation (clinical vs managerial), of working practices in the participating NHS organisations. In the *department* category, statement 3 and 4 shows statistically significant result between the clinical and managerial groups, though the majority of respondents in both groups are in favour of the statements. Both groups agreed about the work pressure (statement 2) and high staff turnover (statement1), which may have an impact on safer care provision. All items under the *'managing patient'* category were either statistically significant at 5% level (statements 5, 8, 9, and 10) at 10% level (statement 6 and 7). Given patients encounter clinical staff more often than managerial staff, it is natural that a greater number of clinical staff would say they have to deal with the high volume of patients compared to managerial staff (statement 5). The same applies to statement 7 (patient complaining about treatment), where the majority of the clinical staff was in a denial mode compared to managerial staff. For the *'managing resources'* category, managerial staff disagreed compared to the clinical counterpart that they have a sufficient number of staffs (statement 11) and have the right skill-mix to improve patient safety (statement 12). Both groups agreed with respect to two items under the *'learning'* category (statements 21 and 22).

Working Practices		**Clinical**		**Managerial**		**p-value**
	N	**Yes**	**No**	**Yes**	**No**	
About the Department						
1.High Staff Turnover	259	106	55	72	25	0.273
2.Workplace very pressured	259	113	49	61	36	0.274
3.Lots of Standardized procedures	259	124	38	93	4	0.000*
4.Handovers between teams are managed systematically	257	160	1	93	3	0.006*
Managing Patient						
5.Have High volume of patients each week	259	90	72	55	42	0.045*
6.Have High variety of patients each week	259	96	66	53	44	0.051**
7.Patient often complain about treatment	259	43	118	33	64	0.053**
8.Staff experience lack of information of patients	259	102	60	70	27	0.001*
9.Staff spend time with patient sorting missing information	259	130	32	93	4	0.001*
10.Written strategy of Patient Safety (PS) improvements	259	157	5	97	0	0.026*

Managing Resources						
11.Right amount of staff to improve PS	259	104	58	47	50	0.013*
12.Right skill-mix to improve PS	259	104	58	47	50	0.007*
13.Team has necessary on-going training	259	75	87	50	47	0.449
Safer Care Environment						
14.Too many reported incidents	259	55	107	50	47	0.002*
15.Staff bother to report incidents	259	108	54	49	48	0.022*
16.Our mistakes and errors are avoidable	259	125	37	86	11	0.013*
17.Easy to detect error	259	68	94	42	55	0.151
18.Safety investigation procedure is reassuring	259	69	93	50	47	0.162
19.Good Safety Culture	259	125	37	75	22	0.872
20.Dedicated area in the workplace that measures and promote safety performances	259	162	0	93	4	0.047*
Learning						
21.Staff learn from mistakes	259	136	26	74	23	0.165
22.Staff know to find best practices from another organisation	259	137	25	83	14	0.292

**5% significance level; **10% significance level*

Table 5.8: Chi-Square Test between Role and Working practices

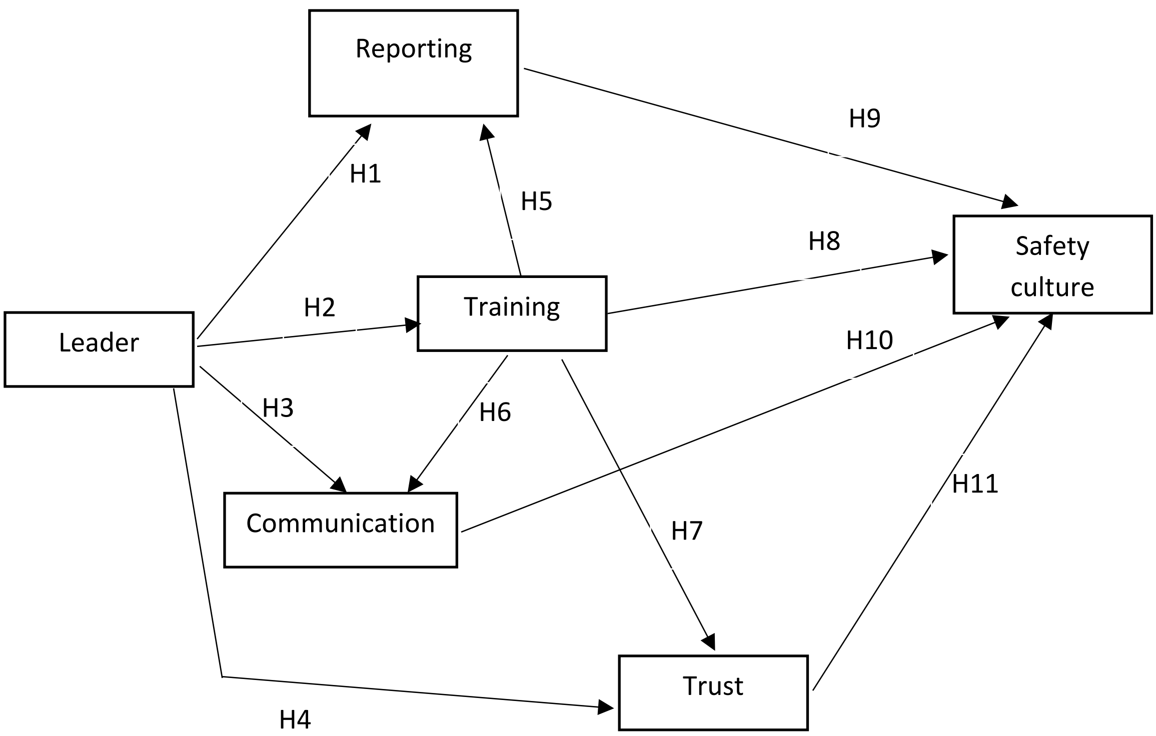
Finally, for the *'safer care environment'* category, statements 14-16 and 20 were statistically significant at 5% level. It is interesting to observe that statements 14 and 15 have a level of disagreements between clinical and managerial staff. Clinical staff were in denial mode when asked about the number of reported incidents. The majority of them said 'NO' whereas the majority of managerial staff agreed that there were too many reported incidents. Similarly, for another item more linked to the clinical job, i.e. staff bother to report incidents (statement 15), clinical staff agreed with the statement, whereas approximately 50% of managers were only in agreement with that statement.

5.5 Exploratory and Confirmatory Factor Analysis

The literature review chapter (chapter 3 and 4) resulted in the development of the HRO theoretical model with 14 testable hypotheses to test the relationship between dependant (safety culture) and independent variables (Mindful Leader, Trust, Communication, Training, and Reporting). As there was no established questionnaire on HRO that tested the relationship between five independent factors or latent variables on safety culture, the scale items for each factor/latent variable was derived from literature and other secondary sources. As a first step, before testing the relationship between factors, it is important to test the validity and reliability of the item scale used to measure each latent variable in figure 5.4 below.

Based on the literature review process, the following number of scale items per latent variable were identified: Mindful Leader[2] – 7 items; Trust – 7 items; Communication: 5 items; Training: 6 items; Reporting – 7 items; and Safety Culture – 10 items, as explained in Chapter 4, table 4.6.

Figure 5.4: Hypothesized HRO theoretical Model



[2] Mindful Leader called as leader from hereon

To establish the unidimensionality of latent variables, an exploratory factor analysis (EFA) using principal component analysis (PCA) with a varimax rotation was performed for five independents latent variables together and a separate EFA for the dependant variable- Safety Culture. The EFA helped in finalising the items for the dependant and independent variables. After conducting PCA, confirmatory factor analysis was performed to establish convergent and discriminant validity of the variables.

5.5.1 Exploratory Factor Analysis

Factor analysis is a statistical technique for measuring the underlying factors that are difficult to measure on its own and are measured by a large number of observed variables or items. Exploratory factor analysis is conducted in this research, in particular principal component analysis, to identify a group of scale items that are highly intercorrelated and may represent an underlying latent or unobserved variable. The SPSS 25.0 statistical package was used to conduct EFA. All 32 scale items representing five latent variables were entered in the SPSS window to conduct EFA with varimax rotation. Some of the key outputs generated from the EFA using principal component analysis are listed below which will be used to explain the results from the analysis

- The communalities table help to identify variables that have low communalities, say lower than 0.40, which indicates that the scale item does not contribute much to measuring the underlying factors. Communalities is basically R-square value from multiple regression analysis.
- Components with high Eigen values, at least greater than one, are likely to represent a real underlying factor, which can also be visualized using a scree plot.
- The component matrix shows the Pearson correlations between the scale items and the components, which is also called factor loadings. The accepted factor loading in the operations management study is 0.6 or more (Hair et al., 1998).

- Varimax rotation helps to redistribute the factor loadings so that each item measures precisely one latent variable or factor.

The result of the EFA including communalities tables, eigen value, component matrix with varimax rotation is presented in Appendix III. Results from the first run of-the Exploratory Factor Analysis, using principal component analysis, on 32 items measuring 5 underlying latent variables (i.e. leader, trust, communication, training, and reporting) are shown in Appendix III. The results show communalities, eigen value, and component matrix with varimax rotation. The communalities table, see Appendix III, have R-square value for each item greater than the threshold of 0.4. Only RF1 and RF7 have values close to 0.4. PCA results resulted in deleting of 11 items (3 from leader, 3 from trust, one from communication, 2 from training and 2 from reporting were due to the following reasons as recommended by literature.

- Three items belonging to Leader (leader 5, 6 and 7) loaded on two components and their factor loadings were less than the threshold value of 0.6.
- Three items of trust (Trust 5, Trust6 & Trust7) were cross loading and had value less than 0.6.
- One item of communication (Comm 1) cross loading with less than 0.6 loading.
- For training, 2 items (tr 5, tr6) were cross loading with less than 0.6 loadings.
- For reporting, 2 items (RF1, RF2) cross loading and less than 0.6 loadings.

The analysis thus, ended up with 21 scale items (Leader: 4 items, Communication: 4 items, Training: 4 items, Reporting: 5 items, and Trust: 4 items). Table 5.9 below shows the results of PCA for the final 21 items and the scale items' their factor loadings on the five latent variables. Component factor loadings of five components, their eigen values and % variation explained by them are generated from the eigen value table below, which means that there are five underlying factors that have eigen value >1 and represents 63.87% of the variation in the output. In the operations management research, the model is considered good fit, if it can explain more than 60% variation in the results.

The final outcome of the principal component analysis is presented in table 5.9 and table 5.10. Table 5.9 provides information about items included and deleted from the underlying latent variables. Table 5.10 shows how the scale items load to their respective underlying latent variables and percentage variance explained by each component. The total variance explained by the five underlying latent variables is 66.04%, which is above the threshold value of 60% (Forza, 2002; Hair et al., 1998).

The reliability of a variable is measured by Cronbach's Alpha, α (or coefficient alpha) that indicates how well a test measures what it is designed to measure, or it indicates if the multiple scale items measuring the underlying latent variables are reliable. According to the literature, Cronbach's Alpha higher than 0.7 is acceptable, meaning that initial theoretical assumptions that link a specific set of scale items to a latent variable are correct (Nunnally, 1978; Forza, 2002; Sanchez, 2013). The Cronbach's Alpha value for all five underlying factors in table 5.10 is higher than the threshold value of 0.7, and thus can be considered as a reliable instrument to measure the five underlying latent variables.

Latent Variables	Items measuring the latent variables	Items deleted
Mindful Leader (4)	**Lead1**: Clinicians/Managers in leadership positions, at all levels of the organisation, have a shared vision for patient safety ; **Lead2**: Clinicians/Managers in leadership positions, at all levels of the organisation, align policies and activities to support patient safety; **Lead3**: Clinicians/Managers in leadership positions participate in the quality improvement activities; **Lead4**: Clinicians/Managers in leadership positions promote quality improvement activities.	Lead5, Lead6, Lead7
Trust (4)	**Trust1**: Trust amongst all employees is necessary for effective safety improvement ; **Trust2**: Trust amongst employees helps to deal with problematic situation at work ; **Trust3**: Involvement of teams in the process improvement will lead to increased trust and commitment to achieve patient safety objectives ; **Trust4**: Trust between employees is enhanced by improvement in top-down and bottom-up open communication.	Trust5, Trust6, Trust7
Communication (4)	**Com2**: The use of easy to understand structured communication so all team members can participate in safety management practices ; **Com3**: Good communication flow exists up and down the chain of command ; **Com4**: Co-workers feel comfortable giving individual feedback to each other ; **Com5**: The team feel comfortable communicating their viewpoints periodically with senior management .	Com1
Training (4)	**Train1**: Training and simulation are used improve the practical skills of staff ; **Train2**: Practicing for emergency situations helps the team to cope with such events when they happen ; **Train3**: Multidisciplinary team training provided for working more effectively; **Train4**: Multidisciplinary team training provided for working more efficiently.	Train5, Train6
Reporting (5)	**Report2**: Staff are informed about errors that have happened; **Report3**: Transparency in reporting enables greater improvement of patient safety ; **Report4**: Staff are given feedback about changes enacted as a result of event/error reporting ; **Report5**: Staff discuss ways to prevent errors from happening ; **Report7**: Staff at lower hierarchical levels of clinical competence are encouraged to report errors.	Report1, Report6

Table 5.9: Items deleted after Exploratory Factor Analysis

Factor	Items	Loading	Variance	% Variance	Average Variance Explained	Cronbach Alpha
Mindful Leader	Lead1	.803	3.446	16.41	0.723	0.866
	Lead2	.878				
	Lead3	.676				
	Lead4	.669				
Communication	Com2	.744	2.914	13.88	0.624	0.820
	Com3	.676				
	Com4	.814				
	Com5	.766				
Trust	Trust1	.645	2.869	13.66	0.687	0.829
	Trust2	.650				
	Trust3	.609				
	Trust4	.668				
Training	Train1	.715	2.341	11.15	0.614	0.737
	Train2	.731				
	Train3	.736				
	Train4	.623				
Reporting	Report2	.610	2.300	10.95	0.662	0.770
	Report3	.613				
	Report4	.617				
	Report5	.676				
	Report7	.632				
Extraction Method: Principal Component Analysis; Rotation Method: Varimax with Kaiser Normalization; Rotation converged in 9 iterations.						

Table 5.10: Scale validity and reliability test for five latent variables

The EFA was separately conducted for the dependant variable, Safety Culture (SC), which is a ten items measure that was derived from the literature. The results of the

EFA is presented in table 5.11. Other results linked to EFA including communalities table, scree plot and eigen value were included in Appendix III. Five scale items- SC1, SC6, SC7, SC9, SC10 were deleted as they had a factor loading value < 0.6. All remaining five items have a factor loading value close to or greater than 0.6. The percentage variance explained by the five scale items equates to 64.96%, which is higher than 60% and considered acceptable within Operations Management research (Forza, 2002). The Cronbach's Alpha value for the five items scale is 0.863, which is above the threshold value of 0.7, indicating that the five items scale accurately measure safety culture.

Component Matrix[a]		**Items deleted**
	Component	
	1	
SC2: Open reporting of incidents among team members for Safety Culture (SC)	.865	SC1, SC6, SC7, SC9, SC10
SC3: Improving clinical practices to support SC	.762	
SC4: Reliability of processes is maintained by formally assessing SC	.807	
SC5: Prompt actions due to SC audit supports effective reliability	.847	
SC8: Formal briefings used to reduce errors in the complex process	.741	
Cronbach's Alpha	**.863**	
% Variance	**64.96%**	
Extraction Method: Principal Component Analysis; a. 1 components extracted.		

Table5.11: Scale validity and reliability analysis for Safety Culture

5.5.2 Non-response and common method bias

Non-response bias may occur when invited participants are unable or unwilling to respond to the survey instrument due to certain reasons that make them different from those people who respond to the survey. One method to test for non-response bias is to conduct independent sample t-tests for the early and late respondent category, where late respondents are used as a proxy for non-respondents (Armstrong and Overton, 1977). Around 150 responses were categorized as an early response, and the last 109 responses were classified as the late response. Conducting t-test for both sets of independent and dependent latent variables resulted in no difference in the results between early and late response (p-value > 0.05), further reinforcing that non-response bias is not a serious concern.

The common method bias test is done to check the presence of mono-method bias when all data linked to independent and dependent variables were collected from a single respondent. Researchers recommend using Harman’s single-factor test to detect the presence of mono-method bias (Podsakoff et al., 2003). In this test, all scale items are loaded to a single latent factor, and unrotated factor analysis is performed on all variable scores. If the percentage variance explained by the single factor exceeds 50%, it is an indication that the data suffer from common method bias. In other words, if one factor explains most of the covariance in the independent and dependent variables, it is reasonable to conclude that a significant common or mono method variance is present. When all 41 items (including dependent and independent variables) were included to run the EFA with no rotation and all items loading to a single factor, the resulting un-rotated solution identified seven factors with eigenvalues greater than one (see table 5.12), suggesting that any mono-method bias that exists is not likely to be problematic (Podsakoff et al., 2003). The average variance explained by the first factor is 39.2% which is less than the recommended threshold of 50% to report the presence of common method bias.

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**14.506**	**39.206**	**39.206**	14.506	39.206	39.206
2	2.614	7.066	46.272			
3	2.300	6.217	52.490			
4	1.577	4.263	56.752			

5	1.348	3.643	60.395			
6	1.232	3.330	63.725			
7	1.077	2.910	66.635			
8	.896	2.423	69.058			
9	.809	2.186	71.244			
10	.763	2.061	73.305			
11	.695	1.878	75.183			
12	.691	1.868	77.050			
13	.648	1.752	78.802			
14	.611	1.652	80.454			
15	.571	1.544	81.998			
16	.515	1.393	83.391			
17	.472	1.275	84.665			
18	.468	1.264	85.930			
19	.456	1.233	87.163			
20	.443	1.197	88.359			
21	.378	1.023	89.382			
22	.364	.985	90.367			
23	.362	.977	91.344			
24	.347	.939	92.283			
25	.342	.925	93.207			
26	.319	.863	94.071			
27	.289	.780	94.851			
28	.261	.704	95.555			
29	.250	.674	96.230			
30	.225	.608	96.838			

31	.216	.583	97.420			
32	.204	.551	97.972			
33	.200	.540	98.511			
34	.171	.462	98.973			
35	.142	.383	99.356			
36	.124	.335	99.691			
37	.114	.309	100.000			
Extraction Method: Principal Component Analysis.						

Table 5.12: EFA to test for common method bias

5.5.3 Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) was performed to test for convergent validity to make sure that the multi-items of these five factors are in agreement and is confirmed if they load only on the constructs to which they belong to and thus, to confirm the convergent validity of the latent constructs. Testing was conducted to check whether each item's estimated path coefficients on its posited latent variable is significant (Anderson and Gerbing, 1988). AMOS 25 was used to conduct CFA.

Several goodness-of-fit indices suggested in SEM literature was used such as Chi-Square statistics divided by the degree of freedom (Normed Ch-square: χ^2/df), Comparative fit index (CFI), Goodness of fit index (GFI), Tucker-Lewis Index (TLI), and Root Mean Square Error of Approximation (RMSEA) to assess the model fit. The χ^2values is the index of the absolute fit assessing the extent to which the covariances estimated in the model match the covariances in the measured variables (Kline, 2005). As suggested, the following criteria were used to assess the model-fitting (Kline, 2005): recommended values: χ^2/df is less than 3; all fit indices to be greater than 0.90 with a theoretical upper value of 1.00, and the recommended value of RMSEA to be 0.05 and accepted up to 0.08.

A five-factor model consisting of leadership, reporting, training, communication, and trust was found to fit the data well. $\chi^2(48) = 68.975$, with a probability of .025, root mean square error of approximation (RMSEA) = . 06, goodness-of-fit index (GFI)

= .90, TLI = .97, confirmatory fit index (CFI) = .98, with all values within the acceptable limits (Hu & Bentler, 1999). This analysis also showed that all items loaded significantly on their associated constructs ($p < .001$), which confirms the constructs' convergent validity (Bagozzi & Yi, 1991). The CFA generates loading of each item on their respective latent variable and thereby delete any further items associated with a single factor or latent variables based on the threshold factor loading of 0.6 or higher (Forza, 2002; Sanchez, 2013). Table 5.13 shows the standardized regression weights or factor loading of each item on their respective underlying latent variable. Critically, the data suggests that all item loadings are high than the threshold value (>0.6) and statistically significant at the $p<0.001$ level. The CFA results revealed support for the five latent variables indicating the distinctiveness of these variables in the model. The values suggest that the unidimensionality of each latent variable and thus, convergent validity is confirmed (Bagozzi, Yi, and Phillips, 1991).

			Estimates
Leader4	<---	Lea	.675***
Leader3	<---	Lea	.695***
Leader2	<---	Lea	.823***
Leader1	<---	Lea	.965***
Trust1	<---	Tru	.721***
Trust2	<---	Tru	.844***
Trust3	<---	Tru	.684***
Trust4	<---	Tru	.631***
Train1	<---	Tr	.602***
Train2	<---	Tr	.658***
Train3	<---	Tr	.776***
Train4	<---	Tr	.850***
Com2	<---	Com	.734***
Com3	<---	Com	.901***
Com4	<---	Com	.745***

			Estimates
Com5	<---	Com	.767***
RF2	<---	Re	.672***
RF3	<---	Re	.646***
RF4	<---	Re	.777***
RF5	<---	Re	.677***
RF7	<---	Re	.648***

***Significant at 0.001 level

Table 5.13: Standardised regression weight from the CFA Analysis

5.6 Descriptive and Inferential Statistics for Latent Variables

After conducting EFA, the average and standard deviation for all six latent variables were calculated based on the final number of items for each latent variable (see table 5.10 and table 5.11). Respondents were asked to rate the items based on their view of the current state of practice of that item in their organisation. Each item was scored on a Likert scale of 1-5 (where 1 stand for 'item never practised' in the organisation, 2- rarely practised, 3- sometimes practised, 4 – often practised, and 5 - item all the time practised within the organisation). The average score for the six latent variables was presented in table 5.14. The average score for the Leader variable was the highest (4.28) followed by Trust (4.16), Safety Culture (4.09), Reporting (4.06), Communication (3.98), and Training (3.67). The average scores for five out of six latent variables were close to 4, which shows that all 259 respondents agreed that all factors were often practised within the organisation.

Training received the lowest score among all six factors, which shows that respondents feel that there could be an improvement in training for emergency situations or general training to improve skills sets and also multi-disciplinary team training. Two sample t-test was also conducted to assess if the scores for the latent variables were affected by the 'Gender' of the respondent or 'the role' they take within their organisation. The male respondents rated all six factors higher than the female respondents, which shows they perceive higher practices of the selected latent variables than their female counterparts. There were significant differences in the average scores of male and female groups for Leader, Communication and Safety Culture variables when the test was conducted at 1% significance level.

