THE FUNCTIONAL RESONANCE ANALYSIS METHOD: ASSESSING, ADVANCING, AND APPLYING A NOVEL SYSTEMS THINKING METHODOLOGY IN HEALTHCARE RESEARCH

by © Ali McGill

A thesis submitted to the School of Graduate Studies
in partial fulfillment of the requirements for the degree of

Ph.D. in Interdisciplinary Studies
Memorial University of Newfoundland

December, 2023

St. John's, Newfoundland and Labrador, Canada

Abstract

Introduction

This PhD research work assesses, advances, and applies a novel systems thinking methodology in healthcare research; the Functional Resonance Analysis Method (FRAM). An extensive review of the literature is provided and knowledge gaps related to assessing and advancing the FRAM in healthcare research are addressed. Additionally, the research work applies the FRAM and a customized version of the methodology, DynaFRAM, to examine how the community based health and social care system for older people currently operates in Newfoundland and Labrador. The FRAM analysis intends to identify areas of strength and vulnerability in a local care system and use those insights as a basis to propose health policy recommendations for the implementation of a more integrated model of care for older people. Although this thesis applies the FRAM and DynaFRAM to examine health and social care for older people in NL, the literature presented demonstrates the methodology can be applied to complex healthcare processes and systems in other jurisdictions.

Aims

The three aims of this research work are:

i) To assess and demonstrate the usability of the FRAM as a methodology to analyze complex processes and systems in the healthcare domain (chapter 2).

ii) To advance the FRAM in the healthcare domain by:

   a) providing guidance on qualitative data collection and analysis to inform the building of a FRAM model (chapter 3).

b) providing guidance on quality enhancement criteria and strategies so resulting FRAM models and insights afforded by them are trustworthy (chapter 4).

iii) To apply the methodology (FRAM and DynaFRAM) in a community based health and social care system to identify micro-, meso-, and macro-level challenges and opportunities that impact capacity to move toward a more integrated model of care delivery for older people in NL (chapter 5).

Methods

a) To assess the usability of the FRAM as a healthcare research methodology, a scoping review of the literature was conducted in accordance with Joanna Briggs Institute methodology.

b) To advance the FRAM in healthcare research. Two papers were written to provide methodological guidance to healthcare researchers, administrators, and clinicians.

c) In conducting research of the community based health and social care system in NL, the FRAM and DynaFRAM were applied to model the local care system for older people and create a hypothetical patient journey scenario. Data collection consisted of document review, focus groups, and semi-structured interviews with health and social care professionals providing care and service to older people in the community setting.

Findings

a) The scoping review presented in chapter 2 assessed and demonstrated the FRAM's usability and practical application in modeling complex healthcare processes and systems in the healthcare domain.

b) The papers presented in chapters 3 and 4 provided healthcare domain specific guidance on data collection and analysis to inform the building of a FRAM model and the inclusion of quality enhancement criteria and strategies that can enhance the trustworthiness of healthcare studies using the FRAM.

c) The community based study presented in chapter 5 identified challenges and opportunities for implementing integrated care in one health region. Findings from the FRAM and DynaFRAM analysis informed the co-design of micro-, meso-, and macro-level process improvement recommendations that aim to move one community based comprehensive geriatric assessment process towards a more integrated model of care.

Conclusions

This thesis met the intended aims of assessing, advancing, and applying the FRAM as a novel healthcare research methodology as demonstrated in the papers presented. Healthcare system design and policy recommendations to move the community based health and social care system towards a more integrated model of care were needed. This could not be accomplished without an understanding of how health and social care professionals conduct their work and how older people may receive care under dynamic conditions.

The FRAM and DynaFRAM modelling provided an enhanced understanding of system operations and functionality and demonstrated a critical step that should not be overlooked for decision makers in their efforts to implement transformative healthcare system changes.

Acknowledgements

I have had enormous academic and personal support over the course of this work. I am incredibly grateful to Dr. Brian Veitch, Dr. Rose McCloskey, and Dr. Doug Smith who have guided and challenged me over the years. Their knowledge and experience pushed me to examine problems from varied perspectives. The academic mentorship and guidance I've been fortunate to receive from this group has inspired me and has also challenged me beyond what I thought I was capable of. It has been a pleasure to work under their supervision and guidance and I will be forever grateful. I also want to thank Dr. Vahid Salehi as a trusted collaborative research partner and co-author. I am grateful for his guidance and friendship.

The financial support from the Future Ocean Coastal Infrastructure Consortium is acknowledged with immense gratitude. Reducing my professional work to undertake this academic journey would not have been financially possible without this support.

Thank you to the study participants who donated their time to offer their immense knowledge, experience, and expertise. The work would not be possible without their continued interest and enthusiasm.

To my husband Trevor and our children, Nick, Neel, and Leena, thank you. You are my greatest cheerleaders and without your love, support, and understanding this would not be possible. Thank you also to my mother Barbara and my father Peter who taught me the value of hard work and commitment. Without your role modelling I would not be where I am today.

Table of Contents

List of Tables

List of Figures

Chapter 1.

1.1 Introduction

This thesis aims to assess, advance, and apply a novel systems thinking methodology in healthcare research, the Functional Resonance Analysis Method (FRAM). This introductory chapter will begin by providing an overview of how population aging is challenging governments, healthcare organizations, and clinicians to reassess the way healthcare is currently delivered to older people in Newfoundland and Labrador (NL). Timely access to comprehensive and integrated care for older people delivered by a community based interdisciplinary team is a necessity for future healthcare system functioning and sustainability. A review of the literature on the concept of integrated care for older people will be presented with an explanation of its key components, as well as the health system levels through which integrated care takes place. An overview of research work presented in this thesis will also be provided. The research work intends to assess and advance the FRAM as a healthcare research methodology. Additionally, the research work intends to apply the FRAM to examine how the local community based health and social care system for older people currently operates. The FRAM analysis intends to identify areas of strength and vulnerability in the care system and to use those insights as a basis to propose health policy recommendations for the implementation of a more integrated model of care for older people in NL. A description of systems thinking and the FRAM will be provided as well as the rationale and supporting evidence for their use. The remainder of the chapter will present the research aims and questions, objectives, thesis organization, and contribution and novelty of the doctoral work in the development of health policy.

1.1 Problem Statement

Like many countries worldwide, Canada is facing major demographic changes in its population that will have a significant impact on future healthcare system functioning. Canada's population of older people, those age 65 and older, will grow by 68% in the next 20 years (1). This is significant as this population currently consumes about 45% of all public-sector healthcare dollars spent by the provinces and territories (2). With respect to the potential impact ageing will have on the healthcare system, a third of older people in Canada currently live with three or more chronic conditions, with 32% taking five or more medications (3). The presence of multiple chronic illnesses is significant, as it has been correlated with increased physician, hospital, and emergency department visits, as well as worsened emotional health and self-rated health (3). Additionally, 25% of Canadians over age 65 are frail, with this number increasing to over 50% for those older than 85 (4). As the population ages, the presence of multimorbidity and frailty will grow. The greater and more resource-intensive healthcare use by older people coupled with the aging of the population is a concerning trend, especially given the way healthcare is currently organized and delivered in Canada.

Although often celebrated for its universal access, the Canadian healthcare system has come under scrutiny in the last decade regarding sentiments that existing funding structures and models of care are unsustainable, and the system itself is outdated and not responsive to the needs of Canadians (5). Healthcare spending trends in Canada indicate the largest expenditures are continuously in the categories of hospitals, drugs, and physician services (6). When reporting on reform in the public sector in Canada's largest province, Drummond (2012) described the healthcare system as not a system at all, but rather a series of disjointed services delivering care (7).

For older people with complex care needs, one of the greatest challenges is navigating the fragmented care landscape where medical care has largely developed independently from social care (8). Goodwin et al. (9) state individuals with complex care needs often must make “strenuous efforts to access the care they need and too often find themselves disempowered, disengaged, and unable to manage (p.7). Traditional, episodic care delivery models are not designed for older people who are medically complex and frail. Ideally, these individuals would benefit from health and social care that is more comprehensive, coordinated, person-centered and accessible in the communities in which they live.

1.2 Local Context

Finding ways to improve the way health and social care is delivered to older people with existing resources is both a challenge and a national priority (10, 11). In Newfoundland and Labrador (NL), a province in Atlantic Canada, the older adult population is the highest in Canada (12) . Despite this, health and social programming for older people in NL has been described as rudimentary (12). The recent Health Accord for NL publication calls for a rebalancing of the health system where an integrated model of care is implemented for older people in the community setting (13). Community based and home based care through the deployment of interdisciplinary teams are common-place care alternatives to institutionalization in long term care facilities (14). Moving towards an integrated community based care model for older people in NL is an opportunity to produce better health and better healthcare for residents, that can follow an older person over their life course and adapt to their changing needs (15).

Integrated care for older people is described in the Health Accord (13) as:

> An early assessment of frailty with a comprehensive plan where all care providers receive timely information, and the right care provider delivers the right care at the right time that can provide a respectful pathway of care for older persons and promote a more appropriate allocation of human and financial resources (p. 90).

In an urban location in NL, a group of geriatricians have already begun the process of conducting early assessments and comprehensive care planning for older people by implementing community based Comprehensive Geriatric Assessments (CGA). A CGA is a time-intensive, multidimensional process that aims to identify the medical, social, and functional needs of older people to develop an integrated/coordinated care plan to address those needs (16-18). A CGA is considered the gold standard of care and intervention for older hospitalized people, showing improvements in function and decreases in mortality and institutionalization (18-20). Despite the success of the CGA in the hospital setting, further work is required to explore its applicability in other settings due to difficulties in coordinating multidisciplinary team members and their work (21). Due to this fragmentation, older people and their caregivers may find themselves navigating an uncoordinated collection of clinical encounters that can lead to communication challenges, inefficiencies, reduced quality of care, and patient and caregiver frustration (22). In the local setting in NL, geriatric physicians are often conducting the CGA in isolation which has led to reduced service accessibility and timeliness due to the labor and time-intensive nature of the CGA.

There is a lack of robust data that can better inform local healthcare decision makers and policy makers regarding how the CGA process is organized and functions within the local community based health and social care system. Additionally, the unique and coordinated efforts of managers and health and social care professionals in delivering services to older people are also not fully realized. There are several models, standards, and frameworks in the literature to guide integrated care design and implementation (17, 23, 24). In a scoping review of integrated care implementation, Threapleton et al. (2017) found there to be a lack of robust evidence identifying the most effective or beneficial approaches (25). Alternatively, the authors outline a more pragmatic approach by presenting three potential prerequisites.

(i) Understanding the key components of integrated care for older populations.

(ii) Understanding how integration takes place through the micro-, meso-, and macro-levels of the healthcare system.

(iii) Anticipating implementation challenges to effectively make changes within different care contexts and settings.

These three prerequisites are further explained below.

1.3 Integrated Care

1.3.1 Understanding Key Components of Integrated Care for Older People

Integrated care aims to improve the quality and efficiency within and across the micro- (clinical level), meso- (organizational, professional), and macro- (system) levels of health and social care while ensuring it is organized around the needs, preferences, and goals of older people (26).

The World Health Organization (WHO) has introduced the Integrated Care for Older People (ICOPE) approach that supports the delivery of integrated care models globally by encouraging governments, health organizations, and clinicians to focus on achieving outcomes that are most relevant to the daily lives of older adults and their family/caregivers (27). For care to be organized, coordinated, and delivered around the needs and goals of older people, care models need to be designed with the goal of maintaining and preventing decline in an older person's intrinsic capacity and functional ability (16, 27). The WHO defines intrinsic capacity as all the physical and mental capacities that an older person can draw on, this can include the ability to remember, see, hear, think, and walk (16). An older person's intrinsic capacity can be impacted by injuries and illnesses as well as other age-related changes (28).

Functional ability is defined by the WHO (16) as having "the health-related attributes that enable people to be and do what they have reason to value" (p 28). This would include the ability of older people to care for themselves, be mobile, make decisions, contribute to society, and form and maintain relationships (28). Integrated care has been found to be especially relevant for older people with multimorbidity and frailty due to the complexity of their health and social care needs which exposes them more often to issues of access, continuity, and coordination (29, 30). For older people with multimorbidity, healthcare delivery that focuses solely on individual health conditions cannot address how these conditions interact and impact overall functioning (16). Models that are disease based will often result in the inefficient use of resources and duplication in services that can result in gaps in care for patients who are medically complex (9). Goodwin et al. (2013) explains integrated care as a person-centered approach that can improve the quality of care delivery where care is poorly coordinated and disjointed (9).

Integrated care for older people can also contribute to improved health outcomes at an equivalent cost to traditional care delivery models, offering a better return on investment and allowing older people to live longer while continuing to participate in society (31). Efforts should be made by governments, organizations, and clinicians to reorganize health and social care services to move towards integration by including the following key components (16, 17, 25, 26).

i) person-centred care
ii) comprehensive geriatric assessments
iii) interdisciplinary teams
iv) case management
v) goal setting and shared decision making
vi) support for self management
vii) amalgamated information and data sharing systems
viii) strong community linkages
ix) supportive leadership, governance, and financing mechanisms
x) home-based interventions

The above key components in the literature should not be viewed as 'one-size-fits-all': they should be considered a set of best practice principles that could take on different forms when applied in different contexts and care settings (32). Implementing changes to improve the integration of care for older people will benefit from both international and local evidence (25).

1.3.2 Levels and Dimensions of Integrated Care

Integration is ultimately the degree to which clinicians and service providers collaborate and communicate in their efforts to meet the health and social care needs of individuals and populations (33). Much of the evidence on the effectiveness of integrated care is at the micro-level with little focus on meso-level and macro-level elements (26, 32). Although there may be positive change and efficiency at the micro-level, sustainability may not be possible without considering interlevel interactions (25). For there to be interlevel connectivity and sustainability there needs to be consideration for the levels and enablers of integrated care prior to implementation. Table 1.1 provides descriptions of the micro-, meso-, and macro- levels through which integrated care for older people takes place, as well as the enablers of integration - normative and functional - that connect the levels of the system (24, 31, 32). The information presented in the table represents a set of building blocks that can be understood by decision makers to promote the effective development of integrated care in healthcare policy and practice (9).

Table 1.1

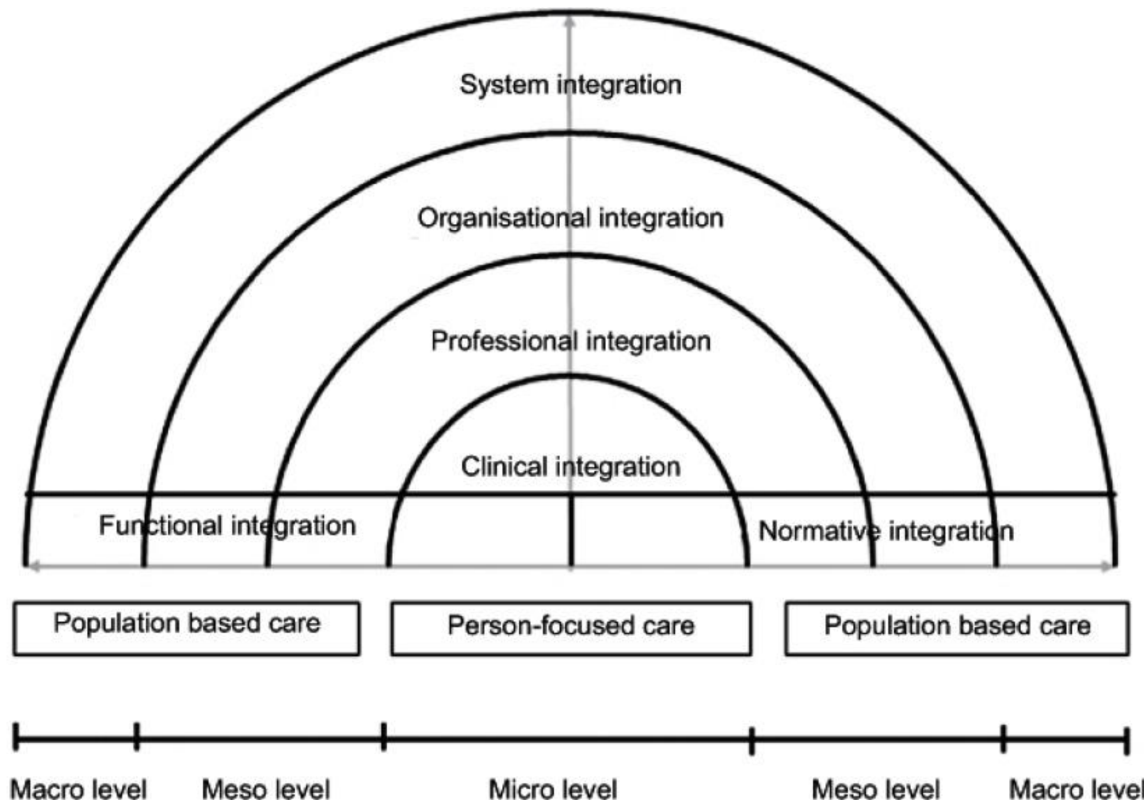
Descriptions of the levels and enablers of integrated care (24,31,32).

Levels	***Descriptions***
Micro-level	The clinical or interventional level, which is concerned with how health and social care services are coordinated and delivered to older people.
Meso-level	The organizational and professional level. The organizational level is concerned with inter-organizational shared governance, collective action, and collaboration. The professional level is concerned with partnerships among health and social care professionals that have a shared accountability to provide care and service delivery to older people.
Macro-level	The policy or sector level. Concerned with governmental, educational, and regulatory arrangements that guide organizations and professionals in the delivery of comprehensive care and services to older people.
Enablers	***Descriptions***
Normative	The development of a shared vision/culture among stakeholders and organizations (clear goals and objectives) that can facilitate interdisciplinary collaboration to meet the needs of older people.
Functional	The coordination of support functions essential for service delivery to older people, such as information technology, financial management, human resources, strategic planning, and quality improvement.

Additionally, Valentijn et al. (24) present a conceptual framework, the Rainbow Model of Integrated Care (Figure 1.1) that has been used to study and understand integrated care (9).

Figure 1.1

Rainbow Model of Integrated Care - Valentijn et al. (24).



The Rainbow Model provides a multi-level holistic vision for integrated care expressed as both person-focused and population-based care (24). A person-focused approach occurs at the micro-level (clinical integration) of the healthcare system and places emphasis on the values, needs, and preferences of the person receiving care. Healthcare delivery that is person-focused also bridges the gap between medical and social care.

Valentijn et al. (24) underscores this "as it acknowledges that diseases are simultaneously a medical, psychological, and social problem" (p. 4). The goal of clinical integration is to facilitate a longitudinal process of care delivery to individuals that is comprehensive and coordinated around their total needs (preventative and curative) (22, 24). This approach contrasts the episodic and disease-focused approach that has shaped how healthcare has traditionally been delivered. Healthcare professionals have been trained separately and practice within their own mental models with a focus on individual clinical encounters with patients (22). The result of this is a healthcare system that satisfies the structural and organizational requirements of siloed health and social care delivery, rather than the values, needs, and goals of individuals and populations.

Population-based care attempts to address the needs of a defined population taking into account the health characteristics of the population and the burden of morbidity (24). In the case of older people living in NL, consideration would need to be given to how care should be organized and delivered to a population that has high levels of multimorbidity, chronicity, and frailty. The Rainbow model also presents meso- (organizational and professional) and macro-level (system) integration processes as well as enablers for integrated care (functional and normative).

Organizational integration refers to efforts to develop inter- and intra-organizational strategies to provide comprehensive services to individuals and populations. This may include common governance, funding alignment, and the presence of networks and alliances to improve collaboration and collective action (24, 25). Professional integration refers to the relationships and partnerships that are developed between professionals within and across organizations to deliver comprehensive services to a population. This type of integration challenges the traditional hierarchical roles and responsibilities of health and social care professionals by moving away from solo professional care and towards team-based care delivery.

Individuals and populations would have access to a team of professionals and access the right professional for their needs, at the right time, in the right place. Macro-level (system) integration refers to how governmental directions and regulation (care standards and safety, scopes of practice, professional competencies) can facilitate organizations and professionals to deliver care to individuals and populations (32).

Enablers of integrative care are normative and functional spanning the micro-, meso-, and macro-levels of care to achieve connectivity (24). Normative integration refers to the shared goals and culture as well as leadership and vision for how care is delivered (32). Leadership plays a key role in disseminating an integrated approach by ensuring the mission and vision among organizations and professionals is understood and reflects the needs of individuals and the population (24). Functional integration includes the organization and coordination of essential support functions (information technology, performance data, payment structures) and linking them to the process of clinical care delivery (24, 32). Limitations on ability to access and share performance data and electronic health information among clinicians has been cited as a barrier to integration (32). The ability to access data and clinical information as well as share it effectively are essential connectors for successful integration (34).

Wodchis et al. (33) conducted a seven country cross case analysis of integrated care for older people and none of the programmes examined had fully integrated information systems. Additionally, these programmes identified the greatest challenge being the sharing of data across organizational and professional boundaries with family physicians (33). Some studies suggest the most effective approaches to integrated care for older people who are medically complex is to place the family physician at the centre of the care team (35-37).

Family physicians are an essential care provider in the care of older people, but several factors have been identified that cite challenges in engaging family physicians in community based integrated care. Family physicians are most often independent practitioners and the payment structures (Medicare) in place for their reimbursement lie outside of healthcare organization funding models (33). An additional challenge identified by Wodchis et al. (33) is the limited time family physicians can dedicate to care planning and case reviews due to workload constraints. The WHO (16) states "unless a people centred and integrated health approach is adopted, healthcare will become increasingly fragmented, inefficient, and unsustainable" (p. 7). The literature describes integrated care as an important means of assisting the healthcare sector to be come a more value-driven, person-centred system that produces better outcomes (8). Despite these findings, the implementation science of integrated care has been described as weak, which may be due to programmes being immature and lacking in focus (38). Additionally, the level of complexity and scale of the work that would be required to redesign how care is delivered to older people may be viewed by government, organizations, and clinicians as too overwhelming (31). Threapelton (25) suggests acquiring a better understanding of the local context in which care is to be delivered can potentially identify challenges and opportunities for integrated care implementation.

1.4 Systems Thinking

1.4.1 Anticipating Challenges and Opportunities in the Local Context

A transformative redesign of community based health and social care delivery using an integrated care approach is necessary but cannot be accomplished without an understanding of how health and social care professionals currently conduct their work and how older people receive care under the dynamic conditions.

This understanding can assist in anticipating both challenges and opportunities in implementation of community based integrated care programming.

The National Academies of Sciences, Engineering, Medicine [NASEM] (9) states:

> Without examining each level of the healthcare system – the environment, the organization, the health workers, and the patient at the center and how they interact and either help or inhibit one another, it is difficult to discern how their incentives and activities align and contribute to positive or negative effects on quality (p 9).

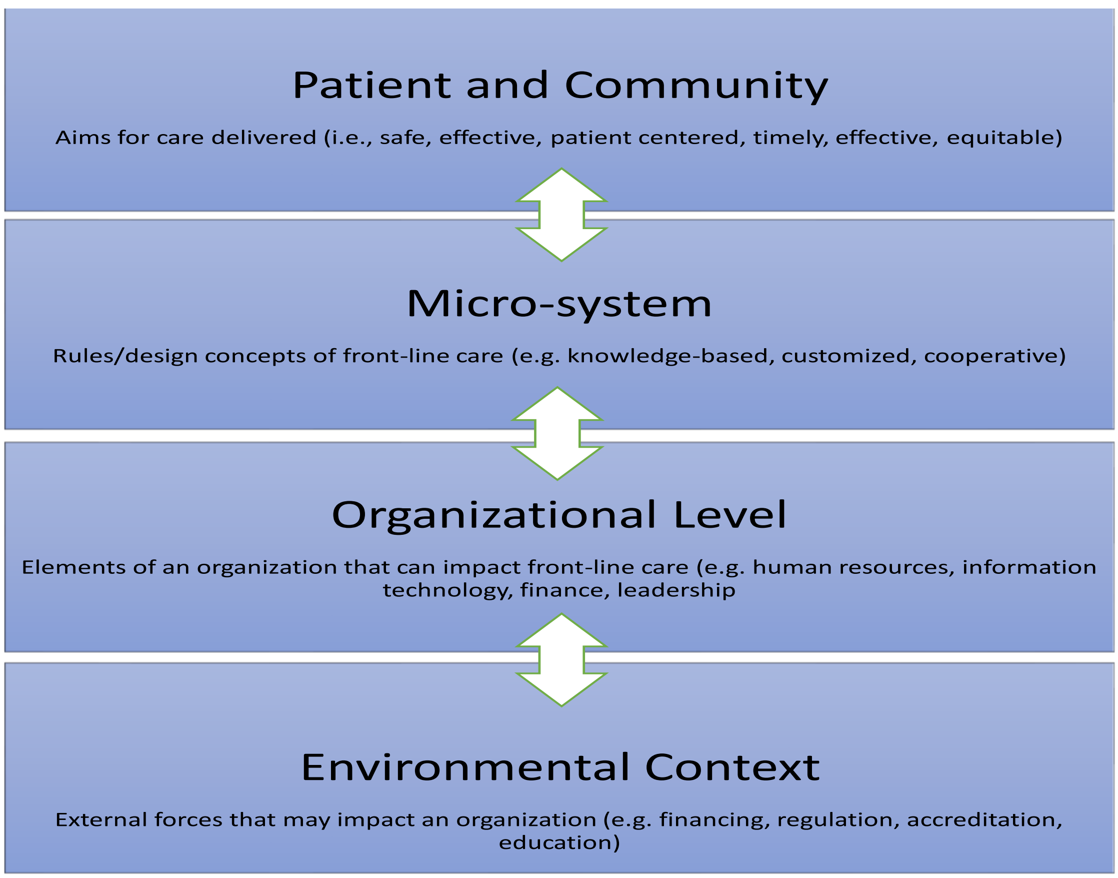
Systems thinking is a conceptual approach that can improve the delivery of healthcare by considering the multiple factors involved in healthcare delivery and understanding how these elements operate and impact one another (39)**.** Systems thinking is described by the WHO as an approach that petitions for a more in depth understanding of the connections, interrelationships, interdependencies, and behaviours among the elements that make up healthcare processes and systems (40). Systems thinking acknowledges that the healthcare system is non-linear and there are proximal and distal, or upstream and downstream elements within a health system that can have an impact on healthcare outcomes and the patient experience (22, 40, 41).

Deficiencies at the blunt end or environmental/organizational level can create inefficiencies and cascade down to the sharp end or micro-/patient-provider level leading to poorer outcomes (22). Systems thinking provides an important perspective that moves away from assigning blame and shame to front-line workers for poor system outcomes (22). Alternatively, systems thinking aims to identify where are processes working and where are they also breaking down by identifying both the strong and weak interfaces in a system (22).

In the landmark report on global health quality, Crossing the Quality Chasm (42) a systems-thinking framework guided the committee that produced the report (22). The four-level framework (see Figure 1.2) adapted from Berwick (43) and NASEM (22), shows how health system levels are interconnected and interdependent.

Figure 1.2

Health system levels



Research conducted using a systems-thinking approach can improve the delivery of healthcare by considering the multiple factors involved in delivering care to patients and understanding how these elements operate and impact one another, assisting in the design and integration of people, processes, policies, and organizations to promote improved health and reduced costs (39). As defined by Kaplan (39), a systems approach to health is one that:

i) applies scientific insights to understand the elements that influence health outcomes

ii) models the relationships between those elements

iii) alters the design, processes, or policies based on the resultant knowledge to produce better health at lower cost.

Quality has been described as a systems property that is impacted by decisions occurring at multiple levels of the healthcare system. Therefore, the design of healthcare systems should be optimized at all levels (22). The WHO challenges healthcare leaders across the globe to use a systems lens to examine vulnerabilities in healthcare practices and policies (44). By taking this holistic perspective, the underlying issues that result in poor quality can be identified, such as process inefficiencies and weakly structured organizations (22). Such an approach is thought to be capable of uncovering fundamental processes that influence health system outcomes, identify areas of vulnerability, and highlight areas of strength that can be amplified to improve performance (45). In considering how to operationalize a systems thinking approach for examining and analyzing community based health and social care delivery for older people, a novel systems thinking methodology was identified – the Functional Resonance Analysis Method (FRAM).

1.5 The Functional Resonance Analysis Method (FRAM)

Gaining an in-depth understanding of the everyday activities, processes, and structures of healthcare systems and how they interact has been a difficult undertaking for researchers and decision-makers to date. Without a comprehensive understanding of these key features, healthcare system improvements and sustainability efforts will continue to be difficult (46). Healthcare is a complex socio-technical system and is dependent on a multitude of dynamic interactions and everyday activities between humans, organizations, technology, and the environment (47). In complex systems, such as healthcare, behaviour of the system is challenging to predict due to the complexity of relationships between professionals, patients, organizations, and the environment (48). Healthcare is hierarchical and multileveled (micro-, meso-, macro-levels) with each level nested within one another (49). In considering the care of an older person in the community setting one can appreciate the complexity of the system in which healthcare professionals perform their work and older people access care.

A geriatrician conducts a visit with an older person with unique and complex needs (frailty, multimorbidity, social challenges). This interaction occurs within an organization where multiple interdependencies enforce or constrain the delivery of care (availability of human resources, operating hours, procedures, care guidelines) and the organization itself operates within an environment (regulation, government) that is impacted by policy and allocation of resources. Inefficiencies at the more distal levels of healthcare (meso-, macro-levels) can trickle down and impact the patient provider interaction (micro-level) and the outcomes that result from it (22). New insights are needed to gain an understanding of the elements that interact and have an impact on health system functionality and outcomes (39).

A new approach to collecting data is necessary that acknowledges and confronts the complexity and variability of everyday healthcare operations. Variability in healthcare can be attributed to dynamic and uncertain processes and systems. Within a complex socio-technical system, human and organizational performance will always vary and adjust to meet demands. These adjustments will produce positive outcomes but can also at times result in poor outcomes. Part of the difficulty in understanding how healthcare processes and systems function and operate is that many healthcare activities are unpredictable, intractable, and not reproducible. Underlying contextual features and human variability can significantly impede efforts to control healthcare processes and individual responses to them (50). The CGA process is itself it quite variable because of the circumstances related to how health and social care professionals and organizations conduct their work and how individual patients (older people and their families) engage the process. Variability (positive or negative) can emerge at several points and can dissipate or propagate as older people move through the process.

The FRAM is a systemic, non-linear mapping approach used to produce a functional model of the everyday activities, interdependencies, and variabilities within a process or system, demonstrating complexity, which may otherwise be invisible (51). The FRAM was first developed in the early 2000s in the field of engineering to be used in research and development related to safety and accident analysis (52). One of the key components of the FRAM is the recognition of a gap between the concepts of Work as Imagined (WAI) and Work as Done (WAD). The closer one is to the work (clinical, micro-level), the more accurate their understanding about how the work is done; as one moves from the work (meso-/macro-level), their understanding becomes less accurate and more simplified (53).

There is a gap between the WAD understanding front-line workers have regarding system functionality and the WAI understanding organizations, administrators, and policy makers have. If this gap can be reconciled, healthcare system administrators and policy makers can implement practice and policy changes that could more accurately reflect the dynamic work conditions of the healthcare system and potentially contribute to the improved safety, quality, and efficiency of healthcare delivery. Organizing an approach to accurately describe WAD within a system such as healthcare is a complex endeavour. Simple flowcharts and/or diagrams cannot adequately describe how a system behaves (54). The FRAM is a methodology that attempts to elucidate this complexity by focusing on identifying and describing the functions of work and the interdependencies and variability that can emerge in a healthcare process or system under the dynamic conditions of everyday work.

1.5.1 Steps of the FRAM

The methodology uses a stepwise approach for building and analyzing FRAM models. The steps explained below have been adapted for the healthcare context from an original description (55).

- Step 1 is concerned with identifying a clearly described purpose and scope of a FRAM analysis of a healthcare process.
- Step 2 of the FRAM is concerned with identifying and describing the activities required for a healthcare process to take place.
- Step 3 is concerned with describing how the activities in a healthcare process vary.
- Step 4 aims to show how the aggregation of variability in activities impacting one another early in healthcare process (upstream) may have an impact on activities later in the process (downstream).

- Step 5 is concerned with monitoring the process and identifying how any negative variability that emerges can be dampened and how any positive variability can be enhanced.

1.5.2 Principles of the FRAM

There are four underlying principles of the FRAM that can explain the outcome of a process or how something happens. These four principles are outlined below as explained by Hollnagel & Slater (56).

1. The principle of equivalence of successes and failures assumes that things can go right and go wrong in much the same way, so different consequences don't necessarily require different types of explanations. Outcomes, both acceptable and unacceptable, occur because individuals, groups, and organizations have an ability to adjust what they do in expected and unexpected conditions.

2. The principle of approximate adjustments assumes that work is continuously adjusted in relation to the existing conditions (time, information, conflicts, interruptions, resources, tools). Adjustments are not precise, they are approximate and are made by individuals, groups, and organizations. This principle explains why most often things go right but can also explain why occasionally things can go wrong.

3. The principle of emergence acknowledges there are situations in which it is not possible to explain an outcome or a result due to an identifiable cause. In a complex process or system, the variability from multiple activities can combine in unexpected ways (producing a non-linear effect) and outcomes of these interactions are more appropriately explained as emergent rather than resultant. The use of the term emergent acknowledges that the interaction of activities in a complex system is not entirely understood and that an explanation of outcomes in terms of causality is not appropriate.

4. The principle of resonance assumes that in some situations multiple approximate adjustments in work can coincide and mutually influence one another in unintended ways resulting in the emergence of noticeable variability. This variability can lead to outcomes (negative and positive) that may not have been anticipated. This is known as functional resonance.

1.5.3 FRAM Terminology – Functions and Aspects

The FRAM refers to activities in a process as "functions" (51). Functions are continuously carried out in complex processes and can be human, organizational, or technological (57). The functions of a healthcare process can be described or characterized by six aspects: Input (I), Output (O), Resources (R), Time (T), Control (C), and Preconditions (P), these are best explained below by Clay-Williams et al. (54).

1. The Input is what the function acts on or changes (what initiates the function).

2. The Output is what is produced from the function (an outcome or state change).

3. A Precondition is a condition that must be satisfied for a function to happen.

4. The Resources are materials, technology, or people needed to execute a function (what is consumed during execution).

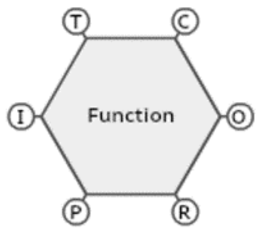
5. The Control is how the function is regulated or controlled (e.g., guidelines, protocols).

6. The Time refers to any temporal requirements of the function.

The data gathered to identify functions and then describe them in terms of their aspects should come from information-rich sources who are stakeholders in the process, such as healthcare professionals, and patients and their families. The FRAM uses qualitative data collection methods, such as interviews and focus groups, to gather accounts from stakeholders who can accurately describe the activities in a process and how the activities are connected and mutually dependent. Document review of clinical guidelines, protocols, and procedures can be helpful preparation for interviews as it provides the researcher with insight into the practice setting and how work is intended to be carried out (55). Researchers have also used observations to gather data necessary to build a FRAM model. Observing work as it is performed in context can potentially contribute rich data regarding the nuances of how a healthcare process or system operates (58). In a FRAM model, a function is diagramed visually as a hexagon with aspects branching from the corners of the hexagon. Figure 1.3 is an example of a function adapted from Hollnagel et al. (55).

Figure 1.3

FRAM function hexagon.



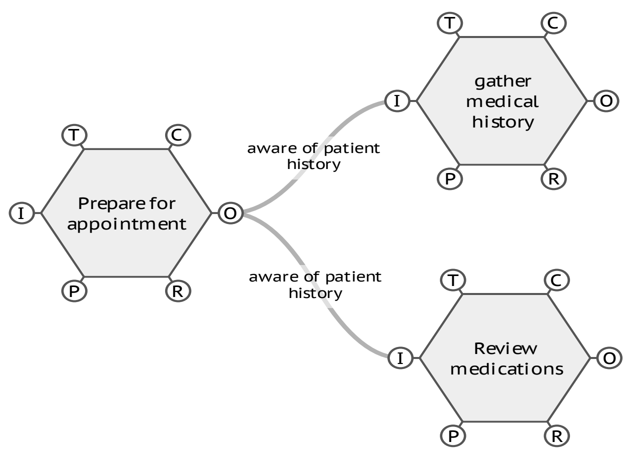
1.5.4 Couplings

When the functions in a process are identified and described in terms of their aspects, a graphical FRAM model can be built using the FRAM Model Visualizer (FMV) software programming (59). One of the objectives of the FRAM is to identify how functions are connected/interdependent, also known as "coupling" of functions (51). Functions are coupled through mutually shared aspects and can impact one another in a variety of ways. For instance, when there is variability in how a function is carried out, functions can absorb any variability by mutual dampening each other. They can also amplify the variability by mutually reinforcing each other (60). The variability and adjustments of functions is an essential and normal part of work and can lead to both successful and unsuccessful outcomes (51). Using the FMV software, researchers can input functions and aspects to create a model depicting all of the functions of a healthcare process and how they are coupled (61). As an example, three functions of the process of comprehensive geriatric assessment are depicted in Figure 1.4.

The figure shows an example of how functions are coupled through mutually shared aspects. The function <Prepare for appointment> has an Output "Aware of patient history" which is also the Input or what starts the functions <Gather medical history> and <Review medications>.

Figure 1.4

Coupling of functions in the CGA process.



1.5.5 Potential Variability

Potential variability refers to what could happen under different conditions in a healthcare process (55). Data is collected from stakeholders to learn how functions in a process can potentially vary. Gathering this information from stakeholders is important to determine what might happen or vary while carrying out a healthcare process.

The FRAM is concerned with the variability that can potentially occur in the outputs of functions within a process rather than the variability of the function itself. Hollnagel et al. (55) describe three ways the output of functions can vary:

1. The uniqueness of the function (endogenous or internal variability)

2. The conditions in which the function is performed (exogenous or external variability)

3. The variability from the output of functions that occur earlier in the process (functional upstream-downstream coupling)

Hollnagel et al. (55) explain that it is important for researchers to understand that when a FRAM model is built, the model is a representation of all "the potential or possible relationships or dependencies within a process without referring to a specific situation" (p. 32). For instance, if the FRAM is used to examine the community based CGA process, data would be collected to identify functions of the CGA process and then describe them in terms of their aspects. Stakeholders in the CGA process would additionally provide data on how the outputs of functions in the CGA process vary. This variability is usually described in two ways: time and precision. The variability in the output of a function related to time can be described as too early, on time, too late, or not at all, As it relates to precision, the variability in the output of the function can be described as imprecise, acceptable, and precise (56).

1.5.6 Actual Variability

Actual variability in the CGA process can only be determined by monitoring a specific situation or scenario within the process. For instance, an older adult presents to their family doctor with functional decline and multimorbidity. The scenario in which they navigate the community based CGA process can be monitored to identify what functions were activated and what mutual dependencies or resonance occurred in the process. A specific scenario such as this is referred to as an instantiation (56).

If several older people were referred for CGAs, those instantiations can be analyzed to determine the actual variability that occurred in each instantiation of the CGA process. Recommendations could then be made regarding how the variability could be managed by enhancing positive variability and dampening negative variability.

1.5.7 Dynamic FRAM Modelling (DynaFRAM)

FRAM models can also be used to conduct Dynamic FRAM Modelling (DynaFRAM). This approach, developed by Smith et al. (2020) can depict the variations that belong to specific executions of a process over a set period, known as functional signatures (62). DynaFRAM software was designed to be complementary to FRAM Model Visualizer (FMV) software (62). The FMV can provide a visual representation of potential variability and DynaFRAM can provide a visual representation of actual variability using functional signatures, which are comparable to instantiations (62). The result of using DynaFRAM is the ability to visualize a unique functional path (functional signature) through a complex process or system. The functional signature depicts what is produced at the end of a function (functional output), showing when it occurs and for how long it occurs (63).

If several functional signatures are collected, the differences identified between them may offer functional explanations for the variability in the outcomes of the system (64). Functional signatures are distinct from instantiations because they can demonstrate temporal variations that occur in specific executions. In understanding how a healthcare process such as community based CGA functions and is organized, time is a significant factor. FRAM models can demonstrate what people, organizations, and technologies can do to produce a certain output, but cannot demonstrate how long it takes to produce the output as well as the times in a process when nothing is happening (65).

An example of this would be the waiting time experienced by older people when they have been referred from one professional to another in the CGA process. DynaFRAM provides an important means of tracking and visualizing how long a patient journey through the process takes and the times in which an older person would be waiting for care. Waiting times are an important indicator of quality and efficiency and using DynaFRAM to collect and record functional signatures (patient journeys) provides an opportunity to conduct comparisons and gain an understanding how the variations, such as waiting times, impact outcomes (64).

1.6 Current State of Knowledge and Gaps

When examining the state of knowledge on the FRAM, gaps in the literature were identified in two areas. The first gap was related to an understanding of how the FRAM has been used in healthcare research and the lack of guidance around how the design of a qualitative research study can inform the building of a FRAM model and instill trustworthiness in study findings. Review papers have been conducted examining how the FRAM has been applied in a variety of domains, but none have exclusively examined the application of the methodology in the healthcare domain (52, 60).

The FRAM is an emerging methodology, and the rising number of healthcare studies using the FRAM warranted further understanding. The need for a scoping review of the literature on the use of the FRAM in healthcare research was evident. Such an understanding would increase the reach of the methodology in the healthcare domain and be helpful for researchers and clinicians seeking to examine complex healthcare system issues. In the process of preparing the scoping review of the literature, a number of fundamental FRAM documents and guiding literature available to novice FRAM researchers were identified and reviewed (51, 55, 56). The guidance on how to design a qualitative research study to inform the building of a FRAM model was limited.

Additionally, the guidance available to researchers using the FRAM on establishing trustworthiness in study findings using quality enhancement criteria and strategies was also limited. The second area in which gaps in the literature were identified was in relation to the context of the application of the FRAM. With its wide scope of application in the healthcare domain, the FRAM has been used to examine complex processes such as hospital discharge in older adults (66-69), safety in medication administration (70, 71), and how care guidelines can differ from clinical practice (54, 72). When considering how to implement community based integrated care for older people, a review of the existing studies identified the following gaps/opportunities for research using the FRAM:

i) No study using the FRAM to examine and analyze complex healthcare processes has modelled and analyzed community based health and social care for older people.
ii) No community based study has used DynaFRAM to create a functional signature depicting a patient journey through a complex healthcare process.

iii) No study has used FRAM modelling (FRAM and DynaFRAM) as a methodological approach for identifying challenges and opportunities for the implementation of a community based integrated model of care.

1.7 Why the FRAM and DynaFRAM?

This section explains the reasons behind choosing the FRAM and DynaFRAM to meet the aims and objectives of this PhD research work. Complex healthcare processes, such as the CGA process are often described as intractable, in the sense that they are not well understood and do not behave in a predictable way (48). The CGA process requires a high number of functions as well as a high level of interdependencies between functions to produce outcomes. Because of this, the process is challenging to describe and much more challenging to predict or manage (73). To gain an improved understanding of the CGA process, functions of the process need to be identified, and an understanding of the interrelationships between the functions and how they are organized is also required (73).

Process mapping/modelling has been identified as an effective approach to gain an understanding of how healthcare processes are organized and to support improved healthcare process design, implementation, and more effective care coordination (74). A process is described as a group of interconnected tasks performed using organizational resources to produce an outcome (74). Developing a systems level understanding of how a healthcare process works using process mapping/modelling has been identified as an essential step to effective quality improvement (75).

In a systematic review of process mapping in healthcare, Antonacci et al. (76) states “the capacity of process mapping to bring together diverse stakeholder perspectives and provide a visual representation of the system is key to addressing the complexity which characterizes healthcare processes” (p. 8). In other domains, such as engineering and business, various process modelling approaches have been applied to gain an improved understanding of how people, technology, and organizations interact to achieve outcomes and how processes can be redesigned effectively (51, 77, 78).

Despite the benefits of process mapping/modelling, there is a lack of knowledge in the healthcare community regarding the broad range of methods and their applicability, hindering adoption (75). Jun et al. (75) reviewed and characterized various process mapping/modelling approaches from a number of different domains in order to evaluate how healthcare workers perceived usability and utility of the methods. The review identified flowcharts had been most utilized and favoured by participants due to their ability to provide an improved understanding of the sequence of a care process. Other process mapping/modelling methods were considered more helpful for understanding complex processes, such as communication diagrams (understanding interactions), swim lane activity diagrams (identifying roles and responsibilities of stakeholders), and state transition diagrams (providing a patient centred perspective) (75).

When describing complex healthcare processes Hollnagel et al. (48) state “the whole is not only greater than the parts, but qualitatively different from the sum of the components" (p. 60). Breaking down a complex healthcare process into separate parts for examination will provide an incomplete picture masking interactive complexity that should not be ignored (48). A strength of the FRAM is that it uses both qualitative inquiry and process mapping/modelling.

Combining these approaches can provide an enhanced description and understanding of the complexities of healthcare work by gathering contextual data while also capturing and depicting the dynamic nature of work activities with process mapping/modelling (79). Healthcare has been described as a complex sociotechnical system that is dependent on the interactions between humans, technology, and organizations delivered in and across multiple sectors that are often loosely connected (80). The FRAM has demonstrated an ability to identify strengths and vulnerabilities in complex healthcare processes that can impact outcomes for older people transitioning from hospital to home (66-69). Traditional research paradigms and methodologies fail to gain an understanding of the complexities of everyday healthcare work (48). Recommendations are often characterized by fragmentation and standardization with knowledge dispersed over different professional groups and research communities (41). Acknowledging and confronting complexity in the healthcare system requires a clear description and level of understanding of the specifications and activities of healthcare delivery under dynamic conditions (51). The FRAM is an approach that has been shown to achieve this level of understanding and with this knowledge can assist in identifying potential problem areas and areas of success within a process or system (62). A central tenet of the FRAM is the understanding that systems and processes are not linear; rather, they are complex and are required to adapt to available information and changing conditions and resources. Having an improved understanding of complexity and variability and its impact on operations can assist in the process' design, and the integration of people, processes, policies, and organizations (39).

DynaFRAM has demonstrated an ability to conduct dynamic modelling of patient journeys using functional signatures (69). In addition to creating a model of the transitional care process for older patients discharged home from hospital, Salehi et al. (45), were able to test the model using DynaFRAM. DynaFRAM was able to visually demonstrate what functions were active in each patient's transition process, including when those functions become active and for how long, (45). Salehi et al. (45) was also able to demonstrate how DynaFRAM can measure system performance to compare outcomes of processes, which assists in understanding how performance varies within a single process. The authors found that DynaFRAM provided a visual representation of what happened for the patient over the course of their transition process, when it happened, for how long, and the quantity and quality of the output for each active function. This included the couplings/interdependencies between active functions and the variations in the outputs of active functions. These findings allowed the authors to identify the distinctions between a successful and unsuccessful transition. This doctoral research work has adopted the FRAM and DynaFRAM to model the process of CGA in the community based health and social care system.

1.8 Research Aims and Questions

Considering the knowledge gaps that exist in the literature, this thesis has three overall aims each with an associated research question or questions.

i. To assess the FRAM as a healthcare research methodology.
    - How has the FRAM been used to examine complex processes in the healthcare domain?

ii. To advance the FRAM as a healthcare research methodology

- What factors should researchers consider when designing qualitative healthcare studies using the FRAM?

- How can researchers employ quality enhancement criteria and strategies in their qualitative research efforts so resulting FRAM models and insights afforded by them are trustworthy?

iii. To apply a systems thinking methodology (FRAM and DynaFRAM) to inform the development of practical policy initiatives that can move the community based CGA process towards a more integrated model care.

- What are the key components of integrated care for older people?
- How does integration take place through the micro-, meso-, and macro-levels of the healthcare system?
- How does the community based health and social care system currently operate for older adults at any stage of the CGA?
- How does variability in the community based CGA process create challenges or generate opportunities for delivery of integrated healthcare services to older people in the local context?
- What policy recommendations can be made to move the community based CGA process towards a more integrated approach to service delivery?

1.9 Thesis Organization

A manuscript style thesis is provided consisting of four papers presented as Chapters 2, 3, 4, and 5 respectively (Figure 1.5). The scoping review (chapter 2) was written to address the first aim and associated research question.

The methods papers (chapters 3 and 4) were written to address the second aim and associated research questions. The research paper (chapter 5) was written to address the third aim and associated research questions.

Figure 1.5

Four manuscripts comprising the thesis.

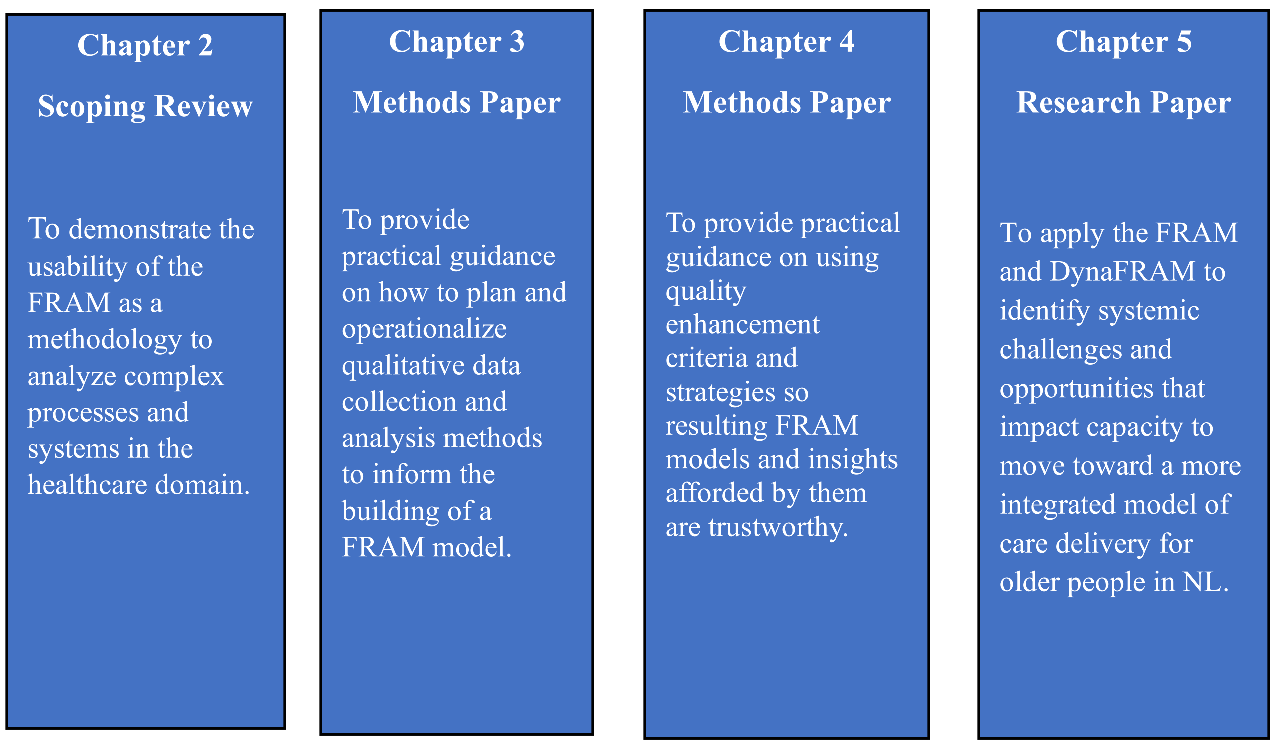


Table 1.2 presents the individual chapters in more detail to elaborate on how the author completed tasks which address the objective(s) of the papers and the overall aims of the thesis.

