# Addressing Rural Health Access Inequity by Assessing Potential and Organizational Readiness for Antifragile Electronic Health Project Design in Rural Communities

by

Samuel Petrie

A thesis submitted to the Faculty of Graduate and Postdoctoral Affairs in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Health Sciences

Carleton University
Ottawa, Ontario

## Abstract

There is a rural health access equity gap (especially for specialist care) within Canadian and international universal healthcare systems. Electronic health (eHealth) can address that gap, but pilot projects rarely scale to other contexts, or sustain in their original settings. Antifragile design and complexity informed principles can improve pilot project lifespans. Antifragile entities gain stability from uncertainty, rather than lose integrity. Antifragile operators include *optionality, non-linear evaluation, hybrid leadership, starting small, and avoiding suboptimization*. The greater the presence of these antifragile indicators, the greater the likelihood a project succeeds in its initial context and scales to others. The antifragile design portfolio (ADP) is comprised an organizational readiness tool and evaluative framework which promotes antifragile operator integration into eHealth implementation in rural communities. Two central findings reflect rural nuance and investigating tacit knowledge of rural implementation facets:

1. **Output 1**: Composite Design Cycle Theory – organizational readiness tool for antifragile eHealth deployment
2. **Output 2**: Matrix of Scale – evaluative framework to assess antifragility and institutional investment of an eHealth project

Together, these outputs can help eHealth programs sustain and scale in rural communities and contribute to addressing the health access equity gap in rural communities and are part of the antifragile design portfolio. Further, these outputs contribute to the creation of placed-based health policy advocated for by the Canadian Medical Association. In a place-based system, strong patient partnership, and care tailored for the needs of the patient can improve outcomes as

well as health system function. The antifragile design portfolio is uniquely situated as a mid-level theory to inform policymakers and decision makers and help reform rural health policy.

## Acknowledgements

I'd like to first thank the residents of the rural communities where I was fortunate enough to spend time as a research resident as part of the Free Range international knowledge exchange. From Storuman, Sweden, to Burra, Australia, I felt welcomed into these communities. The people I met thought these field research opportunities were articulate, kind, and engaged with addressing rural healthcare access inequity. They made the lived experience of being a rural resident an important part of my research process, and instilled in me a sense of strong community in the case of adversity. I hope the results of this doctorate will aid rural places in achieving the health service they deserve.

While working through the COVID-19 pandemic has been challenging and has certainly influenced my work, it has also made me realize the importance of my research. I am thankful for the support from my Graduate Advisory Committee, my friends and family, and my devoted partner in satisfying the requirements of the doctorate program within the department of Health Sciences at Carleton University. I would particularly like to thank my partner, Zoe, whose "words of affirmation, coffee, and good food" were well appreciated throughout my doctoral research. As was her keen aesthetic eye and patient ear as I practiced countless seminars and presentations and had her edit papers and other material. I could not have done this without you. Thank you.

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# Chapter 1: Impact of the Novel Coronavirus (COVID-19) Pandemic on Doctoral Research Activities

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*Some problems are so complex that you must be highly intelligent and well informed just to be undecided about them.*

*~Laurence J. Peter*

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In the winter of 2020, my research was following closely to the timelines outlined in the Carleton Health Sciences PhD stream table. Partnerships were being built with organizations who had interest in both electronic health (eHealth) and implementation. Chief among those institutional partners was the IWK health centre in Halifax, specializing in pediatrics and critical care. Through a CIHR funded health systems impact fellowship, I would have been embedded within their organization for a year to assess the readiness of adopting a clinical information system at multiple sites across the province of Nova Scotia. Instead, that partnership, as well as a partnership with the Ontario Telehealth Network (OTN) and a local initiative out of the Ottawa Civic emergency department, were cut short as goals and resources shifted to combat the global COVID-19 pandemic.

This has had a profound effect on my research, both positively and negatively, and has required adjustments regarding how I collected my data, the context of previously collected data, and how I should rectify my recommendations with the realities of a COVID-19 encumbered health system. Adverse effects of the pandemic are chiefly the break down of personal

networking and partnerships. Being awarded a health systems impact fellowship would have given me an opportunity to prospectively validate the antifragile indicators and organizational readiness capabilities exhibited by institutions in a 'real world' implementation effort. In addition to that, the fellowship would have given me access to many important stakeholders and personnel involved with implementation and decision-making. Getting their feedback on my work – either formally or informally – would have helped immensely in iterating these rules and protocols for future implementation efforts.