There was also a difference in perception of the two groups for Trust variable, which was significant at 5% level. There was no significant difference in perception between male and female groups were identified for Training and Reporting variables.

Factor	**N**	**Average**	**Standard Deviation**	**Gender**		**p-value^**	**Role**		**p-value^**
				Male	Female		Clinical	Managerial	
Leader	259	4.28	0.60	4.40	4.19	0.004*	4.28	4.27	0.917
Trust	259	4.16	0.73	4.29	4.07	0.012**	4.12	4.23	0.239
Training	259	3.67	0.63	3.71	3.65	0.427	3.61	3.78	0.042**
Communication	259	3.98	0.80	4.21	3.83	0.000*	3.92	4.09	0.075***
Reporting	259	4.06	0.67	4.11	4.03	0.301	4.02	4.12	0.210
Safety Culture	259	4.09	0.70	4.25	3.98	0.001*	4.04	4.17	0.146

**1%significance level; **5% significance level; ***10% significance level; ^Two sample t-test conducted (equality of variances not assumed)*

Table 5.14: Descriptive and Inferential Statistics for HRO Latent Variables

When two sample t-test was conducted between clinical and managerial job roles, training was statistically significant at 5% level and Communication at 10% significance level. All other latent variables were not statistically significant when comparing the scores of clinical group versus the managerial group. Respondents in managerial position scored higher for the Training and Communication latent variables compared to their clinical counterparts.

5.7 Structured Equation Modelling (SEM) Analysis

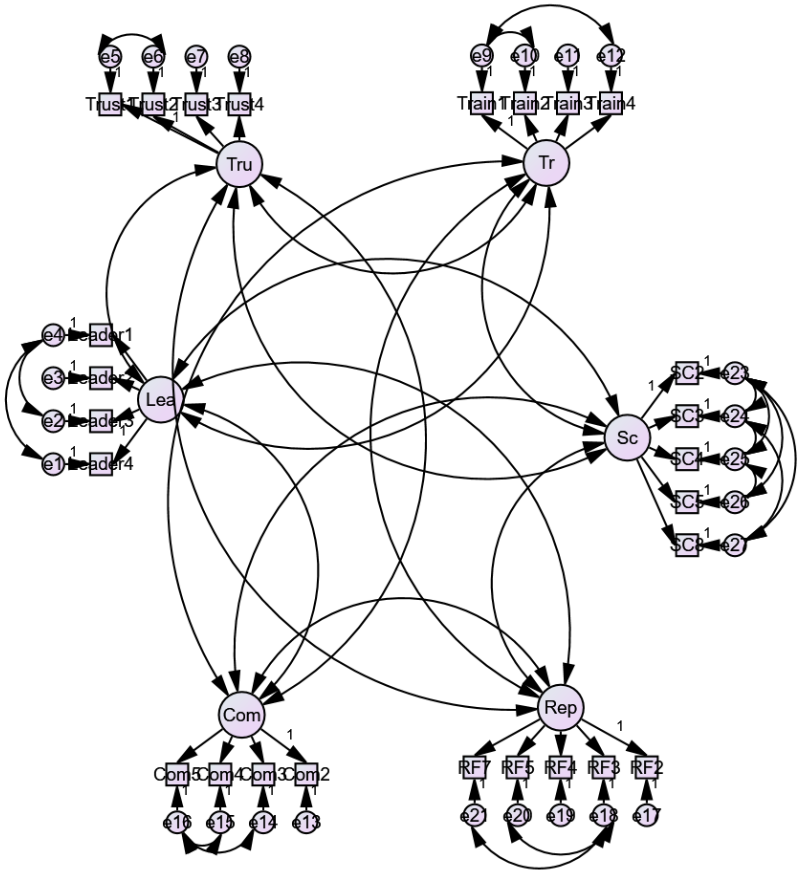
To test the hypothesized model presented in figure 5.4, Structural Equation Modeling (SEM) (Bollen, 1989) was performed using AMOS 25. SEM is increasingly being used to simultaneously understand the relationship between the dependent and independent latent variables in the operations management field (Shah and Glodstein, 2006; Roberts et al., 2010). In this research, SEM is a preferred alternative to regression analysis to test the hypothesize model as it is considered superior to regression (Roberts et al., 2010). The critical point of using SEM over regression is that it offers a simultaneous test of the entire system of variables in a hypothesized model. Thus, SEM enables assessment of the extent to which the model is consistent with the data (Byrne, 1994; Shah and Glodstein, 2006; Roberts et al., 2010).

A two-step approach (Anderson and Gerbing,1988) was used, consisting of a measurement model followed by a structural model. AMOS 25 with maximum likelihood estimation was used to develop the factor structure of our measurement model.

5.7.1 Measurement model

AMOS 25 with maximum likelihood estimation was used to develop the factor structure of our measurement model with six factors (dependent variable: safety culture and five independent variables: leader, reporting, training, communication, and trust), see figure 5.5. CFA was conducted first to establish the convergent validity of the six multi-item measures. Convergent validity can be tested with a measurement model by examining if each indicator’s estimated path coefficient on its posited construct is significant (Anderson and Gerbing, 1988).

Figure 5.5: Measurement model (6 factors)



As suggested, the following criteria were used to assess the model-fitting (Kline, 2005; Hu and Bentler, 1999; Hair et al., 2010): Recommended values:

- $\chi^2/df < 3$ is good,
- All fit indices > 0.90 is great and > 0.8 is sometimes permissible,
- The value of RMSEA < 0.05 is considered good and between 0.05- 0.1 as moderate.

Results indicated that the model fits the data well based on the global indices values generated from the CFA. $\chi^2(268) = 606.23$, CMIN/DF = 2.26 with a probability of .000, RMSEA = . 067, GFI = .85, TLI = .90, CFI = .91, with all values within the acceptable limits (Hu and Bentler, 1999). This analysis also showed that all items loaded significantly on their associated latent variables ($p < .001$), which confirms the latent variables' convergent validity (Bagozzi and Yi, 1991).

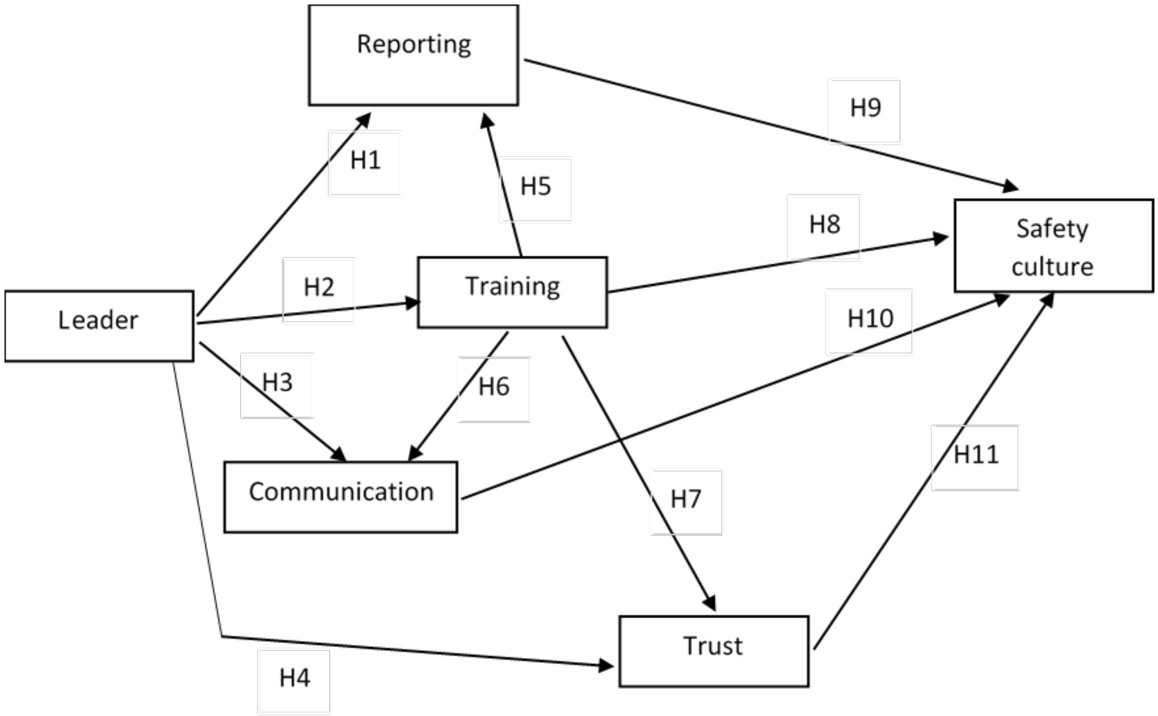
The magnitudes of the average variance extracted (AVE) of all latent variables were also calculated and found between 0.61 and 0.73, which was greater than the minimum accepted value of 0.60, (Table 5.10 and 5.11), thus providing further evidence of the convergent validity of the scales. Discriminant validity was assessed by comparing the shared variance (squared correlation) between each pair of constructs against the average of the AVE for these two constructs. Within each of the fifteen possible pairs of constructs, the shared variance estimated was found to be lower than the average of their AVEs, confirming discriminant validity (Fornell & Larker, 1981).

The CFA and the measurement model helped to establish the reliability, convergent validity, and discriminant validity of the base model. The fit indices reported from the measurement model was acceptable and indicates that the model fits the data well based on the global indices values. Once the measurement model is validated, structure equation modelling was now conducted to test the causal links between latent variables.

5.7.2 Structural Model

Based on the literature review, the theoretical model proposed, see figure 5.4, is presented again to remind the hypotheses to be tested in this section. All hypotheses get tested in the structured equation modelling (SEM) analysis conducted on AMOS 25 software.

Figure 5.4: Hypothesized/ Baseline model derived from the literature



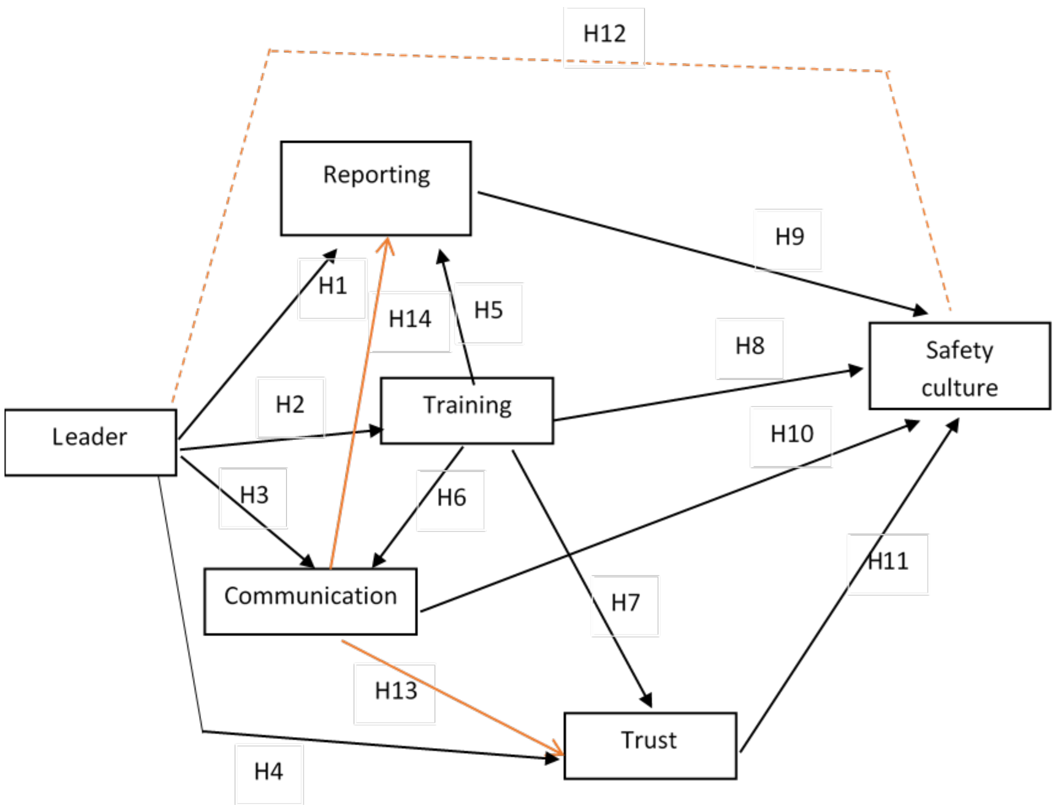
The CFA and measurement model helped to assess the quality of the model, which was converted into a structural model to test the relationship between six latent variables included in the HRO theoretical model (figure 5.4). When conducting SEM analysis, first, the original theoretical model (Baseline model- figure 5.4) was tested, and then other possible models were subsequently tested and compared to identify the best fit model. The identified best fit model was selected based on the values of RMSEA, GFI, CFI, TLI, CMIN/DF generated by different models.

The hypothesized model is (Baseline model) tested using the structural equation modelling using AMOS 25 software to test all the 11 hypotheses. In the AMOS software, the double arrow between latent constructs, see measurement model in figure 5.5, is replaced by a single arrow, as shown in figure 5.6. The first output from the analysis, including all fit indices (GFI, TLI, CFI), CMIN/DF, and RMSEA values, were reviewed to assess if the proposed model was the best fit model. The analysis generated structural path coefficients (regression weights) between two latent variables. Table 5.15 presents the summary of outputs for the hypothesized model. Following were the values of indices for the base model: $\chi^2(272) = 741.94$, CMIN/DF = 2.73 with a probability of .000, RMSEA = . 082, GFI = .82, TLI = .85, CFI = .87.

Except CMIN/DF, all fit indices values are below the acceptable limits (i.e. RMSEA < 0.08; All fit Indices >0.9). The fit indices value suggest that the base or hypothesized model was not the best fit model and alternate models need to be explored that have fit indices close to threshold value suggested by the literature.

The alternate models (Model 2, Model 3, and Model 4) with additional paths between the six latent variables which were not tested in the base model or derived from the literature were tested to find the appropriate model that fits the data well. In Model 2, additionally, a direct path from Leader to Safety Culture was introduced. Model 3 is identical to Model 1, with additional paths from Leader to Safety Culture and communication to trust. Model 4 is also identical to Baseline Model 1, with additional paths from Leader to Safety Culture, Communication to Trust, and Communication to Reporting.

Figure 5.6: Alternate SEM model



When Model 2 was tested (adding path from Leader to Safety Culture to the baseline model) in AMOS, following were the values of indices for the Model 2: $\chi^2(270) = 735.06$, CMIN/DF = 2.72 with a probability of .000, RMSEA = . 082, GFI = .82, TLI = .85, CFI = .87. Except CMIN/DF, all fit indices values are below the acceptable limits (i.e. RMSEA < 0.08; All fit Indices >0.9) and like those of the base model (Model 1). The fit indices values for Model 3 and Model 4 were presented in table 5.15. Based on the fit indices value, **Model 4 is chosen as the best fit model** as all the values of the indices are close to threshold values and better than fit values for Model 2 and Model 3.

Model	Additional path	χ^2	df	χ^2/df	GFI	TLI	CFI	RMSEA
Model 1		741.94	272	2.73	.82	.85	.87	.082
Model 2	Leader→ SC	739.46	271	2.73	.82	.85	.87	.082
Model 3	Leader →SC, CO →TR	643.27	270	2.38	.84	.88	.90	.073
Model 4	Leader →SC, CO →TR, CO →RE	611.92	269	2.28	.91	.89	.91	.070

Table 5.15: Summary of outputs for the baseline and alternate models

The standardised structural estimates and the p-value for all the paths in Model 4 were presented in table 5.16, and the standardised weights were visually shown in figure 5.6. Following inferences were drawn from the regression weights and p-values reported in table 5.16:

- Leader does not have a direct impact on Trust as the standardised regression weight is very low (0.024) and p-value (0.648) is greater than 0.05, which means leader does not impact on the latent variable -Trust
- The relationship between Leader and Trust is positively mediated by Communication. The standardised structural path coefficients between Communication and Trust (H13) is very strong (0.761) and p-value (0.000) suggest Communication significantly impact Trust.
- Leader does not directly impact Safety culture as Hypothesis H12 is rejected due to p-value (0.483) is greater than 0.05 and regression weight is very low (-.034).
- Communication also significantly impact on Reporting variable (H14) based on the regression weight (0.417) and p-value (0.000).

Hypothesis Tested/ Direct Effect	Standardised regression weights	p-value
Leader → Reporting (H1)	0.279	0.000***
Leader → Training (H2)	0.328	0.003**
Leader→ Communication (H3)	0.417	0.000***
Leader → Trust (H4)	0.024	0.648
Training → Reporting (H5)	0.308	0.004**
Training → Communication (H6)	0.278	0.001**
Training → Trust (H7)	0.240	0.000***
Training → Safety Culture (H8)	-0.090	0.192
Reporting → Safety Culture (H9)	0.316	0.000***
Communication → Safety Culture (H10)	0.447	0.001**
Trust → Safety Culture (H11)	0.369	0.014**
Leader → Safety Culture (H12)	-0.034	0.483
Communication → Trust (H13)	0.761	0.000***
Communication → Reporting (H14)	0.417	0.000***

Mediation hypotheses supported by the Model 4:

Leader → Training → Reporting

Leader →Training → Communication

Leader → Training → Trust

Additionally, the following relationships were found:

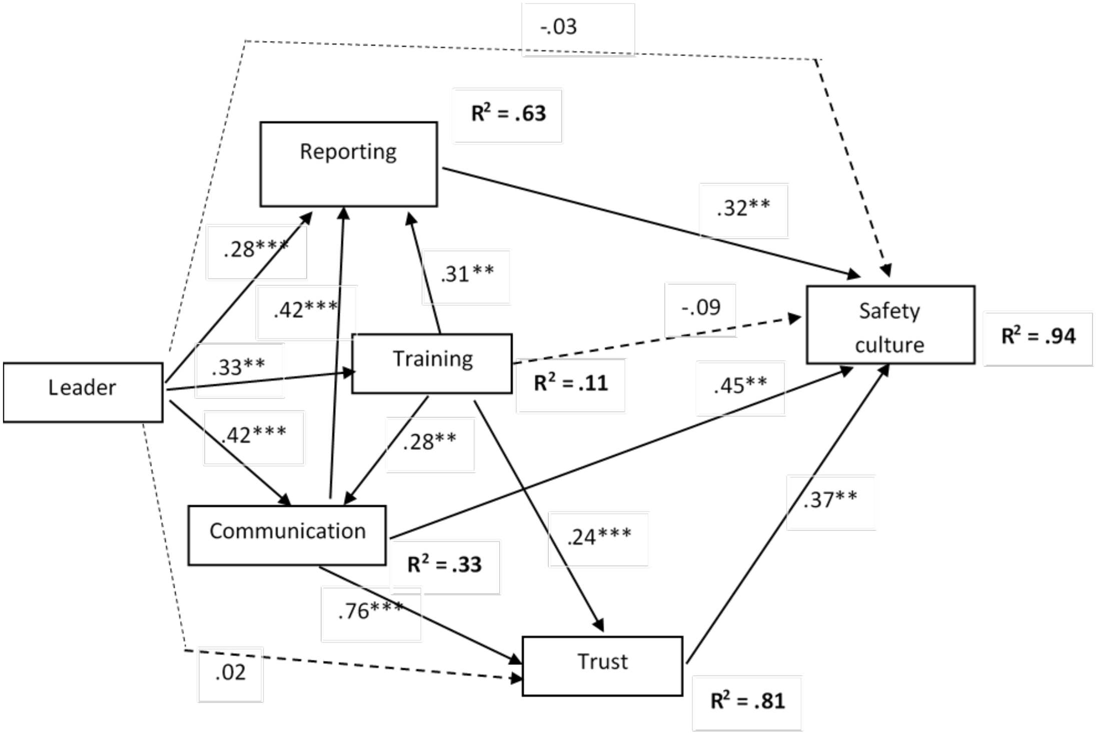
1. Direct path. Comm- Trust
2. Direct path; Comm - Reporting
3. Complete mediation: Leader- Comm-Trust
4. Partial mediation: Leader-Comm-Reporting
5. As hypothesized, Leader doesn’t have a direct relationship with SC, but through all the four intervening factors

***p-value <0.1% significance level; ** p-value < 1% significance level

Table 5.16: Model fit indices and hypotheses results for alternate Model 4

The best fit model (i.e. Model 4) was presented in figure 5.7, and the detailed results were included in Appendix III. The dotted line indicates those hypotheses were rejected. The solid arrow indicates the causal links between latent variables based on accepted hypotheses, as reported in table 5.16. Figure 5.7 also reports the R-square value for each independent latent variable in the final model.

Figure 5.7: Final Model representing HRO Model



The R-square value for Safety Culture (0.94) indicates that 94% of the variation in the Safety Culture can be explained by the other five latent variables. The high R-square value is also an indicator of how good is the final model in understanding the relationship between six latent variables. The literature suggests the R-square value > 0.7 as an indicator of a very strong predictive model (Moore and Flinger, 2013; Zikmund, 2000). Training positively mediates the relationship between Leader and Reporting/ Communication/ and Trust. The Role of Communication in improving Trust and Reporting and, at the same time, positively influencing Safety Culture is a very promising finding, which will be further reflected and discussed in the next chapter.

The results in table 5.16 and figure 5.7 show that the model supports all our hypotheses except H4 and H8. In addition, the following results are also found from the SEM analysis, which was unexpected and needed an explanation, which will be given in the discussion chapter:

1. Direct path. Comm→ Trust
2. Direct path; Comm→ Reporting
3. Complete mediation: Leader→Comm→Trust
4. Partial mediation: Leader→Comm →Reporting

5.8 Summary of the chapter

The chapter summarises the result of the survey from 259 respondents from NHS Wales. The demographic details of the respondent revealed that female participated more in the survey compared to their male counterparts. Similarly, the majority of the respondents (two-third approximately) were from a clinical background, and the remaining were from the managerial background, including people working in the administrative departments. The text analysis of the HRO definition helped in creating a wordle (see figure 5.2 and figure 5.3) that visually presents the meaning of HRO as interpreted by respondents based on Gender and Role in the organisation. The wordle demonstrated emphasis on keywords such as safe, staff, zero, errors, and accidents and when the definition of HRO was compared by Gender and Role, keywords such as harm, care, processes, safe/safety, zero, and staff were used more often in their definition of HRO. Based on the textual analysis of the definition of HRO, the author developed own definition of HRO by summarising the keywords that were used more frequently in the definition of HRO – "*An accountable and open organisation that consistently performs to the highest standards of patient care, has a high level of accountability, deals sympathetically and comprehensively with failures, while always striving for continuous improvement to achieve the goal of patient safety over a long time with close to zero deaths, or errors.*"

The twenty-two statements linked to the working context of NHS Wales were grouped into five categories to understand respondents' perception about the department they work for: about the department, managing patient, managing resources, safer care environment, and learning. There were differences in perceptions based on Gender (table 5.7) and Role (table 5.8), mostly linked to categories ‘managing patients’, and ‘safer care environment’.