Table 1.2

Papers and their connection to the overall aims of the thesis.

Chapter 2	Aim(s)	Objective(s)	Tasks
The Functional Resonance Analysis Method as a healthcare research methodology: A scoping review	To assess the FRAM as a healthcare research methodology.	To demonstrate the usability of the FRAM as a methodology to analyze complex processes and systems in the healthcare domain.	i) Identify concepts and definitions used to define or describe the FRAM in healthcare research ii) Identify research question(s), aim(s), or objective(s) that have been examined using the FRAM in healthcare research iii) Identify methods that have been used to operationalize the FRAM in healthcare research iv) Identify the processes and/or activities that have been examined using the FRAM in healthcare research v) Identify key findings

Chapter 3	Aim(s)	Objective(s)	Tasks
Building a Functional Resonance Analysis Method (FRAM) Model: Practical Guidance on Qualitative Data Collection and Analysis	To advance the current knowledge of the FRAM and its application in the healthcare domain.	To provide guidance on how to plan and operationalize qualitative data collection analysis methods to inform the building of a FRAM model.	i) Identify key factors researchers should consider when designing qualitative healthcare studies using the FRAM ii) Identify how researchers can operationalize qualitative data collection and analysis methods in healthcare studies using the FRAM iii) Identify the resources required to build a FRAM model iv) Identify how researchers can build FRAM models that more accurately reflect the everyday realities in healthcare processes.

Chapter 4	Aim(s)	Objective(s)	Tasks
Establishing Trustworthiness in Healthcare Process Modelling: A Practical Guide to Quality Enhancement in Studies Using the Functional Resonance Analysis Method	To advance the current knowledge of the FRAM and its application in the healthcare domain.	To provide guidance on quality enhancement criteria and strategies so resulting FRAM models and insights afforded by them are trustworthy.	i) Provide an overview of the FRAM and the importance of qualitative data collection in conducting a FRAM analysis ii) Present Lincoln and Guba's trustworthiness criteria and quality enhancement strategies for researchers using the FRAM to apply iii) Provide illustrative examples and tables depicting how quality enhancement strategies have been used to establish trustworthiness criteria in select healthcare studies using the FRAM

Chapter 5	Aim(s)	Objective(s)	Tasks
Mapping the Way: Functional Modelling for Community Based Integrated Care for Older People	To apply the FRAM and DynaFRAM to inform the development of practical policy recommendations for moving the community based health and social care system towards a more integrated model of care for older people in NL.	To use FRAM and DynaFRAM to identify systemic challenges and opportunities that impact capacity to move toward a more integrated model of care delivery for older people in NL	i) Map the everyday activities and interdependencies of the CGA process in the community based system using the FRAM to produce a functional model. ii) Identify instances of potential variability occurring in the CGA process from the data obtained from health and social care providers who conduct everyday work in the system. iii) Provide an example of variability in the CGA process by developing a functional signature from a hypothetical patient journey scenario using DynaFRAM iv) Determine how the emergence of negative and positive variability can create challenges or generate opportunities for delivery of integrated health and social care for older people v) Co-design multi-level process improvement recommendations supported by normative and functional dimensions of integration.

1.10 Contribution and Novelty

The contributions of this doctoral research work are made by addressing gaps in the literature to assess and advance the use of the FRAM in the healthcare domain. Additionally, a contribution has also been made in healthcare policy development for community based integrated care for older people. This is achieved by using of a novel approach (FRAM and DynaFRAM) to conduct a multi-level systemic examination and analysis of community based health and social care for older people in the local context. As evidenced by the micro-, meso-, and macro-level policy recommendations produced, the FRAM is a methodology that can comprehensively model and analyze a complex healthcare process spanning multiple healthcare sub-systems. Four papers were written and are presented as Chapters 2, 3, 4, and 5 in this thesis. The contributions and novelty of each paper are summarized in Table 1.3 explained in further detail below.

Table 1.3

Thesis contributions

Chapter	Contributions
Chapter 2 – The Functional Resonance Analysis Method as a Healthcare Research Methodology: A Scoping Review	• No review of the literature had previously been conducted specifically examining the application of the FRAM in the healthcare domain. • Thirty-one papers were reviewed. • Provided insight into how the FRAM can has been operationalized in healthcare research (research questions/aims/objectives, methods used, healthcare processes examined, key findings) • Identified the usability and suitability of the FRAM for modeling complex healthcare processes.
Chapter 3 – Building a Functional Resonance Analysis Method Model: Practical Guidance on Qualitative Data Collection and Analysis	• Practical guidance for researchers on steps 1 and 2 of the FRAM. These steps are currently underspecified in the literature. • Review of qualitative data collection and analysis methods and guidance on how to operationalize these methods to inform the building of a FRAM model.
Chapter 4 – Establishing Trustworthiness in Healthcare Process Modelling: A Practical Guide to Quality Enhancement in Studies Using the Functional Resonance Analysis Method	• Practical guidance for employing quality enhancement criteria and strategies (Lincoln & Guba's trustworthiness criteria) in their qualitative research efforts so that resulting FRAM models and insights afforded by them are trustworthy.

Chapter 5 – Mapping the Way: Functional Modelling for Community Based Integrated Care of Older People	• Demonstrated how FRAM modelling was able to achieve a micro-, meso-, and macro-level understanding of how work is done on an everyday basis in the community setting. • The model provided a map of the complex functional paths navigated by professionals and older adults every day. • The patient journey (functional signature) depicted the operations and functionality of a complex process (CGA) across multiple subsystems over time. • FRAM modelling provided an understanding of variability and its downstream impacts assisting in the identification of challenges and opportunities for implementing integrated care in the local context. • FRAM modelling demonstrated its ability to inform the co-design of multi-level policy recommendations for moving the CGA process towards a more integrated model of care for older people.

1.10.1 Chapter 2

The scoping review presented in Chapter 2, revealed the usability and practical application of the FRAM in modeling complex healthcare processes and systems in the healthcare domain. No comprehensive review literature on the use of the FRAM as a healthcare research methodology had previously been conducted. The review identified how the FRAM provided a comprehensive understanding of how healthcare work is done and how that work can become more efficient, safer, and better supported. Insight into how the FRAM has been operationalized in healthcare research can assist researchers, clinicians, and policymakers in their understanding of how this methodology can be used to strengthen healthcare systems.

1.10.2 Chapter 3

The paper presented in Chapter 3 offers practical guidance for researchers on steps 1 and 2 of the FRAM. The guidance in the fundamental FRAM literature related to these vital steps of the methodology is currently underspecified. These steps focus on:

i) The development of a clearly described purpose and scope of a FRAM analysis.

ii) The identification and description of the functions required for a healthcare process to take place.

When conceptualizing and planning a study using the FRAM, it is important for researchers to appreciate that simply appropriating qualitative methods to identify the functions, aspects, and interdependencies of a healthcare process does not suffice. A review of qualitative data collection and analysis methods is provided with practical guidance on how to operationalize these methods to inform the building of a FRAM model. Select examples from the FRAM healthcare literature are also provided.

1.10.3 Chapter 4

The contribution to the literature made by the paper presented in Chapter 4 will enhance the knowledge of healthcare researchers, administrators, and clinicians in designing qualitative research using the FRAM that can establish trustworthiness in study findings. To build a FRAM model, researchers rely on contextual data gathered from key stakeholders. An important consideration for researchers using the FRAM is how they will establish trustworthiness in their study findings given the data used to build and analyze a FRAM model can be subjective. The goal of any study using the FRAM is to produce a model that is an accurate depiction of the everyday activities and interdependencies of a complex healthcare process. Accurate modelling is dependent on the quality of the data gathered from stakeholders and study design decisions made by the researcher(s).

Employing qualitative research methods for building a FRAM model without considering and presenting quality enhancement criteria and strategies will be met with challenges from end users, funders of healthcare research, as well as healthcare publications that disseminate healthcare research. These decision makers will be seeking how they can assess the quality of a FRAM model and ultimately the trustworthiness of FRAM research findings. The contribution to the literature made by this paper aims to provide practical guidance to researchers on how to employ quality enhancement criteria and strategies in their qualitative research efforts so that resulting FRAM models and insights afforded by them are trustworthy.

1.10.5 Chapter 5

Transformative health policy and system design is difficult to accomplish without an understanding of how variability emerges under dynamic conditions in complex healthcare processes. The research paper presented in Chapter 5 demonstrates the ability of FRAM modelling (FRAM and DynaFRAM) to depict the scale of the complexity in which health and social professionals conduct their work and the dense web older people are required to navigate to receive care. The FRAM analysis assisted the research team in gaining a systems level understanding of how health and social care work is done on an everyday basis across multiple sub-systems. The hypothetical patient journey provided an example of the functional path that could be taken by an older person. Gaining an understanding of potential variability and how variability emerged along the hypothetical journey and its downstream impacts assisted in anticipating challenges and opportunities for implementing integrated care in the local context. The visual depiction of work in the FRAM model and in the animation of the hypothetical patient journey using DynaFRAM provided health and social professionals the opportunity to examine and appreciate the work being conducted outside of their respective subsystems and mental models. Visualization of system challenges and opportunities was impactful and generated dialogue and feedback that informed the co-design of multi-level process improvement recommendations that aim to move the local community based CGA process towards a more integrated model of care.

1.11 Co-authorship Statement

This doctoral work crosses the disciplines of Systems Engineering and Health Policy. The idea for this doctoral work was originally proposed to the author by Dr. Rose McCloskey who is a professor of Nursing and Health Sciences at the University of New Brunswick Saint John. Dr. McCloskey has extensive interdisciplinary research experience in Gerontology. Dr. McCloskey had previously collaborated on a research study examining the hospital to home transition process using the FRAM with Dr. Brian Veitch and Dr. Doug Smith, and a doctoral student, Vahid Salehi from the Faculty of Engineering and Applied Science at Memorial University. Dr. McCloskey, Dr. Veitch, and Dr. Smith had agreed to each be a research supervisor for the author's doctoral work in applying the FRAM to examine and analyze a complex healthcare process for older people. Dr. McCloskey has contributed significantly to guiding the author on the development of research questions and to the required areas of knowledge pertinent to the health and social care of older people.

Dr. Doug Smith has extensive experience working with the FRAM and studying complex socio-technical systems. He contributed significantly to this doctoral work through his guidance and teaching on the FRAM and DynaFRAM. Dr. Smith provided seminars for the author as well as ongoing guidance in directing the author to the required areas of knowledge pertinent to complex socio-technical systems and demonstrating variability using functional modelling.

Dr. Smith provided support and direction to the author when building the community based health and social care FRAM model and the development of the functional signature to create a hypothetical patient journey using DynaFRAM. Dr. Smith was also instrumental in working with the author in determining how to disseminate study findings.

This was achieved through the use of a supplementary video file and tables demonstrating how variability emerged in the CGA process and impacted downstream functions.

Dr Vahid Salehi is a post doctoral fellow in Engineering and Applied Science at Memorial University. Dr. Salehi has been a trusted research collaborator and a co-author. Dr. Salehi played a helpful role in data collection and analysis and the building of the FRAM model. Dr. Salehi assisted the author as a notetaker in conducting semi-structured interviews with study participants and also provided guidance and assisted the author in building the FRAM model.

Dr. Brian Veitch has guided the author in overall direction of the doctoral research work. Dr. Veitch has directed the author on appropriate course selection and organized biweekly meetings with the author and Dr. Smith and Dr. McCloskey to create opportunities for regular mentorship and guidance for the completion of the doctoral work. Dr Veitch has provided constant and continuous feedback to the author. His research expertise in complex sociotechnical systems and system design has been vital to the author in preparing research questions, the research proposal, and thesis papers.

The author was responsible for composing this thesis. She (the author) was the first author on the papers presented in the following chapters and was the principal investigator on the research study presented in Chapter 5. In each of the following chapters the author will provide a more detailed co-authorship statement acknowledging the contributions made by Drs. Veitch, McCloskey, Smith, and Salehi.

References

1. Canadian Institute of Health Information. Seniors in transition exploration pathways across the care continuum 2017 [Available from: https://www.cihi.ca/sites/default/files/document/seniors-in-transition-report-2017-en.pdf.

2. Canadian Institute of Health Information. National health expenditure trends. 2021.

3. Canadian Institute of Health Information. How Canada compares: results from the commonwealth fund's 2017 international health policy survey of seniors. 2018.

4. Muscedere J, Andrew MK, Bagshaw SM, Estabrooks C, Hogan D, Holroyd-Leduc J, et al. Screening for frailty in Canada's healthcare system: a time for action. Canadian Journal on Aging/La Revue canadienne du vieillissement. 2016;35(3):281-97.

5. Britnell M. In search of the perfect health system: Bloomsbury Publishing; 2015.

6. Information CIoH. National health expenditure trends. 2020.

7. Drummond D. Commission on the reform of Ontario's public services.; 2012.

8. Dessers E, Mohr BJ. Integrated care ecosystems. Designing Integrated Care Ecosystems: A Socio-Technical Perspective. 2019:13-23.

9. Goodwin N, Stein V, Amelung V. What is integrated care? Handbook integrated care. 2021:3-25.

10. Allin S, Veillard J, Wang L, Grignon M. How can health system efficiency be improved in Canada? Healthcare Policy. 2015;11(1):33.

11. Information CIoH. Measuring the level and determinants of health system efficiency in canada. 2014.

12. NL Health Accord. Our Province. Our Health. Our Future. A 10-Year Health Transformation: The Blueprint Summaries of Implementation Recommendations. . 2022.

13. NL Health Accord. Our Province. Our Health. Our Future. A 10-Year Health Transformation: The Report.; 2022.

14. De Bruin SR, Billings J, Stoop A, Lette M, Ambugo EA, Gadsby E, et al. Different contexts, similar challenges. SUSTAIN's experiences with improving integrated care in Europe. International Journal of Integrated Care. 2020;20(2).

15. NL Health Accord. Our province. Our health. Our future. A 10-year health transformation: The summary. 2022.

16.World Health Organization. World report on ageing and health: World Health Organization; 2015.

17.World Health Organization . Framework on integrated, people-centred health services. 2016.

18.Parker SG, McCue P, helps K, McCleod A, Arora S, Nockels K, et al. What is comprehensive geriatric assessment (CGA)? An umbrella review. Age and ageing. 2018;47(1):149-55.

19. Ellis G, Gardner M, Tsiachristas A, Langhorne P, Burke O, Harwood RH, et al. Comprehensive geriatric assessment for older adults admitted to hospital. Cochrane database of systematic reviews. 2017(9).

20. Mazya AL, Garvin P, Unosson M, Ekdahl A. Outpatient comprehensive geriatric assessment: Effects on frailty. European Geriatric Medicine. 2016;7(Suppl 1):16.

21. Welsh TJ, Gordon AL, Gladman J. Comprehensive geriatric assessment–a guide for the non-specialist. International journal of clinical practice. 2014;68(3):290.

22. National Academies of Sciences Engineering, Medicine. Crossing the global quality chasm: improving health care worldwide. 2018.

23. Sullivan-Taylor P, Suter E, Laxton S, Oelke ND, Park E. Integrated people-centred care in canada–policies, standards, and implementation tools to improve outcomes. International Journal of Integrated Care. 2022;22(1).

24. Valentijn PP, Schepman SM, Opheij W, Bruijnzeels MA. Understanding integrated care: a comprehensive conceptual framework based on the integrative functions of primary care. International journal of integrated care. 2013;13.

25. Threapleton DE, Chung RY, Wong SY, Wong E, Chau P, Woo J, et al. Integrated care for older populations and its implementation facilitators and barriers: A rapid scoping review. International Journal for Quality in Health Care. 2017;29(3):327-34.

26. Briggs AM, Valentijn PP, Thiyagarajan JA, de Carvalho IA. Elements of integrated care approaches for older people: a review of reviews. BMJ open. 2018;8(4):e021194.

27. World Health Organization . Integrated care for older people: guidelines on community-level interventions to manage declines in intrinsic capacity. 2017.

28. World Health Organization . Ageing and health 2022 [Available from: https://www.who.int/news-room/fact-sheets/detail/ageing-and-health.

29. Armitage GD, Suter E, Oelke ND, Adair CE. Health systems integration: state of the evidence. International journal of integrated care. 2009;9.

30. Kodner DL. All together now: a conceptual exploration of integrated care. Healthcare Quarterly (Toronto, Ont). 2009;13:6-15.

31. De Carvalho IA, Epping-Jordan J, Pot AM, Kelley E, Toro N, Thiyagarajan JA, et al. Organizing integrated health-care services to meet older people's needs. Bulletin of the World Health Organization. 2017;95(11):756.

32. Angus L, Valentijn PP. From micro to macro: assessing implementation of integrated care in Australia. Australian Journal of Primary Health. 2018;24(1):59-65.

33. Wodchis WP, Dixon A, Anderson GM, Goodwin N. Integrating care for older people with complex needs: key insights and lessons from a seven-country cross-case analysis. International Journal of Integrated Care. 2015;15.

34. Valentijn PP. Rainbow of Chaos: A study into the theory and practice of integrated primary care: Pim P. Valentijn,[Sl: sn], 2015 (Print Service Ede), pp. 195, Doctoral Thesis Tilburg University, The Netherlands, ISBN: 978-94-91602-40-5. International Journal of Integrated Care. 2016;16(2).

35. Bodenheimer T. Coordinating care-a perilous journey through the health care system. New England Journal of Medicine. 2008;358(10):1064.

36. Curry N, Ham C. Clinical and service integration. The route to improve outcomes London: The Kings Fund. 2010.

37. Ham C. The ten characteristics of the high-performing chronic care system. Health economics, policy and law. 2010;5(1):71-90.

38. Goodwin N. How do you build programmes of integrated care? The need to broaden our conceptual and empirical understanding. International journal of integrated care. 2013;13.

39. Kaplan GS, Bo-Linn GW, Carayon P, Pronovost PJ, Rouse WB, Reid PP, et al., editors. Bringing a systems Approach to Health.2013.

40. De Savigny D, Adam T. Systems thinking for health systems strengthening: World Health Organization; 2009.

41. Aase K, Waring J. Crossing boundaries: Establishing a framework for researching quality and safety in care transitions. Applied ergonomics. 2020;89:103228.

42. Richardson WC, Berwick D, Bisgard J, Bristow L, Buck C, Cassel C. Institute of medicine. Crossing the quality chasm: a new health system for the 21st century. Washington, DC: National Academy Press; 2001.

43. Berwick DM. A user's manual for the IOM's 'Quality Chasm'report. Health affairs. 2002;21(3):80-90.

44. Kieny MP, Bekedam H, Dovlo D, Fitzgerald J, Habicht J, Harrison G, et al. Strengthening health systems for universal health coverage and sustainable development. Bulletin of the World Health Organization. 2017;95(7):537.

45. Clarkson J, Dean J, Ward J, Komashie A, Bashford T. A systems approach to healthcare: from thinking to practice. Future healthcare journal. 2018;5(3):151.

46. Manyazewal T. Using the World Health Organization health system building blocks through survey of healthcare professionals to determine the performance of public healthcare facilities. Archives of Public Health. 2017;75(1):1-8.

47. Holden RJ, Carayon P, Gurses AP, Hoonakker P, Hundt AS, Ozok AA, et al. SEIPS 2.0: a human factors framework for studying and improving the work of healthcare professionals and patients. Ergonomics. 2013;56(11):1669-86.

48. Hollnagel E, Braithwaite J. Resilient health care: CRC Press; 2019.

49. Begun JW, Zimmerman B, Dooley K. Health care organizations as complex adaptive systems. Advances in health care organization theory. 2003;253:288.

50. Braithwaite J, Wears RL, Hollnagel E. Resilient health care: turning patient safety on its head. International Journal for Quality in Health Care. 2015;27(5):418-20.

51. Hollnagel E. FRAM, the functional resonance analysis method: modelling complex socio-technical systems: Ashgate Publishing, Ltd.; 2012.

52. Patriarca R, Di Gravio G, Woltjer R, Costantino F, Praetorius G, Ferreira P, et al. Framing the FRAM: A literature review on the functional resonance analysis method. Safety Science. 2020;129:104827.

53. Iflaifel M, Lim RH, Ryan K, Crowley C. Resilient health care: a systematic review of conceptualisations, study methods and factors that develop resilience. BMC health services research. 2020;20:1-21.

54. Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implementation Science. 2015;10(1):1-8.

55. Hollnagel E, Hounsgaard J, Colligan L. FRAM-the Functional Resonance Analysis Method: a handbook for the practical use of the method: Centre for Quality, Region of Southern Denmark; 2014.

56. Hollnagel E, Slater D. FRAMSYNT A FRAM Handbook. 2022.

57. Ross A, Sherriff A, Kidd J, Gnich W, Anderson J, Deas L, et al. A systems approach using the functional resonance analysis method to support fluoride varnish application for children attending general dental practice. Applied ergonomics. 2018;68:294-303.

58. Weston LE, Krein S, Harrod M. Using observation to better understand the healthcare context. Qualitative Research in Medicine and Healthcare. 2021;5(3).

59. Hollnagel E, Hill R. FRAM Model Visualiser Instructions. 2020.

60. Salehi V, Veitch B, Smith D. Modeling complex socio-technical systems using the FRAM: A literature review. Human factors and ergonomics in manufacturing & service industries. 2021;31(1):118-42.

61. Sujan M, Bilbro N, Ross A, Earl L, Ibrahim M, Bond-Smith G, et al. Failure to rescue following emergency surgery: a FRAM analysis of the management of the deteriorating patient. Applied Ergonomics. 2022;98:103608.

62. Smith D, Veitch B, Khan F, Taylor R. Integration of resilience and FRAM for safety management. ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering. 2020;6(2):04020008.

63. Salehi V, Smith D, Veitch B, Hanson N. A dynamic version of the FRAM for capturing variability in complex operations. MethodsX. 2021;8:101333.

64. Smith D. DynaFRAM n.d. [Available from: https://www.engr.mun.ca/~d.smith/dynafram.html.

65. Saurin TA, Rosso CB, Colligan L. Towards a resilient and lean health care. Resilient health care. 2017;3(17):3-17.

66. Buikstra E, Clay-Williams R, Strivens E. Modelling a Typical Patient Journey Through the Geriatric Evaluation and Management Ward to Better Understand Discharge Planning Processes. Resilient Health Care: CRC Press; 2021. p. 81-100.

67. Laugaland K, Aase K, Waring J. Hospital discharge of the elderly-an observational case study of functions, variability and performance-shaping factors. BMC health services research. 2014;14(1):1-15.

68. O'Hara JK, Baxter R, Hardicre N. 'Handing over to the patient': A FRAM analysis of transitional care combining multiple stakeholder perspectives. Applied ergonomics. 2020;85:103060.

69. Salehi V, Hanson N, Smith D, McCloskey R, Jarrett P, Veitch B. Modeling and analyzing hospital to home transition processes of frail older adults using the functional resonance analysis method (FRAM). Applied Ergonomics. 2021;93:103392.

70. Oduyale MS, Patel N, Borthwick M, Claus S. Co-administration of multiple intravenous medicines: Intensive care nurses' views and perspectives. Nursing in Critical Care. 2020;25(3):156-64.

71. Schutijser BCFM, Jongerden IP, Klopotowska JE, Portegijs S, de Bruijne MC, Wagner C. Double checking injectable medication administration: does the protocol fit clinical practice? Safety Science. 2019;118:853-60.

72. van Dijk LM, van Eikenhorst L, Wagner C. Daily practice performance (Work-as-Done) compared to guidelines (Work-as-Imagined) of medication reconciliation at discharge: Outcomes of a FRAM study. Safety Science. 2022;155:105871.

73. Santana S, Redondo P. Process mapping: a tool to foster intra-and inter-organizational coordination in primary care. Family Medicine & Primary Care Review. 2018(1):41-6.

74. Jun GT, Ward J, Morris Z, Clarkson J. Health care process modelling: which method when? International Journal for Quality in Health Care. 2009;21(3):214-24.

75. Antonacci G, Lennox L, Barlow J, Evans L, Reed J. Process mapping in healthcare: a systematic review. BMC Health Services Research. 2021;21(1):342.

76. Holt J. UML for Systems Engineering: watching the wheels: IET; 2004.

77. Eriksson H-E, Penker M. Business modeling with UML. New York. 2000;12.

78. Clay-Williams R, Austin E, Braithwaite J, Hollnagel E. Qualitative assessment to improve everyday activities: Work-as-imagined and work-as-done. Transforming healthcare with qualitative research: Routledge; 2020. p. 71-82.

79. Carayon P, Bass EJ, Bellandi T, Gurses AP, Hallbeck MS, Mollo V. Sociotechnical systems analysis in health care: a research agenda. IIE transactions on healthcare systems engineering. 2011;1(3):145-60.

Chapter 2.

The Functional Resonance Analysis Method as a Healthcare Research Methodology: A Scoping Review*

Co-authorship statement. A version of this chapter has appeared in the journal - JBI Synthesis published by Walters Kluwer Health publishing company. The first author, Ali McGill led the writing of the scoping review. Dr. Rose McCloskey supervised an independent study course where the author completed the Joanna Briggs Institute Systematic Review Training and subsequently developed a scoping review protocol on the FRAM as a healthcare research methodology. Dr. McCloskey was an instrumental co-author and guided the author in the preparation and organization of both the scoping review protocol and the scoping review publication. Dr. Brian Veitch and Dr. Doug Smith also supervised and co-authored both the protocol and scoping review. All authors participated in discussions to enhance the concepts presented in the scoping review. All authors revised, edited, and made recommendations for improvements to earlier drafts of the scoping review.

* McGill A, Smith D, McCloskey R, Morris P, Goudreau A, Veitch B. The functional resonance analysis method as a healthcare research methodology: A scoping review. JBI Evidence Synthesis. 2022 Apr 1;20(4):1074-97. https://doi.org/10.11124/JBIES-21-00099

Abstract.

Objective: The objective of this review was to examine and map the literature on the use of the Functional Resonance Analysis Method (FRAM) in healthcare research.

Introduction: The FRAM is a resilient healthcare tool that offers an approach to deconstruct complex systems by mapping healthcare processes to identify essential activities, how they are interrelated, and the variability that emerges, which can strengthen or compromise outcomes. Insight into how the FRAM has been operationalized in healthcare can help researchers and policy-makers understand how this methodology can be used to strengthen healthcare systems.

Inclusion criteria: This scoping review included research and narrative reports on the application of the FRAM in any healthcare setting. The focus was to identify the key concepts and definitions used to describe the FRAM, the research questions, aims, and objectives used to study the FRAM, the methods used to operationalize the FRAM, the healthcare processes examined, and the key findings.

Methods: A three-step search strategy was used to find published and unpublished research and narrative reports conducted in any country. Only papers published in English were considered. No limits were placed on the year of publication. CINAHL, MEDLINE, Embase, PsycINFO, Inspec Engineering Village, ProQuest Nursing & Allied Health were searched originally in June 2020 and again in March 2021. A search of the gray literature was also completed in March 2021. Data were extracted from papers by two independent reviewers using a data extraction tool developed by the reviewers. Search results are summarized in a flow diagram, and the extracted data are presented in tabular format.

Results: Thirty-one papers were included in the final review, and most (n=25; 80.6%) provided a description or definition of the FRAM. Only two (n=2; 6.5%) identified a specific research question. The remaining papers each identified an overall aim or objective in applying the FRAM, the most common being to understand a healthcare process (n=20; 64.5%). Eleven different methods of data collection were identified with interviews being the most common (n=21; 67.7%). Ten different healthcare processes were explored, with safety and risk identification (n=8; 25.8%) being the most examined process. Key findings identified the FRAM as a mapping tool that can identify essential activities or functions of a process (n=20; 64.5%), how functions are interdependent or coupled (n=18 58.1%), the variability that can emerge within a process (n=20; 64.5%), discrepancies between work as done and work as imagined (n=20; 64.5%), the resiliency that exists within a process (n=12; 38.7%), and the points of risk within a process (n=10, 32.2%). Most papers (n=27; 87.1%) developed models representing the complexity of a process.

Conclusions: The FRAM aims to use a systems approach to examine complex processes and as evidenced by this review, is suited for use within the healthcare domain. Interest in the FRAM is growing, with most of the included literature being published since 2017 (n=24; 77.4%).

The FRAM has the potential to provide comprehensive insight into how healthcare work is done and how that work can become more efficient, safer, and better supported.

2.1 Introduction

Healthcare is a complex socio-technical system and is dependent on a multitude of dynamic interactions and everyday activities between humans, organizations, technology, and the environment (1). In addition, healthcare systems worldwide are challenged by an aging workforce, growing costs, sicker patients, rapidly changing technology, and a lack of sufficient long-term care planning and services (1). Compounding this are the structural gaps between the silos of primary care, acute care, and community based care that often must be bridged by healthcare professionals, patients, and caregivers (2). Gaining an in-depth understanding of the everyday activities, structures, and processes of healthcare systems has been a difficult undertaking for researchers and decision-makers to date. Without a comprehensive understanding of these key features, healthcare system improvements and sustainability efforts will continue to be difficult (3). Part of the difficulty in deconstructing issues within healthcare systems is that many activities and processes are unpredictable, intractable, and not reproducible. Underlying contextual features and human variability can significantly impede efforts to control healthcare processes and individual responses to them (4).

Resilient Health Care is an emerging field that attempts to understand how everyday clinical work is done, and the elements and approaches that enable front-line providers, clinical teams, and organizations to adjust performance and effectively manage challenges in care settings. Iflaifel et al. (5) explains, gaining this knowledge allows for a better understanding of how front-line providers "anticipate, monitor, respond and adapt to threats" and how these professionals can be viewed "as resources and assets rather than as a problem to be solved or standardized."(p.2) uj

One of the key components of RHC theory is the recognition of a gap between work as imagined and work as done in the healthcare system. Work as imagined and work as done have been described in RHC literature as two ends of a wedge, the sharp proximal point is work as done, and the blunt distal end is work as imagined. The closer one is to the work (sharp end), the more accurate their understanding about how the work is done; as one moves further from the work (blunt end), their understanding becomes less accurate and more simplified (5). If this gap can be reconciled, healthcare system administrators can make decisions that could more accurately reflect the dynamic work conditions of the healthcare system and potentially contribute to the improved safety, quality, and efficiency of healthcare delivery.

Organizing an approach to accurately describe “work as done” within a system such as healthcare is a complex endeavour. The Functional Resonance Analysis Method (FRAM) is a RHC methodology that attempts to elucidate this complexity. The FRAM was first developed in the early 2000s in the field of engineering to be used in research and development related to safety and accident analysis. A central tenet of the FRAM is the understanding that systems and processes are not linear; rather, they are complex and are required to adapt to available information and changing conditions and resources.

The FRAM is a functions-based, qualitative approach that analyzes and maps the everyday activities involved in a process and identifies areas of performance variability that can emerge and improve or compromise the intended outcomes (6). Functions are the activities or groups of activities that are required to produce an outcome, such as obtaining a blood sample from a patient (7).

The FRAM provides a map of how work is conducted by using qualitative methods, such as observations, interviews, document reviews, and focus groups to obtain data from workers who perform the activities necessary for a process to occur. The FRAM also identifies variabilities in everyday activities that require individuals or organizations to adjust their performance for the process to occur. Examples of these variabilities include staffing levels and patient acuity (8, 9). Hollnagel et al. (10) explains the FRAM deconstructs a healthcare process into discrete activities or functions to describe “what a system does” rather than describe “what a system is”(p.2). For instance, in exploring the transition of older adults from hospital to home, rather than identify a hospital discharge, Laugaland et al. (7) described the activities necessary for the discharge to occur, such as notifying family of the pending discharge, organizing post-discharge services, and arranging transportation between settings of care. The FRAM identifies activities that influence and/or are dependent on each other in order for a process to occur. Laugaland et al.(7) noted that when hospital discharge is unexpected, families may not be prepared, which may result in a delayed discharge and activation of post-discharge services (7). In keeping with the FRAM, the impact of a small change in one activity (i.e., notification of family) can become unusually large and can spread to other functions (ability to discharge patient or activate services).
Hollnagel et al. (10) refer to this phenomenon as "functional resonance." Functional resonance produces unexpected outcomes, which can be negative or positive, and are viewed as emerging from variations in how a process is performed (10).

O’Hara et al. (2) state that the model developed from a FRAM analysis “could provide healthcare professionals and managers with a ‘roadmap’ to understand where unwanted and/or positive variability is within their local systems and identify what the consequences of that variability are for patients and the system as a whole”(p.8).

The aim of this scoping review is to examine, map, and report the evidence on the extent and nature of the use of the FRAM in health\care research. This scoping review does not intend to assess the validity of other suitable methods for analyzing healthcare processes and does not comparatively rank the FRAM against other similar approaches. As an RHC tool, the FRAM is an emerging methodology, and the rising number of papers using the FRAM in recent years warrants further understanding of the use of the methodology in the healthcare domain. The World Health Organization challenges healthcare leaders across the globe to use a systems lens to examine vulnerabilities in healthcare practices and policies (11). Such an approach is thought to be capable of uncovering fundamental processes that influence health system outcomes, identify areas of vulnerability, and highlight areas of strength that can be amplified to improve performance (12). Findings from this scoping review will advance our understanding on how one systemic methodology has been used to understand healthcare system processes. Such an understanding will be helpful for researchers and clinicians seeking to conduct research on complex healthcare system issues. A preliminary search for existing scoping reviews on this topic has been conducted in the JBI Evidence Synthesis (Ovid) search platforms in addition to CINAHL, (EBSCO), MEDLINE (Ovid), Embase (Elsevier), PsycINFO (EBSCO), Inspec (Engineering Village) and ProQuest Nursing and Allied Health (ProQuest) search platforms. We did not locate any other scoping reviews on this topic.

2.2 Review questions

The purpose of this scoping review was to locate, examine, and describe the literature on the use of the FRAM in healthcare research. Specifically, the review will seek to answer the following questions:

i) What concepts and definitions are used to define or describe the FRAM in healthcare research?
ii) What research question(s), aim(s), or objective(s) have been examined using the FRAM in healthcare research?
iii) What methods have been used to operationalize the FRAM in healthcare research?
iv) What processes and/or activities have been examined using the FRAM in healthcare research?
v) What key findings were identified?

2.3 Inclusion criteria

Participants

This review considered research and narrative reports on the use of the FRAM that included any professional care provider, patient, or recipient of healthcare products or service.

Concept

The concepts of interest were the key concepts and definitions of the FRAM; research question(s), aim(s), or objective(s); the method(s) used to operationalize the FRAM; the processes and/or activities examined using the FRAM; and key findings.

Context

This scoping review considered papers that used the FRAM in any healthcare setting, including hospitals, long-term care facilities, and social settings where healthcare services were provided, such as schools, offices, community, and working environments. Papers that examined the transitions between two or more health settings, such as hospital to home, were also considered.

2.4 Types of sources

This scoping review considered both experimental and quasi-experimental study designs including randomized controlled trials, non-randomized controlled trials, before and after studies, and interrupted time-series studies. In addition, analytical observational studies including prospective and retrospective cohort studies, case-control studies, and analytical cross-sectional studies were considered for inclusion. This review also considered descriptive observational study designs including case series, individual case reports, and descriptive cross-sectional studies for inclusion. Qualitative studies that focused on qualitative data including, but not limited to, designs such as phenomenology, grounded theory, ethnography, qualitative description, action research, mixed methods, and feminist research were also considered. Likewise, systematic reviews and text and opinion papers that met the inclusion criteria were considered for inclusion.

2.5 Methods

This review was conducted in accordance with JBI methodology for scoping reviews (13) and according to an a priori protocol (14).

2.5.1 Search strategy

The search strategy aimed to locate both published and unpublished studies from the inception of the selected databases to March 2021. A three-step search strategy was used for this review. First, an initial limited search was conducted in MEDLINE (Ovid) to identify text words in titles and abstracts, and index terms from relevant articles. These terms were used to draft an initial search strategy in MEDLINE, and the search was reviewed by a second librarian using the Peer Review of Electronic Search Strategies (PRESS) guidelines (15). Second, a librarian (AG) undertook searching using the identified text words and index terms in each of the following databases: MEDLINE (Ovid), CINAHL Full-Text, (EBSCO), Embase (Elsevier), PsycINFO (EBSCO), ProQuest Nursing and Allied Health (ProQuest), and Inspec Engineering Village (Elsevier). Thirdly, the reference lists of all papers and reports meeting inclusion criteria were searched. Databases were originally searched in June 2020 (with Engineering Village searched in September 2020), and searches were updated in March 2021. No date or language limits were applied to the search results; however, only English-language papers were included due to this being the language that all reviewers understood. To supplement the database searches, gray literature searches were conducted in March 2021 in ProQuest Dissertations and Theses (ProQuest), Google, and Google Scholar. Results were limited to English language, and the first 100 results of searches in Google and Google Scholar were screened. See Appendix A for the database and gray literature search strategies.

2.5.2 Source selection

Following the search, all identified citations were uploaded into Endnote X8 (Clarivate Analytics, PA, USA) and duplicates removed. All identified titles were imported into Covidence (Covidence, Melbourne, Australia) where titles and abstracts were screened by two independent reviewers (AM, RM) for assessment against the inclusion criteria for the review. Potentially relevant citations were retrieved in full and their citation details imported into the JBI System for the Unified Management, Assessment and Review of Information (JBI SUMARI; JBI, Adelaide, Australia)(16). The full texts of selected citations were assessed in detail against the inclusion criteria by two independent reviewers (AM, RM). Full-text papers that did not meet the inclusion criteria were excluded and reasons for the exclusion were recorded (Appendix B). Disagreements that arose between the reviewers at each stage of the study selection process were resolved through discussion.

2.5.3 Data extraction

Data were extracted from papers included in the scoping review by two independent reviewers (AM, RM) using a data extraction tool developed by the reviewers in the a priori protocol (15). The data extracted included source details such as year of publication and country of origin. Additional information included healthcare process/activity of interest, the research question(s)/aim(s)/objective(s), key concepts/definitions/description of the FRAM, description of the method(s) used to operationalize the FRAM, and key findings.

2.5.4 Data analysis and presentation

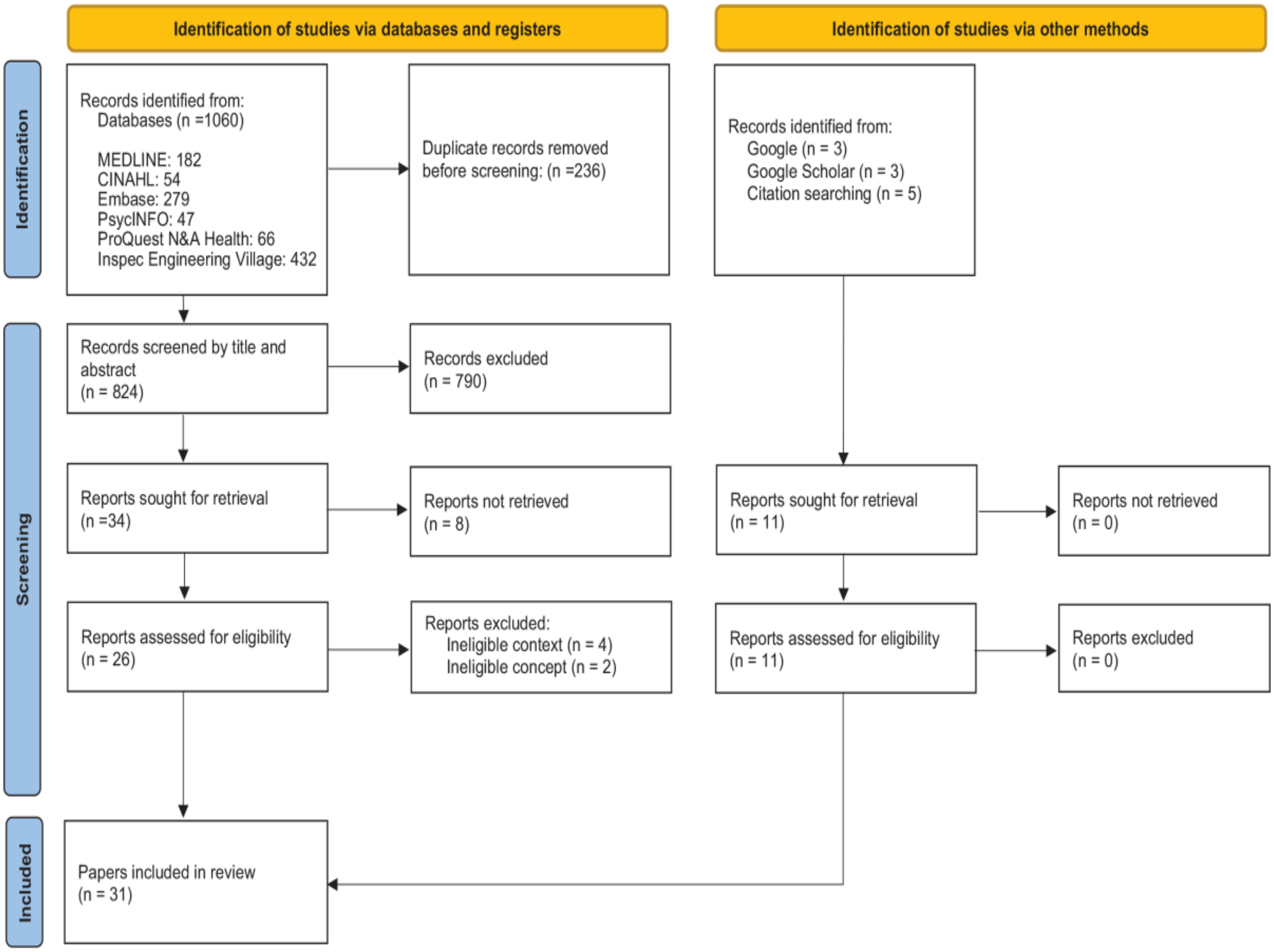
The extracted data is presented in tabular form (Appendix 3) in a manner that aligns with the research questions of this scoping review. The table reports on distribution of papers by year of publication; country of origin; setting; descriptions concepts and definitions of FRAM; methods used; research question(s), aims(s), and objective(s); health process/activity of interest; and key findings. A narrative summary accompanies each of the tabulated results.

2.6 Results

Through database searches, 1060 records were identified. After 236 duplicates were removed, 824 records were screened by title and abstract, and 790 were excluded. Full texts of 34 records were sought for retrieval. The authors of eight records were contacted for full-text versions, with none retrieved. Twenty-six full-text records were then assessed for eligibility with six excluded; reasons for exclusion are detailed in Appendix B. Additionally, 11 records were identified through other methods, which included citation searching and Google and Google Scholar searching. Figure 2.1 presents a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram (17) of the record selection and inclusion process; 31 papers were included in the final review (2,7,10,18-35,37-46).

Figure 2.1

Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Flow Diagram



2.7 Characteristics of included sources

Dates of publication for included literature ranged from 2012 to 2021, with the majority (n= 24; 77.4%) published in 2017 or later (2, 18-40). All included literature was written in English, with six (19.4%) records each from Australia (19, 20, 24, 26, 33, 41), United Kingdom (2, 21, 27, 30, 37, 42), and Denmark (10, 29, 34, 35, 39, 43).

Of the remaining literature, three (9.7%) records each were from Turkey (22, 23, 32) and Brazil (18, 38, 44), and two (6.5%) from The Netherlands (31, 40). There was one (3.2%) each from Canada (45), Italy (28), Norway (7) Scotland (25) and Sweden (46). The majority of the literature were research studies (n=27; 87.1%), with 17 of these (54.8%) being qualitative descriptive studies (7, 20, 21, 24-28, 31-35, 37, 40, 41, 45), four (12.9%) case-studies (19, 29, 34, 39), four (12.9%) mixed methods studies (22, 23, 30, 45), and one (3.2%) each of secondary analysis of qualitative data (2) and grounded theory (18).

Most of the research studies took place in a hospital, including three (9.7%) each in intensive care (21, 27, 41) and in the emergency department (33,38,42) two (6.5%) in neonatal intensive care (22, 23) and one (3.2%) each in an operating room (46). geriatric evaluation and management (19), cardiosurgical department (20) neurosurgery (28), and a spine center (34). An additional nine (32.3%) studies were hospital-wide, examining more than one location in a hospital (7, 24, , 29, 31, 32, 35, 37, 39, 43). The remaining settings include the transition between the hospital and the community (n=3, 9.7%) (2,40,45), primary care (n=3; 9.7%) (10,18, 25), radiopharmaceutical dispatch (n=1, 3.2%) (44), and a dental practice (n=1; 3.2%)(30). Detailed characteristics of the included papers are presented in Appendix C.

2.8 Concepts, definitions, and descriptions of the FRAM

Concepts that provide a background understanding of the principles from which the FRAM was developed were explained in many of the papers (n=14; 45.2%). The two most-discussed concepts were “Work as Imagined and Work as Done” (n=14; 45.2%) (2, 10, 18, 19, 23, 25, 31, 33, 37, 40, 41, 43, 45, 46) and Safety II (n=12; 38.7%) (2, 10, 19-23, 28, 35, 37, 40, 43).

Resiliency in healthcare was another concept discussed in eight (25.8%) of the included papers (10, 18, 21, 23, 28, 30, 43, 46). The majority of papers in this review provide a definition or description of the FRAM by explaining activities or functions in a process and the steps necessary to operationalize the FRAM (n=25; 80.6%) (2, 7, 10, 20-33, 35, 37, 40, 41, 43-46). Descriptions of the FRAM in the papers included in this review are provided in Appendix C.

2.9 Research questions, aims, and objectives

Of the 31 papers reviewed, 27 (87.1%) were research papers, and the remaining four (12.9%) papers were non-research, including a handbook and discussions on the use of FRAM in general healthcare and in the emergency department. Only two papers (6.5%) identified a specific research question (28,43). Patriarca et al. (28) aimed to identify risks associated with neurosurgery, and Hounsgaard (43) aimed to investigate work adjustments required to maintain safety and identify opportunities for improved safety. The remaining papers each identified an overall aim or objective in applying the FRAM to a specific healthcare process (Appendix D). The most common aim or objective was to use the FRAM to understand a process (n=21; 67.7%) (7, 18-20, 24-26, 28,29, 32-35, 37, 39-42, 44-46). Nine (29.0%) papers used the FRAM to examine and/or understand variability in a process (7, 21-23,28, 31, 38, 43, 45), and five (16.1%) used it to identify how to change or improve a process (2, 25, 40, 43, 46). Three (9.7%) papers sought to obtain users' views on a process (27, 33, 45), three (9.7%) wanted to describe an existing process (19, 20, 45), and two (6.5%) sought to understand how to implement a new process (30, 33). One (3.2%) paper aimed to explore responses to variability in a process(41), and another (3.2%) provided guidance on using the FRAM to examine a process (10).

2.10 Methods used to operationalize the FRAM

Eleven different methods of data collection were identified across the included papers (Appendix C). Common methods for data collection included interviews of key informants (n=21; 67.7%) (7, 18-20, 23-26, 28-31, 33, 34, 37-40, 43, 45, 46), document reviews (n=15; 48.4%) (7, 18-20, 24, 25, 28-30, 33, 41, 43-46), and observations (n=12; 38.7%) (7, 18, 21, 23, 28, 31, 33, 37-39, 45, 46). Observational methods in 12 papers included "walk through" or "process walk" style observations (21, 33, 39), observation of medication administration (23, 31, 38), observing blood sampling processes (39), naturalistic or direct observation of surgical procedures,28, 46 activities surrounding hospital discharge (7), blood sampling (37), and physician referral work (18). Salehi et al. (45) observed both team meetings and older patients in their homes after discharge from hospital. In three papers, guides were used to monitor observations, including a standardized tool to observe patient blood sampling (37), a standardized form to observe nursing medication administration (31), and a structured guide to observe hospital discharge processes (7). In studying the discharge process for older patients, Laugaland et al.(7) provided a description of moderate participant observation, "which entails that the researcher be present and identifiable but not an active participant … the researcher observes and interacts occasionally"(pg.4). Kaya et al. (23) also used observation as a method to validate interview data on the work involved for the administration of drugs in a neonatal intensive care unit. The types of documents reviewed varied, with several relating to direct patient care, including patient care guidelines/procedures (n=6; 19.4%) (19, 20, 29, 33, 41, 46), patient care documentation/records (n=6; 19.4%) (7, 19, 22, 25, 45, 46), government policies (n=2; 6.5%) (18, 24), and dental claim forms (n=1; 3.2%) (30). Focus groups were used as a method of data collection in nine (29.0%) papers (19, 22, 25-28, 40, 45, 46).

Other methods of data collection included workshops conducted with healthcare staff involved in the process of interest (n=4; 12.9%) (21, 23, 30, 37), secondary analysis of previously collected data (n=3;9.7%) (2, 22, 35), surveys/questionnaires (n=3; 9.7%) (28, 30, 45), collection of narrative stories (n=2; 6.5%) (34 35, 39), and idea sharing through emails (n=1; 3.2%) (21).

2.11 Processes and activities of interest

There were 10 processes explored using the FRAM (Appendix E): safety and risk identification (n=8; 25.8%) (10, 26, 28, 34, 39, 42, 43, 46), medication administration (n=6; 19.4%) (21-23, 27, 31, 38), transitional care (n=4; 12.9%) (2, 7, 19, 45), hospital management (n=3; 9.7%) (24, 32, 33), blood sampling (n=3; 9.7%) (37, 39,41), identification and management of sepsis (n=3; 9.7%) (25, 29, 35), and management of anticoagulation therapy (n=2; 6.4%) (20, 40). The remaining processes were each examined in one (3.2%) paper, identification of the referral process from primary care to specialized practitioners (18), operationalization of a fluoride varnish program (30), and radiopharmaceutical dispatch process (44).