Additionally, the COVID-19 pandemic has hindered the field work that was made available through the Free Range international knowledge exchange. Through this partnership, I was able to attend rural health meetings with scholars, practitioners, policymakers, and patients in a diverse range of contexts across the world. These meetings include places such as Iceland, Australia, Sweden, and in Canada. They were immensely helpful in exposing my research and ideas to the 'front-lines' of implementation and health services, and to get valuable insight in what works where and for whom (coincidentally, the mantra of a research methodology used within this dissertation, realist evaluation). While I was still able to communicate with members of the Free Range research group via online mediums, the ability to physically meet up with these seasoned researchers and be located in place at the research contexts was extremely helpful in formulating impactful hypotheses regarding system function and implementation patterns.

Being unable to travel also impacts the ethnographic methodology, Dirt Research, utilized by both myself and the lab of my supervisor, Dr. Paul Peters, the Spatial Determinants of Health Laboratory (SDHL). Dirt research is the mindset in which researchers embed themselves within the communities they are researching. They live in them, shop in them, socialize in them, and of course research in them. By fully embracing the context in which you are deriving

knowledge, you appreciate connections and relationships which otherwise could have been more difficult to understand if the analysis was being done via statistics and other published materials. In fact, doing research in rural communities *necessitates* the partnership with communities, and developing holistic approaches to the problems they face. Therefore, being held at arm's length (or, ocean's length) subtracted from the value of some of the novel observations learned about through virtual meetings, reports, or similar material. Without physically being in place with the very populations and people who this research should reach, creating important protocol and policy consequentially suffered.

### 1.1 eHealth Culture Shift

On the other hand, there were some (if not positive) interesting effects to my research borne out the COVID-19 pandemic. The first being the explosion in interest and literature regarding electronic care and virtual services. COVID-19 shuttered many of the physical brick-and-mortar establishments which had been providing care in person to minimize transmission and contact between patients, providers, and allied health personnel. Elective surgeries were cancelled, emergency departments went into veritable lock down, and out-patient clinics were shuttered. Care which had previously been provided in face-to-face format had to be adjusted to be provided over virtual mediums. In some cases, there had been precedent for doing this before. In many however, practitioners and policymakers did not have the experience or published materials to reference to implement such services in a timely and robust manner. This was doubly true in most rural areas, where resources were already limited *before* the pandemic, and this hamstrung efforts to create a better rural response. There were many impressive efforts undertaken by rural centres of care though – from becoming amplifiers of responsible health

policy in the time of the pandemic to providing improvised eHealth services, rural responses to COVID-19 possessed encouraging signs.

The embracement of eHealth as a viable method of service provision is hard to overstate. Almost overnight, 15 years of trepidation, hesitancy, and reservation about implementing eHealth slackened significantly (1–3). Bluntly, hospitals and other healthcare teams simply had no other choice. The options were to either embrace eHealth and find a way to make it work for their service, see a marked decrease in their ability to provide high quality care to patients, and a high quality experience for providers. Organizations which have been looking to introduce eHealth to standard practice (such as Canada Health Infoway) rallied around this revival of interest and implementation of eHealth across the country (4).

The uptake and dissemination of eHealth initiatives is an interesting proxy for measuring innovation within rural communities. Rural health services are usually expected to be resilient in their operations (5). When applied at the system level, resilience should be coveted by every stakeholder within that system. When applied individually however, at a personal, organizational, or unit level, resilience can be used as a way to deflect the need for more resources or better support. Asking individuals to be resilient is usually the product of being asked to do more with less – less resources, less training, and less support.

Health policy too changed at a rapid pace. Decision-makers and policymakers from the largest hospitals to the smallest clinics began to see the potential of eHealth in mitigating some of the difficulties in providing effective care under the parameters of the 'new normal' (6,7). This led to an explosion of literature, efficacy tests, efficiency modeling, and statistical evidence supporting the implementation of eHealth where physical care was not feasible (8–10). Of course, in Canada, most of the effort to create a comprehensive eHealth scheme arose in urban

centres, governed by urban-centric policy. This wasn't a surprise, as a majority of Canada's population resides within certain geographical boundaries, but the fact remained rural communities – just as Canadian as their urban cousins, and just as deserving of care – did not see a fraction of the resources allocated to them. This left rural communities adrift, and the presence of autonomous change dictated if they were actively thriving or hopelessly coping with the challenges which had to be met head on.