After analysis of the working practices, EFA and CFA were conducted to refine the items measuring the six latent variables of the HRO framework proposed in this research – Leader, Trust, Training, Communication, Reporting, and Safety Culture. Here, the first five factors were considered as independent variables and Safety Culture as the dependant variable. The theoretical model derived from the literature (see figure 5.4), also called as hypothesized or baseline model, including 11 hypotheses, was tested using SEM analysis in AMOS25. SEM analysis helped understand the causal link between independent variables and their impact on the Safety Culture. The AMOS output revealed that the baseline model is not the best fit model, and several other alternate models, including three additional hypotheses, were tested to identify the best fit model. The alternate model 4 was chosen as the best fit model based on the reported AMOS outputs on fit indices, RMSEA value and χ^2 / DF value. Model 4 had an R-square value of 0.94, which can be interpreted as 94% of the variation in the result of Safety Culture can be explained by the five independent latent variables. Such a high R-square value is rarely seen in the Operaitons Management research and it can be stated with confidence that the revised HRO structural model (figure 5.7) is a robust model. The model revealed no significant relationship between Leader and Safety Culture and Leader and Trust. The Leader had a full mediation effect on Trust through communication. Training acted as a mediator between Leder and Communication/Reporting/ and Trust. The alternate model identified additional causal links between Communication and Trust, and Communication and Reporting. The next chapter discusses these new findings and compares them with the literature to highlight the contribution made by this research.

Chapter 6 Discussion

6.1 Introduction

The research on HRO in Healthcare is still in its infancy despite its development in other safety-critical sectors (Weick and Sutcliffe, 2007; Babyar, 2020; Cantu et al., 2020). The literature review of this study identified a lack of clear guidelines or models for achieving high reliability practices. A few frameworks/models and survey instruments were proposed to test safety culture and high reliability practices in the healthcare setting (e.g. Pronovost et al., 2006; Vogus and Sutcliffe, 2007a,b; Chassin and Loeb, 2013). But none of models seem to be universally applied to explain how healthcare can achieve the five hallmark principles of HRO. The first three hallmarks (preoccupation with failure, reluctance to simplify, and sensitivity to operations) are important in anticipating a problem and the last two hallmarks help organisations to contain the failure by quickly responding to it when an error occurs (commitment to resilience, deference to expertise). Some of the recent publications on HRO application in different industries, including healthcare (e.g. Agwu et al., 2019, Cantu et al., 2020; Babyar, 2020) clearly identified the organisation's struggle to achieve high reliability practices despite the presence of guiding principles that appear to be universal in nature. In particular, the literature stated that most organisations lack an understanding of features that can enable them to achieve and sustain high reliability practices (Babyar, 2020).

The HRO concept and its relationship with the Operations Management (OM) literature reveals a surprising lack of cross-over studies. Therefore, the obvious gaps include the perception of the staff with regards to the positioning of HRO as a form of quality improvement or as a distinct set of skills/competencies. These issues also include translating HRO principles into an existing culture and potentially the relationship with existing improvement programmes. However, the most significant challenge at the organisational level and how the right practices, rituals, and artefacts are designed that reinforce and legitimise HRO as a model for running a business and engaging clinicians with the management aspects of controlling processes. It is unclear whether HRO will be a management initiative or a clinical process or a combined approach. The realisation of HRO in its application will therefore rest with the perceptions of HRO by staff and the use of management-led enabling mechanisms that would allow an HRO approach to be legitimated and accepted by staff (a common mindset). In short, the major issue is the cultural acceptance and legitimacy of HRO as perceived by staff.

The literature gap on how organisations can embrace HRO, what organisational features can enable organisations to transition towards HRO, and how those features interact and impact the safety culture of an organisation is the focus of this study. It is hypothesised that the organisational features can be the enabler to embed the five hallmarks of HRO within an organisation. Similarly, as the literature identified, there is no point in classifying organisations as HRO or non-HRO as every organisation will benefit from exhibit the hallmarks of HRO. Instead, the focus should be on how organisations can develop a culture or a model that can embed the HRO hallmark.

Based on the literature gap, this research aims to ***develop a HRO theoretical model to understand the concept of the HRO as it applied within the context of the Welsh NHS setting***. The aim of the study is achieved by answering the following two research questions.

Research Question 1 (RQ1): What are the perceived organisational features that enable higher reliability in the healthcare context?

Research Question 2 (RQ2): How the perceived organisational features interact with each other to enable higher reliability in the healthcare context?

Chapter 5 answered the two research questions and tested the HRO theoretical model to understand the causal links between organisational features that enable high reliability practices in healthcare organisations. In this chapter, the researcher will discuss how the unique findings from the Welsh NHS setting contribute to the existing HRO body of knowledge and extend the field of research by discussing the novel contributions of this study. In particular, the contributions will be discussed linked to the refined definition of the HRO, the working practices that may impact HRO principles realisation, the revised HRO theoretical model, how the revised model compares with existing HRO models, and the role of sensemaking and systems theories in explaining the two research questions and how the findings pave a path to set directions for future research.

6.2 Definition of HRO

The literature review highlighted gaps in the understanding of HRO by the healthcare professionals and, more importantly, their struggle to embrace and sustain high reliability practices (Chassin and Loeb, 2011; Tolk et al., 2015; Ghaferi et al., 2016; Cantu et al., 2020; Babyar, 2020). Thus, it was important for the researcher to sensemaking how healthcare workers perceive the term ‘high reliability organisations’ before discussing the key results influencing the HRO theoretical model. An open-ended question was asked to Welsh healthcare workers on how they define HRO. Figure 5.2 and Figure 5.3 in Chapter 5 summarises the keywords that appear in the definition of HRO.

In Chapter 3, the researcher collated a range of definitions of HRO shared by eminent scholars in the field of HRO (see table 2.1). This helped to understand how different authors and industry perceive HRO. The common keywords appearing in the definition of HRO are ‘safety’, ‘culture’, ‘error’, ‘error-free’, ‘long period’, ‘accidents’, and ‘process’. The researcher has presented a modified version of table 2.1 in this chapter to show how the definition in the literature compares with her own definition of HRO derived from the empirical findings (see table 6.1). Table 6.1 highlights a few keywords that are synonymous with those often used in the literature to define HRO. The last row of table 6.1 includes the researcher’s definition of HRO based on synthesising the definitions provided by survey respondents in the empirical phase of the study (see Chapter 5, section 5.2).

As the resilience engineering field influences HRO conceptualisation, the early definitions of HRO are focused on measuring reliability using quantitative measures such as the number of errors, adverse events, or failure (LaPorte et al., 1990; Roberts, 1990; Rochlin, 1993; Weick et al., 1999). When applying HRO to the healthcare processes, the authors attempted to measure reliability in the form of reduced adverse events or medication errors (Vogus and Sutcliffe, 2007a,b; Babyar, 2020). Given that HRO has many characteristics that are similar to the resilient engineering models of safety management (Hollnagel, 2004, 2012), which tend to have a more quantitative focus, it is unsurprising that the initial definitions of HRO were based on quantitative measures and approaches to safety. It can be said that earlier definitions of HRO were not aligned with Systems theory due to the narrow focus on measurement of reliability and ignoring the soft aspects, which plays a critical role in enhancing the reliability of the complex healthcare system.

The last decade saw a slow shift in the conceptualisation of HRO and extended its focus beyond reliability measurements (of tasks and systems) to understanding the impact of people, processes, and practices on high reliability practices in the healthcare setting as an organisational or systems approach (Kumar et al., 2020; Ghaferi et al., 2016; Christianson et al., 2011; Chassin and Loeb, 2011). As observed in table 2.1 and table 6.1, most of the definitions provided by authors lack the focus on customer service, patient-healthcare interactions, and patient satisfaction. It is important to have those keywords in the definition of HRO for achieving a holistic and reliable understanding of HRO, operations management and improvement processes (Babyar, 2020). In effect, a sensemaking perspective facilitates the researcher to present another definition that is aligned with systems thinking and brings together the socio-technical characteristics needed to sustain the hallmarks of HRO in the long-term. The definition derived from empirical research emphasises the socio-factors, including learning, accountability, patient care and safety, continuous improvement, and the hard and quantitative measures of zero errors and defects. This can be considered as one of the novel contributions of this doctoral research. The researcher definition is influenced by the systems theory adopted for this study to understand the relationships and interactions between organisational features that define HRO.

Definition of HRO	**Industry**	**References**
“Those organisations characterised as HROs all show a positive engagement with the construction of operational safety that extends beyond controlling or mitigating untoward or unexpected events and seeks instead to anticipate and plan for them.”	High-risk industry	Rochlin, 1993: 1549
HROs, such as naval aircraft carriers, nuclear power-generation stations, and air traffic control units, “operate in an unforgiving social and political environment, an environment rich with the potential for error, where the scale of consequence precludes learning through experimentation, and where to avoid failures in the face of shifting sources of vulnerability,	High-risk industries	Weick et al., 1999:83

complex processes are used to manage complex technology”		
“The signature of HRO is not that it is error-free, but that errors don’t disable it”	High risk industries	Weick and Sutcliffe, 2001: 14
“HRO theory… states that organisations can handle complex and hazardous activities at acceptable levels of performance with the proper management of people, technology and processes”	Healthcare	Youngberg, 2004: 13
“consistent performance at high levels of safety over long periods of time”	Healthcare	Chassin and Loeb, 2011:563
“high reliability is not a state that an organisation can ever fully achieve; rather, it is something the organisation seeks or continually aspires to. Second, reliability is fundamentally a dynamic set of properties, activities, and responses.”	Healthcare	Christianson et al., 2011:315
HROs are organisations that engage in cognitive processes and actions directed at actively avoiding seemingly inevitable organisational holdups and containing errors.	Construction	Olde Scholtenhuis & Doree., 2014:658
High reliability organising has its roots in studies of organisations across many industries where failure has drastic consequences and coordinated efforts are needed to ensure safe outcomes (e.g., commercial aviation, nuclear power, and naval aircraft carrier operations). It demands that people coordinate their attention and action to continually improve the functioning of the organisation, while acknowledging that there is always room for further improvement.	Healthcare	Ghaferi et al.,2016;
“ An open and learning organisation that consistently performs to the highest standards of patient care, has a high level of accountability, deals sympathetically and comprehensively with failures, while always striving for continuous improvement to achieve the goal of patient safety over a long time with close to zero deaths, or errors.”	Healthcare	Researcher definition of HRO

Table 6.1: Keywords used in HRO definition

(Source: The Researcher)

Another reason to move away from the traditional definition of HRO based on quantitative measures is that healthcare processes are not always tightly coupled as they are in manufacturing or other service sectors (Daultani et al., 2015). From the sensemaking perspective, any errors in one patient or one process are unlikely to cascade and spiral up or down the internal supply chain (the preceding, following, and parallel processes that support the patient). The high-risk industries involved in earlier HRO research and conceptualisations are characterised by complex interactions and tight coupling enabled through technology. Healthcare can be considered as a high-risk industry, but their processes can be classified as loose coupling and, in some case, tight coupling such as A & E or ICUs. Here human actors involved in the care pathway and their interactions with patients and other caregivers make the process more complex (Reason, 1998). As such, safety systems in healthcare processes tend to focus on organisational enablers and human factors for patients that are non-standardised in the care needed (Vogus, 2011; Reason, 1998). Thus, the researcher definition emphasising more on the soft or socio-factors for enabling high reliability practices is justified.

The most prominent and often repeated keywords from 259 respondents of the survey are the following: ‘staff’, ‘safe/safety’, ‘zero’, ‘errors’, ‘harm’, ‘culture’, ‘quality’, ‘practices’, ‘long’, ‘accident’, ‘people’, ‘care’, and ‘processes’. Comparing the keywords cited in the literature with those from empirical study, there are many similarities in the choice of keywords to define HRO: ‘safety’, ‘culture’, ‘error/harm’, ‘long’, ‘accident’ and ‘process’. The sensemaking perspective was used to bracket and label the common keywords between the empirical study and literature. The conclusion drawn is that irrespective of industry-focus, HRO is about safer, error-free process performance over a longer duration with a focus to build a safety culture in the organisation (e.g. Roberts et al., 1990; Rochlin, 1993; Weick et al., 1999; Lekka et al., 2011; Chassin and Loeb, 2011; Olde Scholtenhuis and Doree, 2014).

After comparing the commonalities in the definition of HRO discussed in the literature and the doctoral research, the researcher will now point towards some of the other HRO keywords highlighted by healthcare workers, which were not explicitly stated within the HRO definitions provided in the literature. Here, the bracketing and labelling from a sensemaking perspective helped identify the keywords that seemed like an outlier (i.e. not identified in the literature). The keywords such as ‘staff’, ‘care’, and 'patient' frequently appeared in the definitions provided by the healthcare workers. The majority of the HRO definition in the literature emphasises a lot on the technical aspect of high reliability practices (Roberts, 1990; Rochlin, 1993; Weick et al., 1999; Cox et al., 2006)– process, safety, error, performance; the definitions have limited focus on the 'softer/people' aspects of achieving high reliability, which is so crucial and important in the healthcare setting (Ghaferi et al., 2016).

The three keywords – staff, care, and patient, define the tightly coupled healthcare processes where multiple interactions between healthcare workers and patients and multiple inputs from workers at different hierarchy (Carroll and Rudolph, 2006; Sutcliffe, 2011; Vogus, 2011; Christianson et al., 2011) influence the effectiveness and reliability of safer care provision over a longer duration. The softer aspect of care plays an even more important role in enhancing safety culture than the technical elements, as evidenced by the HRO theoretical model proposed in Chapter 3 and tested in Chapter 5. All six organisational features included in the HRO model are linked to softer aspects of high reliability performance, which will be further debated and discussed later in the chapter.

Interestingly, there were some differences in the HRO definition proposed by clinicians and managers working in the healthcare setting. The technically trained clinical staff used the word 'accident' more often than managerial staff, while the managers focused more on 'processes' and 'safety' in their definition of HRO. The sensemaking perspective suggest that the use of the term accident may be associated with the clinical need for risk aversion in decision-making more generally and that accidents represent the worst form of safety breech for such professional staff (indeed accidents lead to investigations and pose a threat to the licencing and operating licence of the clinical professional). Given managers lead most of the organisational improvement work, such as Lean in the healthcare setting (Lindsay et al., 2020; Bortolotti et al., 2018; Burgess et al., 2016), it is likely that their definition of HRO will have more emphasis on processes compared to clinicians. Also, safety was highlighted more in the definition of managers than clinicians. One interpretation of this could be that clinicians will implicitly assume safety as part of their job and emphasise other keywords such as harm, accidents, care (see figure 5.3).

The definition of HRO (provided by literature and researcher; see table 6.1) indicates that there is no reason why the focus should only be on the high-risk industry as any industry will benefit from error-free performance over a longer duration. The HRO (high-risk industries) and non-HRO companies (low-risk compared to nuclear, aviation, submarine, healthcare) have a lot in common and the problems can be similar in many ways, and non-HRO can learn from HRO practices and principles (Weick and Sutcliffe, 2007). Thus, it is important to demystify the notion that HRO study applies to only high-risk industries as the concept is slowly being explored in a range of industries, including software (Vogus and Welbourne, 2003), digital operations (Roe, 2004; Salovaara et al., 2019), food retail (Ciravegna and Brenes, 2016), and Public Administration (Roe, 2004; Berthod et al., 2016), to name a few industries showcasing HRO applications. These early case studies also need to understand the issues addressed by this research in terms of the perpetual problem of translating principles into organisational systems of safety management that include all employees. The following quote from Vogus and Welbourne (2003, p.900) supports the justification of the researcher to move beyond HRO and non-HRO classification

> *"..while ordinary organisations may not operate high-hazard technologies, they may face the same conditions of tight coupling and interactive complexity when interacting with their external environments. Thus, even ordinary organisations may be reliability seeking."*

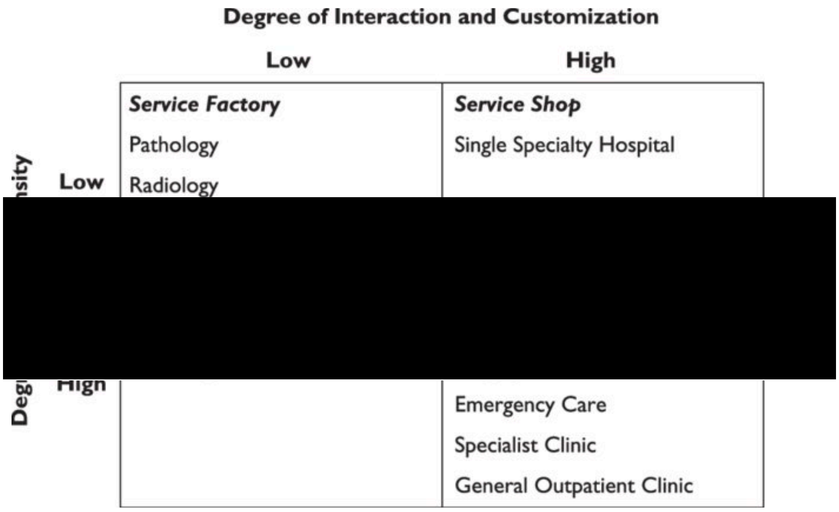
6.3 Working Context of NHS

Chapter 1 and Chapter 3 discussed healthcare operations, its differences with other manufacturing and service operations, and how understanding the 4Vs of operations (Slack et al., 2018) can help manage healthcare operations more efficiently and effectively. The survey instrument managed to capture the working context of the Welsh NHS hospitals by asking 22 questions linked to respondent's perception about their department, managing patient, managing resources, safer care environment and learning. In this section, the survey results are compared with the characteristics exhibited by health services and comment on how those characteristics may influence high reliability practices in the NHS. The researcher's interpretation of the findings is influenced by the sensemaking and systems theories perspective.

The first 13 statements of the working context help understand the issues linked to 4Vs of operations, managing patient, and managing resources (see table 5.7 and table 5.8). There was a mix response for the volume and variety of patients seen by healthcare workers in the Welsh NHS setting. Approximately 62% of the respondents agreed that they see high volume and high variety of patients. 38% saying 'NO' to both questions implies that some of those operations may be involved in support or back-office operations. Given that 38% of the respondents claimed themselves to be involved in managerial positions, it may help understand why close to 38% said NO for volume and variety. From an operations management perspective, understanding of patient-facing and back-office operations to classify healthcare services into service factory, service shop, mass service, and professional service (Verma and Boyer, 2000; Daultani et al., 2015) can help to understand where complex interactions and tight coupling exists and where standardisation is possible (see figure 6.1). Sensemaking also suggests to do bracketing and labelling the events or errors to identify the potential solution or action for the particular type of event. Here, instead of an event, we are classifying healthcare operations based on 4Vs as each classification will require customisation when applying HRO principles (i.e. the combination of Volume, Variety, Coupling, and Interactions will define what actions are required to enhance patient safety).

Each of the classifications requires a different operations strategy for ensuring high reliability performances. For example, in figure 6.1, service factory and mass services receive a high volume of service request with a low degree of interaction and customisation. Such services can benefit from standardisation and lean processes to improve operational efficiency (Slack et al., 2017; Daultani et al., 2015; Schmenner, 1986). These processes can also be considered as loosely coupled processes with a lower degree of complexity (i.e. linear interactions), creating a conducive condition to improve the reliability of the services offered by following standardised processes. The majority of the respondents in the survey agreed that they follow standardised protocol or procedures to make the process fail-safe, as suggested by Ghaferi et al. (2016). Their study suggested that the healthcare workers following standard operating procedures and protocol help reduce mortality rates in the healthcare setting, thereby enabling high reliability practices.

Figure 6.1: Classification of Healthcare services



(Source: Daultani et al., 2015)

Professional services healthcare units such as emergency care may require a different approach to reliability enhancing practices than service factory or mass services operations. Their processes are labour intensive, require a high degree of customisation, involve complex interactions between different professional hierarchy (Lindsay et al., 2020), processes are tightly coupled (Harvey, 2016), and time plays a crucial role in such services to save a life of a patient (Christianson et al., 2011). Carroll and Rudolph (2006) emphasise developing a customised design for the individual healthcare setting based on the contextual factors affecting the delivery of safer care. Understanding of context is very important to develop customised high reliability practices that suit the context. This argument aligns with Systems theory that highlights the importance of understanding the surrounding conditions to understand relationships and interactions between different system parts (Anderson, 2016; Golden and Martin, 2004). The solution identified to manage errors in the service factory setting may not be applicable in the emergency services setting. The following quote from Christianson et al. (2011; pg.318) further highlights the importance of understanding the context.

> *" Embracing HRO concepts will not necessarily be easy in the ICU, where there are simultaneous pressures for cost containment as well as often-changing team members, and on-going evaluation will be needed as HRO processes and practices from non-ICU contexts are implemented in ICUs."*

The Welsh healthcare setting seems to manage handover between teams systematically (item 4), follow standardised processes (item 3), less complains from the patient about treatment (item 7), and have clearly defined patient safety strategy (item 10). These practices will help following the five principles of HRO. However, the respondents also feel they work in a highly pressurised environment (item 2), face a shortage of the right amount of staff (item 11) with the right skill mix (item 12) that may result in high staff turnover (item 4). Stress and burden at work, termed as Muri in the lean lexicon (Liker, 2004), can lead to variable practices and waste creation, including errors and defects in the processes (Liker, 2004; Bicheno, 2018). From sensemaking and systems perspective, it is essential first to understand the reasons for workers' burden and stress and how those can be attributed to variable practices or wasteful processes in the system. Stress and burden often heard keywords in the NHS (Khan et al., 2018; Hannigan et al., 2001), may not help achieve high reliability practices in the healthcare setting.

Another example of an additional burden in an already resource-constrained healthcare system is looking for patient information and sorting out missing information (item 9), which is a classic form of lean waste. However, it is no surprise that respondents agreed to item 9 in the survey as NHS Wales are more reliant on a paper-based patient file, which increases the likelihood of errors and mistakes in a complex healthcare setting (George, 2020), that often involves multiple stakeholders along the patient pathway (Burgess et al., 2016; Esain et al., 2016).