2.12 Key findings

Key findings of included papers are presented in Appendix C and provide the identification of the activities or functions involved in a specific process, including those details that are otherwise invisible (2, 7, 19-21, 23-25, 27-32, 37-39,41,45, 46). The number of activities or functions in each process studied or discussed ranged from zero (18, 22, 26), to 68 (28), with a mean of 24 functions in each paper. Eleven papers do not mention activities or functions (10,18,22, 26, 33, 34,35,40,42,43,44).

Other findings from the papers included the identification of interdependencies or couplings between the activities or functions necessary for a process to be conducted (2, 7, 18, 19, 24, 28, 30-35, 37, 40, 41, 43, 45, 46) variabilities that emerge within a single process (2, 7, 19-21, 24, 25, 28, 30-35, 37, 39, 40, 43, 45, 46), discrepancies between work as done and work as imagined (2, 18-25, 27, 30, 31, 33, 34, 37, 38, 40, 41, 43, 45), resiliencies that exist within a process (2, 18, 21-24, 27, 31, 34, 35, 37, 43), and the points of risk within a process (22, 28, 29, 34, 39, 40, 42, 43, 45, 46). The majority of papers (n=27; 87.1%) developed FRAM models representing the complexity of a process (2, 7, 18-21, 23-25, 27-35, 37-41, 43-46). Models were most often (n=25, 80.6%) informed by collecting qualitative data from front-line clinicians doing the everyday work of the process (2,7,10,19-21,23-25,27-34,37-41,43,45,46). Four papers (12.9%) additionally collected qualitative data from patients to inform FRAM models (2, 7, 40, 45). These key findings are reflective of the FRAM's ability to map a system or process and gain a better understanding of how work is actually done from front-line workers and patients, which may provide healthcare organizations with information to better inform guideline development, policy development, and system design. Specific examples of how the FRAM has demonstrated this include identifying factors that would impede the adoption of clinical practice guidelines, allowing for modification prior to implementation (41), identifying weaknesses in a hospital's surge procedures (24), identifying indicators for the prevention of adverse events in patients with sepsis (35), and identifying management practices that prevented the spread of COVID-19 in healthcare facilities (32).

2.13 Discussion

The purpose of this scoping review was to locate, examine, and describe the literature on the use of the FRAM in the healthcare field. Findings reveal that the FRAM is a relatively new methodology in the healthcare field as evidenced by the large number of papers published in recent years. The FRAM is used predominantly in the United Kingdom, Australia, and European countries. Only one paper was found from a North American country and there were none located from an African or Asian country. According to the World Health Organization, improving system inefficiencies, processes, and transparencies should be a priority in healthcare systems in all countries (48, 49). This review has demonstrated that the FRAM may be a useful approach to understanding healthcare processes and identifying why they are effective and where they can be strengthened. All the papers included in this review presented the FRAM as a means to examine or discuss a healthcare process.

The FRAM allows for a detailed view of complex processes in healthcare by mapping essential system functions, interdependencies between functions, and variabilities that may arise and alter the intended outcomes of the processes (10, 34). In mapping the activities or functions in processes, models or visual representations of a healthcare process are developed. Eighteen of the papers in this review developed FRAM models using the FRAM Model Visualiser software program (2, 19-25, 27, 28, 30-32, 34, 38, 41, 43, 45).

The FRAM Model Visualiser program can be used to construct, visualize, and edit FRAM models (50). FRAM models enable clinicians and policy-makers to gain a deeper understanding of the activities/functions, dependencies, and vulnerabilities within a process or system (5, 28, 34).

Clay-Williams et al. (33), were able to demonstrate this by using the FRAM to examine the very specific activities involved in the routine activity of drawing blood in an emergency department. By creating a FRAM model, clinicians were able to visualize the complexity of what was thought to be a straightforward process.

In addition to creating a model of the transitional care process for older patients discharged home from hospital, Salehi et al. (45), were able to test the model using a customized version of the FRAM known as dynamic FRAM modeling developed by Smith et al. (51). This dynamic version of a FRAM model can visually demonstrate what functions are active in each patient's transition process, when those functions become active, for how long, and the quality and quantity of the active functions output (51) Dynamic FRAM modeling also measures system performance to compare outcomes of processes, which assists in understanding how performance varies within a single process (51). Salehi et al. (45), found that dynamic FRAM modeling provided a visual representation of what happened for the patient over the course of their transition process, when it happened, for how long, and the quantity and quality of the output for each active function. This included the couplings/interdependencies between active functions and the variations in the outputs of active functions. These findings allowed the authors to identify the distinctions between a successful and unsuccessful transition.

While creating a visual model was noted as a strength in several of the papers reviewed (24, 27, 30-33, 40, 41, 45), it can also be considered a weakness. For instance, when Patriarca and colleagues (28), used the FRAM to map the patient pathway in perioperative neurosurgery, the resultant model was highly detailed and "overwhelmingly complex," consisting of 68 activities/functions, each with its own unique conditions, resources, inputs, outputs, dependencies, and time constraints. The concern expressed by the authors is that detailed FRAM models may force analysts to oversimplify the work domain they are mapping or narrow the scope of the analysis to deal with the visualization and management of the variability (28). Tarakçı et al.(32), created a considerably less complex model depicting 14 activities or functions used to manage hospital patients with COVID-19. In this model, Tarakçı et al. (32), were able to create a visual illustration of how the virus could be spread and the hospital variabilities that affect the spread. As noted by the research team, this FRAM model was effective in assisting hospital administrators with responding to the COVID-19 pandemic.

To develop a model that is useful and not overly detailed, Clay-Williams et al. (33), suggests that researchers start at a "higher systems level where possible and drill down where needed"(p.72). Clay-Williams et al. (33), also recommended that FRAM model should consist of no more than 20 activities or functions. Constructed FRAM models identify actual or potential variations in how a process can unfold. These actual or potential variations are referred to as variabilities, and once identified, the process can be adjusted to support or minimize the variabilities. For example, the Raben et al. (35) model revealed that communication between healthcare providers, and nurses' ability to use their clinical judgment facilitate the early detection of sepsis.

This finding resulted in the identification of a leading indicator for the early detection and treatment of sepsis, including obtaining sufficient information from the referring doctor, and allowing nurses to draw on prior experience and clinical judgment when caring for patients with suspect or actual sepsis. In this case, the FRAM identified variabilities that could be strengthened or further supported to improve outcomes. Conversely, Oduyale et al.(27) found that inconsistencies in the availability of data on the compatibility of different drugs compromised patient safety and resulted in erroneously mixing incompatible drugs, obtaining unnecessary additional venous access, or delaying the administration of required medications. These findings pointed to a need to update the medication compatibility charts in patient care areas and to develop a decision-making tool for assessing compatibility, including steps to follow when compatibilities are unknown.

This review supports previous calls to engage end users in healthcare research (52) and process improvements in healthcare (53). In using the FRAM, it is important to consider the target audience, including during the collection of data used to inform model development and when developing a model to share with stakeholders. Most papers included in this review sought input on the activities or functions necessary for a process to occur (2, 7, 19-21, 23-25, 28, 31-34, 37, 39, 41, 43, 45, 46). By engaging those closest to the process, users of the FRAM are able to differentiate between how processes are intended to unfold under ideal conditions and how they actually take place in practice to accommodate individual circumstances and environmental conditions (2, 18-21, 24, 25, 28, 30, 31, 33, 34, 38, 41, 45).

The differentiation between how things are designed to transpire and how they occur in practice is referred is referred to as “work as imagined” and “work as done”(10), work as imagined assumes working conditions are known and can be controlled. Yet this is not always the case in healthcare. The literature is fraught with research and commentary on the impact of poor working conditions (54-56), unexpected circumstances (4, 57-59), and lack of resources (60, 61), all of which can impact how work must be done. The separation of “work as imagined” and “work as done” is a major philosophical underpinning of the FRAM (5, 10). Hollnagel (62) argues that it is nearly impossible to predict or describe how a process will unfold when it is “done by others, at a different time and in a different place.” (p.12) By exposing gaps between work as done and work as imagined, adjustments can be made to reduce unwanted variabilities and support variations that improve or enhance processes (62).

Papers identified in this review demonstrated the FRAM’s ability to uncover work as done in areas such as patient safety (28, 34, 46), clinical practice guidelines (35, 40, 41), administration of medications (21, 23), and the identification of quality indicators for healthcare delivery (39). In each of these papers, the authors were able to identify gaps between how a process was thought to occur and how it actually transpired. By identifying these gaps, authors were able to locate specific points in a process where additional resources or supports were required to achieve desired outcomes. Mapping work as done can explain how established processes can sometimes go wrong. Knowing possible variations upfront provides opportunities to introduce measures that can reduce unwanted variability and support desired practices (5).Another motivating factor for engaging stakeholders with the FRAM is a need to ensure the findings are disseminated in a manner that is meaningful and comprehensible.

Five papers identified in this review presented complex models in a manner that resonated with those interested in and/or working with the process of interest (2, 7, 19, 28, 45). In each of these papers, authors elected to aggregate functions or create functional categories to make the model easier to understand. Three of these papers examined transitions in care and segregated functions into categories such as "admit the patient" (19) (p.141), "assigning an appropriate post-discharge site of care" (7) (p.81), and "escalating care to acute care setting"(2)(p.7). In their study on iatrogenic illness in neurosurgery patients, Patriarca et al. (28) categorized functions as physical or generalized "in order to deal with the visualization and the management of variability"(p.333). An important consideration for researchers is determining the level of specificity needed by or of interest to end users. Care should also be taken to ensure that the chosen approach will create a FRAM model that accurately describes the complexity of the process in question without over-simplifying or omitting important aspects.

Reflecting the importance of safety in healthcare (63, 64), many of the research papers included in this review focused on understanding risk and/or improving safety (2, 10, 19-23, 28, 35, 37, 43, 45). In each of these papers, the FRAM was able to pinpoint specific areas of risk and identify where safety could be compromised. The contribution of the FRAM to this body of literature is its ability to see beyond a single root cause of an actual or potential safety incident and to examine situations or events from a broader perspective. By capturing the series of activities involved in an event, including the work context, and the variations that can occur across all activities that encompass a process, the FRAM is able to uncover conditions that contribute, prevent, and circumvent risk and adverse events (5, 43).

Three papers in this review used the FRAM in conjunction with a more commonly used approach to investigating safety, namely root cause analysis and human technology operational method (34, 43, 46). Alm and Woltjer used both the FRAM and the Root Cause Analysis approach to examine an adverse event that involved surgical materials being left in patients' abdomen during an operation (46). The findings illustrate that compared with traditional methods, the FRAM was able to produce five additional recommendations addressing contextual and organizational factors that contributed to the adverse event which provided a comprehensive perspective (46). Hounsgaard (34) also demonstrated the breadth and depth of a FRAM adverse event investigation by elucidating the complexity of a persistent patient safety problem at a spine center that was not identified using traditional methods in previous investigations.

In addition to modeling processes and examining actual and potential adverse events, the FRAM has been used to identify resiliencies in healthcare (2, 18, 19, 21, 24, 31, 35, 37, 43). Hollnagel et al. (10) define resilience as the adjustments made to unexpected or unique circumstances that arise prior to, during, or after a process. These adjustments are often necessary to manage the realities of the practice environment and to accommodate contextual variations that often present in healthcare. A range of resiliencies and adjustments were noted in this review, including nurses double checking medications together, which is considered best practice (21); designating time at the beginning of each day to attend to cancelations and manage waitlists (18); requesting others not involved in obtaining the venous access to label the blood sample and send it to the lab (37); and exercising clinical judgment and multitasking to detect sepsis (29). In these papers, the FRAM was able to demonstrate why these adjustments were necessary and the impact the modifications had on outcomes.

These variabilities in practice can make positive contributions and help with the attainment of desired goals. Having data on what behaviors, actions, and adjustments lead to success in healthcare is an important step in developing accurate key performance indicators and informing quality and safety interventions in healthcare.

2.14 Limitations

Although this scoping review provides an in-depth overview of an emerging methodology to understand healthcare processes and improve safety, it is not without limitations. Most of the papers in this review were published in the previous two years. Because of this, there is a possibility that there are more papers currently in review or in-press that were not located in this review's search strategy. A recognized limitation by users of the FRAM is the complexity and resource-intensive nature of the methodology (2,7,23,25,34,44). The time and resources required to become proficient in conducting a FRAM analysis is uncertain, although three papers did provide the time required to complete a FRAM analysis, ranging from 35 to 60 hours (2, 21,31). What we know about the utility of the FRAM is based on the experiences of researchers and users of the FRAM; first-hand experiences and perspectives of end users are largely absent. Finally, only English citations were included, which may limit the international scope of these findings.

2.15 Conclusion

The aim of this scoping review was to examine, map, and report the evidence on the use of the FRAM in healthcare research. The FRAM is a methodology that aims to use a systems approach to examine complex issues and as evidenced by this review, is suited for use within the healthcare domain. Uncovering the complexity of everyday activities, interdependencies, and variability that exist in the healthcare system by using the FRAM has the potential to provide more comprehensive insight into how healthcare work is actually done and how that work can become more efficient and better supported. The FRAM has been used in efforts to reconcile work as imagined and work as done, identify resilient behaviors in healthcare providers, improve patient safety efforts, and identify and manage performance variability.

Healthcare is a complex socio-technical system. Efforts to improve safety, efficiency, and quality, and to reduce risk have been difficult to achieve with the methods used to date. The FRAM is still in its first decade as a healthcare research methodology, and although some applications of the FRAM require further development, this review has demonstrated that it is a novel tool that may illicit a better understanding of how to improve processes within the healthcare system. From this, initiatives and policies that more closely match work as done, support system resiliency, strengthen safety efforts, and improve the quality and efficiency of care delivery may be developed and disseminated. From the literature on the FRAM, several implications for research, practice, education, and policy are evident.

2.15.1 Implications for research

This scoping review demonstrates the FRAM may be a useful methodology to study a wide range of healthcare processes. FRAM studies can be highly detailed, and researchers considering using the FRAM should appreciate the complexity of the methodology and the potential need for considerable resources to map a process. Attention must also be paid when presenting findings from investigations that used the FRAM in a way that is understandable to end users while also ensuring the process is truly captured and not overly simplified. The construction of a FRAM model benefits from the inclusion of a wide variety of stakeholders. When applicable, a FRAM analysis should consider the experiences of the patient as well as those of their family members. When trying to understand how complex systems work, patients and their families can provide valuable information regarding their unique experiences. Further research using the FRAM as a methodology to inform safety practices in healthcare is also required. This review demonstrated that the usefulness of the FRAM lies in its ability to map a process and gain a broader perspective on actual or potential safety issues. Further research is needed to identify how the FRAM can best be used to inform safety and risk identification in the healthcare domain.

2.15.2 Implications for practice

Opportunities for teams to conduct FRAM analyses to improve processes at the micro-level are needed. Modeling everyday clinical work using the FRAM allows managers and clinicians to work together to identify the challenges and successes in care delivery. It also allows stakeholders to develop solutions that reduce unwanted variability and enhance variability to achieve successful outcomes.

The FRAM may allow every voice in the process to be heard. This can potentially improve relationships between front-line workers and healthcare organization managers by providing a model that does not simplify or omit the steps and challenges front-line workers encounter. Including front-line workers allows decision-makers to see when care providers' performance adjustments result in positive outcomes, which can potentially assist with developing leading indicators to improve system outcomes. Uptake of clinical guidelines, policies, and procedures developed using a FRAM analysis may also be better received by clinicians when based on work as done rather than work as imagined. The FRAM offers healthcare organizations an alternate means of conducting quality management improvements and monitoring and evaluate existing practices. Findings from the FRAM can provide comprehensive and objective data to demonstrate an organization's commitment to quality improvement. For example, an investigation of a process using the FRAM can be used in hospital accreditation to demonstrate commitment to ongoing surveillance of existing practices.

2.15.3 Implications for education

Fundamental changes in the education and preparation of healthcare providers and decision-makers are required to achieve the systems-level thinking and inquiry needed to affect meaningful change in today's healthcare system. Theories and methods from disciplines other than healthcare are potentially necessary to achieve this. Graduate-level students enrolled in health discipline studies should be introduced to the FRAM. Interprofessional learning and research opportunities where these students can apply the FRAM to health are processes, with guidance from complementary disciplines (e.g., engineering) can potentially inform a new cohort of healthcare leaders who can be agents of change.

Opportunities also exist to create learning experiences for current healthcare providers and system leaders who are interested in using the FRAM to understand healthcare processes. Conference presentations, publications of FRAM studies in healthcare journals, and the creation of FRAM electronic learning opportunities are media that can engage healthcare professionals and researchers in familiarizing themselves and adopting the FRAM as a research methodology. Healthcare providers and leaders armed with systems-level knowledge and methods, such as the FRAM, can approach the complexity of the healthcare system with a new perspective, creating much needed improvements in the quality, safety, and efficiency of the system.

2.15.4 Implications for policy

Findings from this review show how the FRAM can identify variability that emerges from the interaction of activities and functions within a healthcare process. This variability can positively or negatively affect outcomes. Healthcare policy informed by the FRAM can potentially reduce negative variability and enhance positive variability within the system. Papers in this review used the FRAM to capture system resiliencies, such as performance adjustments, that resulted in positive outcomes. Gaining a better understanding of how performance adjustments result in positive outcomes can assist healthcare leaders with identifying leading indicators that can be translated into policy.

FRAM-informed policies may also have the potential for greater adoption among front-line providers because these policies are reflective of the realities of practice. Uptake of FRAM-informed policies may also be better received by clinicians because they are based on work as done rather than work as imagined. The healthcare system in its current state, with an aging population and workforce, is not sustainable. The FRAM has the potential to inform healthcare policy in a new and meaningful way.

2.16 Funding

Research funding was provided to AM by the Ocean Frontier Institute through an award from the Canada First Research Excellence Fund. The funders have not had any role in content development.

2.17 Conflicts of interest

The authors declare no conflicts of interest.

References

1. Holden R, Carayon P, Gurses AP, Hoonakker P, Hundt A, Ozok A, et al. SEIPS 2.0: a human factors framework for studying and improving the work of healthcare professionals and patients. Ergonomics. 2013;56(11):1669-86.

2. O'Hara J, Baxter R, Hardicre N. 'Handing over to the patient': A FRAM analysis of transitional care combining multiple stakeholder perspectives. Appl Ergon. 2020;85:103060.

3. Manyazewal T. Using the World Health Organization health system building blocks through survey of healthcare professionals to determine the performance of public healthcare facilities. Arch Public Health. 2017;75(1):1-8.

4. Braithwaite J, Wears R, Hollnagel E. Resilient health care: turning patient safety on its head. Int J Qual Health C. 2015;27(5):418-20.

5. Iflaifel M, Lim R, Ryan K, Crowley C. Resilient Health Care: a systematic review of conceptualisations, study methods and factors that develop resilience. BMC Health Serv Res. 2020;20:1-21.

6. Smith D, Veitch B, Khan F, Taylor R. Integration of resilience and FRAM for safety management. J Risk Uncertain Eng Syst. 2020;6(2):1-7.

7. Laugaland K, Aaase K, Waring J. Hospital discharge of the elderly-an observational case study of functions, variability, and performance-shaping factors. BMC Health Serv Res. 2014;14(1):1-15.

8. Registered Nurses Association of Ontario. Developing and sustaining safe, effective staffing and workload practices. Toronto: Registered Nurses Association of Ontario; 2017 [Available from http:// //rnao.ca/sites/rnao-ca/files/bpg/Staffing_Workload_ Practices_2017.pdf [Accessed 20 July 2020].

9. Sobaski T. Addressing patient acuity and nurse staffing issues in the acute care setting: A review of the literature. Int J Stud Nurs. 2018;3(3):1-12.

10. Hollnagel E, Hounsgaard J, Colligan L,. FRAM- The functional resonance analysis method: a handbook for the practical use of the method. Middlefart, Denmark [Available from: https://functionalresonance.com/onewebmedia/FRAM_handbook_web-2.pdf [Accessed 23 July 2020]; 2014.

11. Kieny M, Bekedam H, Dovlo D, Fitzgerald J, Habicht J, Harrison G, et al. Strengthening health systems for universal health coverage and sustainable development. Bull World Health Organ. 2017;95(7):537-39.

12. Clarkson J, Dean J, Ward J, Komashie A, Bashford T. A systems approach to healthcare: from thinking to practice. Future Health J. 2018;5(3):151-5.

13. Peters M, Godfrey C, McInerney P, Baldini Soares C, Khalil H, Parker D. Chapter 11: Scoping Reviews. In: Aromataris E, Munn Z, editors. JBI Manual for Evidence Synthesis [internet]. Adelaide: JBI; 2017 [cited 2020 June 2]. Available from: https://synthesismanual.jbi.global.

14. McGill A, Smith D, McCloskey R, Morris P, Goudreau A, Veitch B. The functional resonance analysis method as a health care research methodology: a scoping review protocol. JBI Evid Synth. 2021;19(3):734-40.

15. McGowan J, Sampson M, Salzwedel D, Cogo E, Foerster V, Lefebvre C. PRESS peer review of electronic search strategies: 2015 guideline statement. J Clin Epidemiol. 2016;75:40-6.

16. Joanna Briggs Institute. Joanna Briggs Institute system for the unified management, assessment, and review of information (JBI SUMARI). 2014 Available from: http://www.jbisumari.org/ [Accessed 6 June 2020].

17. Page M, McKenzie J, Bossuyt P, Boutron I, Hoffman T, Mulrow C et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021; 372:n71.

18. Arcuri R, Bulhões B, Jatobá A, Bellas HC, Koster I, d'Avila AL, et al. Gatekeeper family doctors operating a decentralized referral prioritization system: Uncovering improvements in system resilience through a grounded-based approach. Saf Sci. 2020;121:177-90.

19. Buikstra E, Strivens E, Clay-Williams R. Understanding variability in discharge planning processes for the older person. Saf Sci. 2020;121:137.

20. Damen NL, de Vos MS, Moesker MJ, Braithwaite J, de Lind van Wijngaarden RAF, Kaplan J, et al. Preoperative anticoagulation management in everyday clinical practice: an international comparative analysis of work-as-done Using the Functional Resonance Analysis Method. J Patient Saf. 2021;[E-pub ahead of print].

21. Furniss D, Nelson D, Habli I, White S, Elliott M, Reynolds N, et al. Using FRAM to explore sources of performance variability in intravenous infusion administration in ICU: A non-normative approach to systems contradictions. Appl Ergon. 2020;86:1-9.

22. Kaya G, Hocaoglu M. Semi-quantitative application to the Functional Resonance Analysis Method for supporting safety management in a complex health-care process. Reliab Eng Syst Saf. 2020;202(10):1-13.

23. Kaya G, Ovali H, Ozturk F. Using the functional resonance analysis method on the drug administration process to assess performance variability. Saf Sci. 2019;118:835-40.

24. Mahmoudi F, Mohamed S, Tonmoy F. Analysing the resilience of hospitals' surge procedures using the Functional Resonance Analysis Method. 10th International Conference on Engineering, Project, and Production Management, 2-4 Sept 2019 [Available from https://wwwresearchgatenet/profile/Farhad-Mahmoudi/publication/339470671_Analysing_the_Resilience_of_Hospitals%27_Surge_Procedures_using_the_Functional_Resonance_Analysis_Method/links/5e88678a4585150839bd8fdf/Analysing-the-Resilience-of-Hospitals-Surge-Procedures-using-the-Functional-Resonance-Analysis-Methodpdf]. 2020:113-23.

25. McNab D, Freestone J, Black C, Carson-Stevens A, Bowie P. Participatory design of an improvement intervention for the primary care management of possible sepsis using the Functional Resonance Analysis Method. BMC Med. 2018;16(1):174.

26. Meeuwis CJ, Steinmetz V, Hamming JF, Dekker SWA. A FRAM requirements analysis for Safety Differently investigations. Saf Sci. 2020;125:1-4.

27. Oduyale MS, Patel N, Borthwick M, Claus S. Co-administration of multiple intravenous medicines: Intensive care nurses' views and perspectives. Nurs Crit Care. 2020;25(3):156-64.

28. Patriarca R, Falegnami A, Costantino F, Bilotta F. Resilience engineering for socio-technical risk analysis: Application in neuro-surgery. Reliab Eng Syst Saf. 2018;180:321-35.

29. Raben D, Viskum B, Mikkelsen K, Hounsgaard J, Bogh S, Hollnagel E. Application of a non-linear model to understand healthcare processes: using the functional resonance analysis method on a case study of the early detection of sepsis. Reliab Eng Syst Saf. 2018;177:1-11.

30. Ross A, Sherriff A, Kidd J, Gnich W, Anderson J, Deas L, et al. A systems approach using the functional resonance analysis method to support fluoride varnish application for children attending general dental practice. Appl Ergon. 2018;68:294-303.

31. Schutijser B, Jongerden I, Klopotowska J, Portegijs S, de Bruijne M, Wagner C. Double checking injectable medication administration: Does the protocol fit clinical practice? Saf Sci. 2019;118(10):853-60.

32. Tarakçı E, Özay M, Sakallı A, Can E. Understanding Covid-19 management process in health care facilities using Functional Resonance Analysis Method. JHMN. 2020;80:96-101.

33. Clay-Williams R, Austin E, Braithwaite J, Hollnagel E. Qualitative assessment to improve everyday Activities work-as-imagined and work-as-done In, Rapport F, Braithwaite J, editors. Transforming healthcare with qualitative research. Ist ed. London: Routledge; 2020; 70-77.

34. Hounsgaard J, Thomsen B, Nissen U, Bhanderi U. Understanding normal work to improve quality of care and patient safety in a Spine Center. In: Hollnagel E, Braithwaite, J, Wears, R, eds. Delivering Resilient Health Care. 1st ed. New York: Routledge: 2019. p. 118-30.

35. Raben D, Bogh SB, Viskum B, Mikkelsen K, Hollnagel E. Learn from what goes right: A demonstration of a new systematic method for identification of leading indicators in healthcare. Reliab Eng Syst Saf. 2018;169:187-98.

36. Salehi V, Hanson N, Smith D, McCloskey R, Jarrett P, Veitch B. Modeling and analyzing hospital to home transition processes of frail older adults using the functional resonance analysis method (FRAM). Appl Ergon. 2021;93(5):1-17.42.

37. Pickup L, Atkinson S, Hollnagel E, Bowie P, Gray S, Rawlinson S, et al. Blood sampling - Two sides to the story. Appl Ergon. 2017;59(Pt A):234-42.

38. Saurin T, Rosso C, Colligan L. Towards a resilient and lean health care. In Braithwaite J, Wears R, Hollnagel E, editors. Resilient health care: Reconciling work as imagined and work as done. 3rd ed. Boca Raton: CRC Press. Accessed November 27, 2020 from https://www.researchgate.net/publication/309035217_Towards_a_resilient_and_lean_health_care . 2017.

39. Raben DC, Bogh SB, Viskum B, Mikkelsen KL, Hollnagel E. Proposing leading indicators for blood sampling: Application of a method based on the principles of resilient healthcare. Cog Technol Work. 2017;19(4):809-17.

40. Gulpen A, van Dijk J, Damen N, Ten Cate H, Schalla S, ten Cate-Hoek A. Organisation of care for patients using direct oral anticoagulants. Netherlands Heart Journal. 2020;28:452-6.

41. Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implement Sci. 2015;10:125.

42. Sujan M, Felici M. Combining failure mode and functional resonance analysis method in health care settings. Computer Safety, Reliability, and Security: Proceedings of 31st International Conference: SAFECOMP; 2012 September 25-28; Magdeburg, Germany. Sweden: Springer Link; 2012. p. 364-375 [Available from: https://link.springer.com/chapter/10.1007%2F978-3-642-33678-2_31 [Accessed 20 October 2020].

43. Hounsgaard J. Patient safety in everyday work: Learning from things that go right. [dissertation] Odense: University of Southern Denmark.; 2016. [Available from: https://functionalresonance.com/onewebmedia/Hounsgaard%20(2016).pdf [Accessed 1 December 2020). 2016.

44. Pereira A. Introduction to the use of FRAM on the effectiveness assessment of a radiopharmaceutical dispatches process. In: Proceedings of The International Nuclear Atlantic Conference: INAC; 2013 November 24-29 Recife, PE, Brazil. p. [Available from: httphttps:/inis.iaea.org/collection/ NCLCollectionStore/_Public/45/066/45066051.pdf [Accessed 2 December 2020].

45. Alm H, Woltjer R. Patient safety investigation through the lens of FRAM. In, de Waard D, Axelsson A, Berguland M, Peters B, Weikert C, editors. Human factors: A system view of human, technology, and organisation. 1st ed. Maastricht the Netherlands: Shaker Publishing. 2010.

46. Kieny MP, Bekedam H, Dovlo D, Fitzgerald J, Habicht J, Harrison G, et al. Strengthening health systems for universal health coverage and sustainable development. Bull World Health Organ. 2017;95(7):537.

47. World Health Organization. Priorities; 2021 [Available from www.who.int/dg/priorities/en/ [Accessed 5 February 2021].

48. Hill R. FRAM Model Visualizer 2016 [Available from http://functionalresonance.com/FMV/index.html [Accessed 26 February 2021].

49. Smith D, Veitch B, Khan F, Taylor R. Integration of resilience and FRAM for safety management. J Risk Uncertain Eng Syst. 2020;6(2):1-7.

50. Unertl KM, Fair AM, Favours JS, Dolor RJ, Smoot D, Wilkins CH. Clinicians' perspectives on and interest in participating in a clinical data research network across the Southeastern United States. BMC Health Serv Res. 2018;18(1):1-10.

51. Pannick S, Sevdalis N, Athanasiou T. Beyond clinical engagement: a pragmatic model for quality improvement interventions, aligning clinical and managerial priorities. BMJ Qual Saf. 2016;25(9):716-25.

52. Portoghese I, Galletta M, Coppola R, Finco G, Campagna M. Burnout, and workload among health care workers: the moderating role of job control. Saf Health Work. 2014;5(3):152-7.

53. Garcia C, Abreu L, Ramos J, Castro C, Smiderle F, Santos J, et al. Influence of burnout on patient safety: Systematic review and meta-analysis. Medicina. 2019;55(9):553.

56. Teoh K, Hassard J, Cox T. Doctors' perceived working conditions and the quality of patient care: a systematic review. Work Stress. 2019;33(4):385-413.

57. Vincent C, Burnett S, Carthey J. Safety measurement and monitoring in healthcare: a framework to guide clinical teams and healthcare organisations in maintaining safety. BMJ Qual Saf. 2014;23(8):670-7.

58. Braithwaite J. Changing how we think about healthcare improvement. BMJ. 2018;361:1-4.

59. Hannigan B, Simpson A, Coffey M, Barlow S, Jones A. Care coordination as imagined, care coordination as done: findings from a cross-national mental health systems study. Int J Integr. 2018;18(3):1-14.

60. Ji Y, Ma Z, Peppelenbosch M, Pan Q. Potential association between COVID-19 mortality and health-care resource availability. Lancet Glob Health. 2020;8(4):e480.

61. Munthe C, Fumagalli D, Malmqvist E. Sustainability principle for the ethics of healthcare resource allocation. J Med Ethics. 2021;47(2):90-7.

62. Hollnagel E. Can we ever imagine how work is done? HindSight25. 2016.

63. World Health Organization. Patient safety: making health care safer. [Available from: https://apps.who.int/iris/bitstream/handle/10665/255507/WHO-HIS-SDS-2017.11-eng.pdf?sequence=1&isAllowed=y [Accessed 24 February 2021]. World Health Organization; 2017.

64. Stelfox H, Palmisani S, Scurlock C, Orav E, Bates D. The "To Err is Human" report and the patient safety literature. BMJ Qual Saf. 2006;15(3):174-8.

Appendix A: Search strategy

Database searches

MEDLINE (Ovid) Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) 1946 to March 11, 2021 Originally searched June 3, 2020, re-run March 12, 2021			
#	Search string	**Results June**	**Results March**
1	functional Resonance Analysis method.ab,ti,tw.	16	21
2	FRAM.ab,ti,tw.	166	177
3	1 or 2	168	181
March 12, 2021			
4	limit 3 to dt=20200603-20210312		14

CINAHL Full-Text (EBSCO) Originally searched June 3, 2020, re-run March 12, 2021			
#	**Search string**	**Results June**	**Results March**
1	TI “functional Resonance Analysis method”	2	3
2	AB "functional Resonance Analysis method"	12	14
3	TI FRAM	17	16
4	AB FRAM	45	44
5	S1 OR S2 OR S3 OR S4	52	52
March 12, 2021			
6	EM 20200603-		277,272
7	S5 AND EM 20200603-		2

Embase (Elsevier) Originally searched June 3, 2020, re-run March 12, 2021			
#	**Search string**	**Results June**	**Results March**
1	'functional resonance analysis method':ti,ab,kw	37	46
2	fram:ti,ab,kw	252	272
3	#1 OR #2	254	276
March 12, 2021			
4	#3 AND [3-6-2020]/sd		25

PsycINFO (EBSCO) Originally searched June 3, 2020, re-run March 12, 2021			
#	**Search string**	**Results June**	**Results March**
1	TI "functional Resonance Analysis method"	4	5
2	AB "functional Resonance Analysis method"	12	17
3	TI FRAM	13	15
4	AB FRAM	38	45
5	S1 OR S2 OR S3 OR S4	40	47
March 12, 2021			
6	S5 AND RD 20200603-		7

ProQuest Nursing & Allied Health (ProQuest) Originally searched June 3, 2020, re-run March 12, 2021			
#	**Search string**	**Results June**	**Results March**
1	ab("functional Resonance Analysis method")	10	22
2	ti("functional Resonance Analysis method")	1	4
3	ab(FRAM)	50	51
4	ti(FRAM)	16	16
5	ab("functional Resonance Analysis method") OR ti("functional Resonance Analysis method") OR ab(FRAM) OR ti(FRAM)	59	61
March 12, 2021			
6	ab("functional Resonance Analysis method") OR ti("functional Resonance Analysis method") OR ab(FRAM) OR ti(FRAM) Additional limits Date: After 2020 June 03		7

Inspec Engineering Village (Elsevier) Originally searched September 1, 2020, re-run March 12, 2021			
#	**Search string**	**Results September**	**Results March**
1	((functional Resonance Analysis method) WN KY)	12,424	13,013
2	((FRAM) WN KY)	1509	1512
3	((health*) WN KY)	265,748	293,161
4	#1 OR #2	13,879	14,463
5	#3 AND #4	395	438
March 12, 2021			
6	#5 Years: 2020-2022		37

Gray literature searches

Limit to English on all searches

ProQuest Dissertations and Theses (ProQuest) Searched March 2021		
#	Search string	**Results**
1	The Functional Resonance Analysis Method	248,007
2	The FRAM	18,470
3	The Functional Resonance Analysis Method and Health care	101,013
4	The "Functional Resonance Analysis Method" and Health care	19
5	The "FRAM" and Health care	13

Google Scholar Searched March 2021		
#	Search string	**Results**
1	The Functional Resonance Analysis Method	3,510,000
2	The FRAM	1,790,000
3	The Functional Resonance Analysis Method and Health care	623,000
4	The FRAM and Health care	63,800
5	The "Functional Resonance Analysis Method" and "Health care"	454

Google Searched March 2021		
#	Search string	**Results**
1	The Functional Resonance Analysis Method	108,000,000
2	The FRAM	221,000,000
3	The Functional Resonance Analysis Method and Health care	122,000,000
4	The FRAM and Health care	46,100,000
5	The "Functional Resonance Analysis Method" and "Health care"	16,400

Appendix B: Sources ineligible following full-text review

1. Furniss D, Curzon P, Blandford A. Using FRAM beyond safety: a case study to explore how sociotechnical systems can flourish or stall. Theor Issues Erg Sci. 2016;17(5-6):507-32.
   Reason for exclusion: Ineligible context

2. Guiyab M, Rudyk N, Mustard M, Grandy J, Snatenchuk D, McLachlan P. Transfer of accountability among the operating room, post anesthesia care unit, and intensive care units. Can J Crit Care Nurs. 2016;27(2):39.
   Reason for exclusion: Ineligible concept

3. McCarron K. Understanding care bundles. Nurs Made Incredibly Easy. 2011;9(2):30-3.
   Reason for exclusion: Ineligible context

4. Patriarca R, Di Gravio G, Woltjer R, Costantino F, Praetorius G, Ferreira P, et al. Framing the FRAM: a literature review on the functional resonance analysis method. Safety Sci. 2020;129: 104827.
   Reason for exclusion: Ineligible context

5. Roland D. Guideline developers are not the only experts: utilising the FRAM method in sepsis pathways. BMC Med. 2018;16(1):213.
   Reason for exclusion: Ineligible context

6. Singer MR, Moore LL, Garrahie EJ, Ellison RC. The tracking of nutrient intake in young children: the FRAM. Am J Public Health. 1995;85(12):1673-7.
   Reason for exclusion: Ineligible concept

Appendix C: Characteristics of included sources

Author (year)	Country of origin	Setting	Descriptions, concepts, and definitions of FRAM	Methods used	Research questions, aims, objectives	Healthcare process or activity of interest	Key findings
Alm and Woljter[46] (2010)	Sweden	Operating room	A systemic approach to system safety and resilience engineering with an aim to identify functional interdependencies and effects of performance variability in complex socio-technical systems.	Document review Focus groups Interviews Observations	To apply the FRAM to an adverse event investigation of surgical materials left inside a patient's abdomen.	Safety and risk	13 activities/functions 11 instances of variability FRAM does not find a root cause for an adverse event but facilitates the discovery of more complex and systemic dependencies.
Arcuri et al.[18] (2020)	Brazil	Primary care	For analyzing aspects of intractable socio-technical systems.	Document review Interviews Observations	To identify the resilient behaviors exhibited by healthcare providers in the context of operating a decentralized referral prioritization system.	Physician referral process	Identified how activities within a process are adjusted to respond to changes and variations in the clinical settings.
Buikstra et al.[19] (2020)	Australia	Geriatric evaluation & management unit	Identifies outcomes of unexpected variables that emerge in clinical practice.	Focus groups Document review Interviews	Describe the discharge planning processes in a geriatric evaluation and management ward, focusing on variabilities.	Transitional care	4 functions and 61 instances of variability identified.
Clay-Williams et al.[41] (2015)	Australia	Intensive care unit	A method for modeling complex socio-technical systems that captures "work as performed."	Discussions Document review	Identify how the FRAM can assist with the development and implementation of practice guidelines.	Hospital management	31 functions and 7 interdependencies involved in guideline development and implementation.
Clay-Williams et al.[33] (2020)	Australia	Emergency department	Constructs models outlining the activities involved in workplace processes.	Document review Interviews Observations	Describe systemic constraints and identify tasks undertaken within the emergency department, including the different strategies	Blood sampling	Identifying factors that influence how processes unfold and the constraints clinicians face in doing their work.

					individuals use to perform those tasks.		
Damen et al.[20] (2018)	Australia	Cardiosurgical department	Builds models that describe essential activities in processes.	Interviews	Test the utility of the FRAM in assessing preoperative anticoagulation management.	Anticoagulation management	18 functions and 3 interdependencies involved in pre-operative anticoagulation management.
Furniss et al.[21] (2020)	UK	Intensive care unit	Examines performance variability in complex systems.	Discussions Emails Observations	Explore how nurses manage the tensions and contradictions in expected practices around intravenous medication administration.	Medication administration	38 functions and 10 variabilities present in medication administration. Activities performed by nurses to manage obstacles related to medication administration.
Gulpen et al.[40] (2020)	Netherlands	Hospital to community transition	FRAM is a method to visualize processes as they are carried out in everyday practice ("work as done").	Focus group Interviews	Gain insight into how the care for patients on oral anticoagulants is arranged.	Anticoagulation management	Identified areas for improvement, including task division, role clarity, multidisciplinary collaboration, efficiency, and guidance and support.
Hollnagel et al.[10] (2014)	Denmark	Primary care	A systematic approach to creating a representation of how an activity usually takes place.	Case study	To provide guidance on using the FRAM.	Patient safety	Steps to conduct a FRAM analysis with background information to develop an understanding of the method.
Hounsgaard[43] (2016)	Denmark	Hospital wide	A method to investigate adjustments required in processes and how	Interviews Narrative Stories	To investigate work adjustments required to maintain safety and	Patient safety	Work adjustments may be needed to ensure safety, but these adjustments may

			these adjustments impact outcomes.		identify opportunities for improved safety.		impact process outcomes.
Hounsgaard et al.[34] (2018)	Denmark	Spine center	A method that helps in understanding daily routines and the variabilities that can emerge.	Case study Interviews	To investigate a persistent patient safety problem and understand the issues that contribute to it.	Patient safety	Adverse events occur in complex systems and can be used to prevent future events and improve safety.
Kaya and Hocaoglu[22] (2020)	Turkey	Neonatal intensive care	A method that helps understand system complexities.	Focus group Secondary analysis	To identify performance variabilities in the administration of medication.	Medication administration	FRAM promotes situational awareness of work processes.
Kaya et al.[23] (2019)	Turkey	Neonatal intensive care	An alternate approach to safety management that identifies activities that influence system outcomes.	Interviews Observations Workshops	To identify performance variability in the drug administration process.	Medication administration	37 functions identified. Helped staff anticipate conditions that may compromise safety and determine how best to respond.
Laugaland and Waring[7] (2014)	Norway	Hospital wide	A systematic approach to analyze performance variability in complex systems.	Case studies Document review Interviews Observations	To identify hospital discharge activities and Performance-shaping factors that may lead to different outcomes in discharge practices.	Transitional care	10 functions identified. Discharge process for older adults is complex, and existing functions are inadequate to respond to the potential variabilities.
Mahmoudi et al.[24] (2020)	Australia	Hospital wide	A qualitative technique for understanding activities and variabilities in systems.	Discussions Document review Interviews	To assess interactions between various areas of a hospital to understand response to surge capacity.	Hospital management	29 functions and 171 interdependencies. Limitations identified in a hospital's ability to respond to surge capacity.
McNab et al.[25] (2018)	Scotland	Primary care	A method to begin to model and understand complex systems.	Document review Interviews	To understand how patients with sepsis are identified.	Sepsis	14 functions identified. Working conditions influence how sepsis is identified and managed.
Meeuwis et al.[26] (2020)	Australia	No setting	An elaborate method used to analyze everyday performance	Focus groups Interviews	To identify the requirements for a safety investigation.	Safety and risk	Identified the requirements to conduct a safety investigation.

Oduyale et al.[27] (2020)	UK	Intensive care unit	An analysis that creates a model that is a visual representation of activities connected to a process.	Focus groups	To identify nurses' practice around administering multiple medications down a single lumen catheter.	Medication administration	21 functions identified. Workarounds are needed to prevent medication delays and manage drug incompatibilities.
O'Hara et al.[2] (2020)	UK	Hospital to community transitions	A model of system variabilities and the roles of different actors in compromising patient safety.	Secondary analysis	To describe transitional care, explore how activities are related, identify variabilities introduced by patients and families, and develop a logic model to guide development of transitional interventions.	Transitional care	27 functions identified. Identification of points in the transitional process where safety is compromised.
Patriarca et al.[28] (2018)	Italy	Neurosurger y	A method that eliminates observer bias by identifying activities that transpire when work is being performed.	Case study Document review Focus groups Interviews Observations Questionnaires	Identify risk associated with neurosurgery	Safety and risk	68 functions identified. Mapping of patient pathway in a perioperative neurosurgery identified areas of risk for iatrogenic disease.
Pereira[44] (2013)	Brazil	Radiopharm aceutical dispatch	A representation of the dynamics involved in a process to enhance risk assessment comprehension.	Document review	To model a radiopharmaceutical dispatch process to understand the process and how its performance variations can affect the effectiveness of the process.	Radiopharmaceuti cal dispatching	Identification of performance variabilities enhanced understanding of areas of potential compromised safety.
Pickup et al.[37] (2017)	UK	Hospital wide	A systematic approach to describe and examine work as it is done, and to understand interactions and variabilities between functions in a process.	Observations Interviews Workshops	To understand the variability in blood sampling.	Blood sampling	31 functions identified. Identification of factors that cause clinicians to modify the activities involved in sampling blood.

Raben et al.[39] (2017)	Denmark	Hospital wide	A method to analyze how work is performed in a complex system.	Case study Interviews Narrative stories Observations	To identify leading indicators for blood sampling	Safety and risk	15 functions identified. Four leading indicators for blood sampling identified.
Raben et al.[35] (2018)	Denmark	Hospital wide	Describes activities involved in a process and helps illustrate how variations in these activities can affect other activities.	Case study Secondary Analysis	To develop a method to identify leading indicators in healthcare.	Safety and risk	Identification of early recognition of sepsis, which served as a framework to define leading indicators.
Raben et al.[29] (2018)	Denmark	Hospital wide	A model of the activities involved in a process and how these activities are connected.	Case study Document review Interviews	To understand how the early detection of sepsis takes place on a hospital ward.	Sepsis	40 functions identified. Identification of the things that go right on a hospital unit that facilitated early identification and treatment of sepsis.
Ross et al.[30] (2018)	UK	Dental practice	A method for modeling complex organizational systems.	Document review Interviews Questionnaires Workshop	To produce a model to identify opportunities for interventions to support fluoride varnish application.	Dental care	33 functions identified. Identification of areas where improvements can be made for promoting and applying fluoride treatment.
Salehi et al.[45] (2021)	Canada	Hospital to community transition	A qualitative approach is used to visualize and model complex systems.	Document review Focus groups Interviews Observations Questionnaires	To model interactions between different hospital activities involved in the hospital-to-home transition.	Transitional care	38 functions identified. Variabilities resulted in adverse events. Challenges to the transitional process was identified.
Saurin et al.[38] (2017)	Brazil	Emergency department	A tool to model complex systems and show how variability propagation affects performance and outcomes.	Interviews Observations	To compare the utility of FRAM with the value stream mapping model in understanding medication administration.	Medication administration	8 functions identified. Further work is required to determine if the FRAM or the value stream mapping is superior for helping to understand a healthcare process.

Schutijser et al.[31] (2019)	Netherlands	Hospital wide	A method to visualize essential activities of "work as done," including the variability of daily practice.	Interviews Observations	To determine how nurses double check injectable medications in a hospital ward.	Medication administration	23 functions identified. Variabilities identified in how nurses adjust their work activities to ensure double checking of medications.
Sujan[42] (2012)	UK	Emergency department	A process to model the activities functions.	Discussions	To determine if the FRAM can be used as a complementary approach to failure mode and effects analysis in a proactive safety analysis.	Safety and risk	The FRAM offered insights in risk otherwise not identified. Further work is required to determine how the FRAM can be integrated with other methods.
Tarakçı et al.[32] (2020)	Turkey	Hospital wide	A complex modeling method that assumes that accidents are the result of variabilities that take place within a process.	Discussions	To understand the process of hospitalization of patients with COVID-19.	Hospital management	14 functions identified. The FRAM offered a way to understand the hospitalization process and helped to prepare the hospital for a COVID-19 outbreak.

Appendix D: Aim/Objective for applying the Functional Resonance Analysis Method to a healthcare process of interest

	Understand a process	Examine variability in a process	Identify how to change a process	Obtain user views on a process	Describe an existing process	Understand how to implement a new process	Explore response to variability in a process	Guidance on using FRAM to examine process
Alm & Woljter[45]	X		X					
Arcuri et al. [19]	X							
Buikstra et al. [20]	X				X			
Clay-Williams et al. [33]	X			X		X		
Clay-Williams et al. [41]	X						X	
Damen[21]	X				X			
Furniss et al. [10]		X						
Gulpan et al.[40]	X		X					
Hollnagel et al.[11]								X
Hounsgaard[43]		X	X					
Hounsgaard et al. [33]	X							
Kaya & Hocaoglu[22]		X						
Kaya et al.[23]		X						
Laugaland & Waring[7]	X	X						
Mahmoudi et al.[24]	X							
McNab et al. [25]	X		X					
Meeuwis et al.[26]	X							
Oduyale et al. [27]				X				
O'Hara et al.[2]			X					
Patriarca et al. [28]	X	X						
Pereira[44]	X							
Pickup et al. [37]	X							
Raben et al. [39]	X							

Raben et al. [35]	X							
Raben et al.[29]	X							
Ross et al. [30]						X		
Salehi et al.[36]	X	X		X	X			
Saurin et al.[38]		X						
Schutijser et al. [31]		X						
Sujan [42]	X							
Tarakci[32]	X							
	n=21 (67.7%)	n=9 (29.0%)	n=5 (16.1%)	n=3 (9.7%)	n=3 (9.7%)	n=2 (6.5%)	n=1 (3.2%)	n=1 (3.2%)

*Some papers identified more than one Aim/Objective for applying the FRAM

Appendix E: Healthcare Process of Interest Examined using the Functional Resonance Analysis Method

	Safety and Risk	Medication administration	Transitional Care	Hospital Management	Sepsis	Blood Sampling	Anti-coagulation	Referral Process	Fluoride Varnish Care	Radio-pharmaceutical dispatch
Alm & Woljter[45]	X									
Arcuri et al. [19]								X		
Buikstra et al. [20]			X							
Clay-Williams et al. [33]				X						
Clay-Williams et al. [41]						X				
Damen[21]							X			
Furniss et al. [10]		X								
Gulpan et al.[40]							X			
Hollnagel et al.[11]	X									
Hounsgaard[43]	X									
Hounsgaard et al. [33]	X									
Kaya & Hocaoglu[22]		X								
Kaya et al.[23]		X								
Laugaland & Waring[7]			X							
Mahmoudi et al.[24]				X						
McNab et al. [25]					X					
Meeuwis et al.[26]	X									
Oduyale et al. [27]		X								
O'Hara et al.[2]			X							
Patriarca et al. [28]	X									
Pereira[44]										X
Pickup et al. [37]						X				

Raben et al. [39]	X					X				
Raben et al. [35]					X					
Raben et al.[29]					X					
Ross et al. [30]									X	
Salehi et al.[36]			X							
Saurin et al.[38]		X								
Schutijser et al. [31]		X								
Sujan [42]	X									
Tarakci[32]				X						
	n=8 (25.8%)	n=6 (19.4%)	n=4 (12.9%)	n=3 (9.7%)	n=3 (9.7%)	n=3 (10.0%)	n=2 (6.5%)	n=1 (3.2%)	n=1 (3.2%)	n=1 (3.2%)

Chapter 3.