There was also a question of what constitutes 'evidence' for adapting new practice models which have been largely avoided for a better part of a decade in eHealth services. Typically, the evidence-based medicine model of adjusting and creating novel modes of service and protocol takes years to complete (11). Systematic reviews, meta-analyses, and development of top-down repositories of study protocols, methodologies, and results are the foundation of providing medical treatment which can be replicated by hospitals nationally and internationally. In the face of the pandemic however, decision-makers and policymakers had to reconsider what they had to utilize as evidence to create services solutions for patients and providers (12). With the tension for change as high as it was (and in some cases, still is) as well as the rapid nature of COVID-19 progression, evidence which normally is dismissed as anecdotal or contextual (e.g. case studies) became defining literature for which best practice protocols were based. In addition to medical pathology and treatment regimens, this also included the transition of care into virtual spaces and mediums.

This examination of appropriate evidence has been called for a considerable amount of time by rural scholars, as rural places are difficult to assess under standard statistical methods due to their small size (13). Policymakers had to then turn to 'soft' measures of efficacy and efficiency which were mostly qualitative in nature. If the pyramid of evidence is considered,

there was considerable decision-making occurring with little reference to systematic reviews, but more so expert opinion and case studies (14). Had the tension for change not been at the highest pitch, and the low rules environment which accompanied the early days of the COVID-19 pandemic, there certainly would have been pause in implementing eHealth schemes based on the evidence available at the time.

## 1.2 Impact on Dissertation and Research

The shift in adopting eHealth models of care has influenced my work as the COVID-19 pandemic continued to change the main two outputs of my dissertation, together referred to as the antifragile design portfolio. This portfolio is comprised of two component parts, an organizational readiness tool (the *Composite Design Cycle Theory*, or CDCT) to assess an organization's ability to deploy an eHealth project in an antifragile fashion, and an evaluative framework to inform future implementation iterations (the *Matrix of Scale*, MS). Antifragile eHealth projects and the ability of organizations to understand and effectively account for complexity in their implementations, whether consciously or not, is correlated with a greater capacity to scale and sustain novel initiatives (15,16). Assessing organizational readiness is important in understanding, with reference again to the COVID-19 pandemic, which communities are thriving in complex adaptive systems, and which are desperately coping. Being antifragile in approaching eHealth implementation is an indicator of organizational agility and exhibiting an ability to autonomously adapt to change. As seen with a system stressor the magnitude of a global pandemic, institutional agility is important to the lifespan of eHealth projects.

The Matrix of Scale (MS) was derived from a thematic-synthesis of eHealth projects implemented pre COVID-19. This matrix can serve as an evaluative framework for

decisionmakers in rural communities when comparing and assessing pilot projects to implement. Using NVIVO software and drawing on a scoping review regarding patient and provider perspectives of eHealth integration, a matrix was constructed which contains an *antifragile* axis and an *institutional investment* axis. Programs are then assigned a position within the matrix, which is based on their antifragile and investment content, according to *a priori* coding protocols. Ideally, this matrix is applied early in a projects journey through the knowledge translation pipeline and can help implementors address concerns before they could lead to path dependence or project failure. This matrix is informed by discussions with the Office of Spread and Scale (OSS), based out of The Women's College Hospital Institute for Health System Solutions and Virtual Care (WIHV) in Toronto, Canada and shows potential as a framework for evaluation of rural eHealth programs within Canada and abroad.

The antifragile design portfolio, the CDCT and MS, will be discussed in significant depth in Chapter 5 of my dissertation. Ultimately, they are a product of the adaptations which had to be made regarding my methodological approach because of the partnership breakdowns during the pandemic. Ideally, I would have been inserted into groups working to implement eHealth schemes at a system level and record rich data regarding these efforts as an embedded consultant. I had to instead settle for secondary analysis of reports, interviews, and published literature to prospectively validate antifragile design. I was however able to cross-reference that work with previous ethnographic observation to ensure that the antifragile design portfolio is tailored for rural communities. Further, validation of the antifragile design portfolio is supplemented by partnerships I was able to cultivate, including with the Office of Spread and Scale and Free Range international rural research group. These groups have provided me with insight on how

best to deploy the matrix of scale, as well as how to frame an organizational readiness tool for antifragile informed interventions.

It is worth highlighting here the abrupt attitudinal change exhibited by both patients and providers in rural communities regarding the usage and implementation of eHealth. An international ethnography recorded the various ways rural communities responded to the third wave of the pandemic, and eHealth utilization was a key theme within that response. Further, the traits seen during the research residencies pre-pandemic largely dictated the nature of the COVID-19 response of the communities included in the ethnographic investigation. Those which exhibited agility and comfort with change saw relatively fast deployment of eHealth initiatives to adhere to protocols implemented limited face to face healthcare. Other communities which relied on urban centric mandates with a failure to adapt to their specific context saw passive responses relying on interpretation and dissemination of community members.