One of the alarming signals was observed when more than 50% of the respondents stated that they don't receive regular on-going training (item 13) with males complaining more than female respondents and clinicians complaining more than managerial staff. Sensemaking perspective also identifies training as one of the essential components to embed high reliability practices and enable employees to recognise and respond to anomalies (Babyar, 2020; Hales and Chakravorty, 2016; Lekka, 2011;Weick and Sutcliff, 2007). The researcher's HRO theoretical model also highlights the importance of training in enabling employees to practice five principles of HRO and thereby enhancing safety culture in the healthcare setting. From the systems perspective, training is interrelated to building trust, improving communication and reporting, and thereby safety culture in the healthcare setting, as evidenced by the proposed HRO model. The lack of on-going training, from sensemaking perspective, could either be attributed to the highly pressurised work environment (item 2) where employees don't have time to attend continuous professional development (CPD) programs or the lack of resources in the NHS setting to run the on-going CPD courses (Simonavicius et al., 2017).

Another key element for embedding a safety culture in HROs is learning from mistakes (item 21), which received strong support from survey respondents. The majority of the respondents agreed that they learn from their mistakes. Learning culture is key to embed safer practices in healthcare (Madsen et al., 2006; Vogus and Sutcliffe, 2007a, Provera et al., 2010). However, the alarming statistics of preventable errors caused by healthcare workers in the UK and globally (WHO, 2019) point towards deficiency in safety culture and organisational learning, which is key for exhibiting high reliability practices (Weick and Sutcliffe, 2007; Tolk et al., 2015).

Item 14 to 20 in table 5.7 and table 5.8 focused on a safer care environment of the Welsh NHS setting. It was interesting to observe the difference in opinion between male/female and clinicians/managers when answering item 15 (staff bother to report incidents). The majority of the male respondents (and also clinicians) agreed with this statement, though the percentage of females (and also respondent taking managerial roles) stating YES to this statement was significantly lower. Open reporting of incidents is another essential feature of HROs that embeds safety culture practice in the healthcare setting (Reason, 1990; Chassin and Loeb, 2013; Provost et al., 2015; Sutcliffe et al., 2017). Managers in the healthcare setting are generally tasked with leading improvement projects to minimise adverse events and errors in the healthcare setting (Burgess et al., 2016; Lindsay et al., 2020). There is also reported tension between managerial and clinical hierarchy in the healthcare literature (Currie and Suhomlinova, 2006; Burgess et al., 2016; Lindsay et al., 2020), that is often cited as the reason for the lack of sustainability of improvement initiatives such as lean in the NHS (Lindsay et al., 2020; Bortolotti et al., 2018). The goal to be HROs cannot be achieved if the whole organisation is not committed to enhancing safety culture.

The majority of the respondents (approximately 80%) answered that mistakes and errors committed in their department are preventable (item 16). Similar findings were reported in the literature. Literature citing statistics of healthcare errors globally, including IOM report, Francis/Berwick/Keogh reports, and WHO, clearly stated that the majority of those errors were preventable (IOM, 1999; Kohn et al., 2000; Francis, 2010; Berwick, 2013; Keogh, 2013; WHO, 2018). Nearly two decades after the IOM report and on-going research on making healthcare safer, including initiatives such as Lean and HRO, many patients still suffer from preventable harm every day and no proper guide on how to deal with the current situation exists (Elliot et al., 2018; WHO, 2018). From the systems theory perspective, most healthcare issues are not the fault of the individual but systems condition causing those errors as evidenced from Wise's (2018, pg.4001) following statement.

> *"It said that there needs to be a clear acknowledgment that errors may result from the environment in which a doctor works rather than being the fault of an individual. System pressures and the underlying factors causing them, including lack of resources, staffing, and poor infrastructure, must be tackled, it added."*

The HRO model proposed by the researcher is a step forward in this direction to understand the organisational features that can enable healthcare to demonstrate high reliability practices, which seems a distant future based on their current performance (Babyar, 2020; Cantu et al., 2019). It was reassuring to observe that majority of the respondents felt that their organisation have a good safety culture (item 19; over 75% of the respondents agreed to this item) and they have dedicated workplace area where safety measures are reported (item 20; more than 95% agreed to this item). Such practices are the hallmark of HROs who prioritise quality and safety over other metrics in the healthcare setting (Pronovost et al., 2006; Provera et al., 2010; Chassin and Loeb, 2013).

Despite agreeing to the statement of good safety culture in their organisation (item 19), respondents agreed that it is challenging to detect error (over 55% of respondent agreed to item 17) and trust the safety investigation procedures (over 55% of respondent agreed to item 18). Applying a sensemaking and systems perspective to interpret the results of the safer care environment (item 14-20), reveals that there are many items that indicate the respondents' struggle to adhere to high reliability and safer care practices in the Welsh NHS setting. Such systemic failings prevent a unified view of safety and HRO features which suggests that the complexity and coupling of healthcare systems are not the same as organisations where safety has more visible and immediate impact (such as the studies of US aircraft carriers, nuclear facilities, air traffic control etc.). The latter organisations also rely heavily on permanent teams where roles and communication and social factors are stronger. For many NHS processes, there is the impact of shift work and rota systems which means teams form and reform but can also be very temporary sets of relationships. As such, the use of rotas and shift work means that the same team may not actually work together for any more than a couple of weeks or months before parts of the team are rotated. Given the high level of dependency on permanently structured team working for HRO case studies, this feature is less likely to be exhibited in a healthcare setting and relationships will be more fluid as a result. However, the study by Valentine and Edmondson (2014) suggest that in the temporary healthcare team, the focus should be on a set of roles and giving collective responsibility for the whole task to the team which has resulted in a 40% improvement in patient throughput time. The implication from this study is understanding of context is important and accordingly develop solution that fits the context. The researcher holds a similar viewpoint and has discussed it in the preceding sections of the chapter.

6.4 Organisational features Enabling High Reliability Practices

The two research questions of the thesis focused on identifying the organisational features that enable high reliability practices in the healthcare setting and how those features interact with each other in the proposed HRO theoretical model. The literature review identified six organisational features of HRO (i.e. mindful leader, communication, trust, reporting, training, and safety culture) and proposed 11 hypotheses that show the interrelationship between the organisational features in the proposed HRO model. The HRO theoretical model was tested by analysing 259 responses from the Welsh NHS setting using the Structured Equation Modelling (SEM) technique. In this section, the researcher will first discuss the descriptive statistics of six latent variables of the HRO model. Thereafter, the initial and revised HRO theoretical models will be discussed to explain the difference between the two models and the reasons for some of those differences in the revised HRO model. The HRO theoretical model is a novel contribution of this Doctoral Research.

Table 5.14 in Chapter 5 presented the average score, on a Likert scale of 1-5, of all six organisational features of HRO. Average scores for the mindful leader, trust, safety culture, and reporting are above 4, which imply that most of the respondents from the Welsh NHS setting agree that their department or hospital exhibit HRO features and perform well across those organisational features. Communication average rating is close to 4 (3.98) and training scores average of 3.67, which is the lowest score amongst all six organisational features of HRO. In the result section on working practices (section 5.3), more than 50% of the respondents said NO when asked about if their team has necessary on-going training (item 13) in their hospital, which may also explain why the average score for training is comparatively lower than the other five HRO features. Literature accentuates the vital role of training for organisations aspiring to be HRO as training help employees to learn, recognise, and respond to anomalies or unexpected events and at the same time develop control measures to prevent those errors in future (Babyar, 2020; Weick and Sutcliffe, 2007; Lekka, 2011). Training also enables organisations to infuse safety-related behaviours and values amongst healthcare workers to enable them to assess how things can go wrong (Hales and Chakravorty, 2016; Lekka, 2011).

The average score for communication was close to 4 (3.98), but the standard deviation of 0.8 was the highest, which implies that respondents have varied perceptions of how communication works in their hospital. Communication is critical in establishing trust and improving reporting to build a safety culture in the Welsh NHS setting, as identified from the revised HRO theoretical model in Chapter 5 (figure 5.6). Poor communication between healthcare workers is a leading contributing factor in all types of adverse events or medical errors (Sexton et al., 2000; Chassin and Loeb, 2013; Tolk et al., 2015; Cantu et al., 2020; Babyar, 2020). Effective communication between individuals or teams will enable employees to collate, analyse, and devise methods and procedures to contain failures quickly when it occurs (Roberts and Bea, 2001; Weick and Sutcliffe, 2007; Hopkins, 2007). From a sensemaking perspective, communication allows to lift the equivocal knowledge out of the tacit, private, complex, and past to make it explicit, ordered, and relevant to the situation encountered by the individual (Weick et al., 2005).

When comparing the average scores of six HRO factor against control variables such as gender and role of respondents, interesting results were revealed. Overall, the average score of the male respondent was higher than the female respondents, and the t-test further revealed the significant differences in the scores of male and female with respect to four HRO factors (training and reporting scores was similar for both male and female and not statistically significant). The mindful leader, communication, and safety culture scores were statistically significant at 1% level, which means that female respondents' average scores for three factors are lower than their male counterpart and statistically significant. This is a new finding reported in HRO research, as past empirical research on HRO has not discussed differences in results due to the perception of male and female respondents. Similarly, the average scores of respondents in the managerial role were slightly higher than those in the clinical role. Training and communication are the two factors where scores are statistically significant between managers and clinical roles for training (at 5% level) and communication (at 10% level). Literature has highlighted the differences in opinion of clinicians and managers when it comes to benefits from the implementation of continuous improvement initiatives such as Lean (Lindsay et al., 2020; Burgess et al., 2016). Clinicians often resist change in their working practices compared to managers and the low score across six HRO factors can further explain the reason for the same.

Now the results of the revised theoretical model will be discussed vis-à-vis literature and the sensemaking and systems perspective will help to explain why specific hypotheses were accepted and other rejected and new relationship identified in the HRO theoretical model (see figure 6.2 and figure 6.3). The hypothesised theoretical model proposed in Chapter 3 (see figure 6.1) only tested hypotheses H1-H11. The findings chapter (see Table 5.16) *rejected the direct causal link* between the mindful leader and trust (H4), training and safety culture (H8) and at the same time identified two new causal links between communication & trust (H13) and between communication & reporting (H14). The revised HRO model (see figure 6.3) also proved that a mindful leader does not directly impact safety culture but mediated through reporting, communication, and trust. The dotted line in the model shows that there is no direct effect of the leader on trust and safety culture and between training and safety culture.

Figure 6.2: The hypothesised HRO theoretical model

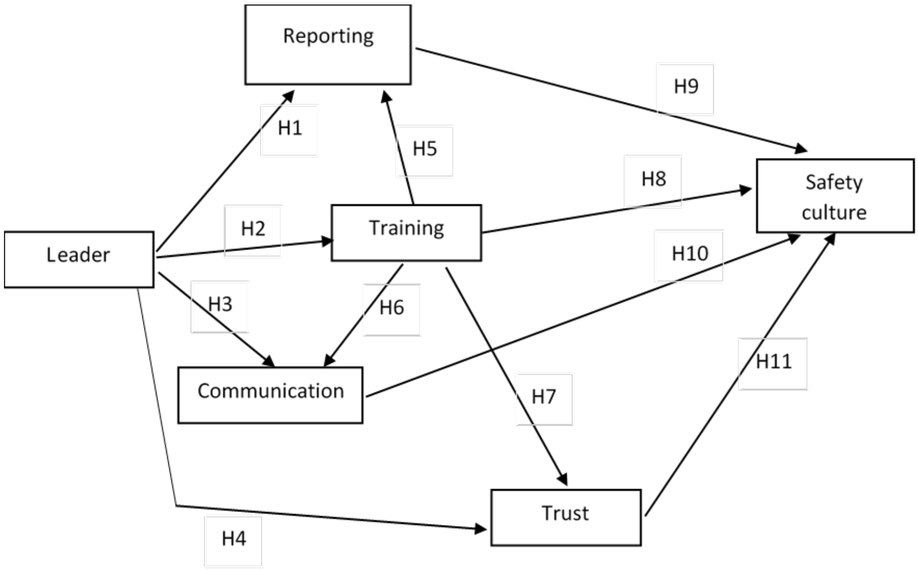
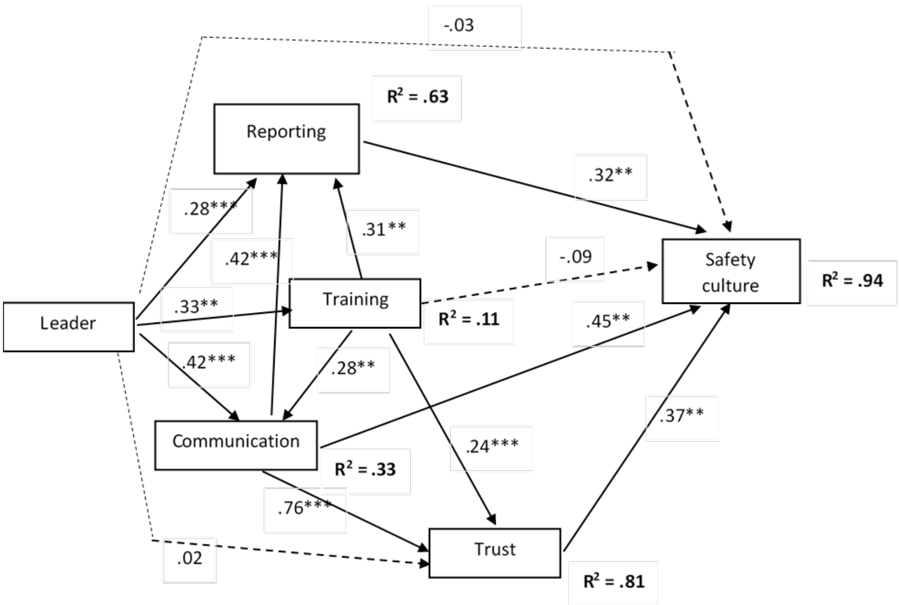


Figure 6.3: The revised HRO theoretical model



The revised HRO model can be considered the novel contribution of this doctoral study, advancing the HRO body of knowledge. Recent HRO literature highlighted a lack of empirical research to explain how organisations can transition towards HRO (Agwu et al., 2019; Babyar, 2020; Cantu et al., 2020). The following quotes from

Babyar (2020) and Cantu et al. (2020) further support this doctoral research and its findings.

> *"High reliability in healthcare organisations remains opaque, with varied structures to recommendations, despite continued interest and accreditation focus. Advancing high-reliability science for healthcare has remained elusive."* (Babyar, 2020: pg.89)

> *"HRO theory within the published literature has not significantly evolved past the original characteristics and hallmarks"* (Cantu et al., 2020: pg.5)

The HRO model encapsulating six organisational features can guide organisations to embrace five principles of HRO and exhibit high reliability practices over a longer duration. This is amongst very few empirical studies that establish causal links between organisational features enabling high reliability practices. The model fit indices for model 4 (see table 5.15, GFI, TLI, CFI) have values close to 0.9, RMSEA <0.08, and Chi-square/ degree of freedom value < 3, which aligns with the recommended value for the best-fit model in the literature (Hu and Bentler, 1999; Hair et al., 2010). The use of SEM allowed testing simultaneously the link between the six organisational features that enable high reliability practices in organisations. The SEM analysis also helped to identify any other causal links between latent variables, which was missed during the hypothesis development stage in Chapter 3 (e.g. communication and trust (H13), communication and reporting(H14)).

The adjusted R-square value for safety culture is 0.94, which indicates that 94% of the variance in the safety culture can be explained by the five predictor variables in the HRO model. This can be considered as a robust model as the literature recommends R-squared value greater than 0.7 as a strong model (Moore et al., 2013; Zikmund, 2000). The R-square value for Reporting is 0.63, which means 63% of the variance in reporting result can be explained by the three predictor variables – Leader, Communication, and Training. Similarly, 81% variance in Trust can be explained by Communication and Training.

The safety culture acts as an integrating force in the proposed HRO model (figure 6.2 and figure 6.3) that allows organisational features, including the mindful leader, communication, trust, training, and reporting, to work synergistically to sustain high reliability practices over a longer duration. The systems theory states that relationships and interactions between parts of the system create the system's performance in total

(Ackoff, 1994). Similarly, safety culture in healthcare organisations is influenced by a group of interrelated organisational features, including trust, communication, reporting, training, and mindful leaders, which are all organisational level constructs. This finding is aligned with the conclusion derived by Cantu et al. (2020) that also stated that the culture of reliability is influenced by the organisational factors included in the HRO model and helps differentiate HROs from others. The definition of safety culture from Sutcliffe (2011) aligns with the proposed HRO model that clearly shows how safety culture is influenced by the five predictor variables in the model- leader, reporting, training, communication, and trust.

"safety culture is a part of organisational culture and encompasses what is valued, beliefs about how things work and behavioural norms that determine the degree to which all organisational members direct their attention and actions towards minimising patient harm during delivery of care. (p.141)".

Safety culture is the combination of values, beliefs, and behaviours that will be developed by healthcare workers based on how mindful leaders in the organisation influence communication and reporting across the hierarchy (Frankel et al., 2008; Madsen et al., 2006), provide resources for on-going training of workers for anticipating and containing adverse events (Hales and Chakravorty, 2016; Lekka, 2011), and building trust in the workplace (Cox et al., 2006). This will help in minimising patient harm when delivering care and regularly using practices and controls to act upon the weak signals that pose a threat to safety (Schulman, 2004; Sutcliffe, 2011).

The relationship between mindful leader and reporting/training/communication, as hypothesised in the initial framework (H1-H3), was identified as significant. Mindful leaders create an environment where employees feel safe speaking up and reporting any adverse events (Yun et al., 2005; Vogus, 2011). Leaders play an important role in improving communication across the hierarchy (Hopkins, 2007; Weick and Sutcliffe, 2007). They influence the development of safety-related values and behaviours among healthcare workers (Flin and Yule, 2004; Hofmann et al., 2003; Vogus, 2011) to speak freely about incidents, communicate viewpoints to other co-workers or senior management, and feel comfortable in giving individual-feedback to one another (Hofmann et al., 2003; Flin and Yule, 2004; Jones and Cox, 2005; Cox et al., 2006). Leaders have the capabilities to engage in collaborative sensemaking with their employees through participation in patient safety or quality improvement initiatives.

Their involvement in projects can foster open and constructive communication with staff members, demonstrate their commitment to safety culture and thereby influence the development of an elaborate set of safety behaviours enacted by workers (Vogus, 2011; Hofmann et al., 2003).

Vogus and Sutcliffe (2007b) showed how the impact of safety organising scale on reduction in medication error is the hospital’s nursing units are augmented by trusting their leaders, i.e. if the nurse has more trust in their manager, the impact on the reduction in medication errors is amplified. This is aligned with other findings that have highlighted effective and committed hospital-level leadership impact on other organisation practices (e.g. communication (H3), training (H2), and reporting (H1)) to influence safety culture (IOM, 1999; Singer et al., 2003). However, the doctoral research shows no direct causal relation between leader and building trust (rejecting hypothesis H4) in the organisation, thus refuting the claim of a relationship between the two latent variables in the literature (Vogus and Sutcliffe, 2007b; Whitener et al., 1998).

Another vital role of a leader is to provide resources to enable workers to develop their technical and social skills to anticipate failure/weak signals in the system and contain it when it occurs (Roberts and Rousseau, 1989; Lekka, 2011). For developing such skills, a range of training is offered with the leadership team's support, including on-the-job and off-the-job training. However, the average score for training was reported slightly lower than the other five features of HRO in this doctoral research. There is a scope of improvement in making more investment in training by the leaders to develop workers’ capabilities to enact HRO principles. The result of the study highlighted the positive role played by training in improving reporting (H5 in figure 6.3; significant at 1% level), communication (H6, significant at 1%), and trust (H7, significant at 0.1% level), which further influence the safety culture practice in the Welsh NHS setting. It was interesting to observe that training does not directly impact safety culture (very weak standardised regression weight (-0.090) and result not statistically significant at even 10% level) but have an in-direct effect on the safety culture through reporting, communication, and trust. The above finding is logical and in consensus with the recent HRO literature (Kumar et al., 2020; Babyar, 2020). Investment in on-going healthcare workers' training can further improve trust and communication across the hierarchy (Frankel et al., 2008; Riley et al., 2010; Lekka,

2011) and improve reporting of adverse events, which are essential features of any HROs (Babyar, 2020; Hales and Chakravorty, 2016).

Another interesting finding reported from the SEM analysis, which was not identified from the literature review, was the relationship between communication and trust (H13, see figure 6.3). The findings reveal the direct impact of communication on trust that helps in establishing a safety culture in healthcare organisations. The result indicates that if the organisation has a good communication channel between organisational hierarchy, it can build trusts among employees. Cantu et al. (2020) concluded that the hierarchical communication style in an organisation discourages reporting weak signals and questioning from the employees, which will impact the safety culture that differentiates HROs from others. Revisiting the literature to identify the direct link between communication and trust led to finding limited literature on communication and trust. Nonetheless, the limited literature highlighted the need for a clear, open, honest, and structured communication channel between the hierarchical levels to strengthen trust, foster further identification and reporting of the problem further upstream from harm, and contribute to embedding an organisational culture that sustains high reliability (Chassin and Loeb, 2013; Cox et al., 2006).

The researcher strongly agrees with the justification provided by authors (Chassin and Loeb, 2013; Cox et al., 2006) and evidenced by SEM output in Chapter 5, i.e. well-established communication across the organisational hierarchy will build trusts among healthcare workers across the hierarchy. Continuous communication is essential to build trust among employees or teams and practices such as giving feedback on actions related to minor incidents will help generate and sustain trust between actors within the organisation (Currall and Epstein, 2003; Cox and Jones, 2006). Safety culture built on mutual trust depends on two ways effective communication between workers and managers and discourse is necessary to align views and express concerns (Clark, 1999). This argument further supports the findings in our framework that communication directly impacts the safety culture and has an in-direct impact on safety culture through the mediation effect of trust. Transparent communication promoted by mindful leader encouraged the development and embedding of trust relations between employees and management (Cox et al., 2006). This indicates that the leader has an in-direct effect on building trust among healthcare workers mediated by communication. However, future research need to further test these new findings in healthcare and other settings.

The revised HRO model is aligned with the systems perspective as it suggests how alignment of a mindful leader with constructs such as training, feedback, and communication is important to generate trust and impact on safety culture, thereby enabling high reliability practices.