The Functional Resonance Analysis Method (FRAM): Using Qualitative Data Collection and Analysis to Inform the Building of a FRAM Model *

Co-authorship statement. A version of the paper presented in this chapter has been published in the International Journal of Qualitative Methods published by Sage Journals publishing company. The first author, Ali McGill led the conceptualization and writing of the paper. Dr. Rose McCloskey, Dr. Brian Veitch and Dr. Doug Smith also supervised and co-authored the paper. Dr. Vahid Salehi also co-authored the paper. All authors participated in discussions to enhance the concepts presented in the paper. All authors revised, edited, and made recommendations for improvements to earlier drafts of the paper.

* McGill A, McCloskey R, Smith D, Salehi V, Veitch B. Building a Functional Resonance Analysis Method Model: Practical Guidance on Qualitative Data Collection and Analysis. International Journal of Qualitative Methods. 2023 Oct 23;22:16094069231211145.

Abstract:

The Functional Resonance Analysis Method (FRAM) is a novel research methodology that uses qualitative data collection methods to map and model complex healthcare processes by identifying and depicting the cumulative activities required to produce an outcome. The FRAM aims to identify the variability that can emerge in a process when healthcare activities are performed under dynamic conditions. With this knowledge, health care system design, safety, and quality improvement recommendations can be developed with a greater understanding of everyday process functionality. Researchers interested in using the FRAM require both an understanding of the methodology itself, as well as an understanding of how to effectively plan and conduct qualitative research. The purpose of this paper is to provide practical guidance to researchers on planning and operationalizing qualitative data collection and analysis methods to inform the building of a FRAM model. A combination of literature and practical experience will be used to examine and suggest appropriate ways for researchers to carry out this work.

Building a Functional Resonance Analysis Method (FRAM) Model: Practical Guidance on Qualitative Data Collection and Analysis

3.1 Introduction

The Functional Resonance Analysis Method (FRAM) is a novel research methodology that uses qualitative data collection methods to map and model complex healthcare processes by identifying and depicting the cumulative activities required to produce an outcome. The FRAM aims to identify the variability that can emerge in a process when healthcare activities are performed under dynamic conditions. With this knowledge, health care system design, safety, and quality improvement recommendations can be developed with a greater understanding of process functionality under dynamic conditions. A strength of the FRAM is that it uses both qualitative inquiry and process mapping/modelling. Combining these approaches can provide an enhanced description and understanding of the complexities of healthcare work by gathering contextual data while also capturing and depicting the dynamic nature of work activities with process mapping (1). Researchers interested in using the FRAM require both an understanding of the methodology itself, as well as an understanding of how to effectively collect and analyze qualitative data. The purpose of this paper is to provide practical guidance to researchers on planning and operationalizing qualitative data collection and analysis methods to inform the building of a FRAM model. This paper does not intend to provide a review of the FRAM healthcare literature, but rather exemplify how researchers have operationalized these methods in select examples. Important considerations for time and human resources required to build a FRAM model are also presented. Additionally, considerations for researchers are presented for building FRAM models that are understandable and accurately reflect the everyday realities of healthcare work.

Important considerations for time and human resources required to build a FRAM model are also presented. Additionally, considerations for researchers are presented for building FRAM models that are understandable and accurately reflect the everyday realities of healthcare work.

3.2 Overview of the FRAM

The FRAM was first developed in the early 2000s in the field of engineering to be used in research and development related to safety and accident analysis (2). The methodology has been used to map, model, and analyze complex processes and systems in a number of domains, such as aviation, maritime transport, industry, and healthcare (3). The FRAM has emerged more recently as healthcare research methodology that is gaining recognition with most studies being published since 2017 (4). In a review of the FRAM literature in 2021-2022, there have been an additional seventeen healthcare related publications featuring the FRAM (5-21). Before using the FRAM, researchers are encouraged to familiarize themselves with the methodology's background and principles. Providing a complete review of the FRAM is beyond the scope of this paper. Fundamental FRAM literature is available that can guide a novice FRAM researcher (22-24). A FRAM model depicts the interdependent activities of work that make up a process to produce an outcome (22). The model created allows clinicians and administrators to gain a greater appreciation of the complexity of a healthcare process that may otherwise be invisible when using more traditional or sequential methods of analysis (4). Studies using the FRAM can provide an understanding of complexity for a numbers of purposes, including process optimization, incident investigation, guideline development and implementation, intervention development, and prospective risk management (8). Currently, there is much discussion in healthcare around complexity with little dedication to researching it appropriately (25).

The key to gaining this understanding is to gather data from information-rich sources who are stakeholders in the process, such as healthcare professionals and patients and their families. Hollnagel and Slater (2022), state "the best sources of information about the activities being analyzed are the people who actually carry them out" (Appendix A: p. 1). The accounts of stakeholders are key to distinguishing between the concepts of work-as-imagined and work-as-done. Work-as-imagined is a description of work that often is conceived from how a healthcare process is supposed to happen according to the literature or a description provided by management. Work-as-done is a description of work as it actually takes place in everyday conditions provided by those who actually do the work (24). The concepts of work-as-imagined and work-as-done are central to the FRAM and several studies using the FRAM have examined this phenomenon and have been able to provide input on how work-as-imagined and work-as-done can be better aligned (12, 18, 20, 21, 26, 27).

3.2.1 Steps of the FRAM

The steps explained below have been adapted for the healthcare context from an original description provided by (23).

- Step 1 is concerned with identifying a clearly described purpose and scope of a FRAM analysis of a healthcare process.
- Step 2 is concerned with identifying and describing the activities required for a healthcare process to take place.
- Step 3 is concerned with describing how the activities in a process vary.

- Step 4 aims to show how the aggregation of variability in activities impacting one another early in healthcare process (upstream) may have an impact on activities later in the process (downstream).
- Step 5 is concerned with monitoring the process and identifying how any negative variability that emerges can be dampened and how any positive variability can be enhanced.

3.2.2 FRAM Terminology

The FRAM refers to healthcare activities in a process as "functions" (24). Functions are continuously carried out in healthcare processes and are human, organizational, and technological (28).For instance, functions carried out by community-based pharmacists would include "obtaining a medical history" and "communicating with the prescriber". For these functions to be carried out, they have temporal and resource requirements (human, technological, operational). Additionally, functions require guidance, such as policies, procedures, and clinical guidelines. All these characteristics of functions are referred to as "aspects" (24). The FRAM specifies how functions are characterized in terms of six aspects: Input (I), Output (O), Resources (R), Time (T), Control (C), and Preconditions (P). Clay-Williams et al. (2015) best defines the aspects that characterize functions:

1. The Input is what the function acts on or changes (what is used to start the function).

2. The Output is what emerges from the function (an outcome or state change).

3. A Precondition is a condition that must be satisfied for a function to happen.

4. The Resources are materials or people needed to execute a function.

5. Control is how the function is regulated or controlled (guidelines, protocols).

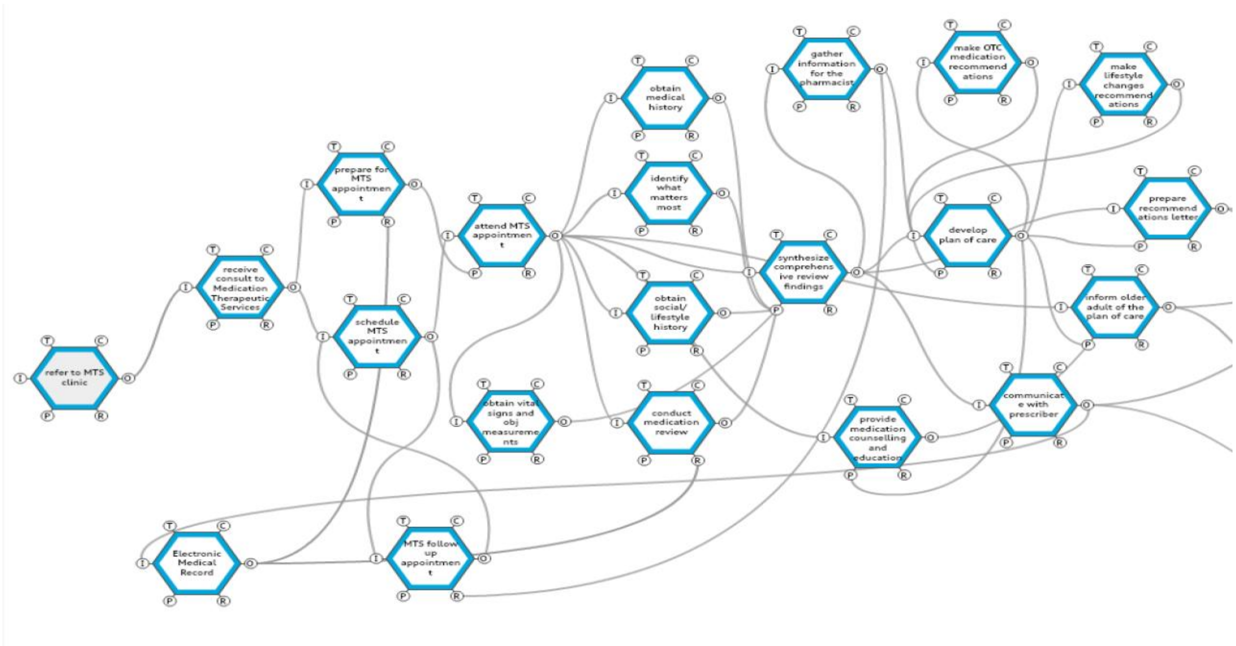
6. Time refers to any temporal requirements of the function.

Functions that are interdependent and impact one another in a process are “coupled” (24). Functions that are coupled are connected through mutually shared aspects. A FRAM model is a visual depiction of all the functions and connections among the functions that exist within a health care process. The graphical depictions can be built, edited, and shared using specialized FRAM software (29).

The visualization of a healthcare process with a FRAM model is a strength of the methodology as it allows clinicians and administrators to see all the potential ways a process can take place and to gain an appreciation the complexity that exists which may otherwise be invisible (4). The authors of this paper are currently conducting a study examining the process of community-based comprehensive geriatric assessment. Figure 3.1 is an example of a FRAM model from the study in progress. that depicts how a medication review with a community pharmacist can potentially take place. It shows the essential functions of the process, as well as how functions are connected and interdependent.

Figure 3.1

A FRAM Model Depicting the Process of Community-Based Medication Review for Older Adults



The process of medication review is a component of the comprehensive geriatric assessment and is completed by pharmacists. Pharmacists collaborate with prescribers to ensure the medication regimes are optimized and safe. The FRAM model depicts how a medication review can potentially take place. It shows the essential functions of the process, as well as how functions are connected and interdependent. Researchers using the FRAM to examine and analyze complex health care processes must be aware that the resultant models, analyses, and recommendations are only as accurate and relevant as the quality of the data collected.

When conceptualizing and planning a study using the FRAM, it is important for researchers to appreciate that simply appropriating qualitative methods to identify the functions, aspects, and interdependencies of a healthcare process does not suffice. A number of resources exist that provide a comprehensive overview of the tenets, methodologies, and methods of qualitative research (30-32). This paper aims to provide practical guidance for researchers on how to operationalize data collection and analysis methods to inform the building of a FRAM model, steps 1 and 2 of the FRAM. The guidance in the fundamental FRAM literature related to these vital steps of the methodology is currently underspecified. Guidance on subsequent steps of the methodology is beyond the intended scope of this paper.

3.3 Designing a Study Using the FRAM – Step 1

The accuracy and validity of a FRAM model is dependent on the data collected and analyzed to build it. Qualitative research examines phenomena in a detailed and holistic way and aims to gain an understanding of and provide insight into real world issues (33). Gathering accounts of how everyday work is accomplished from those who provide healthcare or receive healthcare is essential to building a FRAM model that accurately represents the activities of a healthcare process essential to producing an outcome (22). A clearly described purpose and scope of a FRAM analysis allows researchers to delineate boundaries of the process they intend to examine and provides direction on preparing a sampling plan and determining appropriate methods of data collection.

Oduyale, Patel (34) aimed to "explore the everyday practices surrounding co-administration of multiple IV medicines by Intensive Care Unit (ICU) nurses down the same lumen, the challenges encountered during the process of co-administration, and investigate how compatibility is assessed and managed in practice" (p:157). Focus groups were the chosen method of data collection for this study. The rationale for this decision was to allow ICU nurses with similar experiences to reflect on their everyday practice and provide in-depth responses about shared and common knowledge (34). The sample was purposive in that it aimed to include only qualified nurses from an ICU practice setting, with experience in the process of IV medication co-administration.

A total of 18 ICU nurses were included in three focus groups, no rationale for the sample size was provided, but evidence supporting the size of each focus group was provided to readers. A strength of this study is the clear description of the purpose and scope of the FRAM analysis as well as the rationale provided for the study design choices.

3.3.1 Developing a Sampling Plan

A sampling plan can be broadly defined but should specify an approach to sampling and a rationale for the choices made (35). There is no requirement in qualitative research to explicitly state a sample size as this is often determined by data saturation. Data saturation is defined as the point in the data collection process when additional data does not lead to any new or emergent information (36). With data saturation, the sample number emerges as the study goes on. In examining the most recent FRAM literature, the sample size for studies using interviews as the primary method of data collection ranged from 8 to 31 participants (12, 16, 17, 20, 27).

The section in a study describing sampling is often not the most exciting or interesting one to read, but when it comes to a study using the FRAM it is one of the most important sections to describe explicitly. Studies using the FRAM to examine complex processes aim to identify the functions of everyday work and the potential interdependencies and variabilities that emerge in a process under dynamic work conditions. The data needed to accomplish this goal is best gathered from stakeholders who have firsthand knowledge of how the system or process functions on an everyday basis (22). A clear description of the eligibility criteria, steps taken to recruit participants, study setting, as well as who the participants are relative to the process of interest should be provided for readers. Qualitative researchers can choose from a variety of non-probability sampling methods to recruit participants (31).

3.3.2 Purposive Sampling

In reviewing the recent FRAM literature, several studies elected to conduct a purposive sampling approach in their studies (6, 7, 9, 12, 15, 19, 34, 37-40). Yin (32) claims in qualitative research the sampling approach is most often purposive to ensure the most relevant and plentiful data is obtained given the study topic with an emphasis on information rich sources. The rationale for selecting purposive sampling in studies using the FRAM is to ensure the sample can provide a work-as-done description to inform the building of a FRAM model that accurately depicts a healthcare process of interest under every-day conditions. In their FRAM analysis of the management of the deteriorating surgical patient, Sujan et al. (2022) explained a purposive sampling was employed to identify participants who work on a surgical emergency unit or who would be involved in the wider system effort in caring for deteriorating surgical patients (16). The study additionally provided a table for readers listing the number of participants by professional role.

Schreurs et al. (2022) and Oduyale (2020) also provided readers with tables describing participants in their studies by role and years of experience (12, 34). This is an important addition for any FRAM study because it provides readers with an overview of how broad or narrow the range of information and perspectives on the study focus will be. Health care processes are rarely completed by a lone professional, obtaining information and perspectives from a variety of workers is essential. Ensuring a variety of participants are included in a study is known as a maximum variation sampling, which is a variant of purposive sampling (32). Researchers who use the FRAM should also determine if the study focus would benefit from the inclusion of patients and their family caregivers. Laugaland, Aase (41) first voiced concern over the FRAM focusing solely on health care providers' perspectives and advocated for future studies to include patients and family caregivers. Buikstra, Strivens (37) echoed this sentiment by identifying this as a limitation in their study examining variability in the discharge summary process for older adults. Subsequently O'Hara, Baxter (42) included patients and families as participants in their study which used the FRAM to examine the hospital to home transition process in older adults. The data from this study provided new insights that included upstream hospital functions (e.g., encouraging mobility, supporting a better understanding of medication and condition) leading to improved outcomes for patients following hospital discharge. These findings would not have been realized if only the perspectives of health care professionals were considered.

3.3.3 Convenience Sampling

Convenience sampling is based purely on availability or accessibility of the sample(31). In qualitative research this type of sampling is not preferred because the sources providing the information may not be informative and produce an unwanted degree of bias (32).

Watson et al. (2022) used convenience sampling in a study using the FRAM to examine the process of oxygen prescribing on inpatient units (21). The authors identified the use of convenience sampling as a study limitation because the precise level of understanding and experience of each participant related to the process of oxygen prescribing was not known. This may lead to the development of a FRAM model that does not truly reflect the everyday functions, interdependencies and variability that occurs in the process. Watson et al. explain the rationale for the convenience sampling approach was due to the practical challenges of data collection on a busy inpatient unit.

3.3.4 Snowball sampling

Snowball sampling is an additional approach to sampling that could potentially assist researchers in overcoming recruitment challenges related to access. Polit and Beck (2020) define this approach as the sampling for a study through references from earlier participants in the study. Yin (2015) explains snowball sampling can be an acceptable sampling approach if it is purposeful and not done out of convenience (32). Purposeful snowball sampling aims to ensure that each referral meets predetermined eligibility criteria that ensures they possess the experience and knowledge specific to the process of interest. Arcuri, Bulhões (43) were challenged in accessing physicians for a study using the FRAM to depict the resiliency in the process of referral prioritization. A purposive snowball sampling approach was used to ensure the sample had the desired knowledge and experience to contribute to the study. A weakness identified with snowball sampling is that it could limit the participant pool to a small number of acquaintances (31).

This could be problematic in a health care setting where a snowball sampling approach may only capture workers who come from certain groupings of likeminded participants, such as 9-5 workers. Table 1 describes the different sampling approaches researchers can consider when designing a study using the FRAM.

3.4 Qualitative Data Collection Methods

There are several methods of data collection researchers using the FRAM can consider when designing a study. Polit and Beck (2020) state “it is often difficult to critically appraise the decisions researchers make in collecting qualitative data because details about those decisions are seldom spelled out” (p: 275). Efforts should be made to clearly describe how qualitative data was collected. Since FRAM studies are highly contextual, researchers will need to determine what methods of data collection will capture the data required and provide rationale for why the method(s) chosen were appropriate for the purpose of the study. The following section will review the most common methods of qualitative data collection used in healthcare studies that employed the FRAM with references to select examples from the literature of how researchers have approached data collection and analysis to inform the building of a FRAM model.

Table 3.1

Sampling Approaches Defined with Examples from the FRAM Literature

Sampling Approaches Defined	**Examples from FRAM Literature**
Purposive Sampling involves selecting participants based on their ability to provide the most relevant and in-depth data to analyze	Bos et al., 2022 Buikstra et al., 2020 Damen et al., 2021 Damoiseaux-Volman et al., 2021 Gustafson et al., 2022 Kaya et al., 2019 Oduyale et al., 2019 Schreurs et al., 2022 Schutjiser et al., 2019 Sujan et al., 2021 Sujan et al., 2022 van Dijk et al., 2021
Maximum Variation a variant of purposive sampling that aims to ensure a variety of participants with differing experiences, backgrounds, and knowledge are included (Yin, 2016).	Buikstra et al. (2020) Salehi et al., 2021
Convenience Sampling is when a sample is selected based purely on availability or accessibility to the researcher (Polit & Beck, 2020).	Watson et al. (2022)
Snowball Sampling is when a sample is selected by way of referrals from earlier participants in the study. Snowball sampling can be purposive or out of convenience. (Polit & Beck, 2020)	Arcuri et al. (2020) [purposive]

3.4.1 Semi-Structured Interviews

Semi-structured interviews are the most common method of data collection in healthcare studies using the FRAM (4). DeJonckheere and Vaughn (44) describe semi-structured interviews as an effective method to collect qualitative, open-ended data on a topic of interest from key informants and is guided by a flexible interview protocol that allows for follow-up questions, probes, and comments. Preparation for conducting semi-structured interviews is key. The goal should be to develop well-planned interview questions and probes that can generate rich, detailed accounts while also ensuring a rapport has been developed with the participant (31). Developing a well thought out interview guide first requires an understanding of the healthcare process of interest. Gaining this understanding can assist researchers in determining the general information required to build a FRAM model. Hollnagel et al. (2014) suggest consulting all available sources of information that can potentially form the basis of the interview questions and prompts, this may include document review of policies, procedures, and/or guidelines commonly used by workers in the process (23). Additionally, researchers may want to visit the work setting and meet with key stakeholders prior to conducting an interview. In the FRAM literature there are several resources that can assist in the development of a semi-structured interview guide. Table 2 provides an overview of the resources available in the FRAM literature that can assist researchers in developing a FRAM semi-structured interview guide.

Table 3.2

Resources for Developing a FRAM Semi-Structured Interview Guide

Resource	**FRAM Literature**
Table of guided questions used to explore FRAM conditions	Clay-Williams et a. (2015)
Interview template with examples of questions	Hollnagel et al. (2014) Hollnagel and Slater (2022)
Topic lists	Shutisjer et al. (2019) Damen et al. (2018)
Interview guide	Watson et al. (2022)

Hollnagel et al. (2014) suggest it can be useful if there are two interviewers conducting the semi-structured interview together with one interviewer asking questions and the other taking notes (23). Shutijser et al. (2019) used this approach to conduct semi-structured interviews in their study using the FRAM to examine and analyze the process variation between a protocol for double checking medication and the realities of everyday work by nurses (40). In this study, one researcher conducted interviews with a second researcher taking notes. One interviewer from the work domain who is not a manager or supervisor is also suggested so participants feel they can speak freely (23). Relying solely on notes taken by a second researcher may result in losing the richness and detail of the interview (30). Having an audio recording of the interview with transcribed notes is preferred to note taking since it provides a precise record of the interview that can be revisited by the researcher (30).

To optimize participant responses, Polit and Beck (2020) suggest developing semi-structured interview guides that are flexible enough to allow the participant to feel they can speak freely about their knowledge and experiences, but also have direction with their sequence and reflect the broader research protocol (31). Watson et al. (2022) use an interview guide in their study exploring oxygen prescribing and administration on hospital inpatient wards. The interview guide begins by clearly stating to participants the purpose of the study and what is required of participants (21). This is an important starting point because it orientates participants to the specific process being examined and the information researchers are seeking. A subsequent question early in the interview guide (21) asks, "Can you talk me through the process from your perspective?" (S2). The question is an example of a "grand tour question" which is a type of question that aims to establish a broad setting or topic and does not focus on the specific item of interest or sequence of topics (32). Providing the participant an opportunity to share their experience and knowledge of the process can potentially reveal a significant amount of information about functions, aspects, and potential variability, with opportunities for the interviewer to pose follow up questions. Polit and Beck (2020) also suggest "the ideal interview guide is often conceived of as an inverted triangle, moving from the general to the specific" (p: 96). The interview guide by Watson et al. (2022) goes on to pose several open-ended and closed ended questions as well as prompts regarding the process of oxygen administration on an inpatient ward (21). The questions and prompts focus on identifying the specific functions of the oxygen administration process and the aspects that characterize those functions, as well as how functions are potentially interdependent.

A key point to note in this interview guide is the authors did not use FRAM terminology to elicit details from participants about functions, aspects, and interdependencies, but rather language more familiar to clinicians. This approach allows for the interview to remain more conversational in nature and encourages the participant to use their own words rather than the terminology of the researcher (32). A closing or clean up question at the end of an interview guide can allow the participant to offer any additional information that may not have been covered (31). A simple question, such as ‘what more you can tell me about the process’ can potentially trigger data that was unanticipated (32).

3.4.2 Document Review

As previously described, document review is a data collection method that can inform the researchers about the practice setting and assist in preparation of interview questions (23). Additionally, document review can identify data that provides insight into the context within which research participants operate (45). When examining a health care process or system there may be numerous documents that are used in everyday practice that may guide or have an influence on how work is carried out. These may include best practice guidelines, policies, procedures, as well as documents that facilitate communication between health care providers. Document review is an advantageous method of data collection because it is unobtrusive and relatively stable, with little concern for the potential for researcher influence when compared to other methods, such as observation and interviews (45). Alternatively, there are some limitations in using this method: documents may be challenging to retrieve, they may provide little detail, and in the context of a health care organization, the documents are likely to be aligned with the organization’s agenda or principals (45).

The accuracy of how organizational documents can successfully inform and/or guide work in a dynamic health care setting has become the focus of several studies using the FRAM (12, 20, 26, 27, 38, 46). These studies aim to reconcile the gap between ‘work-as-imagined’ and ‘work-as-done’ by examining documents that guide clinical practice and then using the FRAM to examine and analyze how work is accomplished in everyday practice. Braithwaite, Wears (47) explain documents that are often used in everyday clinical practice are conceived around the premise of ‘‘work-as-imagined’’ rather than ‘‘work-as-done’’ and unfortunately “work-as-imagined always differs from what actually goes on—work-as-done—and the difference increases the further removed people are from the front line.’’ (p: 419). Schrueurs et al. (2022) examined protocols, guidelines, and literature to build a work-as-imagined FRAM model of the process of elastic compression stocking therapy for individuals with chronic venous insufficiency and deep vein thrombosis. After completing the work-as-imagined model, a work-as-done model was built based on interviews with key health care professionals who conduct this work. How practice varied in the process of elastic compression therapy was identified and improvement initiatives for this process were able to be developed.

3.4.3 Observations

Studies employing the FRAM have used observations as part of multi-method data collection (1, 2, 11, 17, 18, 39-41, 43, 46, 48-52). Weston et al., (2021) found workers perform habitual tasks and activities and may not recall their specific actions or be aware of how “tacit and explicit knowledge” can influence work (p; 105). Observational research can explore these contextual nuances that may be challenging to capture in interviews, focus groups, or document analysis (53).

Laugaland et al. (2014) used moderate participant observation in their study examining the functions, variability and performance-shaping factors related to hospital discharge of the elderly (41). This type of observation “entails that the researcher be present and identifiable, though not an active participant (i.e., does not have a role in the practice setting); the researcher observes and interacts occasionally” (p: 4). The observer used a semi-structured observation guide that was developed using the FRAM approach, to observe the work conducted on the day of an older adults’ discharge. Selectivity regarding observations should be an explicit part of the data collection procedure and should reflect the purpose of the study (32)

In their study examining how a protocol for double checking injectable medication administration transfers to practice, Schutijser et al. (2019) conducted work-as-done observations of the daily practice of the double check during the medication rounds (40). The most important proceedings of the double check protocol were marked by the research team when completed by the nurses. Schutijser et al. then described how observations were recorded using a standardized observation form. How observations will be recorded in the field is another important consideration for researchers. Field notes are the observer’s efforts to record, synthesize and understand the data. Tresfon et al. (2022) conducted observations over 10 days on a nursing ward to observe the use of restraints to develop a work-as-done FRAM model of the practice. During the observations data was collected using “in field jottings” that the observers later elaborated on in the form of field notes (18). The observer also kept a research diary reflecting on their role and influence as an observer. Van Djik et al. (2022) argue not using observations in their medication reconciliation study is a limitation due to the potential for participants tailoring their descriptions of their work in interviews (20).

Van Djik et al (2022) reference Shorrock. (54) in their description of this phenomenon as “Work-as-Disclosed” rather than “Work-as-Done” and contend interviews may not provide a true description of everyday work and that some activities of work that are performed unknowingly may also be missed.

3.4.4 Focus Groups

Focus groups are a valuable source of data for researchers using the FRAM. A moderator rather than interviewer typically leads the discussion among participants because the aim of a focus group is not to conduct a group interview; the aim should be for the participants to discuss points raised by the moderator among themselves (30)The ideal number of focus group participants is not exact, and ranges have been provided in the literature: 3 to 8 (30) and 5 to 10 (31, 35). The goal would be for a focus group to be small enough that it allows for the involvement of all participants, but not so small that it limits the richness and diversity of perspectives (30). One strength of conducting focus groups is participants can hear one another’s responses and provide additional comments that they may have been reluctant to make individually (55). Alternatively, as with any group setting there may be instances where using a focus group as a data collection method may deter participation from some participants. Oduyale et al. (2020) conducted focus groups with 20 ICU nurses to build a FRAM model representing the process of co-administration of multiple intravenous medications (34). A limitation identified in the study states “the presence of senior staff members in the focus groups could have prevented some junior nurses from expressing their opinions and co-administration practice freely (p:162).” Researchers using the FRAM should determine how similar or different focus group participants should be.

Heterogenicity can bring different views to the focus group which can generate a more diverse discussion, while homogeneity of the focus group may create a more familiar and comfortable social environment (56). Clarke & Braun (2013) recommend that similarity within the focus group should be determined in relation to the topic of the research (30). Researchers using the FRAM will need to determine what information or knowledge they are trying to gain from the focus group to best answer their research question.

3.5 Building a FRAM Model – Step 2

Before building the model, researchers employing the FRAM should begin their analysis by taking the time to familiarize themselves with the data. Clarke & Braun (2013) describe this as an "immersion in the data with an aim of becoming intimately familiar with the content of the dataset and to start taking notice of what might be relevant to the research question (30)(p: 216). Familiarization may consist of listening and re-listening to audio recordings, transcribing interviews, and reading and re-reading transcripts, and field notes. The following section will outline the activities to build a FRAM model and present examples of different approaches used by researchers in the FRAM literature.

3.5.1 Identifying and Describing Functions and Aspects

There are several examples of how functions and aspects have been identified in healthcare studies using the FRAM (12, 16, 20, 21, 27, 41, 42). The way researchers approached the identification of functions and aspects was not overly well explained, with some studies simply describing it as an "iterative process" (12, 18, 46, 48). Others were more descriptive and provided readers with further insight.

O'Hara et al. (2020) began their analysis by having two researchers analyze the study data to identify the activities that typify the process of hospitalization and discharge in older adults (42). The researchers then met several times over the course of a week (approximately 35 hours) to decide how the work activities could be constructed into discrete functions. Laugaland et al. (2014) identified common functions in the discharge process of older adults by having the first and second authors individually review the field note summaries of observations, followed by a review of the same data by a team of four researchers (41). Laugaland et al. went on to explain the identified functions were then revised several times until the team reached a final consensus and a detailed description of the functions (including associated aspects—time, control, input, output, resources, and preconditions).

3.5.2 Coding

Several studies used the data analysis strategy of coding to identify and describe functions (17, 27, 34, 39, 51). Coding aims to identify meaning in data that is relevant in relation to a research question (57). Linneberg and Korsgaard (58) describe the coding of qualitative data as an approach that enables a deep immersion in the data as well and ensures structure and transparency in the development and presentation of findings. Selective coding is a type of coding that is particularly applicable to the FRAM. This type of coding requires pre-existing theoretical knowledge that provides the researcher with the ability to identify the analytic concepts they are looking for (Clarke & Braun, 2013). A researcher's pre-existing knowledge of the FRAM can guide the analysis and be used to identify functions and describe aspects of functions. Coding can be done by hand or by using coding software, such as NVivo 12 (59)) or CAQDAS (60). Coding software also assists in the storage, organization, and management of large qualitative data sets that can be accessible to multiple members of a research team (58).

Damoiseaux-Volman et al. (2021) took a different approach to coding by developing a code tree based on a work-as-imagined model for the prevention of falls and delirium in older adults admitted to hospital (27). The code tree was a list of functions identified in a work-as-imagined model of the process. To build a work-as-done model of the process, the researchers used the code tree to analyze semi-structured interviews with front-line staff and identify the differences between work-as-imagined and work-as-done.

Three studies used the qualitative data analysis method of Thematic Analysis to analyze data and build a FRAM model (19, 34, 51). Thematic Analysis is a theoretically flexible approach to developing patterns of meaning (themes) across a dataset that addresses a research question (61). Patterns/themes are generated by the researcher using a six-phase process, see Table 3 (57, 62). In this approach researchers using the FRAM code the data to identify and describe functions in terms of their aspects by treating functions as themes.

There are several approaches to data analysis that can be taken by researchers to identify functions and describe them in terms of their aspects. Data analysis using coding strategies appears to be an approach that can lend structure and transparency to the identification and description of functions. To expand the reach of the FRAM in the healthcare domain, future studies should ensure a detailed explanation is provided of the approach taken to identify and describe functions and build a FRAM model.

Table 3.3

Definition and Steps of Thematic Analysis (Braun & Clarke 2021, Clarke & Braun 2013; 2021)

Definition: Thematic Analysis	**Steps of Thematic Analysis**
A widely used qualitative data analysis method that uses a six-phase process to identify patterns of meaning (themes) across a dataset related to a research question, themes are developed through systematic processes of data coding (Clarke & Braun, 2013).	1. Data familiarization and writing familiarization notes
	2. Systematic data coding
	3. Generating initial themes from coded and collated data
	4. Developing and reviewing themes
	5. Defining, refining, and naming themes
	6. Writing the report

3.6 Considerations for Researchers

3.6.1 Time and Human Resources

A potential limitation of the FRAM is the resource and time intensive nature of the method (8, 39, 41, 42, 63). Damen et al. (2021) tracked the time required to build a work-as-done FRAM model, estimated to be 15 hours (38). There are several approaches to data analysis that can be taken by researchers to identify functions and describe them in terms of their aspects. Data analysis using coding strategies appears to be an approach that can lend structure and transparency to the identification and description of functions.

To expand the reach of the FRAM in the healthcare domain, future studies should ensure a detailed explanation is provided of the approach taken to identify and describe functions and build a FRAM model. The time needed to conduct a full FRAM analysis was tracked in four studies with recorded times of 35 to 60 hours (38, 40, 42, 46). Damen and de Vos (2021) estimate the full workload of a FRAM analysis to be approximately 47 hours and suggest the time decreases as researchers become more proficient (8). Future healthcare studies using the FRAM should consider recording the time allotted for each step of the process. Damen et al. (2021) present a table with a breakdown of the time devoted to each step using the FRAM. The data is provided to demonstrate the usability of the FRAM (38). The authors found the time required to conduct a FRAM analysis to be comparable to more traditional methods of analysis, such as Root Cause Analysis. Having this understanding can assist in determining the human resources required to build a FRAM model.

Damen et al. (2021) conducted 20 hours of interviews with three interviewers at two sites in their study examining the process of preoperative anticoagulation management (38). To conduct observations, Laugaland et al. (2014) conducted 90 hours of day-of-discharge observations over several weeks and suggested the importance of having more than one researcher conducting observations to avoid potential observer bias (41) . Data analysis has also been a stage where more than one researcher has conducted the work. In several studies there were 2 to 4 researchers analyzing data and then coming together to review their findings and reach a consensus on constructed FRAM models (15, 27, 41, 42, 51).When designing a research study using the FRAM, an understanding of the resources (human and time) required is an important consideration. Recording and sharing the time and human resources allotted to the different steps in a FRAM analysis would be an important contribution for future studies.

3.6.2 Participant Validation of FRAM Models (Member Checking)

After constructing an initial FRAM model, researchers often take further steps to ensure the model is an accurate representation of the process or system under examination. Several studies have described their approach to "FRAM model validation" (12, 16, 17, 20, 37, 51). In qualitative research this practice is known as participant validation or member checking, which has been described as a vital strategy in establishing credibility (64). Member checking is described as a means of assessing whether an analysis faithfully or fairly represents the experiences of study participants (62). Focus groups, meetings, or workshops are approaches researchers have employed where FRAM models have been returned to study participants to assess accuracy. Schreurs et al. (2022) presented their FRAM model for participant validation to stakeholders at a meeting, then adjusted the model based on feedback, and subsequently presented the revised model to stakeholders prior to model finalization (12). Salehi et al. (2021) used data from focus groups to improve a constructed FRAM model of the hospital to home transition process (51). The focus group data added more functions and new couplings, highlighting the importance of validation prior to finalization of a model. When considering the goal of a FRAM analysis is often to provide recommendations for improving quality, efficiency, and/or safety, the model informing the analysis needs to be an accurate reflection of everyday work. FRAM model participant validation (member checking) is a key step researchers should include in their study design and can also enhance the credibility and trustworthiness of their study findings.

3.6.3 Building Understandable FRAM Models

Researchers need to ensure FRAM models truly capture the process of interest and the constructed model is understandable yet not overly simplified for end users, such as clinicians and administrators (4). Damen and de Vos (8) report clinicians easily grasp the relevance, background, and design of the FRAM. Clay-Williams et al. (2015) conveys similar findings in their study reporting clinicians easily understood the visual representation of functions and additionally found the model to be a useful tool to initiate discussions (26). Bos et al. (2022) conducted a study examining work-as-imagined and work-as-done in pediatric follow up. The authors found the inclusion of the FRAM models in their reflection sessions with staff to be challenging as they required some effort to explain (6). Clay-Williams et al. (2020) suggests that FRAM models should not be overly crowded to remain a useful tool (1). Patriarca et al. (2018) conducted a case study examination of iatrogenic injury in the neurosurgery perioperative patient pathway using the FRAM and found the FRAM to be overwhelmingly complex with sixty-eight identified functions (52). The authors go on to explain, a larger number of functions could potentially result in an analyst having to oversimplify the work domain or narrow the scope of an analysis to deal with the visualization and management of variability. Rather than reducing the number of functions in a process to manage the visualization of variability, Salehi et al. (2021) organized thirty-eight functions into five colour coded functional categories of admission; assessment; synthesis; decision-making; and readmission (51). The organization and colour coding of functions provides some orderliness to the model and names the functional categories with terms clinicians would be familiar with in their everyday work.

3.7 Conclusion

Gaining an in-depth understanding of how everyday work is conducted in a complex healthcare process or system has been a difficult undertaking for researchers and decision-makers to date. Without a comprehensive understanding of how care is delivered and received, healthcare system improvements and sustainability efforts will continue to be difficult. The FRAM can provide this enhanced understanding by combining process modelling and qualitative inquiry. This paper drew from the FRAM literature and practical experience to examine and suggest how researchers can operationalize qualitative data collection and analysis to inform the building of a FRAM model. Considerations for researchers were also presented that highlight the need for FRAM models to be understandable to end users and for researchers to account for the time and human resources required to build a FRAM model. Future papers could expand methodology further in the healthcare domain by offering guidance on approaches to identifying and describing variability and the aggregation of variability in complex healthcare processes and systems.

3.8 Funding

Research funding was provided by the Ocean Frontier Institute, through an award from the Canada First Research Excellence Fund.

References

1. Clay-Williams R, Austin E, Braithwaite J, Hollnagel E. Qualitative assessment to improve everyday activities: Work-as-imagined and work-as-done. Transforming Healthcare with Qualitative Research: Routledge; 2020. p. 71-82.

2. Patriarca R, Di Gravio G, Woltjer R, Costantino F, Praetorius G, Ferreira P, et al. Framing the FRAM: A literature review on the functional resonance analysis method. Safety Science. 2020;129:104827.

3. Salehi V, Veitch B, Smith D. Modeling complex socio-technical systems using the FRAM: A literature review. Human factors and ergonomics in manufacturing & service industries. 2021;31(1):118-42.

4. McGill A, Smith D, McCloskey R, Morris P, Goudreau A, Veitch B. The Functional Resonance Analysis Method as a health care research methodology: a scoping review. JBI Evidence Synthesis. 2022;20(4):1074-97.

5. Jatobá A, Bellas H, Viana J, de Castro Nunes P, Leal R, Bulhões B, et al. Unveiling conflicting strategies in the Brazilian response to COVID-19: a cross-sectional study using the functional resonance analysis method. Dialogues in Health. 2022;1:100056.

6. Bos V, Roorda D, De Sonnaville E, Van Boven M, Oosterlaan J, van Goudoever J, et al. Implementing structured follow-up of neonatal and paediatric patients: an evaluation of three university hospital case studies using the functional resonance analysis method. BMC health services research. 2022;22(1):191.

7. Buikstra E, Clay-Williams R, Strivens E. Modelling a typical patient journey through the geriatric evaluation and management ward to better understand discharge planning processes. Resilient Health Care: CRC Press; 2021. p. 81-100.

8. Damen NL, de Vos MS. Experiences with fram in dutch hospitals: muddling through with models. Resilient Health Care: CRC Press; 2021. p. 71-80.

9. Gustafson O, Vollam S, Morgan L, Watkinson P. A human factors analysis of missed mobilisation after discharge from intensive care: a competition for care? Physiotherapy. 2021;113:131-7.

10. Hedqvist A-T, Praetorius G, Ekstedt M. Exploring interdependencies, vulnerabilities, gaps and bridges in care transitions of patients with complex care needs using the Functional Resonance Analysis Method. 2022.

11. MacKinnon RJ, Pukk-Härenstam K, Kennedy C, Hollnagel E, Slater D. A novel approach to explore Safety-I and Safety-II perspectives in in situ simulations—the structured what if functional resonance analysis methodology. Advances in Simulation. 2021;6(1):21.

12. Schreurs RHP, Joore MA, Ten Cate H, ten Cate-Hoek AJ. Using the Functional Resonance Analysis Method to explore how elastic compression therapy is organised and could be improved from a multistakeholder perspective. BMJ open. 2021;11(10):e048331.

13. Slater D. A systems analysis of the UK COVID 19 pandemic response: Part 2-work as imagined vs work as done. Safety Science. 2022;146:105526.

14. Slater D, Hollnagel E, MacKinnon R, Sujan M, Carson-Stevens A, Ross A, et al. A systems analysis of the COVID-19 pandemic response in the United Kingdom–Part 1–The overall context. Safety Science. 2022;146:105525.

15. Sujan MA. Muddling through in the intensive care unit: a fram analysis of intravenous infusion management. Resilient Health Care: CRC Press; 2021. p. 101-7.

16. Sujan M, Bilbro N, Ross A, Earl L, Ibrahim M, Bond-Smith G, et al. Failure to rescue following emergency surgery: a FRAM analysis of the management of the deteriorating patient. Applied Ergonomics. 2022;98:103608.

17. Thude BR, Brink A, Hansen MS, Morsø L. How to ensure referral and uptake for copd rehabilitation—part 1: disentangling factors in the cross-sectorial workflow of patients with copd to understand why most patients are not referred to rehabilitation. International Journal of Integrated Care. 2021;21(1).

18. Tresfon J, Brunsveld-Reinders AH, van Valkenburg D, Langeveld K, Hamming J. Aligning work-as-imagined and work-as-done using FRAM on a hospital ward: a roadmap. BMJ Open Quality. 2022;11(4):e001992.

19. van Dijk LM, Meulman MD, van Eikenhorst L, Merten H, Schutijser BC, Wagner C. Can using the functional resonance analysis method, as an intervention, improve patient safety in hospitals?: a stepped wedge design protocol. BMC Health Services Research. 2021;21:1-10.

20. van Dijk LM, van Eikenhorst L, Wagner C. Daily practice performance (Work-as-Done) compared to guidelines (Work-as-Imagined) of medication reconciliation at discharge: Outcomes of a FRAM study. Safety Science. 2022;155:105871.

21. Watson A, Mukherjee R, Furniss D, Higgs J, Williamson A, Turner A. A human factors approach to quality improvement in oxygen prescribing. Clinical Medicine. 2022;22(2):153.

22. Hollnagel E. FRAM, the functional resonance analysis method: modelling complex socio-technical systems: Ashgate Publishing, Ltd.; 2012.

23. Hollnagel E, Hounsgaard J, Colligan L. FRAM-the Functional Resonance Analysis Method: a handbook for the practical use of the method: Centre for Quality, Region of Southern Denmark; 2014.

24. Hollnagel E, Slater D. FRAMSYNT A FRAM Handbook. 2022.

25. Greenhalgh T, Papoutsi C. Studying complexity in health services research: desperately seeking an overdue paradigm shift. Springer; 2018. p. 1-6.

26. Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implementation Science. 2015;10(1):1-8.

27. Damoiseaux-Volman BA, Medlock S, van der Eijk MD, Romijn JA, Abu-Hanna A, van der Velde N. Falls and delirium in older inpatients: work-as-imagined, work-as-done and preferences for clinical decision support systems. Safety science. 2021;142:105355.

28. Ross A, Sherriff A, Kidd J, Gnich W, Anderson J, Deas L, et al. A systems approach using the functional resonance analysis method to support fluoride varnish application for children attending general dental practice. Applied ergonomics. 2018;68:294-303.

29. Hollnagel E, Hill R. FRAM Model Visualiser Instructions. 2020.

30. Clarke V, Braun V. Successful qualitative research: A practical guide for beginners. Successful qualitative research. 2013:1-400.

31. Polit D, Beck C. Essentials of nursing research: Appraising evidence for nursing practice: Lippincott Williams & Wilkins; 2020.

32. Yin RK. Qualitative research from start to finish: Guilford publications; 2015.

33. Moser A, Korstjens I. Series: Practical guidance to qualitative research. Part 1: Introduction. European Journal of General Practice. 2017;23(1):271-3.

34. Oduyale MS, Patel N, Borthwick M, Claus S. Co-administration of multiple intravenous medicines: Intensive care nurses' views and perspectives. Nursing in Critical Care. 2020;25(3):156-64.

35. Moser A, Korstjens I. Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. European journal of general practice. 2018;24(1):9-18.

36. Saunders B, Sim J, Kingstone T, Baker S, Waterfield J, Bartlam B, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. Quality & quantity. 2018;52:1893-907.

37. Buikstra E, Strivens E, Clay-Williams R. Understanding variability in discharge planning processes for the older person. Safety Science. 2020;121:137-46.

38. Damen NL, de Vos MS, Moesker MJ, Braithwaite J, van Wijngaarden RAdL, Kaplan J, et al. Preoperative anticoagulation management in everyday clinical practice: an international comparative analysis of work-as-done using the functional resonance analysis method. Journal of patient safety. 2021;17(3):157-65.

39. Kaya GK, Ovali HF, Ozturk F. Using the functional resonance analysis method on the drug administration process to assess performance variability. Safety Science. 2019;118:835-40.

40. Schutijser BCFM, Jongerden IP, Klopotowska JE, Portegijs S, de Bruijne MC, Wagner C. Double checking injectable medication administration: does the protocol fit clinical practice? Safety Science. 2019;118:853-60.

41. Laugaland K, Aase K, Waring J. Hospital discharge of the elderly-an observational case study of functions, variability and performance-shaping factors. BMC health services research. 2014;14(1):1-15.

42. O'Hara JK, Baxter R, Hardicre N. 'Handing over to the patient': A FRAM analysis of transitional care combining multiple stakeholder perspectives. Applied ergonomics. 2020;85:103060.

43. Arcuri R, Bulhões B, Jatobá A, Bellas HC, Koster I, d'Avila AL, et al. Gatekeeper family doctors operating a decentralized referral prioritization system: Uncovering improvements in system resilience through a grounded-based approach. Safety Science. 2020;121:177-90.

44. DeJonckheere M, Vaughn LM. Semistructured interviewing in primary care research: a balance of relationship and rigour. Family medicine and community health. 2019;7(2).

45. Bowen GA. Document Analysis as a Qualitative Research Method. Qualitative Research Journal. 2009;9(2):27-40.

46. Furniss D, Nelson D, Habli I, White S, Elliott M, Reynolds N, et al. Using FRAM to explore sources of performance variability in intravenous infusion administration in ICU: A non-normative approach to systems contradictions. Applied ergonomics. 2020;86:103113.

47. Braithwaite J, Wears RL, Hollnagel E. Resilient health care: turning patient safety on its head. International Journal for Quality in Health Care. 2015;27(5):418-20.

48. Alm H, Woltjer R. Patient safety investigation through the lens of FRAM. Human factors: a system view of human, technology and organisation Maastricht, The Netherlands: Shaker Publishing. 2010:153-65.

49. Raben DC, Viskum B, Mikkelsen KL, Hounsgaard J, Bogh SB, Hollnagel E. Application of a non-linear model to understand healthcare processes: using the functional resonance analysis method on a case study of the early detection of sepsis. Reliability Engineering & System Safety. 2018;177:1-11.

50. Pickup L, Atkinson S, Hollnagel E, Bowie P, Gray S, Rawlinson S, et al. Blood sampling - Two sides to the story. Applied Ergonomics. 2017;59:234-42.

51. Salehi V, Hanson N, Smith D, McCloskey R, Jarrett P, Veitch B. Modeling and analyzing hospital to home transition processes of frail older adults using the functional resonance analysis method (FRAM). Applied Ergonomics. 2021;93:103392.

52. Patriarca R, Falegnami A, Costantino F, Bilotta F. Resilience engineering for socio-technical risk analysis: Application in neuro-surgery. Reliability Engineering & System Safety. 2018;180:321-35.

53. Weston LE, Krein S, Harrod M. Using observation to better understand the healthcare context. Qualitative Research in Medicine and Healthcare. 2021;5(3).

54. Shorrock. S. 2020. Available from: https://humanisticsystems.com/2020/11/01/proxies-for-work-as-done-3-work-as-disclosed/.

55. Carter N, Bryant-Lukosius D, DiCenso A, Blythe J, Neville AJ. The use of triangulation in qualitative research. Oncol Nurs Forum. 2014;41(5):545-7.

56. Liamputtong P. Focus group methodology: Principle and practice: Sage publications; 2011.

57. Clarke V, Braun V. Thematic analysis: a practical guide: Sage Publications; 2021.

58. Linneberg MS, Korsgaard S. Coding qualitative data: A synthesis guiding the novice. Qualitative research journal. 2019;19(3):259-70.

59. Ltd. QIP. NVivo. 2020.

60. Software V. Proxies for work-as-done: 3. work-as-disclosed. Berlin, Germany: MAXQDA 2022 [computer software]. Berlin, Germany: VERBI Software.; 2021.

61. Braun V, Clarke V. Thematic Analysis n.d. [Available from: https://www.thematicanalysis.net/.

62. Braun V, Clarke V. One size fits all? What counts as quality practice in (reflexive) thematic analysis? Qualitative Research in Psychology. 2021;18(3):328-52.

63. McNab D, Freestone J, Black C, Carson-Stevens A, Bowie P. Participatory design of an improvement intervention for the primary care management of possible sepsis using the Functional Resonance Analysis Method. BMC medicine. 2018;16:1-20.

64. Lincoln YS, Guba EG. Naturalistic inquiry. Newberry Park. 1985.

Chapter 4.

Establishing Trustworthiness in Healthcare Process Modelling: A Practical Guide to Quality Enhancement in Studies Using the Functional Resonance Analysis Method *

Co-authorship statement. A version of this chapter has appeared in the International Journal of Qualitative Methods published by Sage Journals publishing company. The first author, Ali McGill led the conceptualization and writing of the paper. Dr. Rose McCloskey, Dr. Brian Veitch, and Dr. Doug Smith also supervised and co-authored the paper. All authors participated in discussions to enhance the concepts presented in the paper. All authors revised, edited, and made recommendations for improvements to earlier drafts of the paper.