All told, the pandemic has had far-reaching effects on the research I carried out during the latter half of my PhD. It put into acute focus the need for hospitals, health authorities, and governments to elevate eHealth infrastructure, schemes, and importance into its highest prioritization possible. It made gathering rigorous evidence difficult and created problems in the traditional knowledge pipeline of evidence-based medicine. It substantially changed the narrative of my work from prospectively validating antifragility, to assessing organizational capacity for antifragile design and the subsequent impacts that would have on autonomous change. Providing a powerful portfolio to policymakers and decision-makers derived from a thematic-synthesis of published eHealth literature and ethnographic observation realized the goal of assessing organizational readiness and compiling an evaluative framework for rural implementation.

Ultimately, the work completed throughout my PhD tenure is manifested in five peer-reviewed publications, over a dozen published reports, and several conference and poster presentations.

# Chapter 2: Introduction

This chapter will serve as an introduction of the problem of equity in rural health access, how eHealth can address that equity gap, and what antifragility and complexity science are and how they can be applied to rural eHealth implementation. Further, methods which were used to establish antifragile design as important, as well as methods which can measure and articulate the presence of antifragile design in an eHealth deployment will be briefly examined. Lastly, a knowledge gap will be identified, along with three research questions which address theory (antifragile design) practice (eHealth implementation) and a link between the two (organizational readiness and an evaluative framework to deploy antifragile projects.) Antifragility, and its impact on rural eHealth implementation, is discussed extensively in this chapter, Chapter 3, Chapter 4, and Chapter 5. Briefly, *antifragility* is defined as systems gaining stability through uncertainty, rather than losing integrity. Operationalizing this theory in rural eHealth implementation is the central output of my doctoral research.

Canada has developed a reputation as a 'nation of perpetual pilot projects'(17). Promising initiatives are scoped out across the health care system, at diverse levels of organization, and monitored to assess their ability to change outcomes. Unfortunately, even when programs are seen to have an ability to provide value to patients, providers, or the system, they rarely scale up to broader levels of health organization. This inability to scale starts with an inability to sustain, as pilot projects are normally rolled back after their initial trial period concludes. This can be for many reasons, but key among them is a lack of funding, the departure of a crucial agent responsible for championing a cause or approach, or a multitude of other factors which contribute to the growing complexity of implementation (18). Especially in the past decade,

technological, administrative, and cultural shifts have layered upon each other, creating a murky milieu of value-laden, inter-connected aspects which can be hard for implementors and research teams to navigate (19).

At the nexus of this problem is the challenge of knowledge translation. Canada has wrestled with the question of how to increase research uptake for a considerable time, and there has been a robust number of resources dedicated to this end. The commonly cited statistic of a research breakthrough taking years to make its way along the policy pipeline to yield tangible results at the bedside is a phenomenon known well across Canadian research circles (20). Funding focus on knowledge translation efforts by the Canadian Institute of Health Research (CIHR) and other federal funding sources signals the importance of moving research into operation (21). Additionally, federally mandated reports regarding the nature of innovation within the Canadian healthcare system have been commissioned and include a multitude of recommendations. It is against this background of incentivizing positive change that the nascent schemes and implementations of electronic health have emerged. *Electronic health* (or *eHealth*) can be defined as any prescription of care through an electronic medium, including telephones, online, or a similar technology. (15)

By 2019, eHealth was steadily gaining traction within health systems and was beginning to be incorporated into standard practice, instead of being seen as a peripheral therapy which would be offered only if necessary. Post pandemic, federally funded reports have recommended that the sentiment and environment regarding eHealth implementation which has been impacted by COVID-19 should be maintained for as long as possible (22) . These reports have also highlighted the attitude change seen in administrators and providers regarding the implementation and uptake of eHealth within health systems. The hesitation, which was

abundant pre-pandemic has eroded significantly, as many health authorities were forced to implement eHealth across organizational disciplines and services. This is surprising, as the Canadian healthcare system has long been stagnant in their approach to innovative practices. Disseminating innovative strategies and frameworks is a priority of funders and policymakers within Canada and abroad, and the COVID-19 pandemic has been a fascinating uncontrolled experiment regarding what works where and for whom.

This question of how to increase innovation within the Canadian health system is a difficult and seemingly insoluble one. Firstly, how do you begin to describe, much less define, innovation? *Innovation* is usually described as the uptake of novel initiatives which meaningfully impact the standard practice or procedures of an organization or institution (20,23). In the 21st century, this usually means associating innovation with technological advancement and implementation. While this can obscure the realities of organizational advancement, (e.g., having a state-of-the-art triage system is useless if there are no trained personnel to work it or support it) instituting technological schemes usually necessitates adjusting other parts of the system to incorporate these changes. These adjustments can be seen from both the management side as well as structurally within the organization (24). These changes to standard practice at multiple levels of a system make technological adaption at an institutional level a good proxy for innovation.