6.5 HRO Model Alignment with Healthcare Safety Model Literature

The normal accident theory (NAT) proposed by Perrow (1984) focused on understanding complex interaction and tight coupling features exhibited by high-risk industries. He proposed classifying industries into low-risk and high-risk and thereby applying NAT principles to high-risk industry. However, the researcher has argued earlier that such classification is meaningless as HRO or NAT principles are relevant to any organisation irrespective of the type or size of the organisation. Other authors have put forward a similar argument in the HRO field (Vogus and Wellbourne, 2003; Weick and Sutcliffe, 2007). Perrow (1984) and Vincent (2010) suggested that safety study should focus on the organisation as a unit of analysis that will develop a holistic strategy to manage and improve safety. The researcher also conducted a survey with most of the items included in the instrument focused at the organisation level to paint an overall picture of how organisational features in the HRO model applies to the Welsh NHS setting.

The Swiss Cheese model by James Reason (2000) highlighted the importance of identifying holes earlier in the process to avoid a weak signal transforming into catastrophic failure. Reason (2000) suggested that organisations can build the defence to prevent holes from passing through the organisation layer by giving more training to employees and develop robust processes and systems to identify weak signals in the system. However, he stopped short of prescribing actions to reduce failure. The researcher’s HRO model build on Reason (2000) work and explain how safety culture can be built and sustained based on established trust, communication, and reporting across the organisational hierarchy and supported by mindful leadership.

Hollnagel (2004, 2012) work on Safety II aligns with HRO principles as it focuses on taking a proactive approach to understand variability in the work practices and develop a capability to anticipate adverse events or errors in the system. He also proposed 'Efficiency-Thoroughness Trade Off (ETTO)' concept that stated the danger of overemphasising efficiency targets as it may reduce attention to the quality and effectiveness of what employees are doing. He also stated that management and design of organisation system are the major cause of failure in organisations. The ETTO and Safety II models fall short in explaining how organisations can sustain high reliability practices over a long duration.

Charles Vincent (2008, 2010) contribution to patient safety research has also influenced the researcher when conceptualising the HRO model. Vincent argued that NHS still operates in a blame mode of operation (Safety I) and mostly react when failure has already occurred in the system. He proposed five important dimensions for measuring and monitoring safety highlighted the need to move towards the Safety II approach. The five dimensions also align with the '*anticipation*' and '*containment*' principles of HRO. However, his work also failed sort of explaining how to exhibit Safety II or HRO characteristics. The researcher's HRO model, building on Reason (2000), Hollnagel (2004,2009, 2012), and Vincent (2010) work, explains how six organisational features can enable healthcare organisations to exhibit high reliability practices or Safety II features. Thus, the doctoral research help in addressing the gap in the existing literature. The HRO model is also aligned with some of the recommendations provided in Francis (2013), Berwick (2013), and Keogh (2013) reports that highlighted serious quality issues in the UK NHS and how patient safety and care can be enhanced. Some of their recommendations focused on outstanding leadership, listening and supporting staff and patient, and measuring quality improvement. The six organisational features in the researcher's HRO model are aligned with the recommendations provided by three reports to build a culture for delivering enhanced patient care and safety in the UK NHS setting.

The findings of the study are also aligned with some of the recommendations provided by the Bevan Commission (2017), 1000 Lives program, Rapid Response to Acute Illness (RRAILS) Programme to control sepsis, Welsh NHS Confederation reports (2016, 2017), and the Prudent Healthcare initiative (Addis et al., 2019). All the stated initiatives/program undertaken by NHS Wales focus on delivering safer and reliable care and being efficient and effective in the healthcare service provisions. However, these initiatives have struggled to show the intended outcomes due to lack of a more consistent and systems approach to implementation of principles across the organisational hierarchy in all Health Boards (Bevan Commission, 2017; Addis et al., 2019), lack of change in clinicians behaviour to physically and psychologically embrace the change (Barker et al., 2016), and limited investment in prevention-based activities and interventions (Welsh NHS Confederation, 2016). Addis et al. (2019) also identified the issue of capacity caused due to staff shortage, lack of diagnostic services during the weekend, lack of resources within the community, which made it difficult for Hospitals to practice Prudent Healthcare principles.

The HRO model directly addresses some of the weaknesses of the aforementioned approaches to deliver safer care in the Welsh NHS. The HRO model highlights the need to focus on behavioural and socio-aspect of high reliability operations, the joint effort required by clinicians and managers to drive change, focused training to allow employees to implement anticipation and containment principles of HRO, improve communication and feedback across the organisational hierarchy. Clinicians play a critical role in embracing, leading, and sustaining any change program in the NHS, and thus their buy-in and commitment are a must for the success of initiatives such as HRO (Babyar, 2020; Kumar et al., 2020; Lindsay et al., 2020).

A limited study has attempted to develop a customised model/framework/ instrument to measure high reliability practices in healthcare. Amongst the most cited work on HRO in healthcare are Pronovost et al. (2006), Vogus and Sutcliffe (2007 a, b), Chassin and Loeb (2013), Vogus and Iacobucci (2016), and Hales and Chakravorty (2016). While the Chassin and Loeb (2006) study focused at the organisational level (which is recommended by other researchers to study HRO- e.g. Weick and Sutcliffe, 2007), the rest of the study developed items that were either focused on ICUs (Pronovost et al., 2006) or focused on nurses (Vogus 2007, a, b; Vogus and Iacobucci, 2016). Hales and Chakravorty (2016) framework is difficult to apply in the UK NHS setting as it requires time and resource commitment by healthcare workers to practice mindfulness before treating any patient. Also, their study failed to show any improvement in performance by adopting mindfulness practice. The Chassin and Loeb (2013) model only included three aspects to measure high reliability practices- leadership, robust process improvement, and safety culture, contrary to six organisational features in the researcher’s HRO model. Moreover, there is limited evidence of the usage of Chassin and Loeb (2013) model on organisational readiness to progress towards high reliability.

Pronovost et al. (2006) presented a safety framework to improve the reliability of healthcare operations and tested it with executive leaders, team leaders and staff in the ICU setting. They provided a guideline for each level on engaging, educating, executing, and evaluating safety practices in healthcare organisations. The uptake of the proposed framework and its application in the healthcare setting is not evidenced in the HRO or safety management literature. The framework does attempt to explain how to achieve high reliability, but those descriptions are very generic, and there are no clearly defined guidelines to implement the framework. Despite the limitations highlighted in the aforementioned HRO framework/model/ instruments (Pronovost et al., 2006; Vogus and Sutcliffe, 2007 a, b; Chassin and Loeb, 2013; Vogus and Iacobucci, 2016; Hales and Chakravorty, 2016), they have informed the development of the researcher's theoretical model and survey instrument.

6.5 Chapter Conclusion

The discussion chapter has compared the key findings identified from the survey study in the Welsh NHS setting with the literature findings to establish novel contribution of the doctoral study. The first contribution of the study reported was the definition of HRO that was developed based on the 259 respondent's definition and compared with the HRO definition in the literature. The definition moves away from the quantitative measures identified in the reliability literature and builds on the socio- and softer aspects required to enable high reliability practices in the healthcare setting. The working practices discussion highlighted the importance of understanding the context of the healthcare setting in terms of 4Vs, interaction, coupling, labour intensity, customisation, which will help identify and prioritise healthcare operations that will significantly benefit from high reliability practices. The working context also suggested improving communication, reporting and training within the Welsh NHS setting to enable them to exhibit HRO characteristics. This study's most important contribution is testing the hypothesised HRO model and revising the model to explain how the six organisational features enable high reliability practices in the healthcare setting. As per the researcher knowledge, this is amongst very few studies that have proposed and tested an HRO model and address the key gap in the literature- how organisations can embrace the five principles of HRO?. The sensemaking perspective helped in theorising and explaining the relationship between six latent variables in the HRO model.

Chapter 7 Conclusion

7.1 Introduction

This chapter will outline the conclusions of this thesis and bring this study to its close. The chapter will reflect upon the research journey and also declare the contributions of the study with respect to the aims and research questions that have guided the study. The chapter will also present and suggest future research directions to advance this embryonic yet critical field of operations management and organisational research.

The research aim and research questions were declared as:

This **research aim** to *develop a HRO theoretical model to understand the concept of the HRO as it applied within the context of the Welsh NHS setting*. The aim of the study is achieved by answering the following two research questions.

Research Question 1 (RQ1): What are the perceived organisational features that enable higher reliability in the healthcare context?

Research Question 2 (RQ2): How the perceived organisational features interact with each other to enable higher reliability in the healthcare

Before answering the research questions, it is essential to understand how respondents to the survey defined the term HRO and what they thought about their working contexts. The literature review highlighted the need to understand "context" (Harvey, 2016; Daultani et al., 2015) before developing any solutions to address patient safety. The findings and discussion chapters first focused on defining HRO and the working context of the Welsh NHS and thereafter answer RQ1 and RQ2. The discussion chapter has already compared how the key findings compare with those reported in the existing literature and how this research has addressed the key gaps in the HRO body of knowledge. In this chapter, the researcher has summarised the key contributions to research and practice that was identified in the last chapter (Chapter 6).

7.2 Contribution to Research

This doctoral research has contributed to the HRO body of knowledge in the following four categories:

- The study has demonstrated the relevance of “sensemaking” and system theories when conducting HRO research in critical safety settings;
- The findings of the study redefine the term “HRO” from a sensemaking and systems theories perspective and have resulted in a ‘bottom up’ (interpretation of HRO in the context of healthcare);
- The findings show the inter-related working practices that impact high reliability working practices and the revised HRO theoretical model explains the interrelationship between the organisational features that promote high reliability practices; and finally
- The new model, which results from this study, closes a gap in the extant academic body of knowledge concerning the HRO model and how they are presented in the literature.

Each of the contributions will now be explored.

The *Sensemaking perspective* and *Systems theory* helped the researcher in the theory building and theory testing phases of the doctoral study and provided support to the findings reported by the survey study within the Welsh NHS context. The cognitive process underpinning sensemaking (Weick et al., 2005; Mamykina et al., 2015) allowed the researcher in the theory-building phase to engage with academic literature, synthesise the key findings linked to organisational features enabling high reliability healthcare practices, and determine the relationships between organisational features in the HRO theoretical model. In the theory testing phase, the retrospective analysis, bracketing and labelling aspect of sensemaking theory (Weick et al., 2005; Mamykina et al., 2015) helped the researcher to compare and contrast the meaning/definition of HRO provided by 259 survey respondents with those cited in the academic literature. This process enabled the researcher to propose her definition of HRO that combines the technical and social aspects required to sustain high-reliability practices in the healthcare setting. Similarly, the sensemaking perspective also allowed to interpret the findings linked to the Welsh NHS's working practices and how those practices may have an impact on enabling high reliability practices in the healthcare setting. As the response to 22 statements in the working context was classified as ‘yes’ or ‘no’, there was a limited scope of conducting inferential statistical analysis. Thus, the researcher used a sensemaking perspective to interpret those results and explain how working practice may impact embracing HRO principles.

Systems theory was the secondary theory applied in this study that emphasises taking a systems approach to understanding how different parts of the system interact with each other and get affected by the environment or surrounding conditions. The IOM report (Kohn et al., 2000), Safety II concept (Hollnagel, 2012) and several other reports linked to safety issues in healthcare (e.g. Keogh, Berwick, Francis, WHO, Bevan Commission, Prudent Healthcare) advocate that quality improvement focus should be on “the healthcare system” as a whole, which was adopted in the doctoral research study. The unit of analysis was considered to be the ‘organisation’ which allowed the researcher to take a systems perspective when analysing and interpreting the result, as advocated by other researchers studying healthcare (Anderson, 2016; Petula, 2005). The definition of HRO proposed by the researcher is also influenced by systems theory. The definition encapsulates the technical and socio elements, a key feature of the systems theory that allows developing a holistic understanding of HRO. The systems theory also helps in the theory testing phase to explain how the organisational features in the HRO model interact and impact the safety culture, thereby affecting high reliability healthcare practices. The revised HRO model provides a holistic explanation of how an organisation can transition towards HRO, addressing a key gap highlighted in the literature review process.

Summarising the key contributions of this study linked to the definition of HRO are as follows: 1) the definitions provided by healthcare workers focused more on the socio-elements compared to those highlighted in the literature, where the focus was more on quantitative measures of accidents and errors; 2) similar to other improvement initiatives (such as Lean healthcare), socio-elements plays a huge role in sustaining improvement and safety culture in organisations as evidenced from the definition of HRO provided by survey respondents; 3) the definition of HRO applies to all types and size of organisations as any organisation would like to have sustained and error-free performance; 4) the perception of what safety and high-reliability practices mean may vary between clinicians and managers.

Summarising the key contributions concerning the understanding of working practices of the Welsh NHS organisations and its link to HRO are as follows: 1) understanding healthcare processes in terms of 4Vs of Operations, coupling (tight vs. loose), and interactions (complex vs. linear) can help clinicians and managers to take a customised approach to develop strategies for high reliability practices based on process characteristics discussed above. 2) increasing work pressure and stress caused due to capacity and skills issue (high volume and variety of patient, lack of right amount and right skill mix of staff) are not conducive for enabling high reliability practices. This finding is also aligned with those reported in the Lean healthcare literature that suggest muri (overburden) can cause "mura" (variation in working practices) and "muda" (waste creation in the healthcare process). 3) training is key for enabling high reliability practices as it allows healthcare workers to practice anticipation principles of HRO (first three HRO principle) by identifying weak signals in the system and use the containment principles (4^{th} and 5^{th} principles of HRO) to respond quickly and contain any adverse impact on patients. 4) clinical and managerial staff need to work together to embed and sustain a safety culture in the healthcare setting. 5) reporting of safety incidents, learning from those adverse events and having a fair safety investigation process can embed a safety culture in the NHS, which is also statistically proven to impact safety culture in the HRO model.

Summarising the key research contributions (including answering the two research questions) when testing and revising the HRO theoretical model, the researcher claims the following contributions that will help in advancing the HRO body of knowledge: 1) this is amongst very few study that has identified how organisations can foster high reliability work practices in the healthcare setting by focusing on developing a safety culture through mindful leadership, investment in training, promoting communication and feedback across the organisational hierarchy, and building trust; 2) this is the first study in the healthcare setting that establishes the causal link between organisational features that facilitate high reliability practices in the form of HRO model; 3) model fit indices, RMSEA values, and adjusted R -square value for safety culture demonstrate the robust HRO model that has managed to encapsulate the key organisational features promoting high reliability practices in the healthcare setting;

4) the model proves the importance of on-going training for healthcare workers to enable them to identify weak signals and contain adverse events quickly when it occurs; 5) it also demonstrates how training can help in improving communication, trust, and reporting in the healthcare setting; 6) leader has in-direct effect on trust (thus rejecting the hypothesis and initial assumption of direct relationship) mediated through communication; 7) communication has a direct effect on improving reporting and building trust in the healthcare setting, which was not identified in the hypothesised theoretical HRO model; 8) reporting, communication, and trust have a direct impact on safety culture, whereas leader and training have an in-direct effect on safety culture mediated through reporting, communication and trust; 9) the revised HRO model addresses the gap in the literature and also build on some of the existing HRO framework/model/instruments to explain how organisation can achieve high reliability healthcare practices. The HRO model aligns with the Safety II work of Hollnagel (2004, 2012) and explains how organisations can transition from Safety I to Safety II / HRO by understanding the interactions between organisational features that enable high reliability practices in healthcare setting.

7.3 Implications for Practice

Based on the alarming statistics on patient harm explored previously, it is difficult to claim healthcare organisations exhibit the features of resilience that characterise HROs (Babyar, 2020; Cantu et al., 2020; Kumar et al., 2020). HROs enable employees to identify weak signals early and take remedial actions to prevent harm. However, healthcare organisations and teams struggle to identify those weak signals earlier in the process due to lack of system and process integration (as identified in reports from the Welsh NHS Confederation, Bevan Commission, and Addis et al., (2019)), overburdened workforce (also identified in the Prudent Healthcare research by Addis et al., (2019)) lack of redundancy or slack resources (e.g. dedicated improvement teams or clinicians having trained in process improvement), uncoordinated and poorly designed processes, intimidating behaviour from senior management that does not help in reporting unsafe behaviours (Barker et al., (2016) and Bevan Commission (2017) identified the need for Welsh clinicians to their behaviour towards patient safety initiatives). Also, the professional demarcation of different speciality (and demarcation across the organisational hierarchy levels) does not help take a "joined-up" systems theory approach to improve the reliability of the processes or embed a safety culture.

This doctoral research has many implications for healthcare workers and researchers on transitioning from Safety I to Safety II practices to embrace HRO. In doing so, healthcare needs to balance the technical and social elements that influence high reliability practices. The literature review and empirical study have highlighted (e.g. Ghaferi et al., 2016), innovation in technology and improvement methodology has a limited effect on mortality rate reduction when used on its own. However, when a healthcare organisation seeks to build a safety culture on the principles of HRO, they are much more likely to avoid saturation point in reducing errors and will accelerate improvement when coupled with innovative technology or improvement methodology.

In the last two decades of patient safety research, since the publication of the IOM report (Kohn et al., 2000), healthcare is still plagued by adverse events and errors, despite significant advancement in healthcare technology and improvement methodologies used in healthcare setting. The unintended consequences of focusing on achieving hospital-level targets have compromised on safety outcomes and safer care provision, as evidenced by the Mid Staffordshire NHS Trust scandal, where more than 600 patients died in a decade, and 95% of those errors were preventable. As systems theory suggest, don't make decisions in isolation and understand the relationships and interactions between different parts of the system, which often does not happen in the healthcare setting. Thus, mindful leaders in healthcare need to prioritise patient safety over efficiency-related targets to transition towards high reliability practices.

The definition of HRO and the HRO model, proposed by the researcher, highlights the importance of socio-factors in enabling high reliability practices. Healthcare leaders can only improve safety culture if they inspire and support their workers by improving communication, trust, and reporting culture across the organisational hierarchy. Here, training plays a significant role in fostering improvement in communication, building trust, and improving reporting culture, allowing to embed safety culture within healthcare organisations. As this HRO study has highlighted, the managers and clinicians need to work together and support each other to realise high reliability healthcare practices. Similar results were reported in Lean healthcare research (e.g. Bortolotti et al., 2018; Lindsay et al., 2020), where tensions between clinical and managerial roles resulted in a lack of sustainability of lean in the healthcare setting. The improvement initiatives should be jointly led by clinical and managerial staff, also identified in the Bevan Commission (2017) and Prudent Healthcare (Addis et al., 2019) reports for the Welsh NHS, to maximise the impact of the initiative on patient safety-related outcomes.

The doctoral research highlighted the importance of understanding the context in which the study is undertaken to avoid developing ‘one size fit all’ solutions for addressing quality issues in the healthcare setting. Understanding 4Vs of operations, type of coupling (loose versus tight), and type of interactions (linear versus complex) exhibited by the healthcare processes will define the type of intervention or solution developed to address the healthcare issues. For example, the orthopaedics department doing particularly conducting knee or hip surgery follows a very standardised procedure for performing surgery, experience less variation and complications, interactions are mostly of linear type, and thus can treat a high volume of patient right first time compared to ICUs or Accident & Emergency department in the hospital. Applying operations management principles to the healthcare setting can help in achieving efficiency and effectiveness metrics simultaneously. An excellent example of such practice is evidenced by the Arvind Eyecare Clinic in India (also termed as “Macdonaldisation” of eyecare surgery) that conducts 400000 eye surgeries annually at a minimal cost (60 times less than in the USA) and without compromising on the quality of surgery (clinical outcomes are superior to the average in the UK hospitals), i.e. achieving high reliability practices at the lower cost (Krishnan, 2015).

Lots of healthcare processes that exhibit high volume, low variety, and low variation can benefit from the use of robotics, digitisation or automation to improve the reliability of the healthcare processes and at the same time allow their expensive staff to focus on other important activities linked to patient care. In an example shared by Chassin and Loeb (2013), where caregivers listen to several hundreds of safety signals per patient emitted by devices such as intravenous infusion pumps or cardiac rate and rhythm monitors, they often experience ‘alarm fatigue’ and may take unsafe actions including lowering the alarm sound or turning it off completely. The majority of the devices used are not integrated with each other, and even staff are not trained to properly use those devices (Chassin and Loeb, 2013). This problem requires collaboration across the healthcare supply chain, including device manufacturers, IT experts, clinical staff, medical informatics professionals, and hospital managers and administrators.

Healthcare can benefit from the integration of processes and decision making with technology to ensure seamless sharing of real-time information across the patient pathway and improve quality of care. However, such an integration is only possible through mindful leadership and end to end integration of healthcare processes with technology. IT plays a vital role in achieving HRO characteristics and sustaining performance over the longer-term. However, the researcher has read about several IT projects failures in the NHS that have failed to integrate technology with people and process. At the same time, several healthcare processes are broken and do not interact with each other (e.g. as highlighted in Francis report (2010), Elliot et al. (2018)). It needs to be fixed, streamlined and integrated first before digitising the healthcare processes as automation of an unsafe process will only increase the risk of harm to the patient when the process is automated (Sparnon and Marella, 2012).

And lastly, how healthcare workers are trained and educated by the university and educational system requires overhauling. Healthcare students in the university are not exposed to OM or HRO topics. Teaching students about high reliability organisational features identified in this study and the basic operations management principles will help them become good clinical workers and develop their managerial thinking required for implementing and sustaining patient safety /improvement initiatives. The researcher would advise the students to learn HRO and OM principles through a case study based approach (exemplar cases of application of HRO /OM principles in healthcare) and use this in-depth knowledge to test their understanding to engage with this subject fully and within the confines of healthcare.

7.4 Implications for Policy

This study has focused on the principality of Wales in the United Kingdom. The researcher believes that her work can be generalised to other contexts in public health care providers with a similar type of healthcare processes. All the safety incidents and errors reported since the IOM report publication highlight a lack of systems thinking in the healthcare setting when embracing quality or patient safety initiatives. The ranking of Health Boards or Trusts based on a list of metrics results in unintended consequences where measures drive poor behaviours. This may include Boards/Trusts manipulating data to meet or exceed the targets, treat patients as numbers to meet bed availability targets, forced towards micro-level working with a focus on achieving their Ward or department targets, and more importantly, compromise on promoting reporting and safety culture.