* McGill A, McCloskey R, Smith D, Veitch B. Establishing Trustworthiness in Healthcare Process Modelling: A Practical Guide to Quality Enhancement in Studies Using the Functional Resonance Analysis Method. International Journal of Qualitative Methods. 2023 Jun 7;22: https://doi.org/10.1177/16094069231183

Abstract.

The Functional Resonance Analysis Method (FRAM) is a novel healthcare research methodology that has increasingly been applied in the healthcare domain. The methodology has an ability to map and model everyday healthcare activities and their interdependencies, as well as demonstrate how variability can emerge and impact system outcomes. To build a FRAM model, researchers gather data from key stakeholders, such as healthcare workers and patients and their families using qualitative data collection methods. An important consideration for researchers using the FRAM is how they will establish trustworthiness in their study findings given the data used to build and analyze a FRAM model can be subjective. To advance the quality of qualitative research, the aim of this paper is to provide practical guidance to researchers on how to employ quality enhancement criteria and strategies in their qualitative research efforts so that the resulting FRAM models and insights afforded by them are trustworthy.

4.1 Introduction

The Functional Resonance Analysis Method (FRAM) is a novel research methodology that has increasingly been applied in the healthcare domain due to its ability to map and model everyday healthcare activities, identify how individual activities are connected and interdependent, and demonstrate the variability that can emerge and impact system outcomes. A strength of the FRAM is that the essential and interacting activities, as well as the complexity of a healthcare process, are visually represented in a non-linear model. Often this complexity is challenging to appreciate using traditional or linear methods of analysis (1). Using the FRAM to gain an in depth understanding of how work is accomplished in the context of a complex healthcare process has been the focus of several studies in recent years (2). With its wide scope of application, the FRAM has been used to examine processes such as hospital discharge in older adults (3-6), safety in medication administration (7, 8), and how care guidelines can differ from clinical practice (9, 10). To build a FRAM model, researchers rely on contextual data gathered from healthcare workers, patients, and their families using qualitative data collection methods, such as interviews, focus groups, and observations (11). An important consideration for researchers using the FRAM is how they will establish trustworthiness in their study findings given the data used to build and analyze a FRAM model can be subjective. The aim of this paper is to provide practical guidance to researchers on how to employ quality enhancement criteria and strategies in their qualitative research efforts so that the resulting FRAM models and insights afforded by them are trustworthy. This paper will begin by providing an overview of the FRAM and how qualitative data collection is essential to conducting a FRAM analysis.

Lincoln and Guba's trustworthiness criteria will then be presented along with several quality enhancement strategies researchers using the FRAM can apply (12, 13). Additionally, illustrative examples and tables depicting how these quality enhancement strategies have been used to establish trustworthiness criteria in select healthcare studies using the FRAM will be presented.

4.2 The FRAM

The following sections will provide rationale for the use of the FRAM in healthcare research, introduce principles of the methodology, define key terminology, and list the steps of the FRAM. Providing a full methodological review of the FRAM is beyond the scope of this paper. Before using the FRAM to examine and analyze a complex healthcare process, researchers need to familiarize themselves with the principles of the methodology, the rationale for its use, and its stepwise approach. This information can be found in greater depth in a number of fundamental FRAM publications (11, 14, 15). There is a website - https://functionalresonance.com/practice.html created by the methodology's founder, dedicated to providing guidance on using the method (16). FRAM modelling software used to build and edit FRAM models can also be accessed on this website, with literature provided that can assist researchers in becoming proficient in its use (17). Literature reviews on the FRAM have also been conducted and provide an overview of methodological development, aspects, and domains of application (18, 19). A scoping review of the literature on the FRAM as a healthcare research methodology by McGill et al. (2) is an additional publication that provides healthcare researchers with an overview of how the method has been applied specifically in the healthcare domain.

4.2.1 Purpose of the FRAM

Hollnagel & Slater (11) state "the purpose of the FRAM is to analyse activities – how something has happened, how something happens, or how something could happen – in order to produce a representation of the activity in a systematic manner using a well- defined format" (p: 2). A FRAM model is a representation of the individual and interdependent activities that are essential in a process to produce an outcome. Healthcare has been described as a complex sociotechnical system that is dependent on the interactions between humans, technology, and organizations delivered in and across multiple sectors that are often loosely connected (20). Traditional research paradigms and methodologies fail to gain an understanding of the complexities of everyday healthcare work. Recommendations are often characterized by fragmentation and standardization with knowledge dispersed over different professional groups and research communities (21). Acknowledging and confronting complexity in the healthcare system requires a clear description and level of understanding of the specifications and activities of healthcare delivery under dynamic conditions (15). The FRAM is an approach that has been shown to achieve this level of understanding and with this knowledge can assist in identifying potential problem areas and areas of success within a process or system (22).

4.2.2 Principles of the FRAM

There are four underlying principles of the FRAM that can explain the outcome of a process or how something happens. These four principles are outlined below as explained by Hollnagel & Slater.

- The principle of equivalence of successes and failures assumes that things can go right and go wrong in much the same way, different consequences don't necessarily require different types of explanations. Outcomes, both acceptable and unacceptable, occur because individuals, groups, and organizations have an ability to adjust what they do in expected and unexpected conditions.

- The principle of approximate adjustments assumes that work is continuously adjusted in relation to the existing conditions (time, information, conflicts, interruptions, resources, tools). Adjustments are not precise, they are approximate and are made by individuals, groups, and organizations. This principle explains why most often things go right but can also explain why occasionally things can go wrong.

5. The principle of emergence acknowledges there are situations in which it is not possible to explain an outcome or a result due to an identifiable cause. In a complex process or system, the variability from multiple activities can combine in unexpected ways (producing a non-linear effect) and outcomes of these interactions are more appropriately explained as emergent rather than resultant. The use of the term emergent acknowledges that the interaction of activities in a complex system is not entirely understood and that an explanation of outcomes in terms of causality is not appropriate.

- The principle of resonance assumes that in some situations multiple approximate adjustments in work can coincide and mutually influence one another in unintended ways resulting in the emergence of noticeable variability. This variability can lead to outcomes (negative and positive) that may not have been anticipated. This is known as functional resonance.

4.3 FRAM Terminology

4.3.1 Functions and Aspects

The FRAM refers to activities in a process as “functions” (11). Functions are carried out continuously in a healthcare process, and can be human, organizational, or technological (23). The functions of a healthcare process can be described or characterized by six aspects: Input (I), Output (O), Resources (R), Time (T), Control (C), and Preconditions (P), these are best explained below by Clay-Williams et al. (9).

1. The Input is what the function acts on or changes (what is used to start the function).

2. The Output is what emerges from the function (an outcome or state change).

3. A Precondition is a condition that must be satisfied for a function to happen.

4. The Resources are materials or people needed to execute a function.

5. The Control is how the function is regulated or controlled (guidelines, protocols).

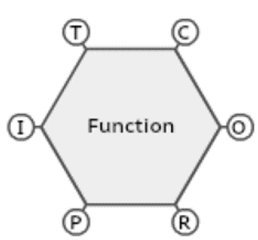
6. The Time refers to any temporal requirements of the function.

The data gathered to identify functions and then describe them in terms of their aspects should come from information-rich sources who are stakeholders in the process, such as healthcare professionals, patients, and their families. The FRAM uses qualitative data collection methods, such as interviews and focus groups, to gather accounts from stakeholders who can accurately describe the activities in a process and how the activities are connected and mutually dependent. Hollnagel et al. (14) found document review of clinical guidelines, protocols, and procedures can be helpful in preparation for interviews as it provides the researcher with insight into the practice setting and how work is intended to be carried out. Researchers have also used observations to gather data necessary to build a FRAM model. Observing work as it is performed in context can potentially contribute rich data regarding the nuances of how a healthcare process or system operates (24). In A FRAM model, a function is diagramed visually as a hexagon with aspects branching from the corners of the hexagon.

Figure 4.1 is an example of a function adapted from Hollnagel et al.(14).

Figure 4.1

FRAM function hexagon

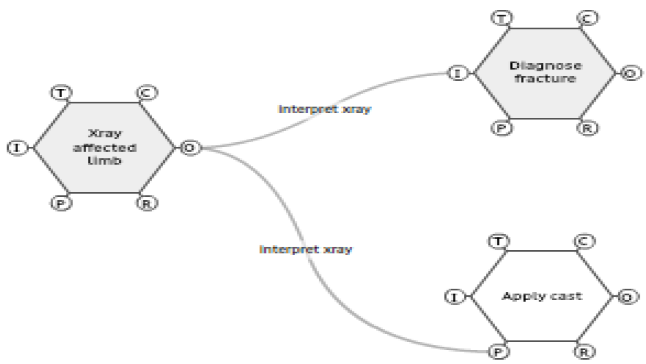


4.3.2 Couplings

When the functions in a process are identified and described in terms of their aspects, a graphical FRAM model can be built using the FRAM Model Visualizer (FMV) software programming (17). One of the objectives of the FRAM is to identify how functions are connected/interdependent, also known as “coupling” of functions (15). Functions are coupled through mutually shared aspects and can impact and one another in a variety of ways. For instance, when there is variability in how a function is carried out, functions can absorb any variability by mutual dampening each other, they can also amplify the variability by mutually reinforcing each other (19). Hollnagel (15) explains the variability and adjustments of functions is an essential and normal part of work and can lead to both successful and unsuccessful outcomes. Using the FMV software, researchers can input functions and aspects to create a model depicting all of the functions of a healthcare process and how they are coupled (25). Figure 4.2 depicts three functions involved in the fracture care process in an Emergency Department. The figure shows how functions are coupled through mutually shared aspects. The function <Xray affected limb> has an Output “Interpret Xray” which is also the Input or what starts the function <Diagnose fracture>. The Output “Interpret Xray” is also the Precondition of the function <Apply cast>.

Figure 4.2

Process of Fracture Care in an Emergency Department: FRAM Function Hexagons with Mutually Shared Aspects



4.3.3 Potential Variability

Potential variability refers to what could happen under different conditions in a healthcare process The FRAM is concerned with the variability that can potentially occur in the outputs of functions within a process rather than the variability of the function itself. Hollnagel et al. (14) describes three ways the output of functions can vary:

1. The uniqueness of the function (endogenous or internal variability)

2. The conditions in which the function is performed (exogenous or external variability)

3. The variability from the output of functions that occur earlier in the process (functional upstream-downstream coupling)

Hollnagel et al. (14) explains it is important to note that when a FRAM model is built, the model is a representation of all "the potential or possible relationships or dependencies within a process without referring to a specific situation" (p: 32). For instance, if the FRAM was used to examine the process of fracture care in an emergency department, data would be collected to identify functions of the fracture care process and describe them in terms of their aspects. Stakeholders in the process would additionally provide data on how the outputs of functions in the process of fracture care vary. This variability is usually described in two ways - time, and precision. Hollnagel et al. (11) explains, the variability in the output of a function related to time can be described as too early, on time, or too late and for precision the variability in the output of the function can be described as imprecise, acceptable, and precise.

4.3.4 Actual Variability

Actual variability in the process of fracture care can only be determined by monitoring a specific situation or scenario within a process. For instance, a patient presents to the emergency department with a fractured arm. The scenario in which they navigate the fracture care process can be monitored to identify what functions were activated and what mutual dependencies or resonance occurred in the process. Hollnagel & Slater (11) refer to these specific scenarios as instantiations. If several patients presented with fractures, those instantiations can be analyzed to determine the actual variability that occurred in each instantiation of the process of fracture care. Recommendations could then be made regarding how the variability could be managed by enhancing positive variability and dampening negative variability.

4.3.5 Steps of the FRAM

Describing the purpose of the FRAM, the principles underlying the methodology, and the description and definition of key FRAM terminology have been provided to ensure readers grasp a basic understanding of the methodology. The steps of the FRAM can be challenging to understand without this knowledge. Below are the five steps for building and analyzing a FRAM model as explained by Hollnagel and Slater (11):

1. Identify a clearly described purpose and scope of a FRAM analysis of a healthcare process.

2. Identify and characterize the essential functions in a process. Together, the identified functions constitute a FRAM model.

3. Describe the potential variability of the functions in the FRAM model, as well as the actual variability in one or more instantiations of the model.

4. Determine the possibility of resonance based on the interdependence among functions given their potential / actual variability.

5. Develop recommendations on how to monitor and manage the variability, either by dampening negative variability or enhancing positive variability.

The goal of any study using the FRAM is to produce a model that is an accurate depiction of the everyday activities and interdependencies of a complex healthcare process. Accurate modelling is dependent on the quality of the data gathered from stakeholders and study design decisions made by the researcher(s). The following sections will aim to provide guidance to researchers on how to use quality enhancement criteria and strategies in their qualitative research efforts so that the resulting FRAM models and insights can produce trustworthy findings and practice and policy recommendations.

4.4 Quality Enhancement

When designing a quantitative healthcare study, researchers move through methodical steps that exert control over the study with a goal of ensuring validity, reliability, objectivity, and generalizability in their study findings (26). These standards of quantitative research are scientifically rigorous and afford end users, such as healthcare administrators and clinicians, with some assurance that the evidence they are including in their decision making is of high quality. Adler (27) explains the same assurance of quality is not as easily demonstrated in qualitative research studies. Adler (27) goes on to explain qualitative research as a paradigm has had to contend with a reputation for being less credible when compared to quantitative research because "finding relationships between numbers is assumed to be more rigorous than deriving meaning from words and actions" (p:1). In qualitative research, the researchers themselves are the principal research instrument (28). This makes the appraisal of quality in qualitative research challenging. The personal characteristics of researchers cannot be appraised but the means researchers use to enhance the quality of their research can be (27). There is debate regarding the essential criteria for evaluating quality in qualitative research (26).

Clarke and Braun (29) explain qualitative research is not about comparisons, testing hypotheses, or replication, rather it is about gathering accounts of knowledge and information that are "produced in particular contexts by participants who come from and are located within, specific contexts" (p. 33). To advance the quality of qualitative research, researchers who employ the FRAM should ensure they take the steps necessary to build trustworthy models that can reliably inform practice and policy recommendations aimed at improving the quality, efficiency, and safety of healthcare delivery.

4.5 Achieving Trustworthiness in Qualitative Research

Reicher (30) suggests it may not be possible to develop one set of quality criteria guidelines that can be applied to the broad range of theoretical approaches across the field of qualitative research. Polit & Beck (26) explain the lack of consensus in the literature makes it challenging to provide guidance on quality standards. While there are different approaches to enhancing the quality of qualitative research, a comparison of approaches is beyond the scope of this paper. For the purpose of this paper, Lincoln & Guba's trustworthiness criteria will be used (12, 13).

Trustworthiness is perhaps the most widely recognized measure of quality in qualitative research and refers to the level of confidence in data, interpretation, and methods used to uphold the quality of a study (26). Lincoln & Guba's trustworthiness criteria – credibility, confirmability, transferability, authenticity, and dependability – are viewed as the gold standard guide to quality enhancement in qualitative research and have been deemed as parallel to the rigor of the well-established quantitative quality criteria (12, 13). Employing qualitative research methods for building a FRAM model without considering and presenting quality enhancement criteria and strategies will be met with challenges from end users, funders of healthcare research, as well as healthcare publications that disseminate healthcare research.

These decision makers will be seeking how they can assess the quality of a FRAM model and ultimately the trustworthiness of FRAM research findings. The remainder of this paper is dedicated to describing Lincoln and Guba's trustworthiness criteria (See Table 4.1) and presenting examples of quality enhancement strategies employed by researchers who have used the FRAM in a healthcare research context. This paper is not meant to provide an exhaustive review of the literature on the use of the FRAM in the healthcare domain, rather the authors are highlighting select studies as examples where researchers have employed quality enhancement criteria and strategies. We believe researchers using the FRAM may find Lincoln & Guba's trustworthiness criteria and the practical strategies for enhancing research quality to be useful when planning their research. As applications of the FRAM to healthcare settings tend to be focused on relatively specific circumstances, such as medication administration and safety in an intensive care unit (7, 31, 32) or the variability that exists in blood collection (33, 34), researchers will have to decide which criteria and strategies are most relevant to building trustworthiness into their particular FRAM model.

4.6 **Credibility**

Credibility is described by Polit & Beck (26) as the confidence in the truthfulness of the study and its findings. Lincoln & Guba (12) equate credibility to internal validity in quantitative research. Member checking, triangulation, reflexivity, persistent observation, and prolonged engagement are specific strategies that have been used by researchers using the FRAM to establish credibility. Each of these strategies is discussed below, along with illustrative examples from the FRAM literature.

Table 4.1

Lincoln & Guba's Trustworthiness Criteria Defined (12, 13, 26).

Trustworthiness Criteria	Definitions
Credibility	The confidence in the truthfulness of the study and its findings. There are two elements to credibility: 1. Carrying out qualitative inquiry in a manner that establishes the veracity of the findings. 2. Taking the necessary steps to demonstrate credibility to readers.
Confirmability	Mainly concerned with showing objectivity and demonstrating how the interpretation of data is corroborated and is representative of the information that participants provided to researchers.
Transferability	An effort to provide enough information and descriptive data for readers to determine how relevant study findings could potentially be to other settings and contexts.
Dependability	Concerned with demonstrating how stable the study findings are over time and conditions and determining if the findings of the study could be repeated if similar participants and a similar context were used.
Authenticity	When researchers convey to readers a sense of context that provide an awareness of the range of the different realities experienced by the participants.

4.6.1 Member Checking

Member checking has been described by Lincoln & Guba (12) as the most crucial strategy to establish credibility. It is also known as participant/respondent validation and explores the credibility of study results by returning data or findings to participants to obtain their feedback and check for accuracy. Member checking ensures the findings resonate with the participant experience and are an accurate reflection of their experiences (35). In the present context of research that employs the FRAM, a common example of member checking is validation of the FRAM model. After constructing an initial FRAM model, researchers take further steps to ensure the model is an accurate representation of the process or system under examination. Several studies have described their approach to FRAM model validation to ensure accuracy of their respective models (3, 10, 25, 36, 37). Buikstra et al. (3) took several steps to ensure their interpretations of participants' responses were accurate in their examination of variability in the discharge process of older adults from hospital. Throughout the interviews and focus groups, study participants were given opportunities to correct notes and offer additional information to researchers. Additionally, when the FRAM model was constructed, it was presented to participants for validation.

Schreurs et al. (36) similarly presented their FRAM model for validation to stakeholders at a meeting, then adjusted the model based on feedback, and subsequently presented the revised model to stakeholders prior to model finalization. Salehi et al. (6) used data from focus groups to improve a constructed FRAM model of the hospital to home transition process. The focus group data added more functions and new couplings, highlighting the importance of validation prior to finalization of a model.

4.6.2 Triangulation

When researchers seek patterns of convergence to advance or substantiate their interpretation of research findings, they are using the well-known quality enhancement strategy of triangulation (38). Triangulation can be achieved by using different methods of data collection, multiple data sources, and multiple investigators (39). The rationale for triangulation is that using multiple methods is superior to a single method in that it can potentially facilitate a deeper understanding and shed more light on a phenomenon (12). Yin (40) advises that researchers "should keep a triangulating mind" when planning their research, "continually watching for opportunities to triangulate their steps" (p:87). The following sections describe three types of triangulation (method, data source, investigator) with examples from the FRAM literature.

Method Triangulation.

Method triangulation is an important strategy that researchers employing the FRAM can implement in the initial stages of study design. Method triangulation is a purposeful approach where multiple data collection methods (interviews, focus groups, document review, and/or observations are used to inform a conclusion about the truth, and can enhance the credibility of a qualitative study (26). Ussher (41) explains the importance of multi-method research and likens it to a jigsaw puzzle by stating "it is only when we put the different pieces of the jigsaw together that we see a broader picture and gain some insight into the complexity of our research" (p.49). Salehi et al. (6) used the FRAM to model the hospital to home transition process for frail older adults. The authors used six different methods of data collection (observations, interviews, focus groups, textual review, home observations, questionnaires) to enhance study findings.

In a scoping review of the literature of the FRAM as a healthcare methodology, McGill et al. (2) noted that multi-method data collection was used in the majority of FRAM studies that were examined. When using the FRAM, researchers should take the time to consider what methods of data collection and combinations of data collection methods can best answer their research question.

Data Source Triangulation.

A convergence of information about a phenomenon from different times, spaces, and/or persons is known as data source triangulation and is an important quality enhancement strategy that researchers can employ when using FRAM in their study design (42). In this instance, researchers using the FRAM to examine and analyze a healthcare process would enrich study findings by seeking the perspectives of all those central to everyday work. This may include patients and their families, as well as healthcare providers from a variety of professional backgrounds. Researchers may also seek out these perspectives in different locations of work (also known as cross site consistency) and over a range of times of the day/week to ensure an accurate description of the phenomenon is captured. van Dijk et al. (10) used the FRAM to gain a better understanding of hospital worker compliance with standards for medication reconciliation. The authors interviewed 63 participants from a variety of healthcare professions (nursing, medicine, and pharmacy). Additionally, the authors conducted these interviews in nine different cardiology and orthopedic wards. The use of data source triangulation related to space and person was identified as a study strength by the authors due to the diversity of the study population, which allowed the authors to gain a better overall view of the process (10).

To strengthen the credibility of the study findings further, the authors could have also conducted interviews at different times and on different shifts to ensure data gathered reflected the work being conducted at all times on a hospital ward. Laugaland et al. (4) conducted observations of the performance shaping factors of the discharge process of older adults and noted the lack of time triangulation as a study limitation. Due to practical and resource-based issues, the authors were only able to conduct observations during regular working hours; they conceded that other performance shaping issues related to the discharge process of older adults may be influential at other times of the day.

Investigator Triangulation.

Investigator triangulation uses more than one investigator in a study to gather data and/or make decisions on coding, analysis, and interpretation (39). Carter et al. (42) describes investigator triangulation as an opportunity to convey alternate perspectives as well as confirm findings. Collaboration between investigators can also potentially reduce bias in decision making and analysis among investigators (26). Thude et al. (37) conducted a FRAM study to build a model of the referring routines from hospital to community rehabilitation for patients with Chronic Obstructive Pulmonary Disease (COPD). A team of four researchers was formed to code the data from interviews and observation notes and to analyze the data identifying the functions and aspects. Any discrepancies identified were discussed to consensus (37).In their study examining fluoride varnish application for children attending general dental practices, Ross et al. (23) had two members of the research team independently code a representative sample of data to identify the functions of the process. This exercise was done to provide readers with a reliability assessment using the qualitative strategy of Inter Coder Reliability (ICR).

O'Connor & Joffe (43) define ICR as "a numerical measure of the agreement between different coders regarding how the same data should be coded" (p: 2). O'Connor & Joffe (43) described the most common way ICR is calculated as "simply reporting the percentage of data units on which coders agree", although there is debate on whether this is the most accurate way to report ICR. The authors expand on this and say statistical tests, such as Cohen's kappa and Krippendorff's Alpha may provide a more accurate representation of ICR because there is correction for the probability of an amount of agreement occurring by chance (43). Despite the debate on how to calculate ICR, this is a useful exercise for researchers to undertake when using the FRAM because it can also establish the trustworthiness criterion of confirmability. This criterion is concerned with objectivity and demonstrating how the interpretation of data is not imagined by the researcher, rather truly represents the information that participants provided (26). Kuraski (44) found the reporting of ICR can potentially make the argument that the analysis was performed "conscientiously and consistently" (p: 8). This can establish credibility and confirmability, and ultimately enhance the trustworthiness of a FRAM model and its accuracy in representing the process of interest.

4.6.3 Reflexivity

Polit & Beck (26) define reflexivity as the awareness a researcher has about their own unique background, set of values, and professional identity and how those characteristics can potentially impact the research process. Researchers can demonstrate reflexivity by keeping a personal journal documenting their own reactions, feelings, insights, and potential biases regarding data collection, analysis, and interpretation (40). An example of this is often demonstrated in observational research with the use of reflective field notes.

Polit & Beck (26) explain reflective field notes are often the personal reflections and experiences of the observer in the field and can provide guidance on how future observations can be made. Tresfon et al. (45) examined the use of restraints on a nursing unit by conducting observations over 10 days. The researcher conducting observations kept field notes as well as a research diary in which they reflected on their role and influence as an observer (45). Presentation of reflexivity to readers often occurs in the presentation of study findings. Reflexivity statements can provide the reader with reassurance that potential for researcher bias was considered and steps to avoid bias were taken (26). When reporting study limitations on the discharge process of older adults, Laugaland et al. (4) described “possible observer bias” and attributed this to observations being conducted by a single researcher with a nursing background (p: 13). The researchers acknowledged the observer’s nursing background could potentially enhance the findings of study but may also affect the accuracy of observations. The researchers recognized this limitation and presented alternative ways the observations could have been conducted and presented how they attempted to control this potential bias. Specifically, the researchers had weekly meetings with the larger research team, who had diverse healthcare backgrounds, to discuss preliminary impressions of the observations made.

These meetings with the larger research team demonstrate an additional quality enhancement strategy described by Lincoln and Guba (12) as peer debriefing, which aims to further explore elements of the research process that “might otherwise remain only implicit within the inquirer's mind" (p: 308). This can be achieved through probing by the debriefer to explore any omissions, perspectives, assumptions, and potential biases not self-identified by the researchers (12). Additionally, a peer debriefer can provide support, challenge assumptions, and can ask tough questions about interpretations (13).

When using the FRAM, researchers should consider reflexivity at all stages of the research process; if reflexive efforts have been made to identify bias or reduce bias, these should be communicated to readers. The presentation of this information is a strategy that can establish study credibility and enhance the trustworthiness of study findings.

4.6.4 Persistent Observation and Prolonged Engagement

When choosing observation as a method of data collection, one way to enhance credibility in the study findings is to ensure the study design allows for prolonged engagement and opportunities for persistent observation (26). With prolonged engagement, the researcher ensures a sufficient amount of time is invested to become familiar with the participants, setting, culture, and context of a study (39); such knowledge cannot be obtained in hurried fieldwork (26). Persistent observation is a strategy that aims to gain an in-depth understanding of the phenomenon in its context by identifying and focusing on the qualities and components of the phenomenon that are most relevant to the problem or issue being studied (26). Lincoln & Guba (13) state "if prolonged engagement provides scope, persistent observation provides depth"(p: 304). Laugaland et al. (4) successfully demonstrated prolonged engagement and persistent observation in their study on hospital discharge of older adults. Over the course of eight months, 173 conversations were had with patients, next of kin, and healthcare providers, as well 90 hours of moderate participant observations. Laugaland et al. explain in moderate participant observation, the researcher does not have a role in the social setting as a participant but is present and identifiable which allows for a high level of involvement while maintaining a level of detachment (6).

The information provided to readers regarding the time spent observing the discharge process and the specifics and depth of what the researchers were observing was well described for readers. Laugaland et al. recognized that their prolonged engagement and persistent observation of the discharge process for older adults was a significant study strength and documented this approach clearly for readers (6). As previously described, credibility is carrying out qualitative inquiry in a manner that establishes the veracity of study findings and takes the necessary steps to demonstrate these efforts to readers. Credibility is a crucial trustworthiness criterion with several strategies that can be exercised to demonstrate its presence in a study. Table 4.2 provides an overview of quality enhancement strategies used to establish credibility in select studies that used the FRAM to examine a healthcare process.

Table 4.2

Strategies to establish credibility and examples where strategies were used in the FRAM healthcare literature.

Trustworthiness Criterion	Strategy	Examples from the FRAM Healthcare Literature
Credibility - the confidence in the truthfulness of the study and its findings	Member checking	Buikstra et al. (2018) Schreurs et al. (2022) Sujan et al. (2022) Van Dijk et al. (2022) Thude et al. (2022)
	Data source triangulation	van Dijk et al. (2022)
	Investigator triangulation	Thude et al. (2022) Ross et al. (2017)
	Method triangulation	Salehi et al. (2021a)
	Reflexivity	Laugaland et al. (2014), Tresfon et al. (2022)
	Prolonged Engagement	Laugaland et al. (2014)
	Persistent Observation	Laugaland et al. (2014)
	Peer Debriefing	Laugaland et al. (2014)

4.7 Confirmability

Confirmability is mainly concerned with objectivity and demonstrating how the interpretation of data is not imagined by the researcher and truly represents the information that participants provided (26). Moser and Korstjens (39) defined confirmability as “the degree to which the findings of the research study could be confirmed by other researchers” (p: 121). The strategies of member checking and ICR were already presented as means for researchers to establish credibility when using the FRAM in healthcare research. Each of these strategies can also be used to establish confirmability. Keeping an audit trail is an additional strategy researchers can take to establish confirmability.

4.7.1 Audit Trail

An audit trail can be achieved by recording and transcribing interviews and focus groups, keeping detailed field notes, methodological or reflexive notes, and/or a study journal. An audit trail allows for other researchers to access the data, recreate the steps taken, and draw similar conclusions (26). Salehi et al. (6) provides readers with information about how data was collected using multiple methods, and then reviewed by the research team. Salehi et al. (6) goes on to describe the use of audio recordings and transcriptions of semi-structured interviews and focus groups with healthcare workers and patients, as well as field notes taken at meetings, and email exchanges between the research team and healthcare workers.

4.7.2 Decision Trail

A decision trail is another strategy that could be implemented by researchers when using the FRAM. This strategy describes the researcher’s decision rules for how data and analytic interpretations are categorized and allows for readers to evaluate the reliability of the decisions being made (26). To date this strategy has not been used to establish confirmability in a study using the FRAM. A decision trail could be used to provide readers with more guidance when it comes to identifying the functions and aspects that are the core of a FRAM model.

Several FRAM studies describe the process of identifying functions and aspects as an “iterative process”, rather than providing a clear description of how their research team finalized their functions and models (4, 5, 7, 31, 32, 36, 46). Without a clear description of this process, readers are left to wonder how final decisions were made and if they accurately reflect the experiences of participants. Some of these FRAM studies overcame this ambiguity by using member checking with participants to validate FRAM models (5, 7, 32, 36, 45). Polit & Beck (26) found that for confirmability to be established, study findings need to represent the information provided by the study participants and make a concerted effort to avoid any researcher biases. Table 4.3 provides an overview of quality enhancement strategies used to establish confirmability in select studies that used the FRAM.

Table 4. 3

Strategies to Establish Confirmability and Examples from the FRAM healthcare literature.

Trustworthiness Criterion	Strategy	Example from FRAM literature
Confirmability - Demonstrating how the interpretation of data is not imagined by the researcher and is representative of the information that participants provided to researchers	Audit Trail	Salehi et al. (2021a)
	Decision Trail	N/A
	Intercoder reliability checks	Ross et al. (2017)
	Member checking	Buikstra et al. (2018) Schreurs et al. (2022) Sujan et al. (2022) van Dijk et al. (2022) Thude et al. (2022)

4.8 Transferability

It is the researcher's responsibility to provide enough information and descriptive data for readers to determine how relevant study findings could potentially be to other settings and contexts (Lincoln & Guba, 1985). This is usually achieved by providing a "thorough, and vivid description of the research context, study participants, and events and experiences observed during the inquiry" (p.408). Odulyale et al. (2020) presented a full description of the context related to the administration of multiple medications using a single intravenous lumen to intensive care unit patients. The potential for physicochemical reactions and harm to the patient are well described. The challenges of determining the safety of administration of multiple medications and the work arounds to ensure safety are also well described for the reader using verbatim quotes from ICU nurses (Oduyale et al.). The quotes from the nurses provided a sense of frustration with some of the daily challenges they face in this process, and also conveyed the decisions they make to adapt to these challenges.

When using the FRAM, researchers may choose to include such descriptions for readers to make a determination related to transferability of study findings. Because of the highly contextualized nature of studies using the FRAM, readers may find the transferability of study findings to be limited. Buikstra et al. (2020) found that the FRAM favours a depth of understanding about a specific workplace over generalizability, so any conclusions drawn from a FRAM study would be largely limited to the specific study setting. Researchers can potentially address challenges in transferability by offering an alternative, such as functional transferability. Several FRAM studies have examined care transitions in the elderly, specifically hospital to home transitions (Buikstra et al. 2020; Laugaland et al. 2014; O'Hara et al. 2020; Salehi et al., 2021).

Although the FRAM models are specific to each work context, many of the functions in the care transitions models are similar and could constitute a type of functional library that other researchers could use to assist in developing new FRAM models specific to their study settings. Table 4.4 provides an overview of quality enhancement strategies used to establish transferability in select studies that used the FRAM.

Table 4.4

Strategy of vivid description used to establish transferability and an example of the use of vivid description in the FRAM healthcare literature.

Trustworthiness Criterion	Strategy	Example from FRAM literature
Transferability - **An effort to provide enough information and descriptive data for readers to determine how relevant study findings could potentially be to other settings and contexts**	Vivid description	Oduyale et al. (2020) O'Hara et al. (2020) Salehi et al. (2021a) Laugaland et al. (2015)

4.9 Authenticity

Polit and Beck (26) explain a study can demonstrate authenticity if it "invites readers into a vicarious experience of the lives being described and enables readers to develop a heightened sensitivity to the issues being depicted" (p: 400). There are a number of ways that researchers can establish authenticity when using the FRAM. Strategies previously described include vivid description, audit trails, prolonged engagement, persistent observation, reflexivity, and impactful and evocative writing (26). Many of these strategies are used to establish other types of trustworthiness criteria and have previously been described.

4.9.1 Impactful and Evocative Writing

This strategy can establish authenticity and aims to bring strong images or feelings to the mind of the reader. In their study using the FRAM to examine transitional care using multistakeholder perspectives, O'Hara et al. reported that in cases where patients were encouraged to retain independence and involvement in their own care while in hospital, they overcame discharge challenges in the home more readily (5). One of this study's key findings was how impactful the perspectives and experiences of older adults were in identifying functions key to the success of the discharge process for this population. The researchers highlighted key findings of their study by providing examples using 'illustrative cases" from the data. Key functions identified in the transitional care process were described for readers, along with how those functions varied and impacted post discharge outcomes. Exemplar cases were presented describing the experiences of older adults. Providing this impactful description allows the reader to see how the knowledge and information gathered from patients and their families can make a significant contribution to the findings of a FRAM study. Salehi et al. (6) included quotes from healthcare professionals in their study on hospital to home transitions in older adults to emphasize the importance of follow up in the community after discharge. The healthcare providers communicate that the success of a discharge depends on the availability and access to appropriate community based follow up and if not in place can result in readmission. Table 4.5 provides an overview of quality enhancement strategies used to establish authenticity in select studies that used the FRAM.

Table 4. 5

Strategies to establish authenticity and examples where strategies to establish authenticity were used in the FRAM healthcare literature

Trustworthiness Criterion	Strategy	Example from FRAM literature
Authenticity - When researchers convey to readers a sense of context that provide an awareness of the range of the different realities experienced by the participants.	Evocative writing	O'Hara et al. (2020)
	Vivid description	Oduyale et al. (2020)
	Audit trails	Salehi et al. (2021a)
	Prolonged engagement	Laugaland et al. (2014)
	Persistent observation	Laugaland et al. (2014)
	Reflexivity	Laugaland et al. (2014)

4.10 Dependability

Dependability is the final trustworthiness criteria to be reviewed. It is concerned with how stable the data from a study is over time and over the conditions of a study (26). Dependability in a study shows that the findings are consistent and could be repeated (39). Maintaining an audit trail is a key strategy technique for establishing dependability. The study field notes, transcriptions, and/or recordings can then be examined by an external reviewer for the purposes of additional strategies, such as peer debriefing (previously described) and inquiry audits.

4.11 Inquiry Audits

Inquiry audits involve having an external researcher not involved in the research process examine the entire research process, including data collection, analysis, and interpretation to evaluate if the findings, interpretations, and conclusions are supported by the data (29).

According to Polit & Beck (26) relatively few comprehensive inquiry audits have been reported in the literature. There are no reported inquiry audits in the FRAM healthcare literature to date.

Similar to the transferability, this may be due to the highly contextual nature of studies using the FRAM to examine a specific process. Researchers using the FRAM should aim to keep an organized account of the research process to facilitate producing an audit trail of sufficient detail that it can support peer debriefing or an inquiry audit that may be undertaken to establish dependability and trustworthiness in the study findings. Table 4.6 provides an overview of quality enhancement strategies used to establish dependability in select studies that used the FRAM.

Table 4.6

Strategies to establish dependability and examples where strategies were used in the FRAM healthcare literature

Trustworthiness Criterion	Strategy	Example from FRAM literature
Dependability Concerned with demonstrating how stable the study findings are over time and conditions. Can the findings of the study be repeated if similar participants and a similar context were used?	Inquiry Audits	N/A
	Audit trail	Salehi et al. (2021a)
	Peer debriefing	Laugaland et al. (2014)

4.11 Conclusion

Studies using the FRAM to examine and analyze healthcare processes are becoming increasingly prevalent (2). Designing and conducting a trustworthy study using the FRAM begins with developing a sound understanding of the methodology itself, as well as how to plan and gather qualitative data while simultaneously threading quality enhancement strategies throughout all phases of the research process. This paper presented several quality enhancement criteria and strategies with examples researchers have used in their respective studies. By using the Lincoln & Guba's criteria for trustworthiness, researchers can build FRAM models that are trustworthy and can produce findings that can assist end users and decision makers in identifying distinct points where vulnerabilities exist or where improvements can be made in healthcare processes. Building a model that truly represents how healthcare is actually delivered and received is noteworthy and can provide new insight into the complexities of a healthcare process that may not otherwise be realized. Using that model to identify how variability emerges and impacts system outcomes has the potential to make significant contributions to improving healthcare quality, efficiency, safety, and design. The FRAM has great potential to expand its reach further in the healthcare domain, but those conducting the research need to do so in a way that instills confidence that the findings and recommendations are trustworthy.

4.12 Funding

Research funding was provided to the first author by the Ocean Frontier Institute through an award from the Canada First Research Excellence Fund. The funders have not had any role in content development.

References

1. McGill A, Smith D, McCloskey R, Morris P, Goudreau A, Veitch B. The functional resonance analysis method as a health care research methodology: a scoping review protocol. JBI Evidence Synthesis. 2021;19(3):734-40.

2. McGill A, Smith D, McCloskey R, Morris P, Goudreau A, Veitch B. The Functional Resonance Analysis Method as a health care research methodology: a scoping review. JBI Evidence Synthesis. 2022;20(4):1074-97.

3. Buikstra E, Strivens E, Clay-Williams R. Understanding variability in discharge planning processes for the older person. Safety Science. 2020;121:137-46.

4. Laugaland K, Aase K, Waring J. Hospital discharge of the elderly-an observational case study of functions, variability and performance-shaping factors. BMC health services research. 2014;14(1):1-15.

5. O'Hara JK, Baxter R, Hardicre N. 'Handing over to the patient': A FRAM analysis of transitional care combining multiple stakeholder perspectives. Applied ergonomics. 2020;85:103060.

6. Salehi V, Hanson N, Smith D, McCloskey R, Jarrett P, Veitch B. Modeling and analyzing hospital to home transition processes of frail older adults using the functional resonance analysis method (FRAM). Applied Ergonomics. 2021;93:103392.

7. Oduyale MS, Patel N, Borthwick M, Claus S. Co-administration of multiple intravenous medicines: Intensive care nurses' views and perspectives. Nursing in Critical Care. 2020;25(3):156-64.

8. Schutijser BCFM, Jongerden IP, Klopotowska JE, Portegijs S, de Bruijne MC, Wagner C. Double checking injectable medication administration: does the protocol fit clinical practice? Safety Science. 2019;118:853-60.

9. Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implementation Science. 2015;10(1):1-8.

10. van Dijk LM, van Eikenhorst L, Wagner C. Daily practice performance (Work-as-Done) compared to guidelines (Work-as-Imagined) of medication reconciliation at discharge: Outcomes of a FRAM study. Safety Science. 2022;155:105871.

11. Hollnagel E, Slater D. FRAMSYNT A FRAM Handbook. 2022.

12. Lincoln YS, Guba EG. Naturalistic inquiry. Newberry Park. 1985.

13. Guba EG, Lincoln YS. Competing paradigms in qualitative research. Handbook of qualitative research. 1994;2(163-194):105.

14. Hollnagel E, Hounsgaard J, Colligan L. FRAM-the Functional Resonance Analysis Method: a handbook for the practical use of the method: Centre for Quality, Region of Southern Denmark; 2014.

15. Hollnagel E. FRAM, the functional resonance analysis method: modelling complex socio-technical systems: Ashgate Publishing, Ltd.; 2012.

16. Hollnagel E. The Functional Resonance Analysis Method n.d. [Available from: https://www.functionalresonance.com/.

17. Hollnagel E, Hill R. FRAM Model Visualiser Instructions. 2020.

18. Patriarca R, Di Gravio G, Woltjer R, Costantino F, Praetorius G, Ferreira P, et al. Framing the FRAM: A literature review on the functional resonance analysis method. Safety Science. 2020;129:104827.

19. Salehi V, Veitch B, Smith D. Modeling complex socio-technical systems using the FRAM: A literature review. Human factors and ergonomics in manufacturing & service industries. 2021;31(1):118-42.

20. Carayon P, Bass EJ, Bellandi T, Gurses AP, Hallbeck MS, Mollo V. Sociotechnical systems analysis in health care: a research agenda. IIE transactions on healthcare systems engineering. 2011;1(3):145-60.

21. Aase K, Waring J. Crossing boundaries: Establishing a framework for researching quality and safety in care transitions. Applied ergonomics. 2020;89:103228.

22. Smith D, Veitch B, Khan F, Taylor R. Integration of resilience and FRAM for safety management. ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering. 2020;6(2):04020008.

23. Ross A, Sherriff A, Kidd J, Gnich W, Anderson J, Deas L, et al. A systems approach using the functional resonance analysis method to support fluoride varnish application for children attending general dental practice. Applied ergonomics. 2018;68:294-303.

24. Weston LE, Krein S, Harrod M. Using observation to better understand the healthcare context. Qualitative Research in Medicine and Healthcare. 2021;5(3).

25. Sujan M, Bilbro N, Ross A, Earl L, Ibrahim M, Bond-Smith G, et al. Failure to rescue following emergency surgery: a FRAM analysis of the management of the deteriorating patient. Applied Ergonomics. 2022;98:103608.

26. Polit D, Beck C. Essentials of nursing research: Appraising evidence for nursing practice: Lippincott Williams & Wilkins; 2020.

27. Adler RH. Trustworthiness in qualitative research. Journal of Human Lactation. 2022;38(4):598-602.

28. Dodgson JE. Reflexivity in qualitative research. Journal of Human Lactation. 2019;35(2):220-2.

29. Clarke V, Braun V. Successful qualitative research: A practical guide for beginners. Successful qualitative research. 2013:1-400.

30. Reicher S. Against methodolatry: some comments on Elliott, Fischer, and Rennie. The British journal of clinical psychology. 2000;39:1.

31. Furniss D, Nelson D, Habli I, White S, Elliott M, Reynolds N, et al. Using FRAM to explore sources of performance variability in intravenous infusion administration in ICU: A non-normative approach to systems contradictions. Applied ergonomics. 2020;86:103113.

32. Kaya GK, Ovali HF, Ozturk F. Using the functional resonance analysis method on the drug administration process to assess performance variability. Safety Science. 2019;118:835-40.

33. Clay-Williams R, Austin E, Braithwaite J, Hollnagel E. Qualitative assessment to improve everyday activities: Work-as-imagined and work-as-done. Transforming Healthcare with Qualitative Research: Routledge; 2020. p. 71-82.

34. Pickup L, Atkinson S, Hollnagel E, Bowie P, Gray S, Rawlinson S, et al. Blood sampling - Two sides to the story. Applied Ergonomics. 2017;59:234-42.

35. Birt L, Scott S, Cavers D, Campbell C, Walter F. Member checking: a tool to enhance trustworthiness or merely a nod to validation? Qualitative health research. 2016;26(13):1802-11.

36. Schreurs RHP, Joore MA, Ten Cate H, ten Cate-Hoek AJ. Using the Functional Resonance Analysis Method to explore how elastic compression therapy is organised and could be improved from a multistakeholder perspective. BMJ open. 2021;11(10):e048331.

37. Thude BR, Brink A, Hansen MS, Morsø L. How to ensure referral and uptake for copd rehabilitation—part 1: disentangling factors in the cross-sectorial workflow of patients with copd to understand why most patients are not referred to rehabilitation. International Journal of Integrated Care. 2021;21(1).

38. Mays N, Pope C. Assessing quality in qualitative research. Bmj. 2000;320(7226):50-2.

39. Moser A, Korstjens I. Series: Practical guidance to qualitative research. Part 3: Sampling, data collection and analysis. European journal of general practice. 2018;24(1):9-18.

40. Yin RK. Qualitative research from start to finish: Guilford publications; 2015.

41. Ussher J. Feminist approaches to qualitative health research. Qualitative health psychology: Theories and methods. 1999:98-114.

42. Carter N, Bryant-Lukosius D, DiCenso A, Blythe J, Neville AJ. The use of triangulation in qualitative research. Oncol Nurs Forum. 2014;41(5):545-7.

43. O'Connor C, Joffe H. Intercoder reliability in qualitative research: debates and practical guidelines. International journal of qualitative methods. 2020;19:1609406919899220.

44. Kurasaki KS. Intercoder reliability for validating conclusions drawn from open-ended interview data. Field methods. 2000;12(3):179-94.

45. Tresfon J, Brunsveld-Reinders AH, van Valkenburg D, Langeveld K, Hamming J. Aligning work-as-imagined and work-as-done using FRAM on a hospital ward: a roadmap. BMJ Open Quality. 2022;11(4):e001992.

46. Alm H, Woltjer R. Patient safety investigation through the lens of FRAM. Human factors: a system view of human, technology and organisation Maastricht, The Netherlands: Shaker Publishing. 2010:153-65.

Chapter 5.

Mapping the Way: Functional Modelling for Community Based Integrated Care of Older People

Co-authorship statement. A version of the paper presented in this chapter has been submitted to a peer reviewed journal and is currently under review. The first author, Ali McGill was the principal investigator for the study and led the conceptualization and writing of the paper. Dr. Rose McCloskey (RM), Dr. Brian Veitch (BV) and Dr. Doug Smith (DS) also supervised and co-authored the paper. Dr. Vahid Salehi (VS) participated in data collection and analysis and also co-authored the paper. The preparation of the semi-structured interview and focus group guides were completed by AM, RM, DS, and BV. Data collection was conducted by AM and VS. AM analyzed data and built the initial FRAM model. VS and AM finalized the FRAM model. DS and AM developed the DynaFRAM functional signature and animation. Contributions were made by all authors to the research paper. All authors revised, edited, and made recommendations for improvements to earlier drafts of the paper.

Abstract.

Background: Healthcare system sustainability is challenged by several critical issues, one of the most pressing is the aging population. Traditional, episodic care delivery models are not designed for older people who are medically complex and frail. These individuals would benefit from health and social care that is more comprehensive, coordinated, person-centered and accessible in the communities in which they live. Delivering this is a challenging endeavour. Community based health and social care professionals are siloed, dispersed across various locations and sectors, each with their own mental models, electronic health information systems, and methods of communication. To move away from fragmented care delivery models and towards a more integrated approach to care, an analysis of the process of community based comprehensive geriatric assessment was conducted in an urban location in Atlantic Canada. The purpose of the study was to identify where in the community based comprehensive geriatric assessment process challenges and opportunities existed for moving towards a more integrated model of care delivery.

Method: The Functional Resonance Analysis Method (FRAM) and Dynamic FRAM (DynaFRAM) modelling were used to model the community based health and social care system and create a hypothetical patient journey scenario. Data consisted of document review, focus groups, and semi-structured interviews with health and social care professionals providing care and service to older people in the community setting.

Findings: Challenges and opportunities for implementing integrated care in the local context were identified. Findings from the FRAM and DynaFRAM analysis informed the co-design of multi-level process improvement recommendations that aim to move the local community based comprehensive geriatric assessment process towards a more integrated model of care.

Conclusions: A transformative redesign of community based health and social care in the local context is necessary but cannot be accomplished without an understanding of how health and social care professionals conduct their work and how older people may receive care under the dynamic conditions. The FRAM and DynaFRAM modelling provided an enhanced understanding of system operations and functionality and demonstrated a critical step that should not be overlooked for decision makers in their efforts to implement a more integrated model of care.

5.1 Introduction

Like many countries worldwide, Canada is facing demographic changes that have a significant impact on future healthcare system functioning and sustainability. Canada's older adult population will grow by 68% in the next 20 years (1). Additionally, 25% of Canadians over age 65 are frail (2). An aging population coupled with rising service demands is concerning given how the Canadian healthcare system is currently designed. Traditional, episodic healthcare delivery models do not support the long-term and intersecting health and social care needs of older people (3, 4). Integrated care solutions are needed that can help older people to maximize health and wellness over their life course and achieve the outcomes that matter to them. To move towards delivering care that is more integrated, a group of Geriatricians in one Atlantic Canadian city began conducting community based Comprehensive Geriatric Assessments (CGA).

A CGA is multidimensional process that aims to identify the medical, social, and functional needs of older hospitalized people to develop an integrated care plan to address their needs (4-7)). Despite the success of the CGA in the hospital setting, further work is required to explore its applicability in other settings, due to difficulties in coordinating multidisciplinary work (8).

In the community, professionals are siloed, dispersed across various locations, each with their own mental models and methods of communication. Due to this fragmentation, older people may find themselves navigating an uncoordinated collection of clinical encounters (9). The WHO (4, 7) advocates for action across health and social care sectors worldwide to enable the delivery of integrated care by enhancing and optimizing the way current services are designed and delivered to older people. This study used a novel methodological approach to gain an improved understanding of how the local system functions and operates.

From these valuable insights, the research team was able to develop multilevel recommendations that can inform the design and implementation of a more integrated model of care delivery.

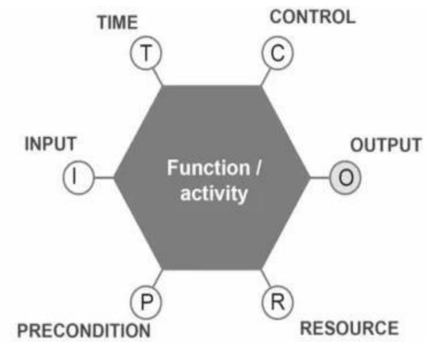
5.2 The Functional Resonance Analysis Method

A new approach to collecting data is necessary that acknowledges and confronts the complexity and variability of everyday healthcare operations. Variability in healthcare can be attributed to dynamic and uncertain processes and systems. Within a complex socio-technical system, human and organizational performance will always vary and adjust to meet demands. These adjustments will produce positive outcomes but can also at times result in poor outcomes. Having an improved understanding of variability and its impact on operations can assist in the design and integration of people, processes, policies, and organizations (10).

The Functional Resonance Analysis Method (FRAM) is a systemic, non-linear mapping approach used to produce a functional model of the everyday activities, interdependencies, and variabilities within a process or system, demonstrating complexity, which may otherwise be invisible (11). The FRAM refers to activities in a process as “functions” (12). Ross et al. explains functions are continuously carried out in complex processes and can be human, organizational, or technological. Functions are described in terms of six aspects - input, output, resources, time, control, and preconditions - that occur when work within a process or system happens (13). Functions are diagramed as a hexagon with its six aspects branching from each corner. An example of a function from Hollnagel et al. (2014) is provided in Figure 5.1 (14).

Figure 5.1

FRAM Function Hexagon



The aspects that characterize functions are best described by Clay-Williams et al. (15)

1. The Input is what the function acts on or changes (what is used to start the function).

2. The Output is what emerges from the function (an outcome or state change).

3. A Precondition is a condition that must be satisfied for a function to be executed.

4. The Resources are materials or people needed to execute a function.

5. Control is how the function is regulated or controlled (guidelines, protocols).

6. Time refers to any temporal requirements of the function.

Functions are interconnected through mutually shared aspects. A FRAM model is a visual depiction of all the functions and connections that exist within a healthcare process. This is a strength of the methodology as it allows clinicians and administrators to visualize the level of complexity of a process as well as all the potential ways a process can take place. FRAM models can also be used to conduct Dynamic FRAM Modelling (DynaFRAM).

This approach, developed by Smith et al. can depict the variations that belong to specific executions of a process over a set period, known as functional signatures (16). The result is the ability to visualize a unique functional path (functional signature) through a process or system.

5.3 Integrated Care

Integrated care aims to improve the quality and efficiency within and across the micro- (clinical, patient level), meso- (organizational, professional), and macro- (policy, sector) levels of health and social care while ensuring it is organized around the needs, preferences, and goals of older people (3). There are several models, standards, and frameworks in the literature to guide integrated care design and implementation (7, 17, 18). Threapleton et al. found there to be a lack of robust evidence identifying the most effective or beneficial approaches to integrated care implementation (19). The authors offer a more pragmatic approach by presenting three potential prerequisites.

(i) Understanding the key components of integrated care for older populations.

(ii) Understanding how integration takes place through the micro-, meso-, and macro-levels of the healthcare system.

(iii) Anticipating implementation challenges, to effectively make changes within different care contexts and settings.

The present study followed this approach and will begin by providing an overview of the literature on the key components of integrated care for older people as well as the levels and dimensions through which integrated care can take place.

To anticipate challenges as well as opportunities in the implementation of integrated care, an examination and analysis of the current process of community based CGA in an Atlantic Canadian city was conducted using the FRAM and DynaFRAM modelling.

5.3.1 Understanding Key Components of Integrated Care for Older People

For care to be organized, coordinated, and delivered around the needs and goals of older people, care models need to be designed with the goal of maintaining and preventing decline in an older person's intrinsic capacity and functional ability (3). The WHO defines intrinsic capacity as all the physical and mental capacities that an older person can draw upon (4). Functional ability defined by WHO (4) "comprises the health-related attributes that enable people to be and do what they have reason to value" (p. 28). The WHO has introduced the Integrated Care for Older People (ICOPE) approach which aims to support the delivery of integrated care models globally by encouraging governments, health organizations, and clinicians to approach health and social care delivery through the lens of intrinsic capacity and functional ability (20).

To achieve this, efforts should be made to reorganize services to include the following key components (3, 4, 7, 19).

i) person-centred care

ii) comprehensive geriatric assessments

iii) interdisciplinary teams

iv) case management

v) goal setting and shared decision making

vi) support for self management

vii) amalgamated information and data sharing systems

viii) supportive leadership, governance, and financing mechanisms

ix) home-based interventions

5.3.2 Understanding the Levels and Dimensions of Integration

Much of the evidence on the effectiveness of integrated care is at the micro-level with little focus on meso-level and macro-level elements (3, 21). Although there may be positive change and efficiency at the micro-level, sustainability may not be possible without considering interlevel interactions (19). For there to be interlevel connectivity and sustainability there needs to be consideration for the levels and dimensions of integrated care prior to implementation. Table 5.1 provides descriptions of the micro-, meso-, and macro- levels through which integrated care for takes place, as well as the domains of integration - normative and functional - that connect the levels of the system (18, 20, 21).

Table 5.1

Descriptions of the levels and dimensions of integrated care:

Levels	*Descriptions*
Micro-level	The clinical or interventional level, which is concerned with how health and social care services are coordinated and delivered to older people.
Meso-level	The organizational and professional level. The organizational level is concerned with inter-organizational shared governance, collective action, and collaboration. The professional level is concerned with partnerships among health and social care professionals that have a shared accountability to provide care and service delivery to older people.
Macro-level	The policy or sector level. Concerned with governmental, educational, and regulatory arrangements that guide organizations and professionals in the delivery of comprehensive care and services to older people.
Dimensions	***Descriptions***
Normative	The development of a shared vision/culture among stakeholders and organizations (clear goals and objectives) that can facilitate interdisciplinary collaboration to meet the needs of older people.
Functional	The coordination of support functions essential for service delivery to older people, such as information technology, financial management, human resources, strategic planning, and quality improvement.

5.4 Study Purpose and Objectives

The purpose of the study was to identify where in the community based comprehensive geriatric assessment process challenges and opportunities existed for moving towards a more integrated model of care delivery. The research objectives were:

1) To map the everyday activities and interdependencies of the CGA process in the community based system using the FRAM to produce a functional model.

2) To identify instances of potential variability occurring in the CGA process from the data obtained from health and social care providers who conduct everyday work in the system.

3) To provide an example of variability in the CGA process by developing a functional signature from a hypothetical patient journey scenario using DynaFRAM.

4) To determine how the emergence of negative and positive variability can create challenges or generate opportunities for delivery of integrated health and social care for older people.

5) To co-design multi-level process improvement recommendations supported by normative and functional dimensions of integration.

5.5 Methods

This study was conducted in an urban location in Newfoundland and Labrador and incorporated multidisciplinary perspectives on the process of community based CGA. Ethical Approval was obtained from The Newfoundland and Labrador Health Research Ethics Authority - IRB00011348. All participants provided written consent.

An exploratory case-study design was employed by the researchers. Mixed method data collection was conducted using semi-structured interviews, document review, and focus groups. Purposive sampling was used to draw from community based managers and health and social care professionals providing care and service delivery to older people at any stage (before, during, or after) of the CGA process (See Table 5.2). Participants were approached by email. The Consolidated Criteria for Reporting Qualitative Research (COREQ) checklist was used to guide the reporting of research for this study (Appendix A).

Table 5.2

Description of participants

Healthcare Professional	Number of Participants
Geriatrician	3
Registered Nurse	3
Nurse Practitioner	1
Family Doctor	2
Physiotherapist	1
Occupational Therapist	1
Social Worker	2
Pharmacist	2
Manager	2

To build an accurate FRAM model, the researchers aimed to capture the variation in sampling by including one or more participants from each health and social care professional and managerial groups in the study. Ultimately data saturation determined sample size. In total, seventeen health and social care professionals and community based managers were enrolled in the study.

5.5.1 Data Collection

Semi-Structured Interviews. Semi-structured interviews were conducted individually in a private setting over the WebEx videoconferencing platform. Interviews were conducted by AM with VS as a note taker. Interviews were recorded and then transcribed.

The length of the semi-structured interviews varied (range 47–120 min, mean = 71 min). Interviews were directed by an interview guide (Appendix B). Questions and prompts were developed to elicit the data necessary to identify and describe functions and their aspects, the interdependencies between functions, and how the CGA process may vary under dynamic conditions. Transcribed interviews were not returned to participants for comment or correction and there were no repeat or follow up interviews. AM is a graduate student who has completed graduate level studies using the FRAM and has domain expertise in Nursing. VS is a Postdoctoral Fellow with an academic research background in Engineering and the application of the FRAM in the healthcare domain. Although the domain expertise of the interviewer could be viewed as a strength, it also could introduce bias due to the potential for preconceived assumptions or understandings of how health and social care services are delivered. In acknowledgment of the potential for bias, the interviewer and notetaker met after each interview as a reflexive exercise to discuss interviews and to make any necessary adjustments for future interviews.

Document review. A review of documents identified by participants that assist in the completion of their everyday work with older people was conducted. Documents included older adult assessment guidelines and standardized referral forms. The documents reviewed assisted in confirming functions and aspects identified in interviews.

Focus Groups. Focus groups were conducted using the WebEx platform. Participants completed a member checking exercise to validate the model. Participants were given time to examine the model and then ask questions and offer feedback on accuracy (Appendix C). Participants eliminated redundant functions and identified new functions and interdependencies to ensure the model was an accurate representation of their work.

5.6 Data Analysis: Steps of the FRAM

In keeping with the FRAM approach, data collected was used to undertake a stepwise examination and analysis. The following sections explain the five steps of the FRAM, and how the research team moved through each step of the methodology.

Step 1 – Clearly Describing the Study Purpose

The research team planned to accomplish the previously stated study purpose by gaining a better understanding of everyday operations and system functionality. Having a clear purpose and scope of the FRAM analysis allowed the research team to:

1) Delineate the boundaries of the process they intended to examine.
2) Prepare a sampling plan.
3) Determine the most appropriate methods of data collection.

Step 2 - Mapping Functions

Functions were mapped in terms of their aspects through data gathered from semi-structured interviews. Interview transcripts were analyzed, and then selective coding of functions and their aspects was conducted by AM. The data gathered from semi-structured interviews and document reviews informed the building of an initial FRAM model. FRAM Model Visualizer (FMV) software was used to graphically depict a preliminary FRAM model (22). Two members of the research team met over three days to review the model and reach a consensus. The researchers conducted an inter coder reliability assessment to measure the level of agreement regarding how the data was coded. A second team member performed selective coding of functions on three randomly selected interview transcripts.

Codes were compared to those of the first team member. The percentage of agreement on identified functions ranged from 86%-88%. The FRAM model of the community based health and social care system is demonstrated below in Figure 5.2 and is further described in the results section. The model as well as individual subsystems of the model can also be found in Appendix D.

Step 3 - Identifying Performance Variability

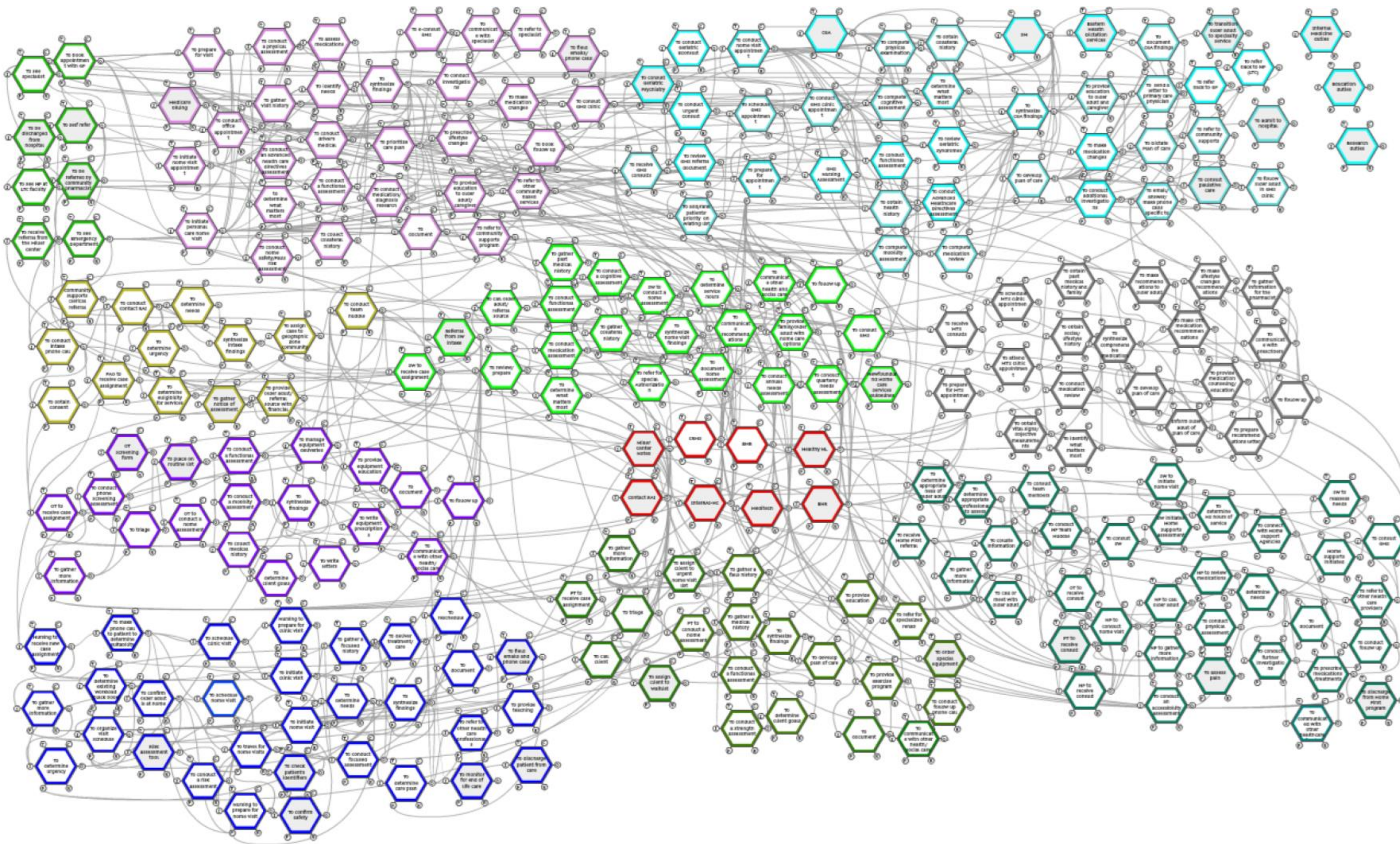
Hollnagel advises researchers to differentiate between the potential variability of functions (the model) and the actual variability of functions (an instantiation)(11). Potential variability is defined as what might happen in the CGA process under dynamic conditions (12). An instantiation represents how a subset of functions within the FRAM model are mutually coupled under certain conditions or within a certain time (14). If considering an older person, an instantiation of the community based CGA process would be their individual journey through the CGA process.

The FRAM model itself can only demonstrate the potential variability of the community based CGA process and not its actual variability. Examining the reasons why the output of a function varies (internal and external forces) as well as how variability will be demonstrated in the function's output (time and precision) should be conducted to gain an understanding of how downstream functions could potentially be impacted (12). For this study, semi-structured interview data informed the analysis of potential variability in the CGA process. Participants were asked specific questions to elicit information on how the outputs from functions could vary and how that variability could show itself in the process (Appendix B).

The team then aimed to develop an instantiation of the CGA process by developing a hypothetical scenario of how variability can emerge in the CGA process. A composite of data gathered from the semi-structured interviews was used to demonstrate an instantiation of a hypothetical patient journey (Appendix E). The DynaFRAM software was designed to be complementary to FRAM Model Visualizer (FMV) software. The FMV can provide a visual representation of potential variability and DynaFRAM can provide a visual representation of actual variability using functional signatures, which are comparable to instantiations (16). This is achieved by capturing and visualizing the variability of functions of an older adult's journey through the community based CGA process. The unique journey and the particulars of variability of that journey (functional outputs) are monitored over time. The functionality of the hypothetical patient journey was then animated over the CGA model demonstrating the touch points the older adult had with multiple community based health and social care professionals over time (23).

Figure 5.2

FRAM Model of the Community Based Health and Social Care System



Step 4 - Determining the Aggregation of Variability

Functions occurring earlier in healthcare process (upstream) can have an impact on functions later in the process (downstream). This is also known as the aggregation of variability. Functional resonance occurs when variability emerges in a system and aggregates in ways that lead to unexpected outcomes (11). For this study, an analysis of the hypothetical patient journey was conducted and the findings describing the impact of upstream-downstream coupling within the community based CGA process are presented in Appendix F.

Step 5 –Make Recommendations (Propose Ways to Manage Variability)

Rather than simply proposing recommendations and ways to manage variability, the team conducted an additional focus group with participants to present study findings and preliminary recommendations. Study participants were invited to dialogue on the results and provide feedback and collaboration so that recommendations to manage variability could be co-designed.

5.7 Results

5.71 Constructing the FRAM Model

Model Orientation. The FRAM model demonstrates the scale and complexity of the system in which health and social care professionals conduct their work. It also provides a detailed view of the dense network older people are required to navigate. The functions are grouped by colour to depict nine interconnected subsystems in which different health and social care professionals conduct their everyday work (See Table 5.3). Subsystems are also depicted individually in Appendix D.

Organization and Categorization of Functions. When examining the functions of each subsystem it was determined that health and social care professionals each organized care for older people in a similar manner. Professionals moved through five categories: Intake, Assessment, Decision Making, Care Planning, and Communication. The intake functions often consist of receiving a referral or being assigned to the care of an older person, followed by a determination of urgency. Appointments are then scheduled, or the older adult is placed on a waiting list for an appointment. The assessment functions vary based on the professional lens. Despite the different professional backgrounds, several functions are repetitive, including collating information from multiple electronic health platforms, gathering medical history, current medications, functional, cognitive, and mobility assessments, and determining needs and goals. Decision making functions consisted of the synthesis of information gathered in the appointments. Care Planning functions were dependent on the professional's scope of practice, and consisted of arranging follow/referral, prescriptions, or discharge from care. Communication functions consist of verbal, fax, email, direct messaging, and documentation in electronic platforms.

Table 5.3

Subsystem by colour

Subsystem model	Function Colour
Occupational Therapy	Purple
Physiotherapy	Army Green
Community Supports Intake	Yellow
Pharmacist	Grey
Social Work	Lime Green
Home First Program	Dark Teal
Nursing	Blue
Geriatrician	Light Teal
Family Doctor	Pink

Model Complexity. Upon first examination, the model is vast and crowded, and the sheer number of functions is overwhelming. When examining the model in more detail it can be appreciated as a collection of interconnected sub-systems or silos representing how work is described by the different professional groups. There are nine interconnected models that make up the larger system model (Appendix D). The number of functions in each subsystem range between 12 and 40, with an average of 27 functions per model. There are also two smaller clusters of functions. A red cluster of functions depicts the multiple electronic health platforms that are used by workers everyday. The cluster of green functions depict the multiple ways the CGA process can be initiated. When each subsystem is examined further, the functions and interdependencies can be appreciated like any other FRAM model, with one difference being the boundaries of each subsystem are expanded by their connections to other subsystems.

Building the Model - Time and Human Resources. The time required of the team to transfer study data into each subsystem model varied. A logbook was kept by a member of the research team throughout the building process. The total building time of the community based model was approximately 113 hours (Table 5.4). As subsequent subsystem models were built, the proficiency in building improved.

Table 5.4

Subsystem Building Time

Subsystem model	Number of Functions	Approximate Time to Build in Hours
Occupational Therapy	19	7
Physiotherapy	21	7
Community Supports Intake	12	5
Pharmacist	20	10
Social Work	24	12
Home First Program	34	14
Nursing	31	14
Geriatrician (GMS Clinic)	40	27
Family Doctor	31	17

5.8 Analysis of Potential Variability

The analysis of potential variability in the CGA process is shown in Appendix F. Functions from which variability emerged were classified into five categories:

i) Intake

ii) Assessment

iii) Decision making

iv) Care planning

v) Communication

Each category details the functions demonstrating potential variability, the manifestations of variability in terms of time and precision, the potential downstream effects of variability, as well as proposed multi-level (micro-, meso-, macro-level) recommendations to enhance positive variability and dampen negative variability. Hollnagel et al. (14) explain actual variability will always "be a subset of the potential variability" and researchers should take the time to conduct the exercise of characterizing potential variability to "avoid being unduly biased by having a specific scenario" (p. 53). The analysis of potential variability provided an improved understanding of how variability can potentially emerge and impact CGA process outcomes.

5.9 Analyzing Variability – A Hypothetical Patient Journey Scenario

To provide an example of how variability emerges and can impact the community based CGA process for older people, a hypothetical patient journey scenario was developed (Appendix F). A patient journey is described as the many 'touchpoints' with healthcare professionals (formal and informal) that occur over time and in numerous locations (9, 24).

The hypothetical patient journey scenario depicts Fred, a 76-year-old male who is referred by his family doctor to the GMS clinic for a CGA due to new onset of cognitive impairment and functional decline. Figure 5.3 illustrates the active functions that depict Fred's patient journey. The functional signature provides an animation of multiple interactions Fred has with health and social care professionals in the community over a period and can be accessed at (23). The scenario demonstrates the extensive waiting times, service duplication, and uncertainty experienced by Fred and his wife. The scenario also demonstrates system strengths, such as interdisciplinary team huddles and opportunities for education, engagement, and the development of self-management skills for older people. Appendix F details the variability in the output of the functions that emerged along Fred's journey and the downstream effects that resulted from the emergence of positive or negative variability. Modelling a hypothetical patient journey using a functional signature provided a bird's eye view of variability and its impact on the functionality of the community based CGA process. The video depicting the animation of the hypothetical patient journey can be accessed at https://www.engr.mun.ca/~d.smith/cbgms.html.

5.10 Challenges for Integrated Care Implementation

Challenges for integrated care implementation are also listed in Appendix I with participant quotations presented to illustrate the findings.

5.10.1 Primary Care Structure

Many family doctors in the local setting practice medicine within the confines of the fee for service structure which limit most appointments to 15 minutes. This leaves little opportunity for older people to communicate their needs and have their needs met. The current structure challenges a family doctor's ability to deliver comprehensive care.

5.10.2 Siloed Design.

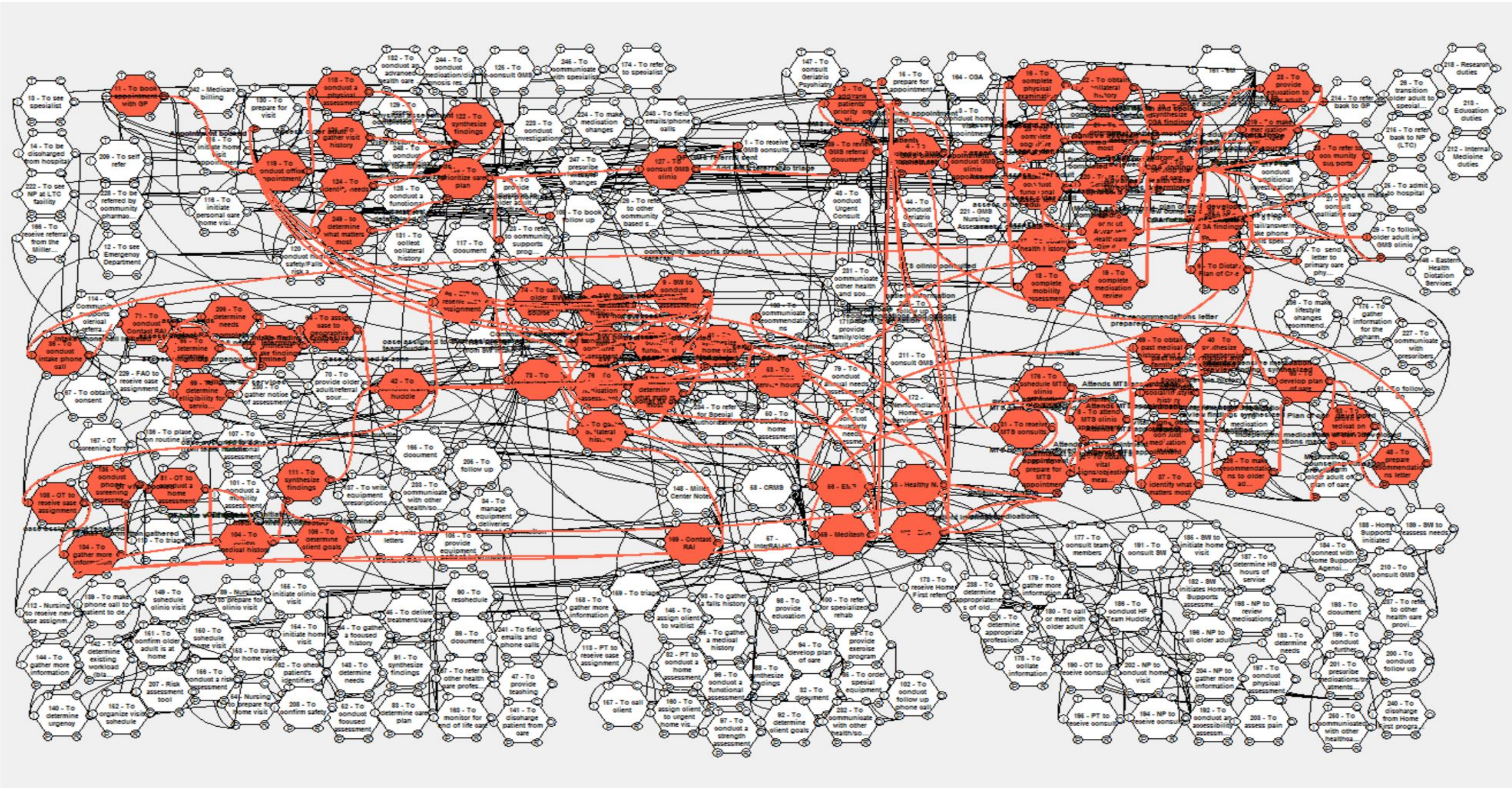
Each professional spends time gathering health information from multiple electronic health platforms, then assesses the urgency of needs and conducts assessment functions. Older people will find themselves 'starting over' with every professional encountered in the process. No one is responsible for monitoring and assisting older people with the multiple services that they may need to access.

5.10.3 Electronic Health Record Interoperability

Patients do not have one medical record; they have multiple records. There are platforms that store hospital-based records, prescription medication history, and manual charts storing professional domain specific documentation. Each of these platforms may or may not be accessible to each professional. As a result, there is a lack of awareness of the involvement of other professionals in the circle of care.

Figure 5.3

Hypothetical Patient Journey Scenario



5.10.4 Expertise of Professionals/Unregulated Workers

Participants communicated they lacked specialized training and education in the care of older people. Formal healthcare education programs graduate generalists challenging the ability to build capacity across the health and social care workforce. There is currently no regulation of personal support workers and no standardization of education and training programs. This results in different levels of knowledge, skills, and abilities in providing care and service delivery to older people.

5.10.5 Communication

Currently there are few mechanisms in place to facilitate interdisciplinary communication and shared care planning. Practice demands for health and social care professionals limit their availability to connect in a timely way. This also impacts consultation and referral practices. There is variability in the specification and completeness of consultation forms resulting in delays in care for older people.

5.10.6 Geriatrician Accessibility

Waiting time from consultation to appointment can be as long as 2 years. Geriatricians described completing the bulk of the CGA, which is a lengthy exam (approximately 2 hours). Geriatricians also described having various practice demands including academic and research responsibilities, as well as hospital-based clinical responsibilities.

5.10.7 Outcome Measurements

There are currently no Patient Reported Outcome Measurements being collected that can provide a means of evaluating current programming.

5.10.8 Shared Goals and Objectives

There are no written/documented shared goals and objectives to guide community based health and social care delivery.

5.11 Opportunities for Integrated Care Implementation

Opportunities for integrated care implementation are also listed in Appendix I with participant quotations presented to illustrate the findings.

5.11.1 Communication

Direct messaging between pharmacists and geriatricians through the electronic health record was identified as convenient and facilitates shared decision making and avoids lost productivity due to missed communication.

5.11.2 Team Huddles

Team Huddles were conducted three days/week in one of six community health zones. These team-based care meetings provided a means of developing shared care planning and identifying which professional(s) could best meet the needs of the older person. Professionals were also given opportunities to problem solve together and develop shared care plans.

5.11.3 Opportunities to Build Self Management Skills

Workers reported older people gained an improved understanding of their prescription and over the counter medication regimes as well as self management skills from comprehensive medication reviews conducted by pharmacists.

Physiotherapists, Occupational Therapists, and Registered Nurses (RN) also offer older people these opportunities when providing teaching on exercises, the use of mobility aides, and instruction on conducting wound care and medication administration.

5.11.4 Accessibility of Health and Social Care Professionals

Nurse Practitioners, pharmacists, RNs, and Social Workers can accommodate timely access for older people referred to their care when compared to Geriatrician access.

5.11.5 Comprehensive Examinations

Community based CGAs provide older people access to comprehensive care planning that aims to maintain and prevent decline in an older person's intrinsic capacity and functional ability.

5.12 Recommendations – Managing Variability

The FRAM analysis assisted the research team in gaining an understanding of how health and social care work for older people is done on an everyday basis. The hypothetical patient journey provided an example of the functional path that could be taken by an older person. Gaining an understanding of potential variability and how variability emerged along the hypothetical journey and its downstream impacts assisted in anticipating challenges and opportunities for implementing integrated care in the local context. Findings from the FRAM analysis informed the development of multi-level process improvement recommendations that aim to move the local community based CGA process towards a more integrated model of care and service.

To ensure recommendations were practical and relevant, health and social care professionals were invited to participate in an additional focus group where the FRAM model and functional signature of the hypothetical patient journey were presented to the group, followed by study findings and preliminary recommendations. The visual depiction of work in the FRAM model and in the animation of the hypothetical patient journey using DynaFRAM provided the professionals the opportunity to examine and appreciate the work being conducted outside of their respective subsystems and mental models. Visualization of system inefficiencies, such as extensive waiting times and duplication of services, was impactful and generated dialogue and feedback that informed the co-design of recommendations. The professionals also dialogued about system strengths that can be further enhanced, such as team huddles, opportunities to build self-management skills, and scope of practice optimization. The co-design of recommendations was a valuable exercise and not only ensured practicality and relevancy, but also provided professionals with a sense of engagement and ownership of process improvement efforts. Recommendations are listed in Appendix H and are also listed as they related to specific functions of the community based CGA process in Appendix F and G.

5.13 Discussion

The current siloed nature of the community based health and social care system is not person-centred and promotes service duplication. The WHO (4) states “unless a people centred and integrated health approach is adopted, healthcare will become increasingly fragmented, inefficient, and unsustainable” (p. 7). A transformative redesign is necessary but is difficult to accomplish without an understanding of how health and social care professionals conduct their work and how older people receive care under the dynamic conditions.

NASEM (9) states,

> Without examining each level of the healthcare system – the environment, the organization, the health workers, and the patient at the center and how they interact and either help or inhibit one another, it is difficult to discern how their incentives and activities align and contribute to positive or negative effects on quality (p 9).

This study examined and analyzed these necessary parameters. The goal of a FRAM analysis is not to point out how a process or system is failing, rather to describe and analyze how the system works (25). A strength of both the FRAM and DynaFRAM is the ability to depict the operations and functionality of a complex healthcare process. The model provided a map of the complex functional paths older people and professionals navigate daily. The functional signature demonstrated how the current process is designed to satisfy the structural and organizational requirements of siloed health and social care delivery.

5.14 Study Limitations and Future Research Directions

The FRAM aims to examine processes and systems in local settings and provide context specific recommendations to manage variability, this limits the transferability of study findings. An additional limitation is the study would have benefitted from the perspectives and opinions of older people and their family/caregivers given the aim of integrated care delivery being centred around patient needs, preferences, and goals. This study was able to demonstrate the use of a functional signature to represent a hypothetical patient journey across multiple subsystems.

Future research could seek to create functional signatures depicting patient journeys using data from prospective or retrospective case study analyses. Case study data would likely provide important insight and perspectives from older people not identified in this study.

Literature published to date on patient journey mapping indicates it holds significant promise for understanding and improving complex care processes (26). This study demonstrated how FRAM and DynaFRAM modelling could be used as a methodological approach to patient journey mapping in complex healthcare processes.

5.15 Conclusion

Addressing the health and social care needs of older people will continue to be a challenge as the population ages. Shifting towards integrated models of care will take time and require both bottom up (micro-level) and top down (meso-, macro-level) support (20). The recommendations presented in this study aim to nudge clinicians, organizations, and governments along the right path. FRAM modelling has demonstrated it can be a useful map to guide them.

5.16 Declarations

5.16.1 Ethics Approval

This study was approved by the Newfoundland and Labrador Health Research Ethics Authority - IRB00011348. All participants gave fully informed written consent.

5.16.2 Funding

Research funding was provided by the Ocean Frontier Institute, through an award from the Canada First Research Excellence Fund.

5.16.3 Acknowledgements

Thank you to the dedicated health and social care professionals and home care providers who work everyday with older people, your work is greatly appreciated. Thank you also to the caregivers who advocate for and support their loved ones.

References

1. Canadian Institute of Health Information. Seniors in transition exploration pathways across the care continuum 2017 [Available from: https://www.cihi.ca/sites/default/files/document/seniors-in-transition-report-2017-en.pdf.

2. Muscedere J, Andrew MK, Bagshaw SM, Estabrooks C, Hogan D, Holroyd-Leduc J, et al. Screening for frailty in Canada's health care system: a time for action. Canadian Journal on Aging/La Revue canadienne du vieillissement. 2016;35(3):281-97.

3. Briggs AM, Valentijn PP, Thiyagarajan JA, de Carvalho IA. Elements of integrated care approaches for older people: a review of reviews. BMJ open. 2018;8(4):e021194.

4. World Health Organization. World report on ageing and health: World Health Organization; 2015.

5. Ellis G, Gardner M, Tsiachristas A, Langhorne P, Burke O, Harwood RH, et al. Comprehensive geriatric assessment for older adults admitted to hospital. Cochrane database of systematic reviews. 2017(9).

6. Mazya AL, Garvin P, Unosson M, Ekdahl A. Outpatient comprehensive geriatric assessment: Effects on frailty. European Geriatric Medicine. 2016;7(Suppl 1):16.

7. World Health Organization. Framework on integrated, people-centred health services. 2016.

8. Welsh TJ, Gordon AL, Gladman J. Comprehensive geriatric assessment–a guide for the non-specialist. International journal of clinical practice. 2014;68(3):290.

9. National Academies of Sciences, Engineering and, Medicine. Crossing the global quality chasm: improving health care worldwide. 2018.

10. Kaplan GS, Bo-Linn GW, Carayon P, Pronovost PJ, Rouse WB, Reid PP, et al., editors. Bringing a Systems Approach to Health2013.

11. Hollnagel E. FRAM, the functional resonance analysis method: modelling complex socio-technical systems: Ashgate Publishing, Ltd.; 2012.

12. Hollnagel E, Slater D. FRAMSYNT A FRAM Handbook. 2022.

13. Ross A, Sherriff A, Kidd J, Gnich W, Anderson J, Deas L, et al. A systems approach using the functional resonance analysis method to support fluoride varnish application for children attending general dental practice. Applied ergonomics. 2018;68:294-303.

14. Hollnagel E, Hounsgaard J, Colligan L. FRAM-the Functional Resonance Analysis Method: a handbook for the practical use of the method: Centre for Quality, Region of Southern Denmark; 2014.

15. Clay-Williams R, Hounsgaard J, Hollnagel E. Where the rubber meets the road: using FRAM to align work-as-imagined with work-as-done when implementing clinical guidelines. Implementation Science. 2015;10(1):1-8.

16. Smith D, Veitch B, Khan F, Taylor R. Integration of resilience and FRAM for safety management. ASCE-ASME Journal of Risk and Uncertainty in Engineering Systems, Part A: Civil Engineering. 2020;6(2):04020008.

17. Sullivan-Taylor P, Suter E, Laxton S, Oelke ND, Park E. Integrated People-Centred Care in Canada–Policies, Standards, and Implementation Tools to Improve Outcomes. International Journal of Integrated Care. 2022;22(1).

18. Valentijn PP, Schepman SM, Opheij W, Bruijnzeels MA. Understanding integrated care: a comprehensive conceptual framework based on the integrative functions of primary care. International journal of integrated care. 2013;13.

19. Threapleton DE, Chung RY, Wong SY, Wong E, Chau P, Woo J, et al. Integrated care for older populations and its implementation facilitators and barriers: A rapid scoping review. International Journal for Quality in Health Care. 2017;29(3):327-34.

20. De Carvalho IA, Epping-Jordan J, Pot AM, Kelley E, Toro N, Thiyagarajan JA, et al. Organizing integrated health-care services to meet older people's needs. Bulletin of the World Health Organization. 2017;95(11):756.

21. Angus L, Valentijn PP. From micro to macro: assessing implementation of integrated care in Australia. Australian Journal of Primary Health. 2018;24(1):59-65.

22. Hollnagel E, Hill R. FRAM Model Visualiser Instructions. 2020.

23. Smith D. Community-Based Geriatric Medicine Services n.d. [Available from: https://www.engr.mun.ca/~d.smith/cbgms.html.

24. Devi R, Kanitkar K, Narendhar R, Sehmi K, Subramaniam K. A narrative review of the patient journey through the lens of non-communicable diseases in low-and middle-income countries. Advances in Therapy. 2020;37(12):4808-30.

25. Sujan M, Pickup L, de Vos M, Patriarca R, Konwinski L, Ross A, et al. Operationalising FRAM in Healthcare: A critical reflection on practice. Safety Science. 2023;158:105994.

26. Joseph AL, Kushniruk AW, Borycki EM. Patient journey mapping: Current practices, challenges and future opportunities in healthcare. Knowledge management & e-learning. 2020;12(4):387.

Appendix A - COREQ Checklist

COREQ (COnsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
Personal characteristics			
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	10
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	9
Occupation	3	What was their occupation at the time of the study?	9
Gender	4	Was the researcher male or female?	NA
Experience and training	5	What experience or training did the researcher have?	9
Relationship with participants			
Relationship established	6	Was a relationship established prior to study commencement?	NA
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	NA
Interviewer characteristics	8	What characteristics were reported about the inter viewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	10
Domain 2: Study design			
Theoretical framework			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	9
Participant selection			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	10
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	9
Sample size	12	How many participants were in the study?	9,10
Non-participation	13	How many people refused to participate or dropped out? Reasons?	NA
Setting			
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	NA
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	10
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	9
Data collection			
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	10
Repeat interviews	18	Were repeat inter views carried out? If yes, how many?	9
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	10
Field notes	20	Were field notes made during and/or after the inter view or focus group?	10
Duration	21	What was the duration of the inter views or focus group?	10
Data saturation	22	Was data saturation discussed?	10
Transcripts returned	23	Were transcripts returned to participants for comment and/or correction?	9
Domain 3: analysis and findings			
Data analysis			
Number of data coders	24	How many data coders coded the data?	11
Description of the coding tree	25	Did authors provide a description of the coding tree?	NA
Derivation of themes	26	Were themes identified in advance or derived from the data?	11
Software	27	What software, if applicable, was used to manage the data?	11
Participant checking	28	Did participants provide feedback on the findings?	14,22
Reporting			
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Appendix I
Data and findings consistent	30	Was there consistency between the data presented and the findings?	Appendix I
Clarity of major themes	31	Were major themes clearly presented in the findings?	18,20,21
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	NA

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.

Appendix B

Semi-Structured Interview Guide

1. Can you tell me a little about yourself?

2. What can you tell me about your role in the delivery of community based health and social care services to older adults in the community setting?

Prompt

i. Is there anything else you can tell me about your role?

3. What are the activities you/your staff typically complete in providing care and services to older adults in the community?

Prompt

i. How is this activity done?
ii. What is a typical result of completing this activity? What are some other results that may occur? What is a good/poor result?
ii. Does anyone else need to be informed of the result of this activity? How is this done?
iii. How do you/your staff know to begin this activity?
iv. Does anything need to be in place prior to beginning the activity?
v. What is the range of time that it can take to complete this activity? What is typical? What is a good/poor result?
vi. What guidelines and policies are considered when performing this activity?
vii. What information is accessed to do this activity? Are there ever difficulties accessing this information?
viii. What factors can cause problems completing this activity?
ix. Is there anything else you can tell me about this activity?

**Questions i-ix will be repeated to assess activities as they are identified*

4. Can you tell me about how you/your staff communicate with other health and social care professionals working in the community setting with older adults?

Prompt

i. How is information typically shared with other health and social care professionals? Can health and social care professionals in the circle of care access one another's documentation?

ii. How do you typically access patient information? Is the information you need easily accessible?

iii. Is there anything else you can tell me about how access patient information and communicate with other health and social care professionals?

Appendix C

Focus Group 1 and 2

Focus Group Guide #1

1. Does this model accurately describe the process of conducting a Comprehensive Geriatric Assessment in the community based health and social care system?

2. Is there anything missing from the model?

3. Are there any areas of the Comprehensive Geriatric Assessment process or the community based health and social care system that are not accurately represented in this model?

4. Is there anything else you would like to say about the model?

Focus Group Guide #2

The purpose of this focus group is to share and dialogue with you all about the study's findings and preliminary recommendations, and provide opportunities for questions, critique, and feedback. We are seeking an opportunity to collaborate with you on recommendations that can be presented to decision makers.

1. We will now take the time to review the individual study findings. We invite you all to dialogue further about these findings.

   Prompt: Are there any questions about the study findings?

   Does anyone have any feedback about the study findings?

   Is there anything in the study findings that you didn't expect? Please explain further.

2. We will now take the time to review individual study recommendations. We invite you all to dialogue further about these recommendations.

   Prompt: Are there any questions about the study recommendations?

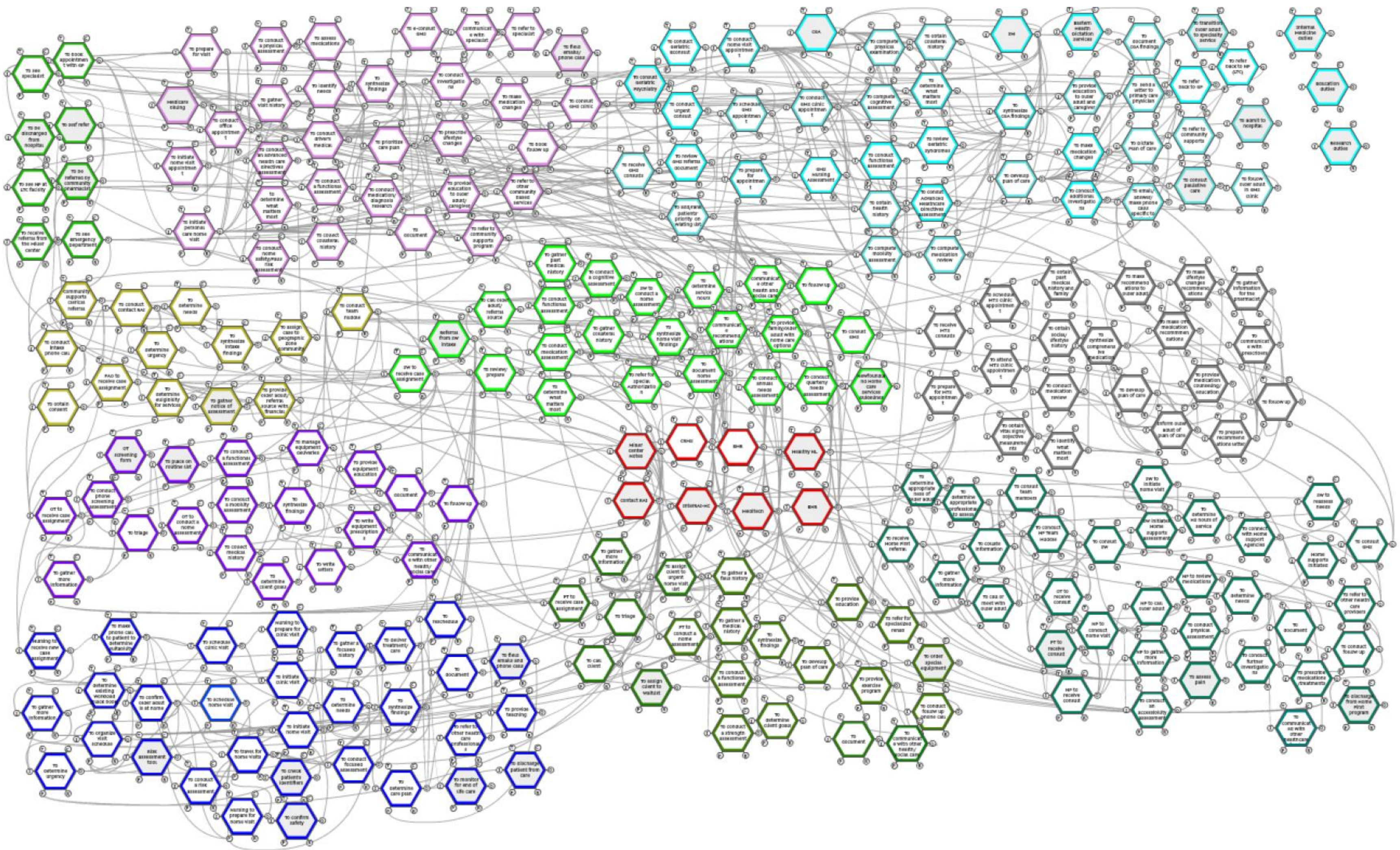
   Does anyone have any feedback about the study recommendations?

   Is there anything in the study recommendations that you didn't expect?

   Is there anything you would add to the study recommendations? Please explain further.