An example of this can be seen in Accident & Emergency Services, where healthcare providers manipulate the systems condition to achieve high scores for treating patients within 4 hours, a target given by Policymakers. Instead of only focusing on targets, which is an efficiency-based measure, healthcare should move towards designing services aligned with patient requirements and processes designed to get treatment right first time. The GIRFT(get it right first time) initiative launched by orthopaedic surgeons (namely Prof. Tim Briggs in 2012) focuses on treating patients safely and right first time as a means of reducing waste and releasing resources for the cash strapped NHS to reallocate to other activities (Pym, 2017; https://www.gettingitrightfirsttime.co.uk/). The policymakers need to promote initiatives like GIRFT in conjunction with targets to improve the reliability of healthcare service offerings.

The HRO model highlights the importance of socio-factors in enabling high reliability practices. Most of the complaint analyses in the healthcare setting has highlighted that communication between the hierarchy or between clinical staff and patients is the main cause of errors or complaints. Policymakers should work in collaboration with education providers (e.g. University or Professional bodies such as Bevan Commission) to change the existing curriculum and upgrade the syllabus by including subjects like operations management, systems thinking, HRO, quality management, leadership and change management, driving innovation, to name a few topics that get taught to all undergraduate medical students. This will have a long-term beneficial impact when these students join the healthcare organisations as they will come with the right mindset on how to enable high reliability practices by taking a system theory approaches to care provision. Medicine school in Universities need to work closely with the Business Schools to develop an effective curriculum that encapsulates topics focused on both technical and socio- aspects of healthcare delivery and facilitate in developing capabilities of students to anticipate weak signals and contain those signals when it occurs through experiential case study approach to learning.

The HRO model highlighted the importance of training in improving communication, trust, and feedback culture, thereby promoting a safety culture in the healthcare setting. However, the overburden of staff and long waiting time to treat patients, along with resource constraint issues, does not help healthcare workers focus on their own development and learn best practices to deliver care and treatment, right first time. Government bodies and policymakers need to incentivise staff to regularly attend training and skill development courses to be aware of the best-in-class approaches to high reliability care provision. Similar to approaches in manufacturing such as Toyota, which organises several events with all stakeholders in the supply chain to share and learn best practices, policymakers can provide resources to Professional Bodies such as 1000 Lives and Bevan Commission to conceptualise quarterly HRO workshops for sharing best practices across Welsh NHS.

Government bodies and policymakers also need to fully understand that high reliability organisational management is not the same as (and has not yet merged as an integrated element of) other service improvement methods and approaches. This lack of integration and the coupling between what is good for safe care and what is good for process improvement is a major void, and governments would be well advised to increase levels of education, potentially fund positions to promote HRO principles in the large-scale hospital and increase the engagement of the professional bodies that represent healthcare employees. The engagement of professional bodies with a high reliability organisational approach would help reinforce the importance of safety from a professional perspective and this forms the last recommendation of this section.

7.5 Reflections on the Research Journey and its Improvement

Conducting doctoral research takes many years and thousands of hours of applied practice. The course of a research project can never be fully planned nor anticipated. The “roller coaster PhD ride” forces a researcher to go through cycles of reflection, assimilation of ideas, synthesis of ideas, after having identified a research gap. This reflection process is aligned with the sensemaking perspective and systems theory approach to problem-solving applied in this doctoral study. The literature review process, which is enjoyable but a painstaking journey and requires perseverance, applied the sensemaking perspective to start identifying the themes and labelling them and systems theory approach helped to synthesise the literature, join different themes together into a coherent theoretical model.

This doctoral study has experienced many points at which the researcher would reflect and rethink events. In retrospect, very little of this research study methodology would actually be changed if this study was to be repeated. The methodology has proven to be highly effective in answering the research questions and engaging with participants and informants from healthcare settings. Upon reflection, however, the researcher experienced the withdrawal of certain health boards at the point at which she was enlisting participating organisations, and upon reflection, she would have applied greater effort to ensure organisations continued to participate in her study. This would mean that more time and effort would be spent with the Welsh Health Boards executives to ensure they participated. This would enlist a wide variety of stakeholders to gain acceptance to any study of this kind.

The researcher underestimated the time it takes to go through the service evaluation process at each Health Board and get approval to administer the online survey instrument with employees across the organisational hierarchy at each Health Board. After the "ethics approval" process was completed at Swansea University, the researcher needed to contact each Board and negotiate access. Out of seven Health Boards, only 3 Boards and one Trust agreed to participate in this study. Still, the paperwork to get the service evaluation approved took approximately nine months across the four Boards/Trust. This time could have been more effectively utilised and shorten the PhD completion cycle. The delay in "ethics approval" and the decision to use a questionnaire (collecting 259 responses as a result) forced the researcher to drop the idea of focusing on a single case organisation to test the HRO model in depth with a single employer. This event was unfortunate but did not undermine the contribution of the study. The Health Board, who initially showed interest in participating in the case study phase in November 2019, pulled out due to enormous work pressure in December 2019 and January -February 2020, and thereafter COVID19 pandemic didn't allow to pursue this request further. The researcher would have also enlisted a longitudinal case study had the time, and the resources been available within the constraints of a doctoral study. This designed method would be risky and would have exposed the researcher to the potential that the case study would begin the research but would not complete the study.

Apart from these modifications, the researcher would not have changed any aspect of her design.

7.6 Limitations and Future Research Directions

Like any research study, this doctoral research also has a few limitations which will be addressed in future research. The service evaluation process in each Health Board required the researcher to take out the demographic questions linked to the department to keep the respondents were employed and instead to use anonymous coded links. The lack of department identification information did not allow the researcher to classify the respondents into low-risk and high-risk healthcare operations (as discussed in Chapter 1, Chapter 3, Chapter 5, and Chapter 6) and thereby conduct cluster analysis across the two groups to highlight any similarity or differences in response linked to the HRO model. Our future research will focus on the context to understand how to develop a customised approach for high reliability depending upon the context of the study.

In the research design phase of the study, the researcher acknowledged the practical limitations of conducting this research (i.e. separate service evaluation/ ethics approval was required at each Health Board/ Trust to gain access which would take significant time if the researcher plan to include Health Boards in Wales and England) and thus only focused on the principality of Wales. The natural extension of this work is to repeat this study but with healthcare organisations from the rest of the United Kingdom. This study would allow the researcher to detect regional differences in the understanding of highly reliable organisations. If differences are found to exist, this would be interesting because it would suggest that the organisational combination of healthcare providers in the locality has a much better group approach to high reliability organisations. If there are differences in individual organisations in the study, that will provide outline behaviour that could inform more theory building.

As stated in the previous section, the researcher tried to conduct a single case study to test the robustness and validity of the HRO model proposed in this study. However, due to the access issue and lack of time, this was not feasible to achieve. The researcher will extend the doctoral research to test the HRO model by conducting multiple case studies in the Welsh and English NHS. The researcher also plans to conduct a secondary analysis of Care Quality Commission (CQC) reports that classify Boards/Trusts as inadequate, adequate, and outstanding based on the five criteria – safe, effective, caring, responsive, and well-led. The secondary analysis will be conducted using the six organisational features of the HRO model and compare how these features are practised differently between Trusts/Boards who were rated as inadequate, adequate, and outstanding. The secondary analysis can inform practitioners and policymakers how outstanding hospitals manage to demonstrate HRO principles and practices.

Another area for fruitful future research is to compare the United Kingdom or, more specifically, those organisations in Wales with organisations in other countries. The purpose of the prospective study will be to test national differences or cultural differences in approach to safety and developing highly reliable systems across the world. This study should include private health care providers in countries such as America or Germany and public organisations because this would allow testing national differences and differences that result from different funding models.

The researcher would also like to conduct a longitudinal study lasting between three and five years to understand how the Welsh Health Boards change over time and whether a common model will eventually be reached through isomorphic change. Emulation of best practice should present the opportunity for sharing common ways of working across common or specific health care pathways. As such sharing best practice in the pathology labs or in palliative care should result in a common model, and a longitudinal study would be able to detect whether models are changing and looking more common. This research would also help to establish the sequence in which organisations change to gain higher reliability and the learning process involved.

7.7 Final Comments

This last paragraph represents the final element of this thesis and the end of a very long journey. This research has presented new insights into high reliability organisations, and it is hoped that future students research in this area of operations management will find this thesis useful to their studies.

Manisha Kumar

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Appendix I: Survey Instrument

Professor Nick Rich,
[redacted], School of Management,
Bay Campus, Fabian Way,
Swansea SA1 8EN

Dear Participants

The purpose of the research study title ***"How do organisations support or inhibit high reliability healthcare processes***, is to investigate what characteristics of Highly Reliable Organisation (HRO) are practiced within the context of healthcare management and how those practises impact on patient safety outcomes and staff outcomes.

This research is conducted by Manisha Kumar, PhD student at School of Management Swansea University, **under the supervision of Prof Nick Rich**, Dr Yujie Cai and Dr. Paul White who can be contacted via following email addresses: [redacted] [redacted] [redacted] [redacted] . I am writing, therefore, to invite you to contribute and benefit from this study. You are under no obligation to participate in the survey and you may decline to answer any given question.

All information we collect about you and your organisation will be treated in strict confidence. Identities will be kept anonymous in any reports or other publications we may produce.

The survey will take approximately 15-20 minutes to complete.

If you have any queries or require any further detail regarding the above-mentioned information, please do not hesitate to contact me at your convenience. If you wish to access the results, please leave your contact details at the end of the survey and we'll send out our findings to you via email in due course.

Thank you for your time and cooperation.

Yours Sincerely,

Manisha Kumar
PhD Student
School of Management
Swansea University
Fabian Way, Crymlyn Burrows,
Swansea, SA1 8EN
Email: [redacted]

Section 1 Organisation & Background

This section was designed to understand your background and your organisation. Please place an ‘x’ in the box that best describes your role within your employer organisation.

1.1 Your Role:

☐	Executive or Director	☐	Consultant	☐	Patient Safety Officer	☐	Medical Doctor
☐	Clinical Governance Manager	☐	Manager	☐	AHP or Nurse	☐	Specialist
☐	Other (please specify)						

1.2 How would you describe yourself?

☐ a. Female ☐ b. Male ☐ c. Transgender ☐ d. Prefer not to answer

1.3 What is your age?

☐ a.18-24 years old ☐ b. 25-34 years old ☐ c. 35-44 years old

☐ d. 45-54 years old ☐ e. 55-64 years old ☐ f. 65+ years old

1.4 How long have you worked in this hospital?

☐ a. Less than 1 year ☐ b. 1 to 5 years

☐ c. 6 to 10 years ☐ d. 11 to 15 years

☐ e. 16 to 20 years ☐ f. 21 years or more

1.5 In your staff position, do you typically have direct interaction or contact with patients?

☐ a. YES, I typically have direct interaction or contact with patients.

☐ b. NO, I typically do NOT have direct interaction or contact with patients.

1.6 What does the term Highly Reliable Organisation (HRO) mean to you?

1.7 As you have defined a Highly Reliable Organisation - How would you rate your performance at the level of your:

1. Organisation	☐	Very Poor	☐	Poor	☐	Average	☐	Good	☐	Very Good
2. Department	☐	Very Poor	☐	Poor	☐	Average	☐	Good	☐	Very Good

Section 2 Patient Safety and Highly Reliable Organisational Practice

This section concerns your view of highly reliable organisational practices and also how well practiced they are in your organisation. Please place an 'x' in the box that most closely describes your view of the current state of practice at your organisation.

OUR PRACTICE
5: All the time **4: Often** **3: Sometimes** **2: Rarely** **1: Never**

To be a highly reliable organisation implies..	1	2	3	4	5
Clinicians/Managers in leadership positions - at all levels of the organisation - should have a shared vision of patient safety	☐	☐	☐	☐	☐
Clinicians/ Managers in leadership positions - at all levels - should align policies and activities to support patient safety	☐	☐	☐	☐	☐
Clinicians/Managers should actively participate in Quality improvement activities	☐	☐	☐	☐	☐
Clinicians / Managers should promote Quality improvement activities	☐	☐	☐	☐	☐
Discussion about patient safety concerns should be promoted	☐	☐	☐	☐	☐
Top management should have visible, consistent involvement in patient safety activities	☐	☐	☐	☐	☐
Top management should make it easy for employees to voice concerns linked to adverse events	☐	☐	☐	☐	☐
To build trust amongst all employees is necessary for effective safety improvement	☐	☐	☐	☐	☐
To build trust amongst employees helps to deal with problematic situation at work	☐	☐	☐	☐	☐
Involvement of teams in the process of improvement will lead to increased commitment to patient safety objectives	☐	☐	☐	☐	☐
Staff should be multi-skilled to be able to back up and support each other	☐	☐	☐	☐	☐
Co-workers feel comfortable giving individual feedback to each other	☐	☐	☐	☐	☐
The team feel comfortable about sharing feedback periodically	☐	☐	☐	☐	☐
When demand for a service gets really busy others in the team will help out	☐	☐	☐	☐	☐
Top down and bottom up open communication is important to build team trust	☐	☐	☐	☐	☐
Safe working to established standards should be the responsibility of the individual	☐	☐	☐	☐	☐
Organisations should not blame individual members of staff for safety failures/events	☐	☐	☐	☐	☐
Individual staff members should be disciplined for deliberate actions of noncompliance with established standards.	☐	☐	☐	☐	☐

To be a highly reliable organisation implies..	1	2	3	4	5
Trust will increase due to open discussions of safety issues	☐	☐	☐	☐	☐
Team members are encouraged to freely speak out about their views and experiences	☐	☐	☐	☐	☐
The use of easy to understand structured communication so all team members can participate in safety management practices	☐	☐	☐	☐	☐
Good communication flow exists up and down the chain of command	☐	☐	☐	☐	☐
Training and simulation are used improve the practical skills of staff	☐	☐	☐	☐	☐
Practicing for emergency situations helps the team to cope with such events when they happen	☐	☐	☐	☐	☐
Multidisciplinary team training will result in working more effectively	☐	☐	☐	☐	☐
Multidisciplinary team training will result in working more efficiently	☐	☐	☐	☐	☐
There needs to be a regular investment in knowledge and skills development	☐	☐	☐	☐	☐
Training on resource management helps in better decision-making behaviour and minimises potential errors	☐	☐	☐	☐	☐
Trust among employees supports an effective safety culture	☐	☐	☐	☐	☐
Open reporting of incidents amongst team members supports an effective safety culture	☐	☐	☐	☐	☐
Improving clinical practices supports an effective safety culture	☐	☐	☐	☐	☐
Formally assessing safety culture is key to maintaining effective reliability	☐	☐	☐	☐	☐
Taking prompt actions because of safety culture audits supports effective reliability	☐	☐	☐	☐	☐
Staff feel comfortable ‘speaking up’ when they witness unsafe practice	☐	☐	☐	☐	☐
Staff feel free to question individuals with more authority when they witness unsafe practice	☐	☐	☐	☐	☐
Formal briefings are used to reduce errors before any major process that has potential for failures	☐	☐	☐	☐	☐
Checklists are used to formally assess whether a process can be undertaken safely	☐	☐	☐	☐	☐
Frontline staff must have high levels of empowered accountability for patient safety	☐	☐	☐	☐	☐
Teams report mistakes/near misses to prevent errors from happening again	☐	☐	☐	☐	☐
Staff are informed about errors that have happened	☐	☐	☐	☐	☐
Transparency in reporting enables greater improvement of patient safety	☐	☐	☐	☐	☐
Staff are given feedback about changes enacted as a result of event/error reporting	☐	☐	☐	☐	☐

Staff discuss ways to prevent errors from happening	☐	☐	☐	☐	☐
Quality/safety reporting should be measured to track the frequency of failures	☐	☐	☐	☐	☐
To be a highly reliable organisation implies..	**1**	**2**	**3**	**4**	**5**
The actions taken after quality/safety reports should be communicated to hospital staff/public	☐	☐	☐	☐	☐
Patients should be encouraged to contribute to error reporting	☐	☐	☐	☐	☐
Patients should be accountable for their own safe practice	☐	☐	☐	☐	☐
Frontline staff need to build a collaborative relationship with middle management	☐	☐	☐	☐	☐
During an adverse event the person with the best knowledge will lead the corrective actions needed regardless of hierarchical position	☐	☐	☐	☐	☐
Dictatorial/autocratic leadership should not be used to manage teams	☐	☐	☐	☐	☐
Robust process improvement tools (like Lean, six sigma or change management) are effective in making healthcare safer	☐	☐	☐	☐	☐
Root cause analysis should be conducted after a failure or event	☐	☐	☐	☐	☐
Teams feel more engaged when a bottom up approach to process improvement is regularly practiced	☐	☐	☐	☐	☐
Standardization of process (based on quality methods) should be practiced but allow some flexibility to choose between standards	☐	☐	☐	☐	☐
Staff at lower hierarchy levels of clinical competence can be trained to identify errors	☐	☐	☐	☐	☐
Staff at lower hierarchical levels of clinical competence should be encouraged to report errors.	☐	☐	☐	☐	☐
High investments in trust will allow employees to be more accountable for their actions	☐	☐	☐	☐	☐
Investments in trust will lead to greater self-reporting of errors and near misses	☐	☐	☐	☐	☐
A failure to comply with a safety procedure should be followed up with retraining where necessary rather than instant disciplinary action	☐	☐	☐	☐	☐
Persistent failures to comply with safety rules should be equated with disciplinary actions taken against the individual	☐	☐	☐	☐	☐

Section 3: The Working Context

When thinking about your workplace and the types of patients you deal with, please place an ‘x’ in the box that most closely describes your view.

Statement	Yes	No	Not Applicable
My department has a lot of staff turnover	☐	☐	☐
I rarely work with the same people each month	☐	☐	☐
The workplace is very pressured	☐	☐	☐
We have lots of standardised procedures	☐	☐	☐
We have a high volume of typical patients	☐	☐	☐
We have high variety of patient types each week	☐	☐	☐
Patients often complain about the treatment they receive	☐	☐	☐
We have too many reported incidents	☐	☐	☐
We often don’t bother to report incidents	☐	☐	☐
We often experience a lack of information about the patient	☐	☐	☐
Many of our mistakes and errors are avoidable	☐	☐	☐
We lack the right amount of staff to be safe	☐	☐	☐
We lack the right skills mix to be safe	☐	☐	☐
Handovers between teams is managed in a systematic way	☐	☐	☐
It is difficult to detect when an error has been made	☐	☐	☐
We often spend time with patients sorting out missing information	☐	☐	☐
The safety incident investigation procedure is quite intimidating to those involved	☐	☐	☐
Our team has the necessary ongoing training	☐	☐	☐
We learn from our mistakes	☐	☐	☐
We know where to find best practices from other organisations	☐	☐	☐
We have a good safety culture	☐	☐	☐
We have a written strategy of patient safety improvement	☐	☐	☐
We have an area in our workplace that measures and promotes our safety performance	☐	☐	☐

Contact Details:

If you would be interested in receiving executive summary of the findings and also participate in future study, please complete your contact details below.

Name		**Organisation**	
Telephone		**Email address**	

Appendix II: Ethics Approval Forms

Swansea University Full Ethics Approval

FULL ETHICAL REVIEW FORM

Name of PI or Student	**Manisha Kumar**
Supervisors*	**Prof.Nick Rich, Dr. P.White & Dr.Yujie Cai**
Date Submitted	**16th July 2018**
Title of Project	**How do organisations support or inhibit high reliability healthcare processes?**
Name of Funder / Sponsor*	**Swansea University**
Finance Code / Reference*	
REC Reference Number	
Duration of Project	*October 2016 – September 2019*

* *Complete if appropriate*

Research must not commence without the approval of the REC

*Attach the following as appropriate. (Those marked * must be submitted)*

- ☑ The full research proposal, with sufficient detail to enable assessment.*
- ☐ Research Ethics Risk Assessment*
- ☐ Letter of ethical approval from another Research Ethics Committee.
- ☐ Information Sheet to be given to potential research participants.
- ☐ Informed Consent form to be given to potential research participants.
- ☐ Written consent from gatekeepers / stakeholders.
- ☐ Research Instruments (e.g. interview schedule, questionnaire).
- ☐ Clearance letter from Criminal Records Bureau (CRB) or equivalent if required.
- ☐ Protocol to ensure compliance with data-protection legislation.

*Provide **a full account** of how you will address **each** of the ethical issues that were identified during the light-touch 'risk evaluation.'*
✓ *Tick those boxes that were identified during the 'light-touch' ethical review*
✗ ***Cross** those boxes that were not identified during the 'light-touch' ethical review*

☑ Will the study involve recruitment of patients or staff through the NHS or the use of NHS data or premises and/or equipment? If this is the case, the project **must** be reviewed by the NHS NRES. (http://www.hra.nhs.uk/research-community/before-you-apply/determine-whether-your-study-is-research/

☒ Does the study involve participants aged 16 or over who are unable to give informed consent? (e.g. people with learning disabilities: see Mental Capacity Act 2005. All research that falls under the auspices of the Act **must** be reviewed by the NHS NRES.)

☒ Does the research involve other vulnerable groups: children, those with cognitive impairment or in unequal relationships? (e.g. your own students). This **may** require review by the NHS NRES.

☒ Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of self-help group or residents of nursing home?)

☒ Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in non-public places)

☒ Will the study discuss sensitive topics? (e.g. sexual activity or drug use)

☒ Are drugs, placebos or other substances (e.g. foods or vitamins) to be administered to study participants, or will the study involve invasive, intrusive or potentially harmful procedures of any kind? (If any substance is to be administered, this **may** fall under the auspices of the Medicines for Human Use (Clinical Trials) Regulations 2004, and require review by the NHS NRES.)

☒ Will tissue samples (including blood) be obtained from participants? (This would fall under the terms of the Human Tissue Act 2004. All research that falls under the auspices of the Act **must** be reviewed by the NHS NRES.)

☒ Is pain or more than mild discomfort likely to result from the study?

☒ Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?

☒ Will the study involve prolonged or repetitive testing?

Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?

☒ Is there a possibility that the safety of the researcher may be in question? (e.g. in international research: locally employed researchers)

☒ Does the research involve members of the public in a research capacity (e.g. participant research)?

☒ Will the research take place outside the UK where there may be issues of local practice and political sensitivities?

☒ Will the research involve respondents to the Internet or other visual/vocal methods where respondents may be identified?

☒ Will *research* involve the sharing of data or confidential information beyond the initial consent given?

☒ Will financial *inducements* (other than reasonable expenses and compensation for time) be offered to participants?

☒ Other significant ethical issues or concerns?