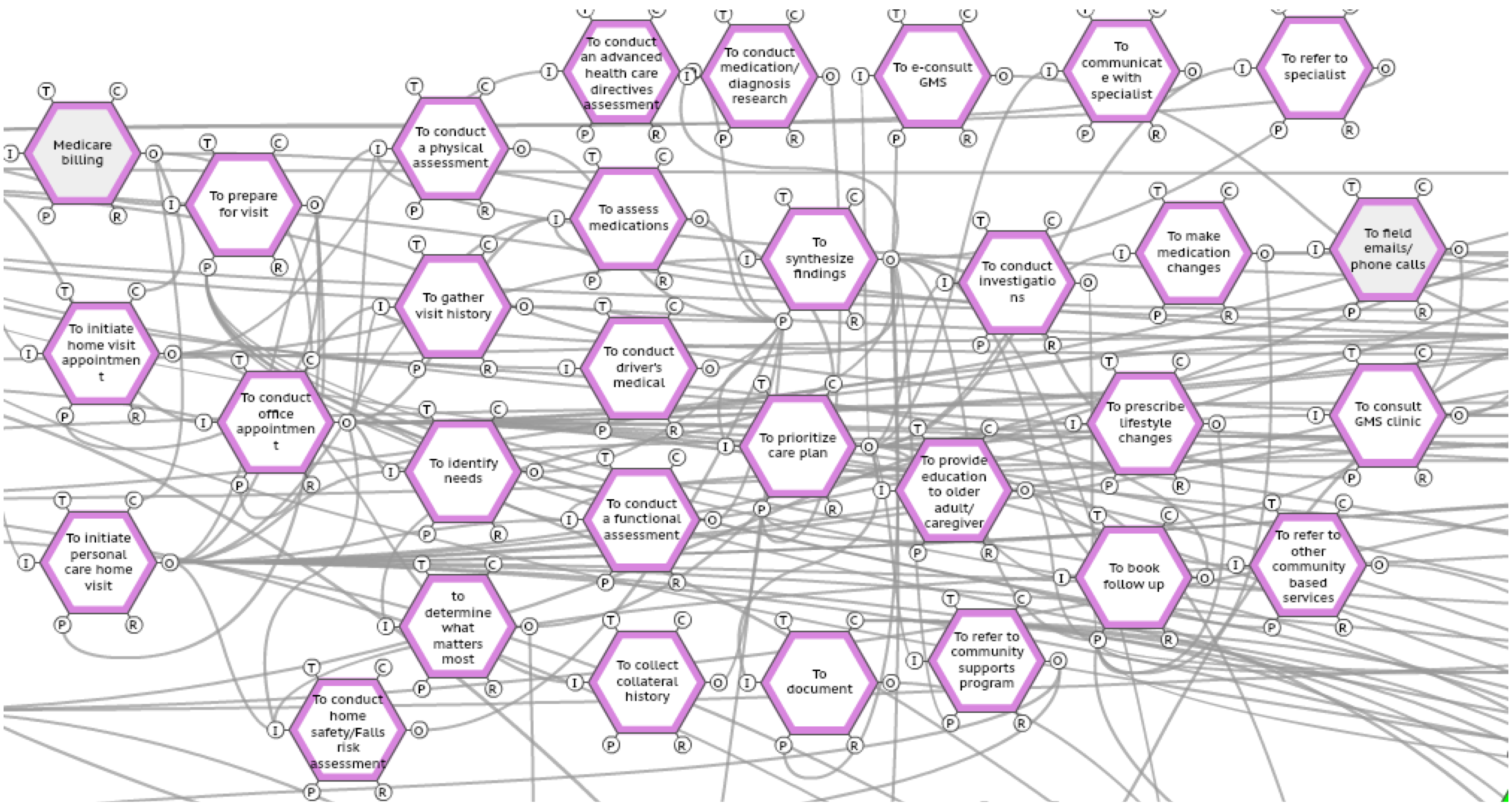
Appendix D

FRAM Model – Community Based Health and Social Care System



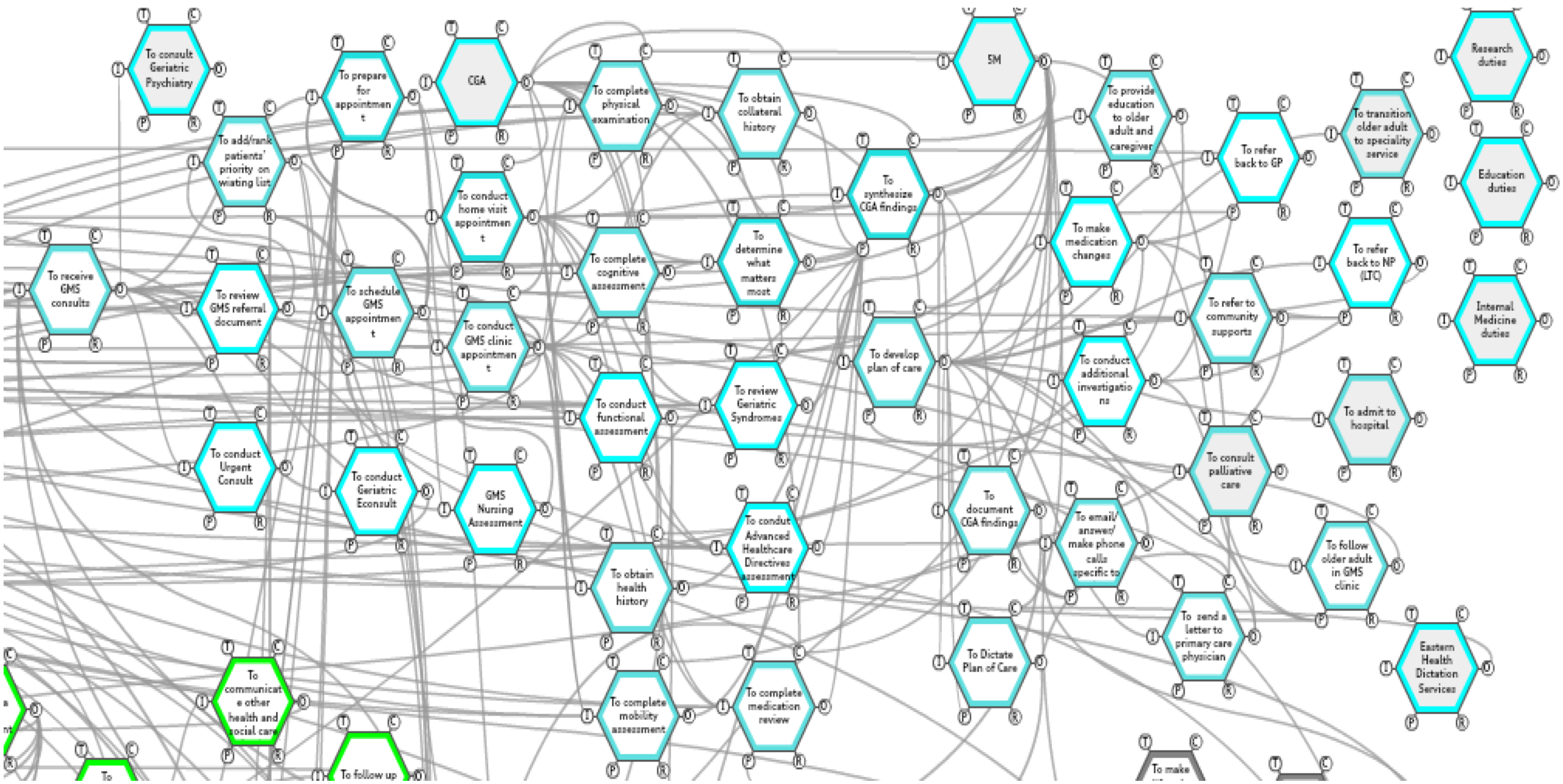
Appendix D

FRAM Model – Family Doctor Subsystem Functions



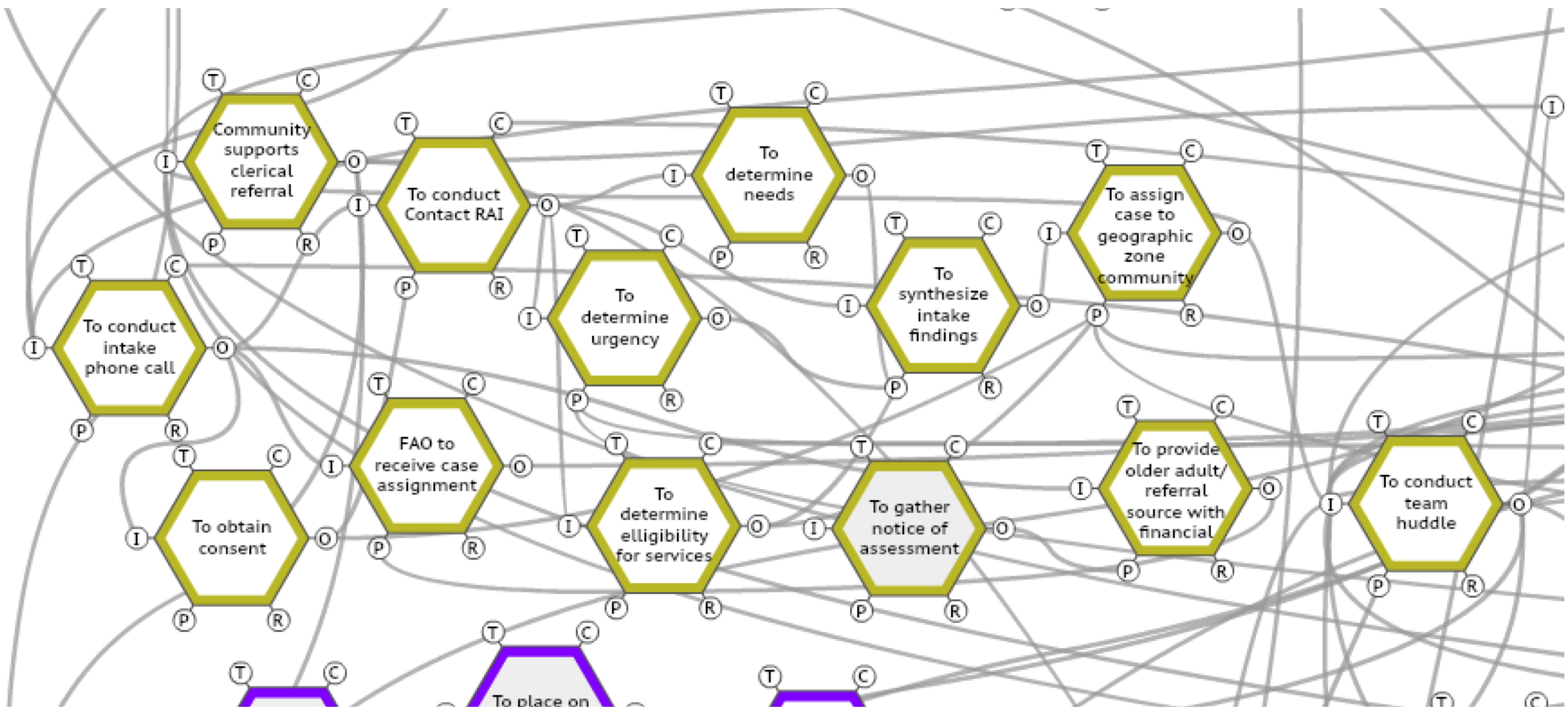
Appendix D

FRAM Model – Geriatric Medicine Services (GMS) Clinic Subsystem



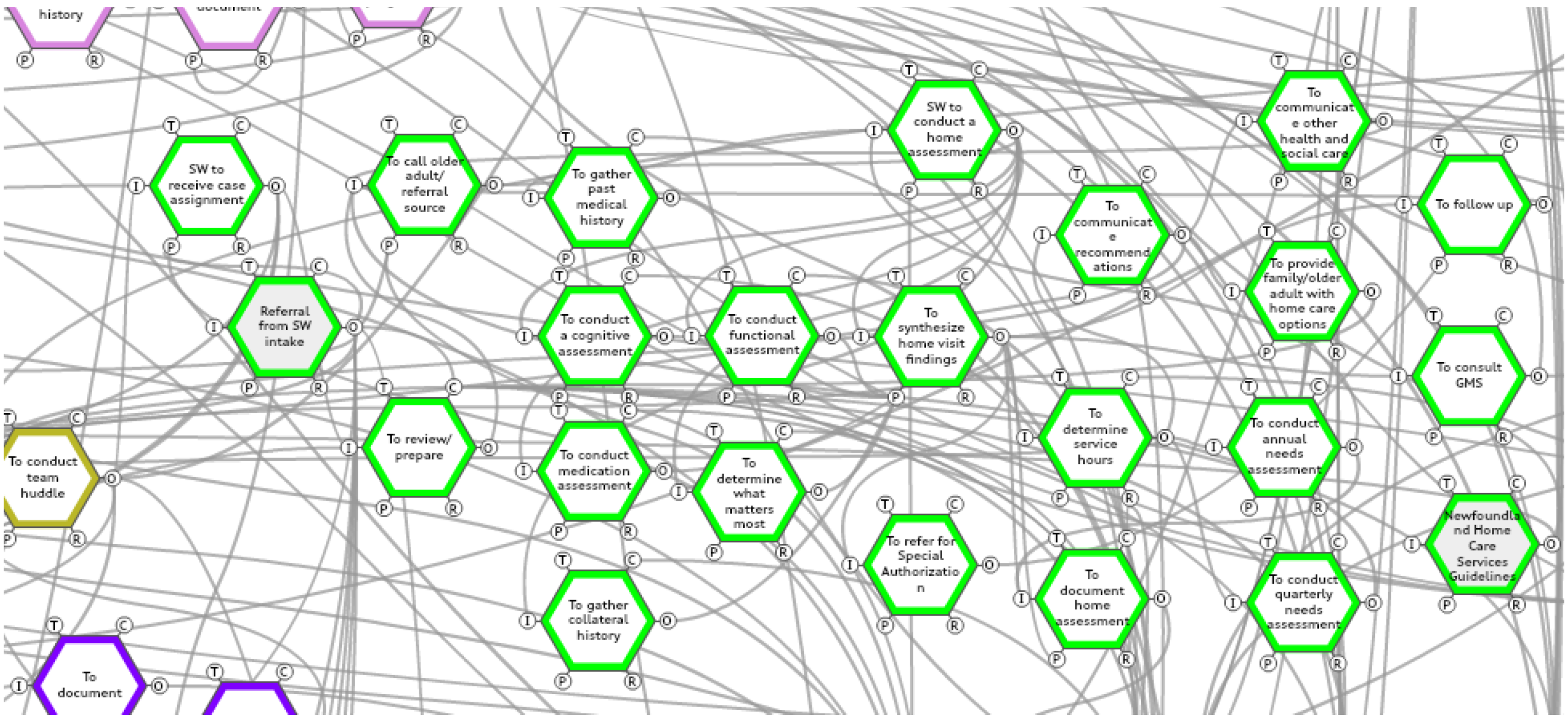
Appendix D

FRAM Model – Community Supports Program Social Worker Intake Functions



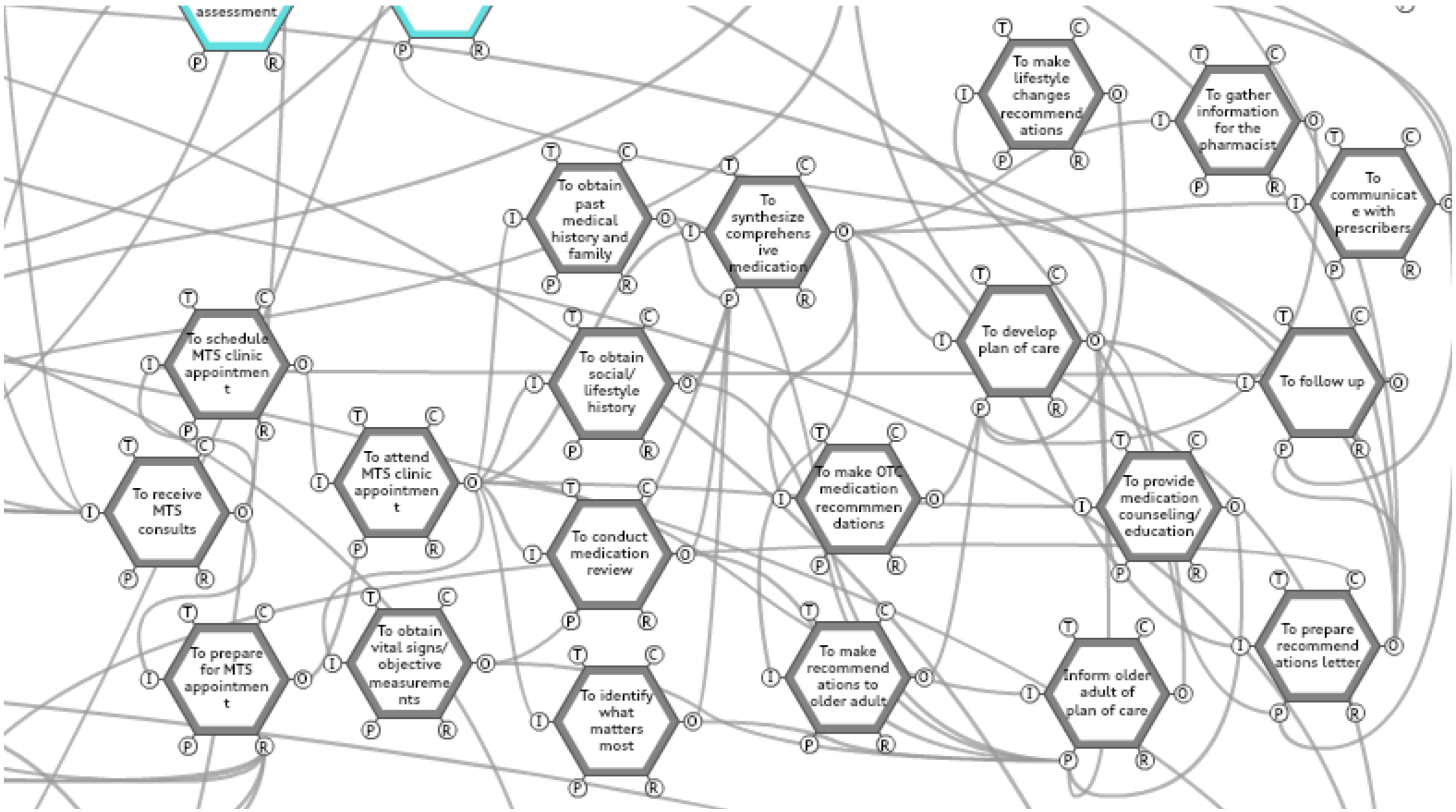
Appendix D

FRAM Model – Community Supports Program Social Worker/Home Visit Functions



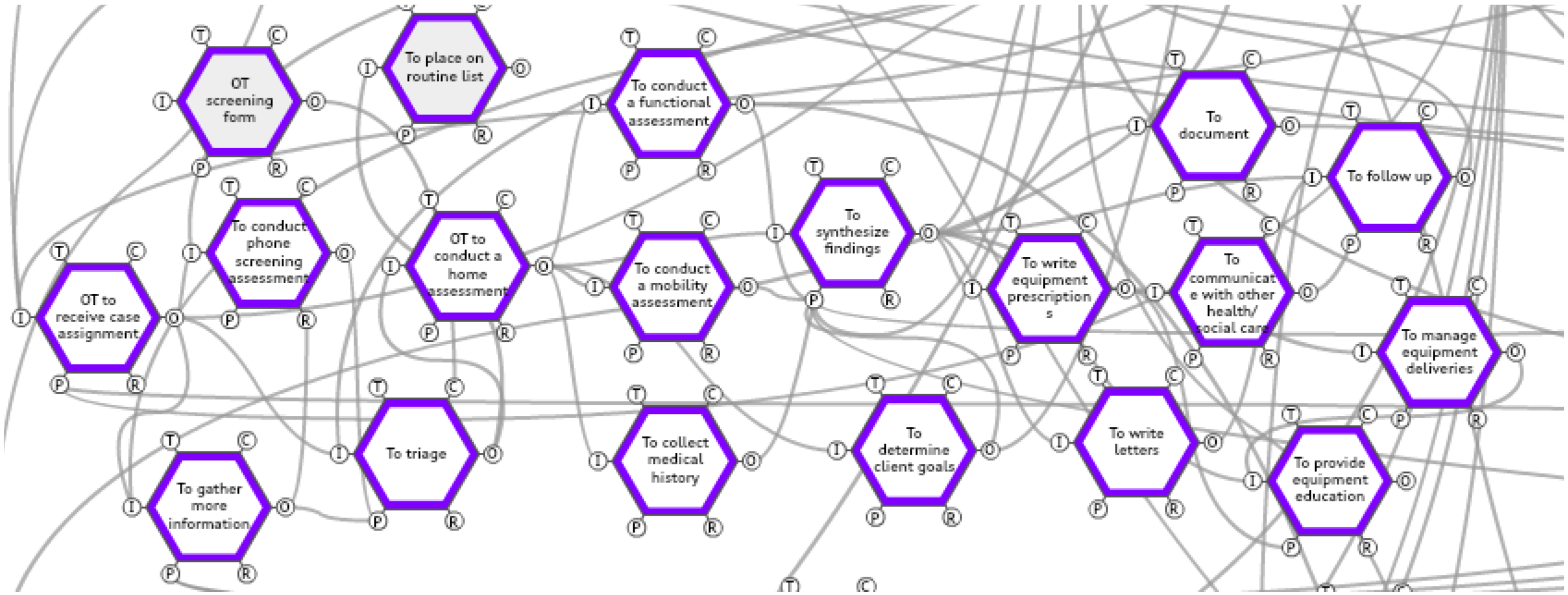
Appendix D

FRAM Model – Medication Therapeutic Services (MTS) Pharmacist Functions



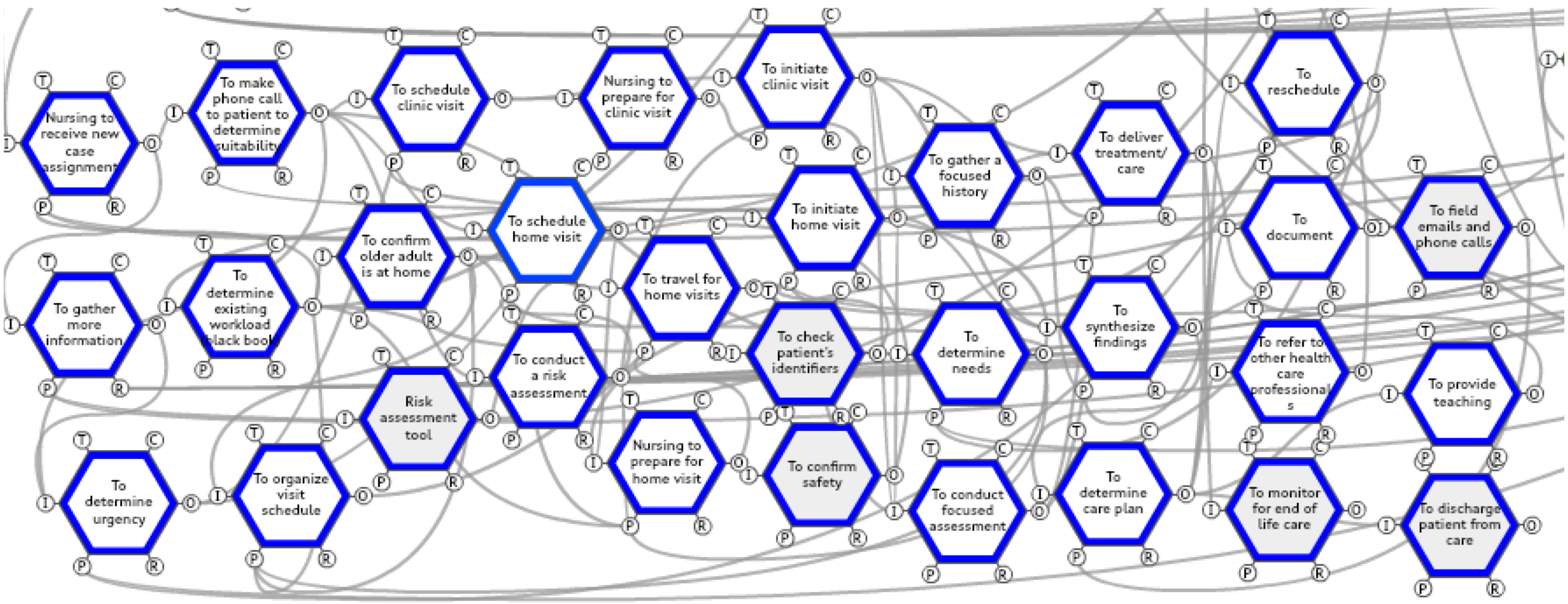
Appendix D

FRAM Model – Community Supports Program Occupational Therapist Functions



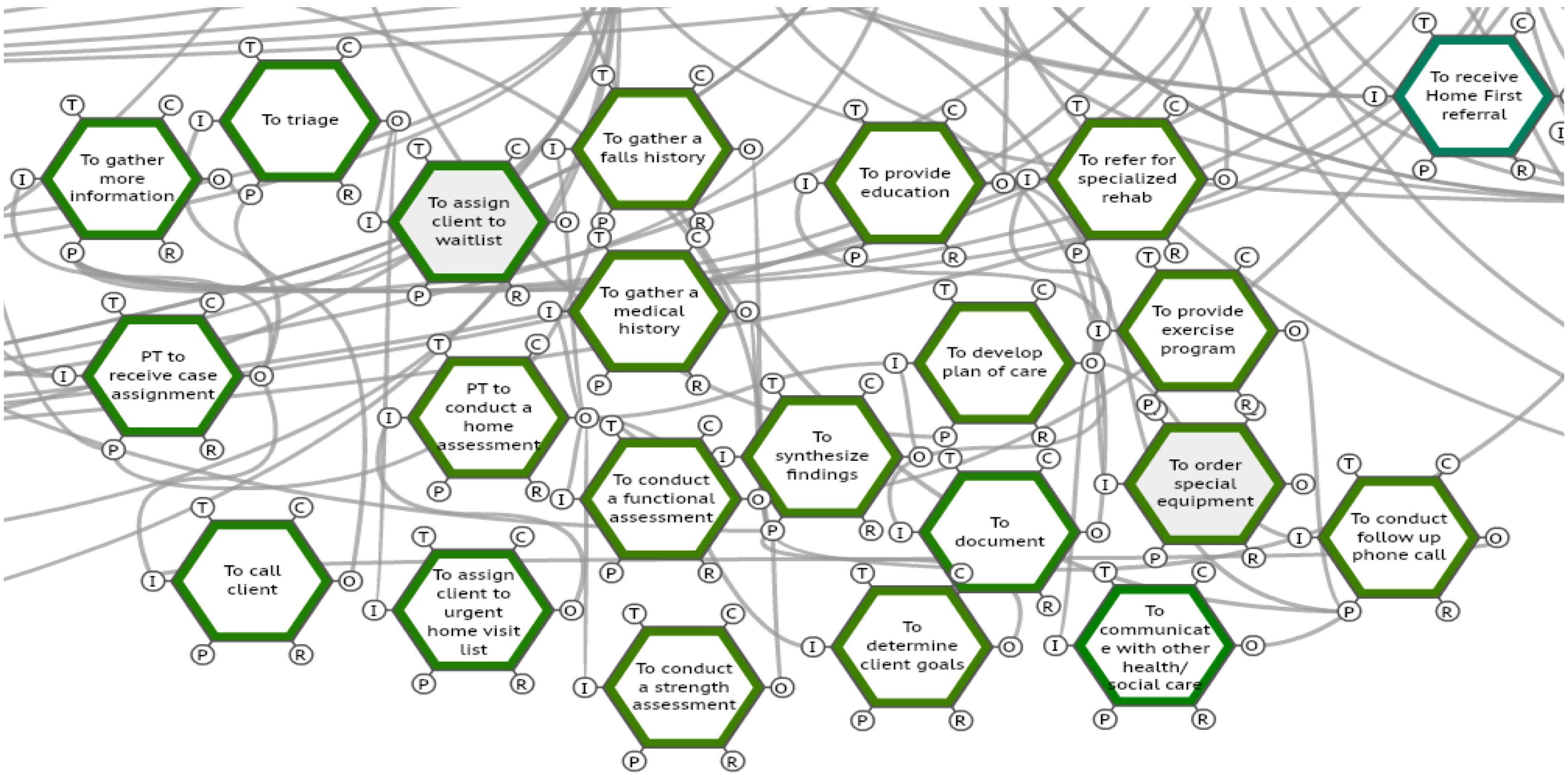
Appendix D

FRAM Model – Community Supports Program Nursing Functions



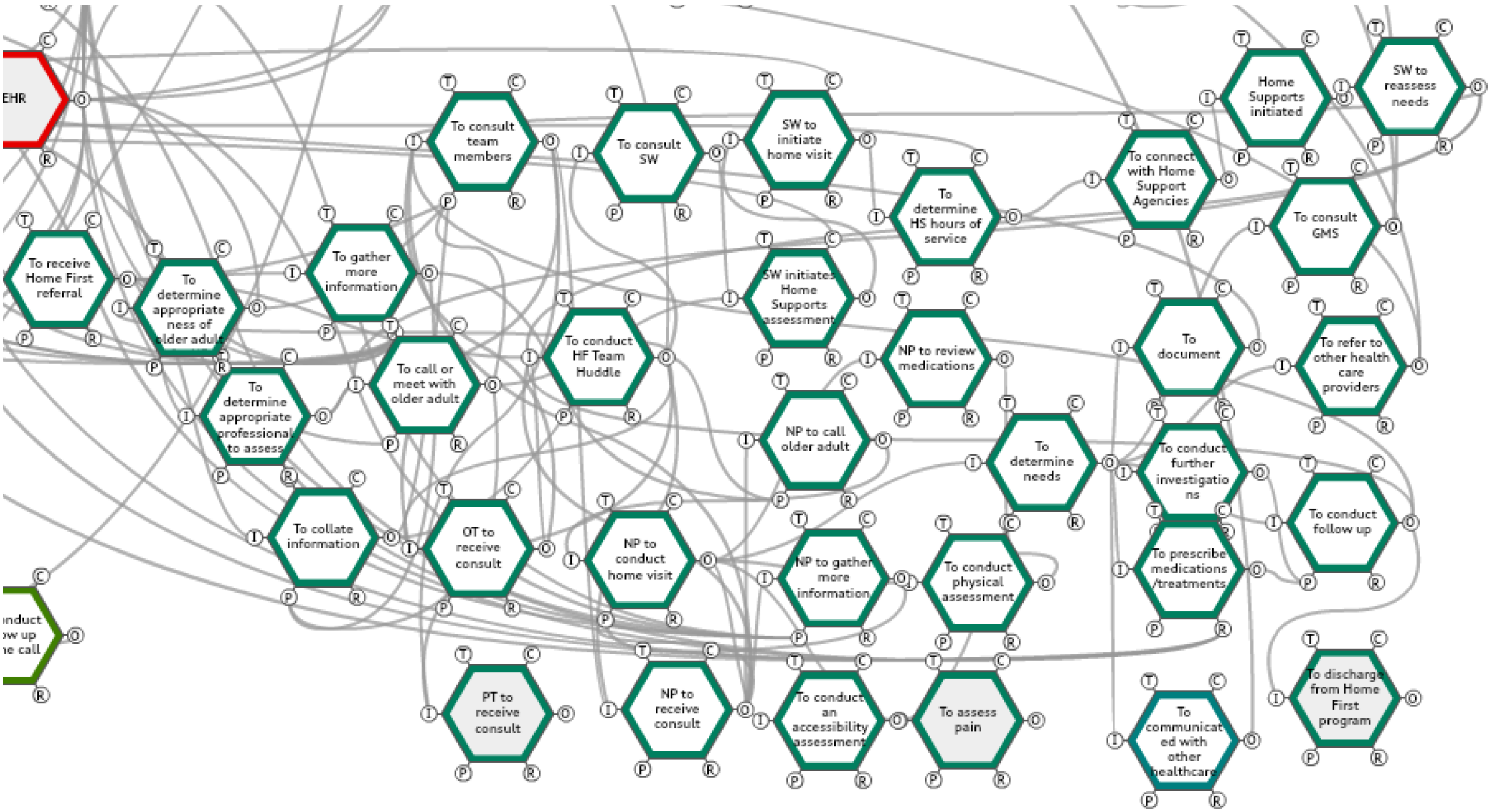
Appendix D

FRAM Model – Community Supports Program Physiotherapy Functions



Appendix D

FRAM Model – Home First Program Functions



Appendix E – Functional Signature

Time	Active Function	Active Function Output	Downstream Coupled Function	Coupled Function Aspect
1	11	Appointment booked	119	I
2	59	patient information	130	P
3	56	patient information	130	P
4	168	patient medications	130	P
5	55	patient information	130	P
6	119	Assess older adult	118	I
7	118	Physical assessment completed	122	P
8	121	Visit history completed	122	P
9	124	GP identified needs	122	P
10	122	Findings synthesized	249	I

11	249	What matters most determined	133	P
12	133	Needs prioritized	127	I
13	133	Needs prioritized	109	I
14	133	Needs prioritized	123	I
15	127	GP GMS referral sent	1	I
16	127	Add GMS referral to triage pool	239	P
36	239	GMS referral document reviewed	2	I
37	2	ranked patients	4	P
39	2	MTS clinic consulted	31	I
43	31	MTS consults received	33	I
44	168	patient medications	33	R
45	59	patient information	33	R
46	55	patient information	33	R

47	33	Pharmacist prepared for MTS appointment	8	P
48	31	MTS consults received	176	I
49	176	MTS clinic appointment scheduled	8	I
50	8	Attends MTS appointment	62	I
51	62	vital signs obtained	40	P
52	8	Attends MTS appointment	37	I
53	37	Medication goals identified	40	P
54	8	Attends MTS appointment	35	I
55	35	Social/lifestyle history obtained	40	P

56	8	Attends MTS appointment	39	I
57	39	past medical history and family history obtained	40	P
58	8	Attends MTS appointment	38	I
59	38	medication review completed	40	P
60	40	Comprehensive medication review findings synthesized	226	I
61	226	Independent medication recommendations made	60	P
62	40	Comprehensive medication review findings synthesized	60	I

63	60	Plan of care developed	63	P
64	63	Medication counseling/education provided	49	P
65	60	Plan of care developed	48	P
68	48	MTS recommendations letter prepared	4	P
70	4	GMS clinic appointment scheduled	15	I
75	55	patient information	15	P
76	59	patient information	15	P
77	168	patient medications	15	P
78	4	GMS clinic appointment scheduled	7	I
79	7	assess older adult	16	I

82	16	Physical examination completed	10	P
85	7	assess older adult	17	I
88	17	Health history obtained	10	P
91	7	assess older adult	18	I
94	18	Mobility completed	10	P
97	7	assess older adult	19	I
100	19	Medication review completed	10	P
103	7	assess older adult	20	I
106	20	Cognitive assessment completed	10	P
109	7	assess older adult	22	I
112	22	Collateral health and social history obtained	10	P
115	7	assess older adult	21	I

118	21	What matters most determined	10	P
121	7	assess older adult	46	I
124	46	Advanced Healthcare Directives determined	10	P
127	7	Assess older adult	216	I
130	216	functional assessment completed	10	P
133	7	Assess older adult	220	I
136	220	Geriatric Syndromes reviewed	10	P
135	10	CGA findings explained to older adult and caregiver	23	P
136	23	Older adult and caregiver given education and	24	I

		information about resources		
137	10	CGA findings synthesized	30	I
138	10	CGA findings synthesized	24	I
139	24	plan of care developed	219	I
140	219	medication changes made	29	P
141	24	plan of care developed	5	I
142	24	plan of care developed	6	I
142	24	plan of care	29	I
143	24	plan of care developed	30	P
143	24	plan of care	214	I
144	30	CGA findings documented	56	I

145	24	plan of care developed	28	I
146	24	CGA findings documented	6	I
147	6	Plan of care dictated	59	I
148	24	Plan of care developed	28	I
149	28	community supports provider referral	36	I
151	36	intake phone call initiated	71	I
152	71	assess elligibility	69	I
153	69	eligible for services	72	P
154	71	assess urgency	65	I
155	65	CS urgency determined	72	P
156	71	assess needs	206	I
157	206	CS needs determined	72	P
158	71	contact RAI completed	72	I

159	72	intake findings synthesized	64	I
160	64	Case assigned to zone	114	I
161	114	case assignment received	66	I
162	66	case assignment received	73	I
163	169	Contact RAI	73	P
164	55	patient information	73	P
165	59	patient information	73	P
166	168	patient medications	73	P
167	73	Community supports SW prepared for phone call to older adult	74	I
170	74	SW home assessment booked	9	I
171	9	SW home assessment initiated	51	I

172	51	cogn assess completed	41	P
173	9	SW home assessment initiated	68	I
174	68	past med hx completed	41	P
175	9	SW home assessment initiated	75	I
176	75	fxn assess completed	41	P
177	9	SW home assessment initiated	76	I
178	76	med hx completed	41	P
179	9	SW home assessment initiated	77	I
180	77	what matters determined	41	P
181	9	SW home assessment initiated	78	I
182	78	collat hx gathered	41	P

183	41	home visit findings synthesized	53	I
184	41	home visit findings synthesized	50	P
185	50	Home assessment documented	138	I
185	138	communicate recommendations and options	171	I
187	138	communicated with other healthcare provider	0	I
188	138	communicated with other healthcare provider	42	I
189	42	case assigned to zone OT from team huddle	108	I
190	108	case assignment received	134	I

191	58	CRMS charting	134	P
192	57	InterRAIHC	134	P
193	55	patient information	134	P

Appendix F

Analysis of Potential Variability – Functions, Manifestations, Downstream Effects, and Multi-level Recommendations

INTAKE					
No.	**Variability (+ or -)**	**Function**	**Manifestation of Variability Time and/or Precision**	**Downstream Effects**	**Proposed Recommendations by Micro-, Meso-, Macro-level**
1	**GERIATRIC MEDICINE SERVICES CLINIC (-)** The consultation form for the Geriatric Medicine Services (GMS) can be received from several sources (specialists, GPs, NPs, Emergency Department, Inpatient Units, LTC facilities, CS program, HF program). Due to workload demands of the Geriatrician the consults may not be reviewed for 2-3months.	To review GMS referral document (Receive Consult)	Time – Too long 2 to 3 months Geriatricians are unable to review consults on a regular basis due to workload and can only be done by taking time away from other duties.	Older adults with declining health may have an urgent need that could worsen and result in a poor outcome (admission, fall etc.)	**MESO 1.** Hiring a Registered Nurse (RN or NP) in an integrated care case management role could alleviate the Geriatrician from non-clinical work and consultations could be received and scheduled for daily/weekly triage.
2	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Because of the demands of Geriatric practice one of the geriatricians will block off a morning or afternoon where they would normally see patients to complete the function of triaging routine consults.	To add/rank patients on priority waiting list	Time – Too long Time away from clinical care	Reduced access, prolonging waiting list.	**MICRO 1.** A case manager could receive and review the consults and would also be responsible for triaging consults. The Geriatrician can collaborate when needed. Consultations could be investigated for appropriateness more thoroughly and triaged more promptly, identifying those with more urgent needs sooner.

INTAKE					
No.	**Variability (+ or -)**	**Function**	**Manifestation of Variability Time and/or Precision**	**Downstream Effects**	**Proposed Recommendations by Micro-, Meso-, Macro-level**
3.	**GERIATRIC MEDICINE SERVICES CLINIC (+)** E-consults are a type of consult that requires review by geriatricians. These consults can be sent by physicians in Eastern Health to ask a clinical question or get specific directions on care delivery for older adults.	Triage	Time - On time Geriatrician must reply within 24 hours. Precision -Precise Direction is clear and focused.	Less unnecessary consultations requiring triage/ booking an appointment at the GMS clinic. Prompt intervention in the primary care setting potentially avoiding decline.	**MICRO 2.** Provide PHC providers with scenarios outlining what is appropriate for E-consult vs. appointment.
4.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Urgent consultations are received by phone or email from referring clinicians and may be related to issues of safety requiring prompt intervention.	Triage	On time Geriatrician replies to same day. Precision - Imprecise If required, an urgent appointment is arranged but this impacts the waiting time of the routine waiting list.	Prompt intervention can prevent harm (ED visit, admission, fall). Increasing volume of urgent consultations further extends the waiting list for routine consultations.	**MICRO 3.** Geriatricians have a number of clinical and non-clinical activities for both Geriatrics and Internal Medicine. A review of clinical duties, such as inpatient rounds, admission privileges, and call for Internal Medicine should be considered.
5.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Depending on the urgency determined by the Geriatrician at the time the consult is reviewed an older adult can wait up to 2 years for an appointment.	Booking appointment	Time – Too long Waiting times for priority 1 visits > 6months, priority 2 visits 1-2 years Contact RAI completed – On time Intake SW guides the CS SW, PT, OT on how urgently they need to book a home visit.	Routine consultations may become more urgent over time without intervention resulting in preventable outcomes (admission to ED,	**MESO 2.** Examination of human resource and infrastructure requirements across the community based system to identify feasibility of creating an integrated CGA process that is less Geriatrician dependent and promotes team-based services.

INTAKE

No.	Variability (+ or -)	Function	Manifestation of Variability Time and/or Precision	Downstream Effects	Proposed Recommendations by Micro-, Meso-, Macro-level
				hospital and LTC facilities.	
6.	**COMMUNITY SUPPORTS PROGRAM (-)** Social Workers and PTs/OTs/Nurses who conduct home assessments receive the Contact RAI (demographic information, social and health history, and reason for referral) and call the older adult or referral source to determine what the needs of the older are.	Conduct contact RAI	Urgent consults – On time <72 hours Routine consults- Too late > 1year	Prompt intervention and to prevent further decline/adverse events. Potential for decline and worsening of condition while awaiting consult.	**MESO 3.** Development and communication of a shared goal of care and service and a shared culture that supports attaining the goal. The overall goal of care and service is maintaining and preventing decline in an older person's intrinsic capacity and functional ability. Health and social care professionals are aware of the expertise, roles, and responsibilities of other professionals.
7.	**COMMUNITY SUPPORTS PROGRAM - (-)** Urgent consultations are seen within 72 hours, for Physiotherapy. Routine consultations are > 1 year	Triage	Time – On time for Urgent consults – within 24 hrs (business days) Routine consults- Too late > 1year	Prompt intervention and to prevent further decline/adverse events. Potential for decline and worsening of condition while awaiting consult.	**MICRO 4.** The Community Support intake process as a single-entry point for accessing a CGA for an older adult with complex needs. The majority of the CGA could be completed by an integrated care team reducing the Geriatrician's workload, with case management to ensure coordination and continuity. **MESO 2.** **MESO 3.**

INTAKE					
No.	**Variability (+ or -)**	**Function**	**Manifestation of Variability Time and/or Precision**	**Downstream Effects**	**Proposed Recommendations by Micro-, Meso-, Macro-level**
8.	**COMMUNITY SUPPORTS PROGRAM (-)** Urgent consultations for Occupational Therapy can be seen within 24 hrs – 1 week. Routines are >1 year	Triage	Time – On time for Urgent consults – <72 hrs (business days) Routine consults- Too late > 1year	Urgent visit may affect each professional's current caseload requiring a shift in their schedule. Prompt visits can initiate services quickly and potentially avoid further decline. Reduced access for patients due to prolonged preparation time for visits related to IT inefficiencies.	**MICRO 4.** **MESO 2.** **MESO 3.**
9.	**ALL HEALTHCARE PROFESSIONALS (-)** To adequately prepare for an appointment with an older adult, health and social care professionals spend time navigating multiple health Information Technology (IT) platforms to gather information about medications, past medical history and social history, diagnostic test results, discharge summaries, and care plans.	Gather information OR prepare for appointment	Every healthcare professional requires 30minutes-1hour per patient to gather information from IT platforms. Precision – Imprecise Patient information could be stored in several IT platforms and may require different sign on credentials.	Duplication in services due to poor accessibility to IT platforms	**MICRO 4.** **MESO 2.** **MESO 3.** **MESO 4.** One chart access for health and social care professionals where access to all documentation, lab results, plans of care are stored and are accessible.

INTAKE					
No.	**Variability (+ or -)**	**Function**	**Manifestation of Variability Time and/or Precision**	**Downstream Effects**	**Proposed Recommendations by Micro-, Meso-, Macro-level**
10.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** The Geriatricians assign urgency to appointments with older adults (P1 – 6 months, P2 – 1-2 years, urgent – next available cancellation) is highly dependent on the information provided on the GMS consultation form.	To add/rank patients on priority waiting list	Precision – Imprecise Some consultation forms are incomplete or provide vague reasoning for consultation. Incomplete or vaguely completed forms are often due to 1. time pressures and volume levels of busy primary care practices. 2. Few primary care clinicians with advanced training and education in caring for older adults which can result in inappropriate consultations that could be managed in the primary care setting.	Inappropriate triage level assigned due to vague/missing information on consultation form. Resulting in delay in accessing care and potentially preventable physical, cognitive decline.	**MACRO 1**. Additional training certifications for all clinicians who specialize in older adult care. (GPs, NPs, RNs, LPNs, SWs, PTs/OTs, pharmacists etc.) Optimize the capabilities of these professionals and their knowledge of clinical resources available in their community. **MACRO 2.** Create a complex care billing code for older adults that remunerates a Primary Care physician appropriately for the time required to care for an older adult. **MACRO 3**. Advocate team-based PHC practices (pharmacist, sw, nursing, OT/PT, MD, SLP) optimized to meet complex care needs of older adults. Older adults with more advanced care needs can be referred to the GMS clinic with the primary care team available to support the recommendations of the GMS clinic.

ASSESSMENT					
No.	**Variability**	**Function**	**Manifestation of Variability Time/Precision**	**Downstream Effects**	**Proposed Recommendation by Micro-, Meso-, Macro-level**
11.	**GERIATRIC MEDICINE SERVICES CLINIC (+)** The GMS LPN conducts an assessment and gathers weight, height, and vital signs ahead of the CGA.	GMS Nursing Assessment	Time – On time Precision – Imprecise The LPN position is shared with another clinic in the building.	When available, the LPN can have a positive impact on clinic flow and reduce the workload of the Geriatrician.	**MESO 5.** Optimize the LPN role to its full scope of practice. In addition to conducting a nursing assessment the LPN could gather information and complete sections of the CGA that do not require the expertise and time of a Geriatrician.
12-16.	**MEDICATION THERAPEUTIC SERVICES CLINIC (+)** The Medication Therapeutic Services Clinic is a pharmacist-led service at Memorial University with multiple referral sources (self-referral, GP/NP/GMS etc.). The pharmacist conducts an assessment to complete a comprehensive medication review.	Comprehensive Medication Review Functions (obtain past medical history, obtain social history, conduct medication review, obtain vital signs and objective measurements, what matters most)	Time – On time Accessibility to this provider is prompt. Precision- Precise Comprehensive review of medications with clear recommendations.	When conducted ahead of a CGA a CMR can reduce the workload of a Geriatrician and the time necessary to complete a CGA. It also involves the older adult/family member more in understanding their medications.	**MESO 6.** Optimize the role of the pharmacist in the MTS clinic. Older adults taking multiple medications would benefit from a comprehensive medication review completed by a pharmacist as a component of an integrated CGA process.
17-20.	**HOME FIRST PROGRAM (+)** NPs conduct home assessments on older adults recently discharged from hospital.	NP assessment functions (review meds, physical assessment,	Precision – Precise The NP role has been identified as essential for patients in the HF program with Family Doctor	Assessments by the NP may identify older adults with more complex	**MESO 7.** Examine the feasibility of introducing the NP role across the HF program and CS programs to improve access to home

		assess pain, conduct accessibility assessment,	where access is problematic or for those older adults without a Family Doctor. Assessments can identify health concerns that need intervention. Time – On time accessibility to this program is prompt.	needs requiring a CGA. Assessment completed by HF program NP to develop a hospital to home transition plan and reduce adverse events (readmission, ED visits, etc.) for older adults.	based PHC services for older adults with complex health issues. **MESO 2.** **MESO 3.** **MACRO 1.** **MACRO 3.**
21.	**FAMILY DOCTOR (-)** Providing comprehensive care to an older adult with complex health and social needs is challenging for Family doctors given the limitations of Medicare billing in NL.	Medicare billing	Precision- Imprecise Family doctors can book and bill for one CGA over a patient's life course. All other visits can only be billed for 15-minute blocks. Any work beyond 15 minutes (communication, documentation, forms etc.) would not be remunerated. Time – too long Family Doctors may have to work outside the 15-minute appointment window for older adult appointments at a financial loss in order to complete all the tasks related to the visit (assessment, documentation, forms, communication)	More frequent appts to address concerns, that may not address the complex needs of the older adult resulting in poor outcomes (admissions, falls, ED visits) Reduced access/Delays. The work required of a family doctor to appropriately assess care for an older adult with complex needs would require time outside the 15	**MACRO 2.** **MACRO 3.** **MACRO 1.** **MACRO 2.** **MACRO 3.**

				minute appt would impact access for other patients in their practice.	
22-29.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Geriatricians conduct a CGA to identify the medical, social, psychological, and functional needs of an older adult to develop an integrated/coordinated care plan to address those needs	Assessment functions (history, physical exam, medication, mobility, cognitive, what matters most, collateral history, functional assessment, geriatric syndrome assessment.	Time – Too long 2 hrs + -There are numerous assessment functions completed in the CGA. Precision – Imprecise Some of the functions could be completed by other professionals. Because there is not an integrated team, the Geriatricians are hesitant to trust the findings of another professional's assessment.	The 2-hour length of the CGA limits the number of older adults that can be seen/day in the clinic.	**MICRO 4.** **MESO 2.** **MESO 3.** **MACRO 1.** **MACRO 2.** **MACRO 3.**
30-35.	**COMMUNITY SUPPORTS PROGRAM (-)** Social Workers complete a Resident Assessment Instrument – Home Care (interRAI-HC) to determine the hours of home care required for an older adult	Assessment functions –Past medical history, cognitive assessment, functional assessment, medications, what matters most, collateral history	Time – On time. SWs are accessible and conduct inteRAI- HC with a range of same day-2 weeks depending on the urgency of the needs, availability of the older adult, and/or SW schedule. The inteRAI-HC assessment is comprehensive. Precision-Imprecise A portion of the SW assessment is comprised of the same assessment categories completed by other healthcare professionals.	Duplication of services with potential delays. The inteRAI-HC is not accessible to other healthcare professionals and is comprised of many of the same assessment categories completed by other health are professionals.	**MICRO 4.** **MESO 2.** **MESO 3.** **MACRO 1.**

36-40.	**COMMUNITY SUPPORTS PROGRAM (-)** Physiotherapists within the CS program conduct assessments of older adults to determine goal setting and needs related to mobility, strength, functional ability as well as equipment needs.	Physiotherapy assessment functions (gather medical history, conduct falls history, functional assessment, strength assessment, determine goals)	Precision – Imprecise A portion of the PT assessment is comprised of the same assessment categories completed by other healthcare professionals. In other programs across Canada PTs are more specialized and conduct more in depth assessments on mobility, strength, and balance and complete objective measurements that can provide the Geriatrician with necessary assessment data and impressions.	Duplication of services with potential delays.	**MICRO 4.** **MESO 2.** **MESO 3.** **MACRO 1.**
41-44.	**COMMUNITY SUPPORTS PROGRAM (-)** The Occupational Therapist's main responsibility is to conduct an assessment and make recommendations on necessary equipment and order equipment and facilitate installation/delivery/education.	OT assessment functions (conduct mobility assessment, conduction functional assessment, determine goals, collect medical history)	Precision – Imprecise A portion of the OT assessment is comprised of the same assessment categories completed by other healthcare professionals. The role of the OT is consultative. OTs in other programs across Canada are more specialized and conduct advanced assessments on function and cognition and complete objective measurements the Geriatricians can used to inform their decisions.	Duplication of services with potential delays.	**MICRO 4.** **MESO 2.** **MESO 3.** **MACRO 1.**
46-47.	**COMMUNITY SUPPORTS PROGRAM (+)** Registered Nurses work in community based clinics and provide care in the home to older adults with complex health needs. They conduct	Assessment functions conduct focused assessment, gather focused history	Time – on time Prompt access to nursing services in the community. Priority is given to palliative patients. Precision – Precise	Reduction in unnecessary visits to ED or admissions to hospital.	**MICRO 4.** **MESO 2.** **MESO 3.** **MACRO 1.** **MACRO 3.**

	assessments upon first meeting older referred to them for care for a variety of reasons (wound care, Intravenous therapy, pain management, catheter care etc.).		The nursing care is often task focused (catheter care, wound care, intravenous treatments, pain management).		

CARE PLANNING					
No.	**Variability (+ or -)**	**Function**	**Manifestation of Variability Time and/or Precision**	**Downstream Effects**	**Proposed Recommendations by Micro-, Meso-, Macro-level**
48.	**MEDICATION THERAPEUTICS SERVICES CLINIC (+)** Pharmacists spend time with older adults to ensure they understand their medication regimen.	Educate patient/caregiver	Precision – Precise When provided with education on their medications, older adults and their family/caregivers can become more active participants in their care.	Increase knowledge and builds self-management skills for older adults and family/caregivers	**MICRO 5.** Encourage more opportunities where older adults and family/caregivers can build capacity for self-management. Promote/optimize services of MTS clinic and encourage PHC providers to collaborate with pharmacists in caring for older adults with complex conditions.
49.	**MEDICATION THERAPEUTICS SERVICES CLINIC (+)** Pharmacists provide a comprehensive review with prioritized recommendations for optimized prescribing to providers (Geriatricians, family doctors, NPs)	Develop a plan of care	Precision – Precise The comprehensive medication review is detailed, and recommendations are prioritized. Time – on time Conducted, prepared, and communicated promptly to providers.	Family doctors/NPs/Geriatricians are provided with guidance on key recommendations for medication optimization. Potential improvements in the management of chronic conditions.	**MICRO 5.**
50.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Geriatricians often conduct education to older adults and their family/caregivers at the end of the CGA	To provide education to older adult and caregiver	Precision – Imprecise The Geriatrician reviews health issues and plan with the older adult and family. Because of the complexity of health conditions there may be several questions the older adult and family member may	The lack of time and the complex nature of health conditions being experienced by the older adult may cause uncertainty and anxiety in both the older adult and their caregiver and result unnecessary ED visits and LTC admissions.	**MICRO 6.** Provide older adults and their family/caregivers with access to case management services to receive ongoing education and support to build self-management capacity and assist older adults in their efforts to age in place. **MICRO 7.** Develop caregiver emotional support and respite programs in communities across the province.

			have. The caregiver may also have a significant amount of burden and community based resources to support them are challenging to access. Time – Too early Each geriatrician described this function as being rushed.		
51.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Accessibility to the GMS service reduces the number of CGA care plans that are developed for older adults.	Develop plan of care	Precision – Imprecise Lack of access to Geriatricians reduces the number of care plans that can be developed by Geriatricians with the multidisciplinary team.	Lack of complex care planning results in unnecessary or preventable admission to ED, Hospital, LTC facilities	**MICRO 3.** **MESO 2.** **MESO 3.** **MACRO 1.** **MACRO 3.**
52.	**FAMILY DOCTOR (-)** The constraints of primary care make developing comprehensive care planning challenging.	Prioritize a care plan	Precision – Imprecise Care planning with each visit often results in prioritizing what is the most pressing issue and additional appointments can be booked to address other issues.	This approach is necessary to accommodate the current system demands of PHC providers, but does not address the complex needs of the older adult and could result in poor outcomes (hospitalization, falls, LTC admission, ED visits)	**MACRO 1.** **MACRO 2.** **MACRO 3.**
53.	**FAMILY DOCTOR (-)** Providing education to their older adult/family	Provide education to older adult	Time – too early The GP spends less time than they would	The lack of time and the complex nature of health conditions being	**MACRO 1.** **MACRO 2.** **MACRO 3.**

	caregivers patients during office visits		like to teach the older adult/family/caregiver regarding new diagnoses/treatments etc.	experienced by the older adult may cause uncertainty and anxiety and result unnecessary ED visits and LTC admissions.	
54.	**COMMUNITY SUPPORTS PROGRAM (-)** Home care services are not part of Eastern Health and quality and consistency of service delivery is variable.	Provide older adult/family with home care options	Precision – Imprecise Home care workers are unregulated and underpaid and have varying levels of education and training in caring for older adults with complex care needs. Home care worker abilities, skills, and knowledge are not standardized and there is no professional body they are accountable to.	High turnover and lack of appropriate human resources can result delays in care and care that does not meet the needs of older adults.	**MACRO 4.** Regulate home care agencies and workers by introducing legislation to standardize education and training programs. Legislation would also introduce practice acts that organize how home care workers safely, legally, and ethically perform their duties and responsibilities.