Declaration: *The project will be conducted in compliance with the ethical policy of the University and the Department. This includes securing informed consent from participants, minimizing the potential for harm, and compliance with data-protection obligations. Any significant change in the purpose, design or conduct of the research will be reported to the Chair of the REC, and, if appropriate, a new application for ethical approval will be made to the REC.*	
Signature of PI or Student	**Manisha Kumar**

APPROVED [redacted] DR CARL CATER

13-8-18

Expert Review 2018

This study. Of highly reliable organisations, is being conducted by Manisha Kumar, PhD student at School of Management Swansea University, under the supervision of Prof Nick Rich, Dr Yujie Cai and Dr. Paul White who can be contacted via following email addresses: [redacted], [redacted] and [redacted]

This study will focus on the "How do organisations support or inhibit high reliability healthcare processes? "What characteristics of HRO are practiced within the context of healthcare management? What sources of failure exist in healthcare systems and how do healthcare organisations learn from such events?

Participation in the research project will involve expert review attempting to strengthen the theoretical model developed from the literature (Stage I).

The research represents an initial stage of expert review and follows a systematic literature review which has resulted in a theoretical model. This stage of development is used to test the theoretical model by gaining expert insights (from a range of academics and practicing experts UK healthcare). The interviews will strengthen the theoretical model and test it such that it will be of a quality level necessary to begin a larger phase of qualitative research. This research will therefore test the initial model that will take knowledge in the field further and mark out the contribution of this work to academic knowledge.

Ethical approval is sought to cover the engagements of the experts and expert review of the model. The methodology is semi-structured interviews with subject matter experts. The informants are therefore experts in their field (of practice or academic). The interviews are semi-structured interview on skype, face to face interviews and follows a detailed protocol (the protocol covers anonymity and the right to withdraw as well as the recording of the interview by electronic means as well as the destruction of such materials stored electronically).

The interview will take the format of a face-to-face or telephonic interview or on skype. The duration will be around 30 minutes in total. A short (5-point Likert scale) questionnaire will be administered before the interview. In total around 15-20 interviews will be conducted in total during 2018.
Participation in the study is entirely voluntary but recognised people with relevant knowledge and participants can withdraw from the study at any time without giving a reason. Participants may also ask questions at any time and discuss any concerns with the researcher or the supervisor as listed above.

The findings of the study will form part of the PhD research project.
All information provided during the interview will be held anonymously so that it will not be possible to trace information or comments back to individual contributors. Information will be stored in accordance with the current Data Protection Act.

Participants can request information and feedback about the purpose and results of the study by applying directly to the researcher [redacted]

19th April 2018
Manisha Kumar
PhD student 2nd Year
Swansea University

[redacted]

19-4-2018

School of Management
Yr Ysgol Reolaeth
Swansea University
Prifysgol Abertawe

Professor Nick Rich,
[redacted], School of Management,
Bay Campus, Fabian Way,
Swansea SA1 8EN

Dated: 19th April 2018

Dear Carl,

RE: Mrs M Kumar (PG Student Number [redacted] Ethical Research Application

I would like to support Manisha's application and clarify something for you. The NHS research (by questionnaire) will not identify individuals nor actually involve anything more than the informant's perception of their working processes and organisational practices. As such it is a service review and therefore should be processed via our internal systems. Manisha will apply (after this application) for full NHS permission to conduct cases and interviews at cases with turnaround organisations. The latter will go through full NHS approval and local sign off too. This application covers only a service review of perceptions of NHS organisational practices. As such – and I have consulted on this – it requires a light touch authorisation. Manisha has a protocol of anonymity and taking part (via completion of the questionnaire) is deemed consent from an unnamed informant. I hope you will accept this application and we can progress to a point where we get NHS ethical consideration for the case work later this year. If you have any questions then please feel free to email me [redacted] or call me on my mobile [redacted]. Yours sincerely,

[redacted]

Professor Nick Rich

Yr Ysgol Reolaeth | School of Management
Campws y Bae, Ffordd Fabian, Abertawe, SA1 8EN | Bay Campus, Fabian Way, Swansea, SA1 8EN
Ffôn/Tel: +44 (0) 1792 295601 Ebost/Email: SchoolofManagement@swansea.ac.uk

SCHOOL OF MANAGEMENT, SWANSEA UNIVERSITY

LIGHT-TOUCH ETHICAL REVIEW FORM

To be completed for all research involving human subjects or datasets

Name of PI or PGR Student	Manisha Kumar
Staff Number or Student ID	[redacted]
Supervisors*	Prof.Nick Rich, Dr.Yujie Cai & Dr. P.White
Date Submitted	19/04/18
Title of Project	How do organisations support or inhibit high reliability healthcare processes?
Name of Funder / Sponsor*	Swansea University
Finance Code / Reference*	
Duration of Project	*October 2016 – September 2019*

* *Complete if appropriate*

***Risk evaluation**: Does the proposed research involve any of the follow?*

✓ ***Tick** those boxes for which the answer is **YES***

✗ ***Cross** those boxes for which the answer is **NO***

☒ Will the research harm or pose any risk to the environment? (e.g. research in environmentally sensitive areas (e.g. SSSIs); permission needed to access field sites; transport of samples between countries (e.g. soil); sampling of rare or hazardous material (e.g. invasive species) that could deplete or endanger)

☑ Will the study involve recruitment of patients or staff through the NHS or the use of NHS data or premises and/or equipment? If this is the case, the project **must** be reviewed by the NHS

☒ Does the study involve participants aged 16 or over who are unable to give informed consent? (e.g. people with learning disabilities: see Mental Capacity Act 2005. All research that falls under the auspices of the Act **must** be reviewed by the NHS)

☒ Does the research involve other vulnerable groups: children, those with cognitive impairment or in unequal relationships? (e.g. your students). This **may** require NHS review, and will typically require the researcher to get **Disclosure & Barring Service (DBS) clearance** (formerly CRB checks)

☒ Will the study require the co-operation of a gatekeeper for initial access to the groups or individuals to be recruited? (e.g. students at school, members of self-help group or residents of nursing home?)

☒ Will it be necessary for participants to take part in the study without their knowledge and consent at the time? (e.g. covert observation of people in non-public places)

☒ Will the study discuss sensitive topics? (e.g. sexual activity or drug use)

☒ Are drugs, placebos or other substances (e.g. foods or vitamins) to be administered to study participants, or will the study involve invasive, intrusive or potentially harmful procedures of any kind? (If any substance is to be administered, this **may** fall under the auspices of the Medicines for Human Use (Clinical Trials) Regulations 2004, and require review by the NHS NRES.)

☒ Will tissue samples (including blood) be obtained from participants? (This would fall under the terms of the Human Tissue Act 2004. All research that falls under the auspices of the Act **must** be reviewed by the NHS NRES.)

☒ Is pain or more than mild discomfort likely to result from the study?

☒ Could the study induce psychological stress or anxiety or cause harm or negative consequences beyond the risks encountered in normal life?

☒ Will the study involve prolonged or repetitive testing?

Will the research involve administrative or secure data that requires permission from the appropriate authorities before use?

☒ Is there a possibility that the safety of the researcher may be in question? (e.g. in international research: locally employed researchers)

☒ Does the research involve members of the public in a research capacity (e.g. participant research)?

☒ Will the research take place outside the UK where there may be issues of local practice and political sensitivities?

☒ Will the research involve respondents to the Internet or other visual/vocal methods where respondents may be identified?

☒ Will *research* involve the sharing of data or confidential information beyond the initial consent given?

☒ Will financial *inducements* (other than reasonable expenses and compensation for time) be offered to participants?

☒ Other significant ethical issues or concerns?

Declaration: *The project will be conducted in compliance with the ethical policy of the University and the Department. This includes securing informed consent from participants, minimizing the potential for harm, and compliance with data-protection obligations. Any significant change in the purpose, design or conduct of the research will be reported to the Chair of the REC, and, if appropriate, a new application for ethical approval will be made to the REC.*	
Signature of PI or Student	**Manisha**

Signature of first supervisor (if appropriate)	[redacted]
Decision of SOM-REC	
Signature of SOM-REC Chair or SOM-REC deputy Chair	
Date	19-04-18
SOM-REC Reference number (office use only)	

Service Evaluation – Cardiff and Vale University Health Board

Bwrdd Iechyd Prifysgol Caerdydd a'r Fro
Cardiff and Vale University Health Board

Ysbyty Athrofaol Cymru
University Hospital of Wales

Heath Park,
Cardiff
CF14 4XW
Phone 029 2074 7747
Fax 029 2074 2128

Parc Y Mynydd Bychan
Caerdydd
CF14 4XW
Ffôn 029 2074 7747
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Eich cyf/Your ref:
Ein cyf/Our ref:
Welsh Health Telephone Network: 1872 2233
Direct Line/Llinell uniongychol: 029 2074 3754
Fax: 029 2033 6365

Private and Confidential
Ms Manisha Kumar
PhD Student
School of Management
Swansea University
Fabian Way, Crymlyn Burrows,
Swansea, SA1 8EN

Dear Manisha

Thank you for your correspondence and the link to your survey regarding service evaluation

I note that you wish to obtain data via an online questionnaire to be completed by the staff that are working the Health Board like Executives Medical Doctors, Nurses, Mangers, Patient safety officers. They are under no obligation to participate in the survey and may decline to answer any given question. All information collected will be treated in strict confidence. Identities will be kept anonymous in any reports or other publications we may produce. The survey will take approximately 15-20 minutes to complete.

I am very supportive of this work which will help organisations to focus upon how to become high reliability organisations and the impact on safe and effective patient care.

Please do not hesitate to contact me if I can be of any further assistance

Yours sincerely

[redacted]

Angela Hughes
Assistant Director of Patient Experience Tel 029 21846108

angela.hughes5@wales.nhs.uk / concerns@wales.nhs.uk

Service Evaluation – Aneurin Bevan University Health Board

Ymchwil Iechyd a Gofal Cymru
Health and Care Research Wales

GIG CYMRU NHS WALES
Bwrdd Iechyd Prifysgol Aneurin Bevan
University Health Board

R&D Department
Clinical Research & Innovation Centre
St Woolos Hospital
Block C, Stow Hill
Newport, South Wales
NP20 4SZ

Research and Development Department
Research Risk Review Panel

☎ 01633 656353
ABB.R&D@wales.nhs.uk

04 February 2019

Manisha Kumar
PhD Student
PGR Suite (2nd floor)
School of Management
Swansea University
Fabian Way, Crymlyn Burrows,
Swansea, SA1 8EN

Dear Manisha,

Title: How do organisations support or inhibit high reliability healthcare processes?
Chief Investigator: Manisha Kumar
Principal Investigator: Manisha Kumar
ABUHB R&D Reference Number: SA/953/19

The Health Board's Research and Development Department reviewed your service evaluation on the 30th January2019

The Department decided that your study did not appear to pose any risk to the Health Board and agreed that your service evaluation be given a favourable opinion.

It is a requirement of this approval that on completion of your Service Evaluation you:

- provide the R&D Department with a copy of your final paper, and
- you share the findings of your evaluation with the department concerned

You are also invited to submit an abstract to the R&D Conference.

If you require a Research Honorary Contract or Letter of Access please contact the R&D Department at the above email address.

If you require any further assistance please do not hesitate to contact the Research and Development Department.

Yours sincerely,

[redacted]

Professor Sue Bale OBE
Research and Development Director
Research Risk Review Panel Chairman

Evaluation – Cwm Taf Morgannwg University Health Board

GIG CYMRU NHS WALES
Bwrdd Iechyd Prifysgol Cwm Taf Morgannwg University Health Board

Your Ref/ eich cyf
Our ref/ ein cyf: JG/TTW
Date/ dyddiad: 25/10/19
Tel/ ffôn: 01443 443421
Fax/ ffacs: 01443 443420
Email/ ebost: CTMUHB_RD@wales.nhs.uk
Dept/ adran: Research & Development Dept

Mrs Manisha Kumar
School of Management
Swansea University
Fabian Way
Crymlyn Burrows
Swansea
SA1 8EN

Dear Mrs Kumar

Re: CT/1072/19 How do organisations support or inhibit high reliability healthcare processes

Thank you for registering the above service evaluation project with the Cwm Taf Morgannwg University Health Board R&D Department. I am pleased to confirm that the service evaluation project met the requirements for proportionate risk review and all requested changes to and points of clarification for the project, have been completed and the identified risk(s) addressed. I am happy to take Chair's action to approve this project. Approval covers Cwm Taf Morgannwg University Health Board only. If this is a multi-site project it is advised that you also obtain the appropriate authorisation from all participating organisations' before commencing the project at those sites.

Any incidents relating to the project should be reported to the Research & Development (R&D) Department and a Clinical Incident Form completed.

On completion of the project please inform the University Health Board R&D Department who will arrange for you to attend a future meeting to present your project to the Group.

It is a requirement of approval that a summary of your project and its findings be submitted to the R&D Department upon completion. This can then be placed on the R&D Departments' web page to provide a useful R&D resource for colleagues across the University Health Board.

It is also a requirement that an abstract is submitted for review and possible inclusion in the University Health Boards annual R&D conference. This facilitates the distribution of all findings and any resultant changes in clinical practice.
I should like to take this opportunity to wish you well with your evaluation and look forward to the presentation of your findings.

If you require any further assistance please contact the Research & Development Department, Royal Glamorgan Hospital, ext 3421.

Yours sincerely

[redacted]

Professor John Geen MSc, PhD, FRCPath
Assistant Director for Research & Development

Evaluation – Velindre Cancer Centre

Canolfan Ganser Felindre
Velindre Cancer Centre

Gwella Ansawdd Ymddiriedolaeth GIG Felindre
Velindre NHS Trust Quality Improvement

REGISTRATION OF PROJECT PROPOSAL

Ref: 1920MISC0021

Date: 10.04.2019

TITLE OF PROJECT: How do organisations support or inhibit high reliability healthcare processes?

INVESTIGATOR/S: Manisha Kumar

Dear Manisha

Thank you for the completed project proposal form and for registering your project with us. Your project has been logged and was approved by Project Review Group on the 4th April 2019.

Once completed, we would appreciate if you could provide us with a copy of your final report or presentation and any other information that may be useful for others wishing to repeat the review at a later stage. If you require any help or advice please feel free to contact us at any time.

Kind regards

Yours sincerely

[redacted]

Eve Gallop-Evans
Clinical Director

[redacted]

Sara Walters
Clinical Audit Manager

Appendix III – Supporting Analysis informing HRO model

1. First Exploratory Factor Analysis Results

Communalities

	Initial	Extraction
LEAD1: Clinical Leaders have shared vision of PS	1.000	.723
LEAD2: Clinical Leaders align to policies & activities for PS	1.000	.783
LEAD3: Leaders participate in QI activities	1.000	.669
LEAD4: Leaders promote QI activities	1.000	.576
LEAD5: Discussions about PS concern promoted	1.000	.729
LEAD6: Leaders have visible and consistent involvement in PS	1.000	.667
LEAD7: Leaders make it easy for employees to voice concern	1.000	.617
Trust1: Trust among employees necessary for service improvement	1.000	.585
Trust2: Trust among employees help to deal with problematic situation	1.000	.722
Trust3: Team involvement in improvement increases commitment to PS	1.000	.542
Trust4: Top Down and bottom up communication for team trust	1.000	.526
Trust5: Increased Trust due to open discussion of safety issues	1.000	.680
Trust6:Trust in employees leads to accountability	1.000	.796
Trust7: Trust leads to greater self reporting of error and near misses	1.000	.824
Com1: Individual encouraged to free speak their views	1.000	.581
Com2: Use of easy structured communication to encourage team participation	1.000	.627
Com3: Good communication flow exist up and down	1.000	.725
Com4: Co-workers comfortable in giving feedback to each other	1.000	.715
Com5: Team comfortable sharing feedback periodically	1.000	.661
Train1: Training and simulation to improve practical skills	1.000	.535
Train2: Practicing for emergency situation	1.000	.605
Train3: Multidisciplinary team training for working effectively	1.000	.736
Train 4: Multidisciplinary team training for working efficiently	1.000	.653
Train 5: Regular investment in knowledge and skills development	1.000	.620
Train 6: Resource mgmt training helps in better decision making behaviour	1.000	.545
RF1: Team Reports mistakes and near misses for mistake-proofing	1.000	.423
RF2: Staff informed about error occurrence	1.000	.681
RF3: Transparency in reporting improves PS	1.000	.594
RF4: Staff given feedback on changes made after reported errors	1.000	.568
RF5: Staff discuss ways to reduce future errors	1.000	.604
RF6: Safety reporting measured to track failure frequency	1.000	.648
RF7:Low hierarchy staff encouraged to report errors	1.000	.476

Extraction Method: Principal Component Analysis.

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	11.716	36.614	36.614	11.716	36.614	36.614	4.625	14.452	14.452
2	2.590	8.094	44.708	2.590	8.094	44.708	4.282	13.383	27.834
3	2.083	6.510	51.218	2.083	6.510	51.218	4.107	12.834	40.669
4	1.548	4.836	56.054	1.548	4.836	56.054	2.926	9.143	49.812
5	1.327	4.148	60.202	1.327	4.148	60.202	2.611	8.161	57.973
6	1.174	3.668	63.870	1.174	3.668	63.870	1.887	5.897	63.870
7	.923	2.883	66.753						
8	.915	2.858	69.611						
9	.762	2.382	71.993						
10	.745	2.329	74.322						
11	.708	2.212	76.534						
12	.653	2.042	78.576						
13	.626	1.956	80.532						
14	.545	1.704	82.235						
15	.520	1.624	83.859						
16	.467	1.458	85.318						
17	.455	1.422	86.740						
18	.421	1.316	88.056						
19	.415	1.296	89.352						
20	.389	1.215	90.566						
21	.356	1.114	91.680						
22	.339	1.060	92.741						
23	.332	1.036	93.777						
24	.307	.960	94.738						
25	.276	.862	95.600						
26	.264	.826	96.425						
27	.226	.706	97.132						
28	.216	.674	97.806						
29	.194	.605	98.410						
30	.192	.599	99.010						
31	.186	.580	99.590						
32	.131	.410	100.000						

Extraction Method: Principal Component Analysis.

Rotated Component Matrix[a]						
	Component					
	1	2	3	4	5	6
LEAD1: Clinical Leaders have shared vision of PS			.789			
LEAD2: Clinical Leaders align to policies & activities for PS			.849			
LEAD3: Leaders participate in QI activities	.413		.665			
LEAD4: Leaders promote QI activities			.679			
LEAD5: Discussions about PS concern promoted	.522		.617			
LEAD6: Leaders have visible and consistent involvement in PS	.455		.554			
LEAD7: Leaders make it easy for employees to voice concern		.440	.519			
Trust1: Trust among employees necessary for service improvement		.584				
Trust2: Trust among employees help to deal with problematic situation	.459	.661				
Trust3: Team involvement in improvement increases commitment to PS		.624				
Trust4: Top Down and bottom up communication for team trust		.658				
Trust5: Increased Trust due to open discussion of safety issues		.758				
Trust6:Trust in employees leads to accountability						.790
Trust7: Trust leads to greater self reporting of error and near misses						.811

Com1: Individual enouraged to free speak their views		.541				
Com2: Use of easy structured communication to encourage team participation	.660					
Com3: Good communication flow exist up and down	.565	.576				
Com4: Co-workers comfortable in giving feedback to each other	.757					
Com5: Team comfortable sharing feedback periodically	.727					
Train1: Training and simulation to improve practical skills				.680		
Train2: Practicing for emergency situation				.681		
Train3: Multidisciplinary team training for working effectively				.758		
Train 4: Multidisciplinary team training for working efficiently				.641		
Train 5: Regular investment in knowledge and skills development	.454			.410		
Train 6: Resource mgmt training helps in better decision making behaviour	.557			.430		
RF1: Team Reports mistakes and near misses for mistake-proofing				.437	.425	
RF2: Staff informed about error occurrence	.474				.546	
RF3: Transparency in reporting improves PS					.599	
RF4: Staff given feedback on changes made after reported errors					.403	

RF5: Staff discuss ways to reduce future errors					.663	
RF6: Safety reporting measured to track failure frequency	.536					
RF7:Low hierarchy staff enouraged to report errors					.552	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization; a. Rotation converged in 10 iterations.						

2. Final Exploratory Factor Analysis Outcomes for five underlying latent variables

Communalities		
	Initial	Extraction
Lead1: Clinical Leaders have shared vision for PS	1.000	.745
Lead2: Clinical Leaders align to policies & activities for PS	1.000	.835
Lead3: Leaders participate in QI activities	1.000	.679
Lead4: Leaders promote QI activities	1.000	.549
Trust1: Trust among employees necessary for service improvement	1.000	.666
Trust2: Trust among employees help to deal with problematic situation	1.000	.743
Trust3: Team involvement in improvement increases trust and commitment to PS	1.000	.549
Trust4: Improvement in top-down and bottom-up communication improves team trust	1.000	.554
Com2: Use of easy structured communication to encourage team participation	1.000	.689
Com3: Good communication flow exist up and down	1.000	.730
Com4: Co-workers comfortable in giving feedback to each other	1.000	.751
Com5: Team comfortable sharing feedback periodically with senior mgmt.	1.000	.712
Train1: Training and simulation to improve practical skills	1.000	.584
Train2: Practicing for emergency situation helps in reaction during actual event	1.000	.654
Train3: Multi-disciplinary team training for working effectively	1.000	.769
Train 4: Multi-disciplinary team training for working efficiently	1.000	.675
Report2: Staff informed about error occurrence	1.000	.596
Report3: Transparency in reporting improves PS	1.000	.592
Report4: Staff given feedback on changes made after reported errors	1.000	.584

Report7:Low hierarchy staff encouraged to report errors	1.000	.598
Report5: Staff discuss ways to prevent errors in future	1.000	.613
Extraction Method: Principal Component Analysis.		

Total Variance Explained									
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.758	36.943	36.943	7.758	36.943	36.943	3.446	16.410	16.410
2	2.116	10.074	47.017	2.116	10.074	47.017	2.914	13.875	30.285
3	1.724	8.210	55.227	1.724	8.210	55.227	2.869	13.660	43.945
4	1.270	6.049	61.277	1.270	6.049	61.277	2.341	11.146	55.091
5	1.001	4.768	66.044	1.001	4.768	66.044	2.300	10.953	66.044
6	.839	3.994	70.038						
7	.734	3.496	73.534						
8	.650	3.096	76.630						
9	.613	2.919	79.549						
10	.594	2.827	82.376						
11	.567	2.702	85.077						
12	.452	2.155	87.232						
13	.438	2.087	89.319						
14	.400	1.906	91.224						
15	.359	1.708	92.932						
16	.331	1.575	94.507						
17	.288	1.372	95.878						
18	.266	1.268	97.146						
19	.247	1.177	98.323						
20	.202	.962	99.284						
21	.150	.716	100.000						

Extraction Method: Principal Component Analysis.

Component Matrix[a]					
	Component				
	1	2	3	4	5
Lead1: Clinical Leaders have shared vision for PS	.616		.584		
Lead2: Clinical Leaders align to policies & activities for PS	.594		.672		
Lead3: Leaders participate in QI activities	.575		.414		
Lead4: Leaders promote QI activities	.572		.429		
Trust1: Trust among employees necessary for service improvement	.714				
Trust2: Trust among employees help to deal with problematic situation	.767				
Trust3: Team involvement in improvement increases trust and commitment to PS	.661				
Trust4: Improvement in top-down and bottom-up communication improves team trust	.586				
Com2: Use of easy structured communication to encourage team participation	.680				
Com3: Good communication flow exist up and down	.763				
Com4: Co-workers comfortable in giving feedback to each other	.660	-.469			
Com5: Team comfortable sharing feedback periodically with senior mgmt.	.692				
Train1: Training and simulation to improve practical skills		.633			
Train2: Practicing for emergency situation helps in reaction during actual event	.477	.564			

Train3: Multi-disciplinary team training for working effectively	.450	.579			
Train 4: Multi-disciplinary team training for working efficiently	.597				
Report2: Staff informed about error occurrence	.595				
Report3: Transparency in reporting improves PS	.629				
Report4: Staff given feedback on changes made after reported errors	.718				
Report7:Low hierarchy staff encouraged to report errors	.432			-.559	
Report5: Staff discuss ways to prevent errors in future	.512	.417			
Extraction Method: Principal Component Analysis.					
a. 5 components extracted.					

Rotated Component Matrix[a]					
	Component				
	1	2	3	4	5
Lead1: Clinical Leaders have shared vision for PS			.803		
Lead2: Clinical Leaders align to policies & activities for PS			.878		
Lead3: Leaders participate in QI activities	.411		.676		
Lead4: Leaders promote QI activities			.669		
Trust1: Trust among employees necessary for service improvement		.645			
Trust2: Trust among employees help to deal with problematic situation	.517	.650			
Trust3: Team involvement in improvement increases trust and commitment to PS		.609			

Trust4: Improvement in top-down and bottom-up communication improves team trust		.668			
Com2: Use of easy structured communication to encourage team participation	.744				
Com3: Good communication flow exist up and down	.676	.464			
Com4: Co-workers comfortable in giving feedback to each other	.814				
Com5: Team comfortable sharing feedback periodically with senior mgmt.	.766				
Train1: Training and simulation to improve practical skills					.715
Train2: Practicing for emergency situation helps in reaction during actual event					.731
Train3: Multi-disciplinary team training for working effectively		.450			.736
Train 4: Multi-disciplinary team training for working efficiently		.472			.623
Report2: Staff informed about error occurrence	.420			.610	
Report3: Transparency in reporting improves PS				.613	
Report4: Staff given feedback on changes made after reported errors				.617	
Report7:Low hierarchy staff encouraged to report errors		.429		.632	
Report5: Staff discuss ways to prevent errors in future				.676	
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.					
a. Rotation converged in 9 iterations.					

3. Exploratory Factor Analysis Results for Safety Culture

Results from the EFA when entering all nine scale items that measures the unobserved latent variable – Safety Culture.

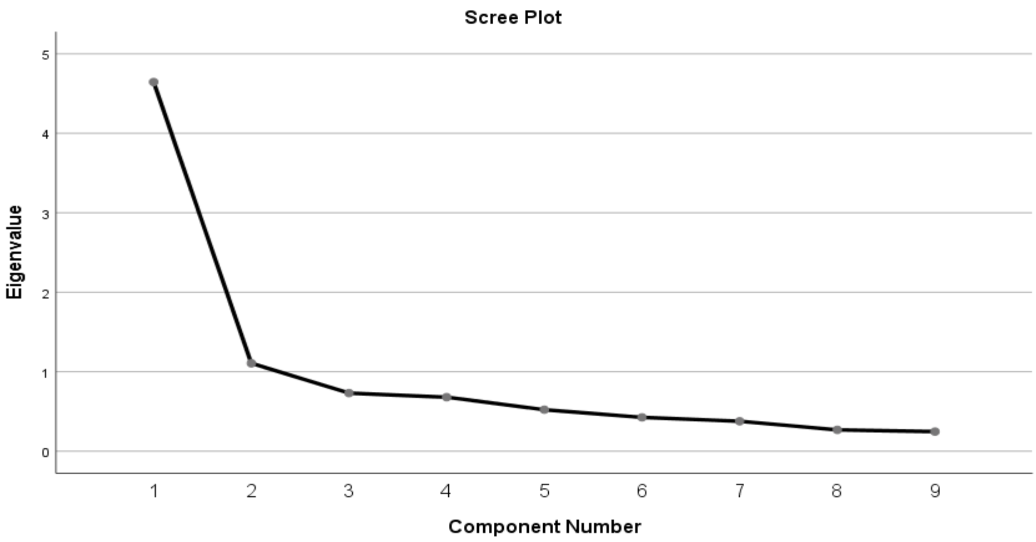
Communalities

	Initial	Extraction
SC1: SC supported by enhancing trust among employees	1.000	.624
SC2: Open reporting of incidents among team members for SC	1.000	.734
SC3: Improving clinical practices to support SC	1.000	.568
SC4: Reliability of processes is maintained by formally assessing SC	1.000	.559
SC5: Prompt actions due to SC audit supports effective reliability	1.000	.721
SC6: Staff comfortably report unsafe conditions	1.000	.630
SC7: Staff can question higher authority for unsafe practices	1.000	.762
SC8: Formal briefings used to reduce errors in complex process	1.000	.643
SC9:Checklist used to assess process safety	1.000	.410
Extraction Method: Principal Component Analysis.		

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.645	51.612	51.612	4.645	51.612	51.612	3.653	40.592	40.592
2	1.106	12.294	63.905	1.106	12.294	63.905	2.098	23.314	63.905
3	.731	8.120	72.025						
4	.679	7.549	79.574						
5	.522	5.797	85.372						
6	.425	4.726	90.098						
7	.377	4.184	94.281						
8	.269	2.985	97.266						
9	.246	2.734	100.000						

Extraction Method: Principal Component Analysis.



Component Matrix[a]		
	Component	
	1	2
SC1: SC supported by enhancing trust among employees	.581	
SC2: Open reporting of incidents among team members for SC	.839	
SC3: Improving clinical practices to support SC	.745	
SC4: Reliability of processes is maintained by formally assessing SC	.743	
SC5: Prompt actions due to SC audit supports effective reliability	.811	
SC6: Staff comfortably report unsafe conditions	.593	.527
SC7: Staff can question higher authority for unsafe practices	.535	.690
SC8: Formal briefings used to reduce errors in complex process	.748	
SC9:Checklist used to assess process safety	.608	

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Rotated Component Matrix[a]		
	Component	
	1	2
SC1: SC supported by enhancing trust among employees	.541	
SC2: Open reporting of incidents among team members for SC	.804	
SC3: Improving clinical practices to support SC	.570	.494
SC4: Reliability of processes is maintained by formally assessing SC	.674	
SC5: Prompt actions due to SC audit supports effective reliability	.821	
SC6: Staff comfortably report unsafe conditions		.761
SC7: Staff can question higher authority for unsafe practices		.869
SC8: Formal briefings used to reduce errors in complex process	.787	
SC9:Checklist used to assess process safety	.409	.492
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.		
a. Rotation converged in 3 iterations.		

Results of EFA after dropping SC1, SC6, SC7, and SC9

Communalities		
	Initial	Extraction
SC2: Open reporting of incidents among team members for SC	1.000	.748
SC3: Improving clinical practices to support SC	1.000	.581
SC4: Reliability of processes is maintained by formally assessing SC	1.000	.652
SC5: Prompt actions due to SC audit supports effective reliability	1.000	.718
SC8: Formal briefings used to reduce errors in complex process	1.000	.550
Extraction Method: Principal Component Analysis.		

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.248	64.968	64.968	3.248	64.968	64.968
2	.632	12.630	77.598			
3	.469	9.374	86.972			
4	.393	7.856	94.828			
5	.259	5.172	100.000			
Extraction Method: Principal Component Analysis.						

Component Matrix[a]	
	Component
	1
SC2: Open reporting of incidents among team members for SC	.865
SC3: Improving clinical practices to support SC	.762
SC4: Reliability of processes is maintained by formally assessing SC	.807
SC5: Prompt actions due to SC audit supports effective reliability	.847
SC8: Formal briefings used to reduce errors in complex process	.741
Extraction Method: Principal Component Analysis.	
a. 1 components extracted.	

Unstandardized Regression Weights Measurement Model

			Estimate	S.E.	C.R.	P	Label
Leader4	<---	Lea	1.000				
Leader3	<---	Lea	.950	.105	9.047	***	par_1
Leader2	<---	Lea	1.190	.115	10.358	***	par_2
Leader1	<---	Lea	1.419	.136	10.404	***	par_3
Trust1	<---	Tru	1.000				
Trust2	<---	Tru	1.204	.083	14.581	***	par_4
Trust3	<---	Tru	.944	.093	10.143	***	par_5
Trust4	<---	Tru	.931	.099	9.434	***	par_6
Train1	<---	Tr	1.000				
Train2	<---	Tr	1.448	.272	5.319	***	par_7
Train3	<---	Tr	1.716	.342	5.024	***	par_8
Train4	<---	Tr	1.957	.393	4.979	***	par_9
Com2	<---	Com	1.000				
Com3	<---	Com	1.361	.096	14.150	***	par_10
Com4	<---	Com	.985	.081	12.171	***	par_11
Com5	<---	Com	.863	.076	11.414	***	par_12
RF2	<---	Rep	1.000				
RF3	<---	Rep	.973	.110	8.809	***	par_26
RF4	<---	Rep	1.223	.122	10.005	***	par_27
RF5	<---	Rep	1.021	.133	7.679	***	par_28
RF7	<---	Rep	.717	.108	6.657	***	par_29
SC2	<---	Sc	1.000				
SC3	<---	Sc	.802	.067	11.974	***	par_35
SC4	<---	Sc	.762	.069	11.059	***	par_36
SC5	<---	Sc	.891	.061	14.690	***	par_37
SC8	<---	Sc	1.019	.079	12.870	***	par_38

Standardized Regression Weights: Measurement Model

			Estimates
Leader4	<---	Lea	.675***
Leader3	<---	Lea	.695***
Leader2	<---	Lea	.823***
Leader1	<---	Lea	.965***
Trust1	<---	Tru	.721***
Trust2	<---	Tru	.844***
Trust3	<---	Tru	.684***
Trust4	<---	Tru	.631***
Train1	<---	Tr	.602***
Train2	<---	Tr	.658***
Train3	<---	Tr	.776***
Train4	<---	Tr	.850***
Com2	<---	Com	.734***
Com3	<---	Com	.901***
Com4	<---	Com	.745***
Com5	<---	Com	.767***
RF2	<---	Re	.672***
RF3	<---	Re	.646***
RF4	<---	Re	.777***
RF5	<---	Re	.677***
RF7	<---	Re	.648***

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	83	606.232	268	.000	2.262
Saturated model	351	.000	0		
Independence model	26	4020.217	325	.000	12.370

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.048	.849	.802	.648
Saturated model	.000	1.000		
Independence model	.286	.218	.156	.202

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.849	.817	.910	.900	.908
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.070	.063	.077	.000
Independence model	.210	.204	.216	.000

Structured Equation Modelling – Structure Model (Base model)

Unstandardised Regression Weights: (Group number 1 – Base Model 1)

Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Label
Tr	<---	Lea	.088	.061	1.436	.151	par_38
Tru	<---	Lea	-.014	.041	-.338	.735	par_37
Com	<---	Lea	.154	.080	1.929	.054	par_39
Rep	<---	Lea	.282	.078	3.641	***	par_40
Tru	<---	Tr	6.722	4.610	1.458	.145	par_41
Com	<---	Tr	6.339	4.358	1.455	.146	par_43
Rep	<---	Tr	4.455	3.082	1.446	.148	par_44
Sc	<---	Tr	-12.197	11.327	-1.077	.282	par_42
Sc	<---	Rep	.549	.152	3.620	***	par_45
Sc	<---	Com	.718	.132	5.447	***	par_46
Sc	<---	Tru	1.605	1.046	1.535	.125	par_47
Leader4	<---	Lea	1.000				
Leader3	<---	Lea	.947	.105	9.027	***	par_1
Leader2	<---	Lea	1.195	.115	10.361	***	par_2
Leader1	<---	Lea	1.415	.136	10.405	***	par_3
Trust1	<---	Tru	1.000				
Trust2	<---	Tru	1.213	.086	14.111	***	par_4
Trust3	<---	Tru	.997	.099	10.025	***	par_5
Trust4	<---	Tru	.958	.105	9.147	***	par_6
Train1	<---	Tr	1.000				
Train2	<---	Tr	4.484	2.862	1.567	.117	par_7
Train3	<---	Tr	4.029	2.791	1.444	.149	par_8
Train4	<---	Tr	5.643	3.834	1.472	.141	par_9
Com2	<---	Com	1.000				

			Estimate	S.E.	C.R.	P	Label
Com3	<---	Com	1.342	.094	14.289	***	par_10
Com4	<---	Com	.964	.079	12.171	***	par_11
Com5	<---	Com	.838	.074	11.258	***	par_12
RF2	<---	Rep	1.000				
RF3	<---	Rep	.970	.110	8.817	***	par_20
RF4	<---	Rep	1.228	.122	10.063	***	par_21
RF5	<---	Rep	1.015	.133	7.660	***	par_22
RF7	<---	Rep	.718	.107	6.681	***	par_23
SC2	<---	Sc	1.000				
SC3	<---	Sc	.794	.068	11.727	***	par_26
SC4	<---	Sc	.759	.070	10.876	***	par_27
SC5	<---	Sc	.892	.062	14.490	***	par_28
SC8	<---	Sc	1.019	.080	12.711	***	par_29

Model 1 Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	79	741.945	272	.000	2.728
Saturated model	351	.000	0		
Independence model	26	4020.217	325	.000	12.370

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.052	.840	.768	.636
Saturated model	.000	1.000		
Independence model	.286	.218	.156	.202

Baseline Comparisons

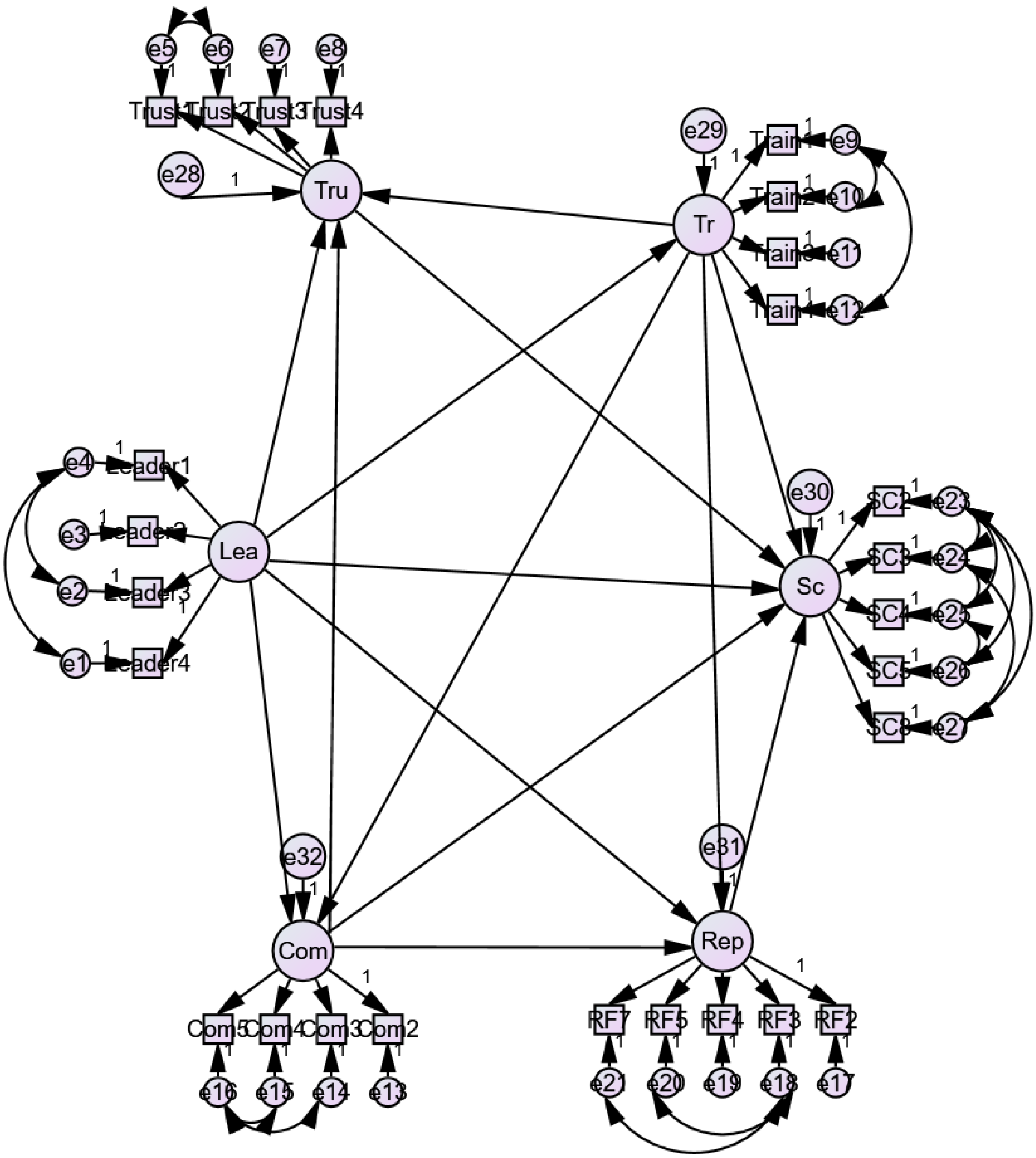
Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.815	.779	.875	.848	.873
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.082	.075	.089	.000
Independence model	.210	.204	.216	.000

Final Model 4 – SEM Analysis

Figure III.1: Final SEM model



Unstandardized Regression Weights: (Model 4)

			Estimate	S.E.	C.R.	P	Label
Tr	<---	Lea	.217	.061	3.545	***	par_38
Com	<---	Lea	.578	.103	5.625	***	par_39
Com	<---	Tr	.581	.179	3.249	.001	par_43
Tru	<---	Lea	.030	.065	.457	.648	par_37
Rep	<---	Lea	.322	.081	3.997	***	par_40
Tru	<---	Tr	.447	.136	3.299	***	par_41
Rep	<---	Tr	.535	.156	3.427	***	par_44
Tru	<---	Com	.679	.077	8.857	***	par_49
Rep	<---	Com	.347	.066	5.278	***	par_50
Sc	<---	Tr	-.184	.141	-1.305	.192	par_42
Sc	<---	Rep	.373	.104	3.584	***	par_45
Sc	<---	Com	.438	.137	3.197	.001	par_46
Sc	<---	Tru	.405	.164	2.461	.014	par_47
Sc	<---	Lea	-.046	.065	-.701	.483	par_48
Leader4	<---	Lea	1.000				
Leader3	<---	Lea	.946	.104	9.058	***	par_1
Leader2	<---	Lea	1.186	.114	10.381	***	par_2
Leader1	<---	Lea	1.416	.136	10.420	***	par_3
Trust1	<---	Tru	1.000				
Trust2	<---	Tru	1.210	.083	14.558	***	par_4
Trust3	<---	Tru	.937	.093	10.060	***	par_5
Trust4	<---	Tru	.926	.099	9.377	***	par_6
Train1	<---	Tr	1.000				
Train2	<---	Tr	1.466	.277	5.301	***	par_7
Train3	<---	Tr	1.735	.347	5.003	***	par_8
Train4	<---	Tr	1.970	.398	4.951	***	par_9
Com2	<---	Com	1.000				

			Estimate	S.E.	C.R.	P	Label
Com3	<---	Com	1.360	.096	14.098	***	par_10
Com4	<---	Com	.986	.081	12.121	***	par_11
Com5	<---	Com	.864	.076	11.426	***	par_12
RF2	<---	Rep	1.000				
RF3	<---	Rep	.951	.108	8.772	***	par_20
RF4	<---	Rep	1.212	.120	10.089	***	par_21
RF5	<---	Rep	1.017	.131	7.755	***	par_22
RF7	<---	Rep	.694	.106	6.546	***	par_23
SC2	<---	Sc	1.000				
SC3	<---	Sc	.801	.067	11.940	***	par_26
SC4	<---	Sc	.762	.069	11.028	***	par_27
SC5	<---	Sc	.892	.061	14.653	***	par_28
SC8	<---	Sc	1.019	.079	12.839	***	par_29

Standardized Regression Weights: (Model 4)

			Estimate
Tr	<---	Lea	.328
Com	<---	Lea	.417
Com	<---	Tr	.278
Tru	<---	Lea	.024
Rep	<---	Lea	.279
Tru	<---	Tr	.240
Rep	<---	Tr	.308
Tru	<---	Com	.761
Rep	<---	Com	.417
Sc	<---	Tr	-.090
Sc	<---	Rep	.316

			Estimate
Sc	<---	Com	.447
Sc	<---	Tru	.369
Sc	<---	Lea	-.034
Leader4	<---	Lea	.675
Leader3	<---	Lea	.695
Leader2	<---	Lea	.823
Leader1	<---	Lea	.965
Trust1	<---	Tru	.721
Trust2	<---	Tru	.844
Trust3	<---	Tru	.684
Trust4	<---	Tru	.631
Train1	<---	Tr	.602
Train2	<---	Tr	.658
Train3	<---	Tr	.776
Train4	<---	Tr	.850
Com2	<---	Com	.736
Com3	<---	Com	.889
Com4	<---	Com	.763
Com5	<---	Com	.744
RF2	<---	Rep	.667
RF3	<---	Rep	.648
RF4	<---	Rep	.770
RF5	<---	Rep	.677
RF7	<---	Rep	.648
SC2	<---	Sc	.798
SC3	<---	Sc	.647
SC4	<---	Sc	.616
SC5	<---	Sc	.745
SC8	<---	Sc	.767

Model 4- Fit Indices

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	82	611.920	269	.000	2.275
Saturated model	351	.000	0		
Independence model	26	4020.217	325	.000	12.370

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.049	.900	.801	.650
Saturated model	.000	1.000		
Independence model	.286	.218	.156	.202

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.848	.816	.909	.900	.907
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.070	.063	.078	.000
Independence model	.210	.204	.216	.000