COMMUNICATION					
No.	**Variability (+ or -)**	**Function**	**Manifestation of Variability Time and/or Precision**	**Downstream Effects**	**Proposed Recommendations by Micro-, Meso-, Macro-level**
54.	**COMMUNITY SUPPORTS PROGRAM and Geriatricians (+)** Three days a week the Geriatricians join the online Team Huddle with one of the CS teams. There are 5 other CS teams that do not have access to the Geriatricians in their team huddles.	Team Huddle	Precision – Precise Team huddles are brief 15-30 minutes. Older adults new to the program are reviewed by the team, Referrals between professionals and the GMS clinic can be generated on new and existing clients depending on needs. Multidisciplinary input for each older adult's plan of care.	More efficient manner of communication between professionals to develop a multidisciplinary plan of care potentially reducing delays in care. More rapid deployment of interventions if urgent or emergent needs are identified, potentially preventing poor outcomes. Capacity building. Team members learn from one another's expertise and become more aware of one another's roles and responsibilities, potentially reducing duplication in services, and increasing trust among professionals.	**MESO 8.** Continue Team Huddles and identify human, organizational, and technological resources requirements to enact Team Huddles for all 6 CS program zones.
55.	**HOME FIRST PROGRAM AND GERIATRICIAN (+)** Geriatricians join the online Team Huddle with the HF program.	Team Huddle	Precision – Precise Team huddles are brief 15-30 minutes. Older adults new to the HF program are reviewed by the	More efficient manner of communication between professionals potentially reducing delays in care. More rapid deployment of interventions if urgent or emergent	**MESO 9.** Continue Team Huddles and identify human, organizational, and technological resources requirements to enact expanded Team Huddles with Geriatricians and other potential health and social care

			team, Referrals between professionals and the GMS clinic can be generated on new and existing clients depending on needs.	needs are identified, potentially preventing poor outcomes. Capacity building. Team members learn from one another's expertise and become more aware of one another's roles and responsibilities, potentially reducing duplication in services, and increasing trust among professionals.	professionals permanently for the HF program .
56.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Geriatricians document their findings in the GMS EMR and dictate their findings to ensure the information is accessible in the hospital EMR/Meditech. This is a trade-off Geriatricians make to ensure their findings are accessible to clinicians who may be caring for an older adult (emergency dept, inpatient units, specialists)	Dictate	Precision – Imprecise Duplication of documentation to ensure availability of findings and plan of care to hospital-based clinicians Time – Too long Time from the audio dictation to transcription depends on the Geriatrician's level of access to dictation	Reduced access for older adults related to prolonged time conducting non-clinical work Delays in transcription result in delays in care plan implementation and communication with other healthcare professionals.	**MESO 4.**
57.	**ALL HEALTHCARE PROFESSIONALS (-)** Documentation by individual healthcare professionals is conducted in several different platforms that may or may	Documentation	Precision – Imprecise The findings of each healthcare professional's assessments and plans of care are stored in several	Reduced access for older adults related to prolonged time conducting non-clinical work. Duplication of services.	**MESO 4.**

	not be accessible to other healthcare professionals.		different IT platforms. Documentation may not be accessible or healthcare professionals may not even be aware the older adult was assessed by another healthcare provider.		
58.	**COMMUNITY SUPPORTS PROGRAM (-)** Physiotherapists spend up to 2 hours documenting home visits due to CRMS narrative documentation.	Documentation	Time – Too long Documentation is in narrative and time consuming to complete.	Reduced access for older adults related to prolonged time conducting non-clinical work	**MESO 10**. More efficient documentation system for CS PTs – populated work sheets to replace some of the narrative charting
59.	**MEDICATION THERAPEUTIC SERVICES CLINIC (-)** Awareness of the role of the MTS in providing comprehensive medication reviews may not be widely known about or understood by providers.	Letter to referring provider/prescriber	Precision – Imprecise Recommendations are made to optimize medication regime for older adults but may never be enacted.	Unfamiliarity with the pharmacist's role at the MTS may result in providers dismissing the recommendations.	**MESO 2.** **MESO 3.** **MESO 6.** **MACRO 1.** **MACRO 3.**
60.	**FAMILY DOCTORS (-)** The family doctor refers older adults to the community supports program for a variety of reasons. They are often unaware of the results of the CS referral because there is no communication between the two unless specifically requested.	To field/make emails/phone calls	Precision – Imprecise The family doctor may have to leave messages or delay returning phone calls due to the demands of their practice that may not allow them to answer or make calls at a time that allows mutual communication. The	Poor communication may result in delays in care and impact outcomes negatively.	**MESO 11.** IT mechanisms to provide opportunities for improved communication between CS, HF, MTS, GMS, and family doctors. Direct messaging notifications.

			older adult may be the only source of information for the family doctor related to the CS appointments.		
61.	**COMMUNITY SUPPORTS PROGRAM (-)** SWs, PTs, OTs, Nurses, may need to communicate with the family doctor about the care needs of a patient and spend time calling, faxing, emailing with variable response times.	To communicate with other health and social care professionals	Precision – Imprecise The CS health or social care provider may have concerns about the older adult. The CS professionals may place phone calls, write emails, send faxes to the family doctors which can vary in terms of response time.	Poor communication may result in delays in care and impact outcomes negatively. Unnecessary appointments booked as a means of communication.	**MESO 2.** **MESO 3.** **MESO 4.** **MESO 11.** **MACRO 3.**
62.	**HOME FIRST PROGRAM (-)** SWs, PTs, OTs, Nurses, NP may need to communicate with the family doctor about the care needs of a patient and spend time calling, faxing, emailing with variable response times.	To communicate other health and social care professionals	Precision – Imprecise The HF NP may wish to communicate the care plan or discharge from HF to the GP.	Poor communication may result in delays in care.	**MESO 2.** **MESO 3.** **MESO 4.** **MESO 11.** **MACRO 3.**

DISPOSITION

No.	Variability (+ or -)	Function	Manifestation of Variability Time and/or Precision	Downstream Effects	Proposed Recommendations by Micro-, Meso-, Macro-level
63.	**MEDICATION THERAPEUTIC SERVICES CLINIC (-)** Pharmacists at the MTS make recommendations and there is variable uptake from providers on enacting these recommendations.	Make recommendations	Precision – Imprecise Pharmacists cannot make changes to an older adult's medication regime. Pharmacists can only make recommendations to prescribers. The prescribers can choose to enact those changes or not.	If the older adult has a PHC provider, they will need to arrange an appointment to address recommendations. This may result in a delay in prescriber addressing/enacting recommendations which could impact outcomes.	**MACRO 5.** Advocate for legislative changes to the scope of practice of pharmacists to enact prescriptive authority.
64.	**MEDICATION THERAPEUTIC SERVICES CLINIC (+)** Pharmacists are available to follow up with older adults and offer services such as deprescribing regimens and optimization of blood glucose management etc.	Follow up	Time – on time Precision – Precise Pharmacists at the MTS have the knowledge and skills to collaborate with prescribers to ensure an older adults' medication regime is optimized.	Follow up with the pharmacist can reduce need to follow up with PHC provider or Geriatrician about medication needs.	**MESO 2.** **MESO 3.** **MESO 6.** **MACRO 1.** **MACRO 3.** **MACRO 6.**
65.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** The complexity of the needs of older adults may not be suitable for the PHC environment.	Follow older adult in GMS clinic	Precision – Imprecise Geriatricians will often follow up with older adults who could be followed by their PHC provider, but they hold on to them to ensure their safety and progress.	Reduced access increases waiting list	**MACRO 1.** **MACRO 2.** **MACRO 3.**

66.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Accessibility of PHC providers (family doctors, NPs)	Refer older adult back to primary care provider	Precision – Imprecise Geriatricians will refer older adults back to their PHC providers (family doctors, NPs) but have concerns that the care plan may not be followed.	Uncertainty in care plan being followed due to constraints of PHC system can result in complications and preventable admissions to ED, Hospital, and LTC facilities.	**MACRO 1.** **MACRO 2.** **MACRO 3.**
67.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** After the CGA is complete it may be determined the safest and most necessary decision is to admit the older adult to hospital	Admit to hospital	Precision – Imprecise Geriatricians have no direct admitting privileges. Older adults requiring admission need to be directed to the Internal Medicine service through the ED rather than a direct admission to the Geriatric Unit. Time- Too long Admitting to Internal Medicine through the ED can be delayed due to the high demand for Internal Medicine services and hospital bed availability	Admission delays with prolonged stays in the ED.	**MICRO 3.**

68.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** Single provider to single provider (Family Doc/NP to GMS clinic) can result in more challenging work for the GMS clinic after the CGA has been completed. The Geriatrician will need to ensure CS are in place.	Refer to community supports	Precision – Imprecise consultations for CGA and care planning is more challenging because the older adult doesn't yet have a team in place and the Geriatrician needs to initiate that process. It's far less challenging to care plan for an older adult who already has a SW, PT, OT.	Delays in care due to organization of care plan and identification of CS team members required.	**MICRO 4.** **MESO 1.** **MESO 2.** **MESO 3.**
69.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** After the CGA it may be determined the older adult would benefit from palliative care services.	Palliative services	Precision – Imprecise After the CGA it may be determined the older adult would benefit from palliative care. Because the GMS clinic does not have access to a team, they cannot administer palliative care and must consult the palliative team, which results in another assessment. If a team was in place the GMS could provide this service. Time – Too Long Time to see palliative care is 2 weeks or more.	Delays in accessing palliative care, duplication in physician services	**MESO 2.** **MACRO 1.**

70.	**GERIATRIC MEDICINE SERVICES CLINIC (-)** After the CGA it may be determined the older adult would benefit from specialty services.	Transitioning to speciality services	Precision – Imprecise After the CGA it may be determined the older adult requires Geriatric Psychiatry services or Neurology, Oncology Time – Too long, time is dependent on urgency and waiting time for specialist	Due to the high demand of speciality services, there may be a delay, and the older adult would require another assessment and plan developed by the specialist. Older adults would be returned to the care of their Family doctors until specialty consultation was in place.	**MESO 2.** **MESO 3.** **MACRO 1.** **MACRO 3.**
71.	**COMMUNITY SUPPORTS PROGRAM (-)** The CS SW, PT, OT, Nurse will prepare a follow up schedule specific to the needs of the older adult.	Follow up	Precision – Imprecise Planned follow up may be interrupted due to the demands of new consultations to their services.	This may result in a delay in follow up. Older adults may experience adverse events or functional decline that could have been preventable.	**MESO 2.** **MESO 3.**
72.	**HOME FIRST PROGRAM (+)** Home First is meant to transition the older adult from hospital to home. Some older adults may require more long-term support and will be referred to the CS program.	Refer to Community Supports	Precision – Precise The care provided is comprehensive and patients are monitored by the team for readiness. Time – On time	Hospital to home transition care may prevent adverse events and admissions to ED, hospital etc. Referral to CS for longer term needs allows the HF program to remain accessible to older adults requiring more	**MESO 2.** **MESO 3.** **MESO 7.** **MESO 9.** **MACRO 1.**

				acute transitional care services.	
73.	**HOME FIRST PROGRAM (+)** Clear timelines and goals are set at the outset. Once met the older adult is referred to their Family Doctor	Discharge	Precision – Precise The care provided is comprehensive and patients are monitored by the team for readiness. Time – On time	Hospital to home transition care may prevent adverse events and admissions to ED, hospital etc.	**MESO 3.** **MESO 7.** **MESO 9.** **MACRO 1.**
74.	**FAMILY DOCTOR (-)** Booking follow up that meets the complex needs of older adults is challenging due to the demands and constraints of primary care.	Follow up	Precision – Imprecise Visits are controlled by Medicare constraints and overall demands of the practice Time – Dependent on the availability of the family doctor. Some family doctors may be more accessible than others.	Delayed follow up or follow up that cannot fully address the complex needs of the older adult may result in adverse events and admissions to ED, hospital etc.	**MACRO 1.** **MACRO 2.** **MACRO 3.**

Appendix G

Analysis of Variability - Hypothetical Patient Journey Scenario

Hypothetical Patient Journey - Fred					
No.	**Variability + or -)**	**Function**	**Manifestation of Variability Time and/or Precision**	**Downstream Effects**	**Proposed Recommendations by Micro-, Meso-, Macro-level**
1.	**Family Doctor (-)**	Prepare for appointment. The presenting concern is memory and anxiety issues. The family doctor spends up to 30 minutes reviewing Fred's labs, prescriptions, and Fred's most recent history before conducting the office appointment. Fred takes a sedative (benzodiazepine), a blood thinner (Warfarin), and several anti hypertensive medications.	Time – too long Precision - Imprecise Having to access multiple platforms rather than one chart in one IT platform is an inefficient use of physician time which could be better spent with their patients.	This has a downstream effect on the function - <To conduct office appointment> The family doctor can only conduct a limited number of visits/day due to these inefficiencies which coincide with other practice demands (high volumes, high complexity, hospital duties etc.) leading to reduced access.	**MACRO 1, 3** **MESO 4**

2.	**Family Doctor (-)**	To conduct office appointment Medicare office visit billing parameters limit visits to 15 minutes	Time – Too early Older adults often have needs that are too complex for a 15-minute visit.	A 15-minute appointment does not allow for a thorough assessment of Fred who has complex needs. Fred and his wife Laura discuss Fred's memory and anxiety only with their family doctor. Fred is also having issues with balance and frequent urination. The family doctor is unaware of these additional health issues. This will have a downstream impact on the functions <To consult GMS Clinic> and <To add/rank patient's on priority waiting list>. Because Fred's other issues are not realized he is deemed to be a routine consult.	**MACRO 2, 3**
3.	**Geriatric Medicine Services (-)**	To consult GMS Clinic	Time – Too long Precision- Imprecise Fred's complexity is not fully realized. The consult is routine and is faxed to the GMS clinic	The consult is not reviewed for 3 months the GMS clinic. This has a downstream impact on impact on health outcomes for Fred. His anxiety worsens at home. He leaves the house less and no longer spends time with his friends.	**MICRO 1, 3** **MESO 1** **MACRO 1**

			will not be reviewed for 2-3months.	Fred's condition continues to decline at home. He becomes more dependent on Laura.	
4.	**Geriatric Medicine Services (-) (+)**	To add/rank patients on priority waiting list. Geriatricians rank consultations as Urgent, Priority 1, and Priority 2	Time – too long the consult is reviewed and is not deemed urgent but is triaged as a Priority 1 where the average waiting time is >6 months.	The Geriatricians wants the CMR completed prior to the GMS visit. A consult will be sent to the MTS 2 weeks prior to the GMS clinic appointment. This will impact the MTS function <To schedule an appointment>.	**MICRO 1, 3** **MESO 1** **MACRO 1**
5.	**Geriatric Medicine Services (-)**	To consult MTS	Precision – Precise The Geriatrician determines Fred would benefit from a Comprehensive Medication Review (CMR) by a clinical pharmacist.	Fred's condition declines further while waiting. He begins to experience worsening balance issues and some falls while mobilizing to the bathroom and while showering/bathing. His anxiety worsens and he is becoming more easily agitated. Laura is exhausted.	**MESO 2, 3, 6**
6.	**Geriatric Medicine Services (-)**	To schedule appointment	Time - Too long Fred is triaged and the GMS appointment is booked for 5 months later.	Fred needs to wait until his GMS appointment is scheduled before an appointment with the pharmacist is booked.	**MICRO 3, 4** **MESO 1, 2**
7.	**Medication Therapeutics Services (-) (+)**	To schedule appointment	Time – Too long Precision - Precise MTS clinic is accessible	Once the GMS appointment is booked and an appointment with the MTS is scheduled. The MTS clinic	**MICRO 3**

			The MTS (pharmacy) clinic is scheduled 2 weeks prior to the GMS visit.	is accessible and can accommodate this GMS clinic time sensitive request.	
8.	**Medication Therapeutics Services (+)**	To gather information The pharmacist spends > 30 minutes accessing several IT platforms to gather information to prepare for the appointment with Fred.	. Time – too long Precision – Imprecise Having to access multiple platforms rather than one chart in one IT platform is an inefficient use of the pharmacist's time which could be better spent with their patients.	This can impact the amount of clinical time available/day for comprehensive medication reviews for older people such as Fred.	**MESO 4**
9.	**Medication Therapeutics Services (+) (-)**	MTS assessment functions (to obtain past medical history, to obtain social/lifestyle history, to conduct medication review, to identify what matters most)	Time – on time Precision – Imprecise Fred is taking several antihypertensives and a benzodiazepine which could be contributing to his balance issues. He is also taking a blood thinner. Fred reports he often falls in the bathroom and when he gets up a night to urinate.	The time spent on assessment functions is lengthy for all healthcare professionals on Fred's journey. Assessment functions could be completed by other professionals and documented in one chart which could avoid Fred having to repeat his medical history and to have repetitive assessments.	**MESO 2** **MACRO 1, 5**
10.	**Medication Therapeutics Services (+)**	Decision making functions (<to make recommendations to older adult> <to develop plan of care>)	Time – on time Precision – Precise	Fred and Laura are involved as members of Fred's health team in the decision making and in the development of recommendations.	**MICRO 5**

		The pharmacists synthesize the information gathered in their assessment and develop a plan care, to make recommendations. To communicate with prescribers	The pharmacist identifies Fred and Laura's goals for Fred's health and wellness and any teaching needs related his medication regime.		
11.	**Medication Therapeutics Services (-) (+)**	The pharmacists can communicate with prescribers by completing a recommendations letters sent by fax. Or can call providers. The MTS pharmacists and Geriatricians alternatively have Direct Messaging (DM) capabilities between their clinics using the EHR.	The pharmacist is concerned about Fred's balance and identifies he's at significant risk for a fall due to interactions and adverse effects from his medication regimen. A Direct Message (DM) is sent to the Geriatrician which expedites communication.	Without independent prescriptive authority, the pharmacist, cannot enact interventions and must defer to a prescriber to address the medication safety concerns. This impacts the functions <to communicate with prescribers> and results in a delay in medication safety intervention for Fred. There is a positive downstream effect on the functions <to schedule a GMS appointment> and <to conduct a GMS appointment> Fred is booked for an urgent appointment. There is also a positive downstream impact on the GMS functions <to complete medication review> and <to make medication changes> The Geriatrician will spend less time on these functions	**MACRO 5**

				due to the assessment and communication provided by the MTS.	
12.	**Geriatric Medicine Services (-)**	Assessment functions (history, physical exam, medication, mobility, cognitive, what matters most, collateral history, functional assessment, geriatric syndrome assessment.	Time – too long Precision – Imprecise Several of the assessment functions conducted on Fred could be completed by other professionals who are more accessible. It is a lengthy appointment due to the number of to assessment functions that are required to ensure the CGA is comprehensive.	There is a downstream impact on the time available to complete the function < To provide education to older adult and caregiver> Assessments completed by other qualified professionals would provide Geriatricians more time for communicating diagnoses and explaining the plan of care to Fred and Laura. Laura returns home uncertain of what to expect.	**MESO 2, 11**
13.	**Geriatric Medicine Services (+) (-)**	Decision Making functions (to synthesize findings, to develop plan of care) -cognitive impairment, requires further workup and follow up with GMS. - Fred's at risk for a significant fall and will require dosage changes and deprescribing and follow up with MTS. Referral to the CS program for homecare	Precision - Precise The decisions made for Fred's care going forward will acknowledge and address the complexity of his needs. Time – too long The waiting time to get to the stage of decision making and planning for Fred was too long since first assessed by his family doctor.	The plan of care is holistic and aims to have a positive impact on outcomes for Fred. The plan of care will not only address his diagnoses but also initiate home supports and improve his safety in the home. Fred experiences functional decline in the time period awaiting the CGA and plan for care. A CGA conducted in the earlier stages of his illness could have prevented his decline and he would not require the level of intervention he does now.	**MESO 2** **MACRO 1**

		eligibility assessment and PT/OT assessments and interventions.			
14.	**Geriatric Medicine Services (-)**	To provide education to older adult and caregiver After the GCA process is complete the Geriatrician spends time reviewing the diagnosis and plan with the older adult and family allowing time for family to ask questions.	Time – too early Precision – Imprecise Very little time left for this function – 15 minutes. Each Geriatrician commented more time needs to be spent on education.	There is much to communicate with Fred and Laura. Fred has several issues that need to be addressed. The new diagnosis and plan are overwhelming for Fred and Laura, they return home with several questions/concerns. More time for questions and teaching and follow up communication would reduce anxiety and uncertainty. Fred and Laura are concerned about financial costs of home care services.	**MESO 2**
15.	**Community Supports –Intake Assessment (+)**	Intake functions (<to conduct intake phone call, conduct Contact RAI, to determine eligibility, to determine urgency, to determine needs)	Time – on time Precision - Imprecise Intake process is accessible and initiated promptly from the time the referral is received from the GMS clinic.	Fred will again answer similar questions already asked of him by his family doctor, MTS pharmacist, and the geriatrician.	**MICRO 6,7**
16.	**Community Supports (+)**	To assign case to geographic zone The intake process is completed. Fred is eligible, he is triaged as urgent. The contact RAI	Time- on time Precision -Precise The intake worker sends notification of Fred's needs for further	Each professional receives the referral information and contact RAI document that was completed documenting Fred's needs.	**MESO 2**

		is sent to the entire zone team for review.	assessment to the CS team (OT, PT, SW)		
17.	**Community Supports Team Huddle and GMS Geriatricians (+)**	To conduct team huddle 3 days a week the entire team with a GMS Geriatrician meet to discuss new patients or current patients. Care plans and problem solving often occur. The team determines who is the right professional(s) for the patient's needs.	Time – On time Very timely, meetings are three times/week. Precision – Precise Opportunity for team members to collaborate regarding assessments, interventions, problem solving and care planning.	The SW and OT determine from the team huddle Fred requires an assessment of personal care needs and OT to assess equipment needs for safety in conducting ADLs (bathing, mobilizing). SW and OT plan to conduct Fred's initial assessment together. This will have a positive downstream impact on the assessments completed by SW and OT reducing duplication and improving communication.	**MESO 2**
18.	**Community Supports – SW and OT (-)**	To review/prepare Both the OT and the SW would take the time review Fred's health and social care information by visiting the multiple IT platforms that contain this information.	Time – too long Precision – Imprecise Similar to the other healthcare professionals, having to access multiple platforms rather than one chart in one IT platform is an inefficient use of time which could be better spent with their patients.	The SW and OT don't have access to all of Fred's history due to the number of IT platforms housing Fred's health information.	**MESO 2**

19.	**Community Supports – SW and OT (-)**	Assessment functions (to gather medical history, to conduct cognitive assessment, to conduct medication assessment, to gather collateral history, to conduct functional assessment, to determine what matters most, to conduct a mobility assessment).	Too long- the SW assessment + OT assessment takes >2 hours. Precision – Imprecise Some of the data collected in this home assessment is information that has already been collected in previous assessments with the family doctor, pharmacists, GMS clinic. The SW and OT don't know what was collected because they don't have access to other healthcare providers' documentation.	Fred becomes frustrated telling the SW and OT the information they are asking for is in his chart. Much of the data is then retrieved from Laura who is also frustrated and feels as though this information has already been collected several times.	**MESO 2, 4**
20.	**Community Supports SW + OT (+)**	Care planning functions (synthesize findings) Through synthesis of the assessment findings, the SW determines Fred is eligible for home care services and determines the hours of services needed.	Timing – on time Precision - Precise Both professionals are able to synthesize information promptly and determine needs and next steps	Fred and Laura feel Fred's needs are well understood and they are included in goal setting for Fred.	**MESO 2, 4**

		Through synthesis of the assessment findings the OT determines Fred needs some equipment to prevent falls (shower chair, bars, bar next to the toilet, a walker to assist him at night, nighttime lighting).			
21.	**Community Supports SW + OT (+)**	Care planning functions (determine service hours and goals to provide family/older adult with home care options, write equipment prescriptions, write letters).	Timing – on time Precision - Precise Both professionals return to their workspace to complete paperwork related to care planning	Fred is given a walker and shower chair and he and Laura will wait to hear form the OT regarding further equipment and installation for Fred's safety. Fred and Laura will also await word from the SW about the number of hours of home care Fred is eligible for and the home care company options that are available.	**MICRO 4** **MESO 2,3,4**
22.	**Community Supports SW + OT (-)**	To document	Time – on time Precision – Imprecise The SW/OT document in the CS documentation portal (CRMS). The SW also documents in the InterRAI-HC which is stored in the Momentum portal.	This documentation is available to all CS health and social care professionals to access and read. It is not available to the family doctor.	**MICRO 4** **MESO 2,3,4**

23.	**Community Supports SW + OT (+)**	Team Huddle	Time – on time Precision - Precise The team huddle is the next day, and the team is updated on Fred's care planning.	Care planning is discussed for Fred. No further professionals required and Fred is scheduled to begin receiving home care services within a week. Process for safety rail installation initiated by the OT.	**MESO 4. 11**
24.	**Community Supports SW, OT, GMS (-)**	Communication with other healthcare professionals	Precision – Imprecise Fred's family doctor is unaware of the specifics of the plan.	Fred's family doctor is made aware that the CS program has been consulted by way of a letter from the GMS clinic and they also receive a letter from the MTS clinic. There is no communication from CS.	**MESO 2, 3**
25.	**Family doctor (-)**	Communication with other health care professionals Fred's family doctor received letters form the GMS clinic and the MTS clinic. The family doctor reviews these prior to the follow up visit with Fred.	Time – On time Precision – Imprecise Fred and Laura attend an appointment with their family doctor who learns about the plan for home care from Fred and Laura.	Fred's family doctor does not have access to the CRMS platform and is not alerted when Fred becomes a client with CRMS. The family doctor feels disconnected from this important aspect of care delivery and must ask Fred and Laura about their experiences and the plan for care with CS homecare.	**MESO 4, 11**

26.	**GMS, Community Supports, MTS clinic, family doctor**	Disposition functions (follow up)	Precision – Precise Time – on time The MTS will meet with Fred to conduct a deprescribing regimen. Community Supports will conduct follow up quarterly phone calls and an annual visit with Fred and Laura to ensure services are meeting their needs. GMS clinic will follow up with Fred until it is determined he no longer requires GMS service. The family doctor will continue to provide PHC services.	Fred's functional condition and balance improve. He feels less anxious about his ADLs and is able to spend time with family and visit with friends.	**MICRO 4** **MESO 3, 4, 8**

Appendix H

Multi-Level Recommendations

Micro-Level Recommendations

MICRO 1. A case manager could receive and review GMS consults and would also be responsible for triaging consults. Consultations could be investigated for appropriateness more thoroughly and triaged more promptly, identifying those with more urgent needs sooner.

MICRO 2. Provide PHC providers with scenarios outlining what is appropriate for E-consult vs. appointment.

MICRO 3. Geriatricians have a number of clinical and non-clinical activities for both Geriatrics and Internal Medicine. A review of clinical duties, such as inpatient rounds, admission privileges, and call for Internal Medicine should be considered.

MICRO 4. The Community Support intake process as a single-entry point for accessing a CGA for an older adult with complex needs. The majority of the CGA could be completed by an integrated care team reducing the Geriatrician's workload, with a case manager (Nursing) to ensure coordination and continuity.

MICRO 5. Encourage more opportunities where older adults and family/caregivers can build capacity for self-management. Promote services of MTS clinic and encourage PHC providers to partner with pharmacists in caring for older adults with complex conditions.

MICRO 6. Provide older adults and their family/caregivers with access to case management services to receive ongoing education and support to build self-management capacity and assist older adults in their efforts to age in place.

MICRO 7. Develop caregiver emotional support and respite programs in communities across the province.

Meso-Level Recommendations

MESO 1. Hiring Registered Nurses (RNs or NPs) in integrated care case management roles. The role would need to be defined to meet the program needs. Scope of practice and responsibilities of the case manager would need to be clearly defined.

MESO 2. Examination of human resource and infrastructure requirements across the community based system to identify feasibility of creating an integrated CGA process that is less Geriatrician dependent and promotes team-based services.

MESO 3. Development and communication of a shared goal of care and service and a shared culture that supports attaining the goal. The overall goal of care and service is maintaining and preventing decline in an older person's intrinsic capacity and functional ability. Health and social care professionals are aware of the expertise, roles, and responsibilities of other professionals.

MESO 4. One chart access for health and social care professionals where access to all documentation, lab results, plans of care are stored and are accessible.

MESO 5. Optimize the LPN role to its full scope of practice. In addition to conducting a nursing assessment the LPN could gather information and complete sections of the CGA that do not require the expertise and time of a Geriatrician.

MESO 6. Optimize the role of the pharmacist in the MTS clinic. Older adults taking multiple medications would benefit from a comprehensive medication review completed by a pharmacist as a component of an integrated CGA process.

MESO 7. Examine the feasibility of introducing the Nurse Practitioner role across the Home First program and Community Supports programs to improve access to home based primary care services for older adults with complex health issues.

MESO 8. Continue Team Huddles and identify human, organizational, and technological resources requirements to enact Team Huddles for all 6 Community Support program zones.

MESO 9. Continue Team Huddles and identify human, organizational, and technological resources requirements to enact expanded Team Huddles with Geriatricians and other potential health and social care professionals permanently for the HF program .

MESO 10. More efficient documentation system for Community Support physiotherapists – create populated work sheets. Reduce narrative documentation.

MESO 11. Information Technology mechanisms to provide opportunities for improved communication between CS, HF, MTS, GMS, and family doctors. Direct messaging notifications.

Macro-Level Recommendations

MACRO 1. Additional training certifications for all clinicians who specialize in older adult care. (GPs, NPs, RNs, LPNs, SWs, PTs/OTs, pharmacists etc.) Optimize the capabilities of these professionals and their knowledge of clinical resources available in their community.

MACRO 2. Create a complex care billing code for older adults that remunerates a Primary Care physician appropriately for the time required to care for an older adult.

MACRO 3. Advocate team based Primary Care practices (pharmacist, social work, nursing, OT/PT, MD) optimized to meet complex care needs of older adults. Older adults with more advanced care needs can be referred to the GMS clinic with the primary care team available to support the recommendations of the GMS clinic.

MACRO 4. Regulate home care agencies and workers by introducing legislation to standardize education and training programs. Legislation would also introduce practice acts that organize how home care workers safely, legally, and ethically perform their duties and responsibilities.

MACRO 5. Advocate for legislative changes to the scope of practice of pharmacists to enact prescriptive authority.

Appendix I

Findings with participant quotes

Identification of Challenges and Opportunities for Integrated Care Implementation

Challenges to Integrated care Implementation

The following section presents the challenges to local integrated care implementation that were determined from the emergence of negative variability in the community based CGA process. Each challenge is followed by quotations from study participants to Illustrate the findings.

Primary Care Structure. Many family doctors in the local setting practice medicine within the confines of the fee for service structure which limit most appointments to 15 minutes. This leaves little opportunity for older people to communicate their needs and have their needs met. The current structure challenges a family doctor's ability to deliver comprehensive care.

"In order for you to achieve some better outcomes, you'd like to have more time, but the system in the way that it's set up, just doesn't allow for that, and I think what happens is because people don't have the time they probably put in referrals to geriatrics that probably aren't necessary but they don't have time to do it [comprehensive geriatric care]. But then that clogs up the geriatric waitlist for things that probably aren't' necessary. Its just people don't have the time" – Family Doctor

"The healthcare system is not set up for primary healthcare physicians to provide good care even if they were upscaled [completed geriatric training] ...you've got to turn over patients really quickly and that's hard to do. You can't you know, see a geriatric patient in 10 minutes and deal with them effectively…the whole infrastructure is not set up for it" - Geriatrician.

Siloed Design. Each professional spends time gathering health information from multiple electronic health platforms, then assesses the urgency of needs and conducts assessment functions. Older people will find themselves 'starting over' with every professional encountered in the process. No one is responsible for monitoring and assisting older people with the multiple services that they may need to access.

"*We're duplicating a lot and we're duplicating a lot of assessment and not focusing as much on the management.*

So again, it comes back to that you know within the strategic plans, how many assessments were done, well, what does that matter if you're not actually managing these people [patients]?" - Geriatrician

"We are more so consultative, because we don't have the resources to be able to stay with the client to get them to their best." – Community Supports Physiotherapist

"I think for us ideally, we would like to be more of a multidisciplinary service. So, I think anytime that we have the opportunity to pull in other disciplines its ideal" – Geriatrician.

Electronic Health Record Interoperability. Patients do not have one medical record; they have multiple records. There are platforms that store hospital-based records, prescription medication history, and manual charts storing professional domain specific documentation. Each of these platforms may or may not be accessible to each professional. As a result, there is a lack of awareness of the involvement of other professionals in the circle of care.

"So that's part of the issue. You know, the whole fragmented disjointed issue. GPs well you're not going to see any of our notes [Community Supports and Home First Programs]. Specialists don't see our notes. They don't oftentimes even know that their [patients] involved with Home First" – Home First Nurse Practitioner

"I think it would be very useful to have sort of a living document that's created around this patient where it's not so heavy on the physician because your other members of the team could complete the mobility assessment and type that in a living document where all the pieces are kept. Different people who are experts. And when a physician comes in, could synthesize all that information and it would be accurate and up to date…I could then create an impression and plan on that document…what you're going to do going forward. – Geriatrician

Expertise of Professionals/Unregulated Workers. Participants communicated they lacked specialized training and education in the care of older people. Formal healthcare education programs graduate generalists challenging the ability to build capacity across the health and social care workforce. There is currently no regulation of personal support workers and no standardization of education and training programs. This results in different levels of knowledge, skills, and abilities in providing care and service delivery to older people.

"*People don't understand frailty and the true impact on function, they're [allied health workers and family doctors] not specialists in that area, they don't have the time sometimes to really, fully assess somebody's function. There are pockets of people that are well trained in older adult care…it would be useful to have people that are trained in geriatric care and are able to document that and communicate that back and forth. There are Occupational Therapists [in other jurisdictions] that are trained to do certain tests of function and come up with these evidence-based scores and number that help inform our decisions"* - Geriatrician.

Communication. Currently there are few mechanisms in place to facilitate interdisciplinary communication and shared care planning. Practice demands for health and social care professionals limit their availability to connect in a timely way. This also impacts consultation and referral practices. There is variability in the specification and completeness of consultation forms resulting in delays in care for older people.

"Why is it such a task to get information from other healthcare providers? We're all talking about team-based care, but no one wants to share information." – Family Doctor

"So maybe it happens [communication], maybe it doesn't, maybe they [patients] get worse, maybe they don't, maybe they get significantly worse. And now they need placement, and they get placed and now they're gone off into long term care and I have no idea" – Family Doctor

"We get roadblocks waiting on medical doctors. They're often impossible to get a hold of, multiple phone call, faxing off letters to say I really need to talk about this client" – Social Worker

Geriatrician Accessibility. Waiting time from consultation to appointment can be as long as 2 years. Geriatricians described completing the bulk of the CGA, which is a lengthy exam (approximately 2 hours). Geriatricians also described having various practice demands including academic and research responsibilities, triaging, as well as hospital-based clinical responsibilities.

"*We do not have great access because there's not very many of them [Geriatricians]. So, a lot of that [geriatric care] is done by primary care"* – Family Doctor

"When I triage someone to it [routine, priority 2 waiting list] it literally keeps me up at night because that person is going to die before we get to her or is going to have a serious outcome and then we must see them urgently. So, the whole list [waiting list] is kind of a joke, right? Isn't it? We're an inefficient service and almost ineffective because we can't get to our lists" - Geriatrician.

"*We're taking patients that people are calling us about and saying can you see this urgently and we say yeah. And a lot of the times those people are already on our waitlist"* – Geriatrician.

Outcome Measurements. There are currently no Patient Reported Outcome Measurements being collected that can provide a means of evaluating current programming.

"This is a big gap in our organization is that older adult care has only started to become a strategic priority. In the strategic plan it mentions number of assessments for home support as a metric. So, which to me is not a good metric. I would like to see us move towards quality standards for older adult care, like standardized outcome measures. There is the ICHOM that has an older adult set. Its an internationally approved set of measures that you should be thinking about annually for an older adult that should guide your care." - Geriatrician

Shared Goals and Objectives. There are no written/documented shared goals and objectives to guide community based health and social care delivery.

Opportunities for Integrated Care Implementation.

The following section identifies opportunities for local integrated care implementation that were determined from the emergence of positive variability in the community based CGA process. Each challenge is followed by quotations from study participants to Illustrate the findings.

Communication. Direct messaging between pharmacists and geriatricians through the electronic health record was identified as convenient and facilitates shared decision making and avoids lost productivity due to missed communication.

"We communicate directly through the EHR messaging. So oftentimes if they have a patient that they want to be seen, they may task us or message us within the EHR. Can you see this person?" – Pharmacist

Team Huddles. Team Huddles were conducted three days/week in one of six community health zones. These team-based care meetings provided a means of developing shared care planning and identifying which professional(s) could best meet the needs of the older person. Professionals were also given opportunities to problem solve together and develop shared care plans.

"We join that huddle three times a week on Monday, Wednesday, and Friday. And if any challenging cases come up, we help from a medical perspective. They [community supports] have no medical leadership, we help them navigate that. And then if there's anyone that comes up from an urgent perspective that would require our services, we offer that urgent assessment…and streamline the care because they're lacking medical leadership and we're lacking a team" – Geriatrician.

"We started experimenting with them [Geriatricians] going on huddles and identifying who the type of clients that we need to be connecting with them about. They're a speciality, we're really using them because we have so many gaps right now in terms of bringing our primary care physicians to the table" – Community Supports Manager

"People [community supports allied health] are reaching out to them [Geriatricians] and they probably didn't think at one point that they had access or could even consult. So that has been tremendous to our program" – Community Supports Manager

Opportunities to Build Self Management Skills. Workers reported older people gained an improved understanding of their prescription and over the counter medication regimes as well as self management skills from comprehensive medication reviews conducted by pharmacists. Physiotherapists, Occupational Therapists, and Registered Nurses (RN) also offer older people these opportunities when providing teaching on exercises, the use of mobility aides, and instruction on conducting wound care and medication administration.

"I find that you know, all clients no matter what age a bit ambivalent and just kind of can be just take their medications as they're told and never ask any questions and that, but I think after these

visits, one thing that I really enjoy seeing them kind of change their perspective and being really thought of as a member of the healthcare team that's empowered." - Pharmacist

Accessible of Health and Social Care Professionals. Nurse Practitioners, pharmacists, RNs, and Social Workers can accommodate timely access for older people referred to their care when compared to Geriatrician access.

"Having that [comprehensive medication review by the MTS pharmacist] in advance of our appointment is so useful because they've done that digging on the medical side because they structure medication review. So, the patient will come back with an accurate med list, an accurate problem list. MTS can also help with the management if it's a polypharmacy issue. So, we'll manage it together" – Geriatrician.

So, the CGA is meant to be multidisciplinary. It's not meant to be single provider. So, it, it is a physician who kind of correlated and develops the plan. But typically, all those other areas, you know the assessment of the mobility would be done with the assistance of a physiotherapist or occupational therapist, the medication piece ideally would done with a pharmacist" - Geriatrician.

Comprehensive Examinations. Community based CGAs provide older people access to comprehensive care planning that aims to maintain and prevent decline in an older person's intrinsic capacity and functional ability.

"The whole point of a comprehensive assessment, the way that is structured is that, so you don't miss anything, and that you do actually have a comprehensive view of the patient before you're moving forward." - Geriatrician

Chapter 6.

6.1 Conclusions

Conducting CGAs for older people in the community setting is a challenging endeavour. The process is dynamic, multifaceted, and requires the execution and coordination of several interdependent functions over time, and over multiple subsystem. The research work conducted identified the level of precision and the time that is required in carrying out a CGA can be significantly impacted by variability that can emerge and propagate over the course of the process. Within a complex healthcare process, the performance of humans and organizations operating within government and regulatory environments will vary significantly and adjustments will be made to meet system demands. These adjustments will produce positive outcomes but can also at times result in poor outcomes. FRAM modelling (FRAM and DynaFRAM) as a systems thinking approach has demonstrated its ability in gaining an improved multi-level understanding of the functionality and variability of the CGA process.

This doctoral work has focused on advancing the knowledge of how the FRAM can been used to gain an improved understanding of the functionality and variability in the everyday operations of a complex healthcare process. Three thesis aims with associated research questions were developed. As evidenced by the scoping review paper presented in chapter 2- the research question was addressed and the intended first aim of the thesis was met. The scoping review revealed how the FRAM has been operationalized in healthcare research, as well as the suitability of its application in modeling and analyzing complex processes and systems in the healthcare domain.

The paper presented in chapters 3 met the second thesis aim and answered the associated research question by identifying the necessary factors to consider when designing a qualitative research study to inform the building of a FRAM model.

The paper presented in chapter 4 provided also met the second thesis aim and associated research question by providing a comprehensive description of quality enhancement criteria and strategies healthcare researchers using the FRAM can employ in their efforts to enhance the trustworthiness of their findings. Two of these papers have been published and one is currently in press in peer reviewed journals with target audiences in the health and social sciences. Although the use of the FRAM in healthcare research is rising, it remains a relatively novel methodology in the healthcare domain. The papers presented in chapters 2, 3, and 4 of this thesis provide healthcare researchers, administrators, and clinicians with domain specific knowledge which can enhance understanding and uptake of the methodology in healthcare research.

The third aim of this doctoral work was also met and the research questions answered as evidenced by the study presented in chapter 5 of this thesis. A literature review of integrated care was conducted and provided a description of the key components of integrated care and an explanation of how integrated care takes place through the micro-, meso-, and macro-levels of the healthcare system. In an effort to anticipate integrated care implementation challenges in the local context, an examination and analysis of the CGA process was undertaken using the FRAM and DynaFRAM. The FRAM model that was built and is presented in Chapter 5 provides a visual depiction of the scale and complexity of the system in which health and social care professionals conduct their work. It also provides a detailed view of the dense web older people are required to navigate to access care. The model is not a typical linear model or flow chart depicting a healthcare process with arrows pointing in one direction.

This is an important distinction. The FRAM model of the community based health and social care system does not attempt to simplify everyday complexity and because of this, the resultant model has provided an improved understanding of how the current community based health and social care system operates.

An analysis of variability was conducted in two ways. Study participants were asked specific questions to elicit information on how the outputs from functions could vary and how that variability could show itself in the process. The hypothetical patient journey was an additional means of assessing variability. It was developed using DynaFRAM and provided an example of a functional path through the CGA process that could be taken by an older person, and the variability that could emerge in impact outcomes. Gaining an understanding of how variability can potentially emerge in the process, and how variability emerged along the hypothetical journey assisted in identifying challenges and opportunities for implementing integrated care in the local context. With this understanding, multi-level policy recommendations were co-designed with health and social care professionals to move the CGA process towards a more integrated model of care delivery.

The application of the FRAM and DynaFRAM in examining and analyzing the human, technological, organizational, and environmental factors impacting the process of CGA has demonstrated how a systems thinking approach can advance healthcare policy development. FRAM modelling provided a work as done understanding of the process and was able to identify strong and weak interfaces in the current process.

The co-design of practical and relevant health policy recommendations were informed by an improved understanding of how health and social care professionals conduct their work and how older people navigate a healthcare journey under dynamic conditions.

Although based on a hypothetical patient journey, DynaFRAM provided an important bird's eye view perspective to consider when designing healthcare processes and policies to support them.

6.2. Limitations & Future work

The FRAM aims to examine processes and systems in local settings and provide context specific recommendations to manage variability. Because of the highly contextualized nature of studies using the FRAM, readers may find the transferability of study findings to be limited. Researchers can potentially address challenges in transferability by offering an alternative, such as functional transferability. Several FRAM studies have examined care transitions in the elderly, specifically hospital to home transitions (1-4). Although the FRAM models are specific to each work context, many of the functions in the care transitions models are similar and could constitute a type of functional library that other researchers could use to assist in developing new FRAM models specific to their study settings.

When designing a research study using the FRAM, an understanding of the resources required is an important consideration. A limitation identified in the research of the CGA process is the resource and time intensive nature of conducting the FRAM analysis. This is a limitation that is also identified in the FRAM literature (2,3,5-7). The building of the community based health and social care system required 115 hours. Unfortunately, the time required to conduct data collection (semi-structured interviews, focus groups, and document review) and the time required to conduct the analysis of variability were not tracked in this study. Future healthcare studies using the FRAM should consider recording the time allotted to conduct an entire FRAM analysis. Damen et al. (8) present a table with a breakdown of the time devoted to each step using the FRAM.

The data is provided to demonstrate the usability of the FRAM. Having this understanding can assist in determining the potential time and human resources required to build a FRAM model. The time required to conduct a full FRAM analysis also does not account for the time and resources required to become proficient in the methodology prior to conducting a study. There are calls to engage end users more in research and process improvements in healthcare (9,10). Further uptake of the FRAM in the healthcare domain would benefit from the engagement of end users, such as clinicians and administrators. Future research efforts could focus on the development of effective teaching and learning strategies for delivering FRAM education to end users.

An additional limitation is the CGA study would have benefitted from the perspectives and opinions of older people and their family/caregivers given the aim of integrated care delivery being centred around patient needs, preferences, and goals. The CGA study was able to demonstrate the use of a functional signature to represent a hypothetical patient journey across multiple subsystems. To improve healthcare quality, improving the patient journey is of paramount importance (11). Future research could seek to create functional signatures depicting patient journeys using data from prospective or retrospective case study analyses. Case study data would likely provide important insights and perspectives from older people that was not identified in this research work. Patient journey mapping can potentially provide a better understanding of the challenges patients and their families face when transitioning between clinical visits and care settings (11). The approach aims to visually map the interactive touch points of the care trajectory (12).

A scoping review of the literature on reporting and conducting patient journey mapping in healthcare indicates it holds significant promise for understanding and improving complex care processes (13). Patient journey mapping is a relatively novel concept in the healthcare domain with low adoption rates, this thought to be due to a lack of a standard approach or methodology (14). Patients and their families offer a unique vantage point as they are often the lone points of continuity and consistency in their individual health journeys (15). The research study of the CGA process demonstrated how FRAM and DynaFRAM modelling could be used as a methodological approach to patient journey mapping in complex healthcare processes. Exploring the application of the FRAM and DynaFRAM using prospective or retrospective case study analyses to inform patient journey mapping is a necessary next step in conducting research using the FRAM.

In considering the challenges facing the current healthcare system, the FRAM is a systems thinking approach that can be used to examine and analyze a number of pressing healthcare issues. The ability to visualize the complexity of a healthcare process as well as animate a patient journey through the process is a strength of FRAM modelling. This ability also provides for a powerful means of communication with decision makers at the organizational, policy, governmental, and regulatory levels.

References

1. Buikstra E, Strivens E, Clay-Williams R. Understanding variability in discharge planning processes for the older person. Safety Science. 2020;121:137-46.

2. Laugaland K, Aase K, Waring J. Hospital discharge of the elderly-an observational case study of functions, variability and performance-shaping factors. BMC health services research. 2014;14(1):1-15.

3. O'Hara JK, Baxter R, Hardicre N. 'Handing over to the patient': A FRAM analysis of transitional care combining multiple stakeholder perspectives. Applied ergonomics. 2020;85:103060.

4. Salehi V, Hanson N, Smith D, McCloskey R, Jarrett P, Veitch B. Modeling and analyzing hospital to home transition processes of frail older adults using the functional resonance analysis method (FRAM). Applied Ergonomics. 2021;93:103392.

5. Damen NL, de Vos MS. Experiences with FRAM in Dutch Hospitals: Muddling Through with Models. Resilient Health Care: CRC Press; 2021. p. 71-80.

6. Kaya GK, Ovali HF, Ozturk F. Using the functional resonance analysis method on the drug administration process to assess performance variability. Safety Science. 2019;118:835-40.

7. McNab D, Freestone J, Black C, Carson-Stevens A, Bowie P. Participatory design of an improvement intervention for the primary care management of possible sepsis using the Functional Resonance Analysis Method. BMC medicine. 2018;16:1-20

8. Damen NL, de Vos MS, Moesker MJ, Braithwaite J, van Wijngaarden RAdL, Kaplan J, et al. Preoperative anticoagulation management in everyday clinical practice: an international comparative analysis of work-as-done using the functional resonance analysis method. Journal of patient safety. 2021;17(3):157-65.

9. Bird M, McGillion M, Chambers EM, Dix J, Fajardo CJ, Gilmour M, et al. A generative co-design framework for healthcare innovation: development and application of an end-user engagement framework. Research Involvement and Engagement. 2021;7(1):12.

10. Verville L, Cancelliere C, Connell G, Lee J, Munce S, Mior S, et al. Exploring clinicians' experiences and perceptions of end-user roles in knowledge development: a qualitative study. BMC Health Services Research. 2021;21(1):926.

11. National Academies of Sciences E, Medicine. Crossing the global quality chasm: improving health care worldwide. 2018.

12. Joseph AL, Kushniruk AW, Borycki EM. Patient journey mapping: current practices, challenges and future opportunities in healthcare. Knowledge management & e-learning. 2020;12(4):387.

13. Davies EL, Bulto LN, Walsh A, Pollock D, Langton VM, Laing RE, Graham A, Arnold-Chamney M, Kelly J. Reporting and conducting patient journey mapping research in healthcare: A scoping review. Journal of Advanced Nursing. 2023 Jan;79(1):83-100.

14. Sijm-Eeken M, Zheng J, Peute L. Towards a lean process for patient journey mapping–a case study in a large academic setting. InDigital Personalized Health and Medicine 2020 (pp. 1071-1075). IOS Press.

15. Aase K, Waring J. Crossing boundaries: Establishing a framework for researching quality and safety in care transitions. Applied ergonomics. 2020;89:103228.