Rural innovation has been the subject of considerable focus in geography. Shearmur recognizes the fact that diversity – while important to innovation – can actually impede innovative process when diversity exceeds a certain thresh hold (25). Shearmur further asserts that rural firms can achieve innovation by networking beyond their immediate region, by being more introspective in nature, and by drawing upon local knowledge and culture (25). The lessons

from these investigations of innovation in rural business can be applied to healthcare. Leveraging local skills within a community is key to facilitating the transfer of ownership of an intervention from an implementation team to a rural setting. As Shearmur observes:

> *"Furthermore, some know-how and knowledge is geographically specific – thus, certain problems cannot be understood in abstraction from particular local contexts, and innovative solutions to these problems emerge where the problems occur, be it cities or remote areas (25)."*

As will become evident, much of deploying an eHealth initiative in an antifragile fashion requires the acknowledgement of rural contexts as different and not disadvantaged, leveraging the wealth of local knowledge which can be referenced during an implementation, and capturing conceptual facets such as creativity and imagination which have real – if not observable – impact on an intervention.

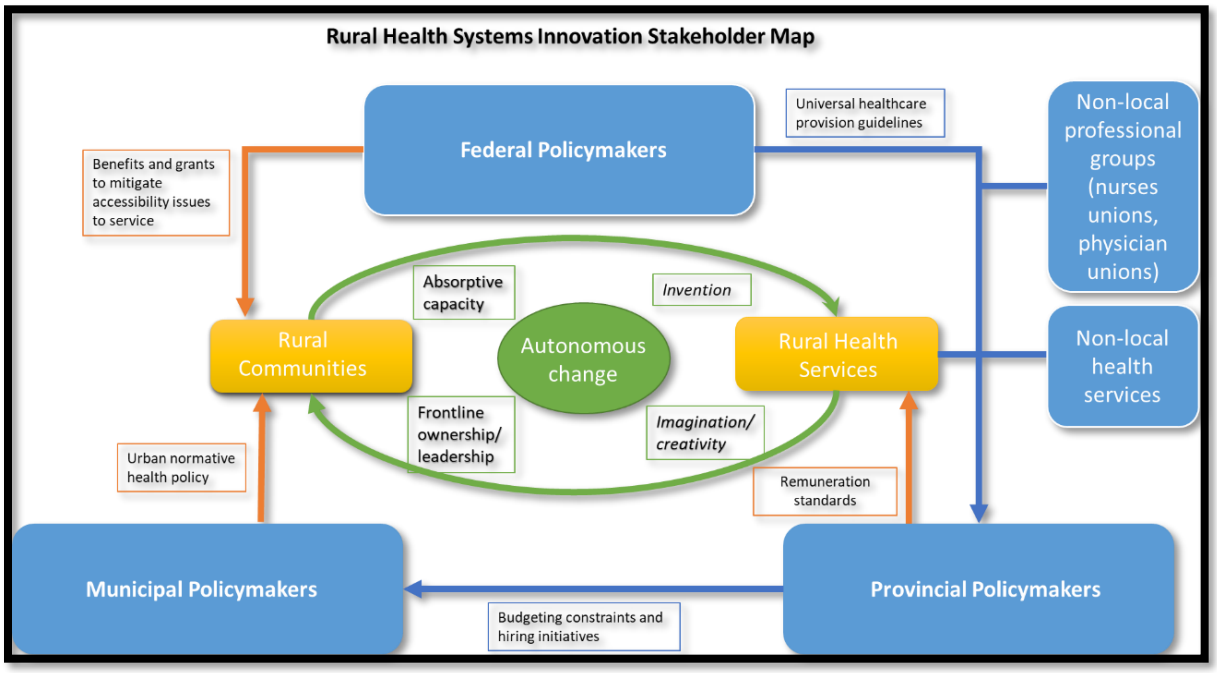
Part of describing innovation is the ability of an organization to manage and institute change (26). *Autonomous capacity* <u>is the ability of communities to adapt to volatile conditions without hierarchical leadership or direction</u> (27). Autonomous capacity is important, because it separates communities that are actively thriving or desperately coping with the changing parameters of, in this case, health service provision. Indicators of autonomous capacity include the ability to 'innovate'; i.e., being able to take strategies as they become available and apply them to their unique situation as needed. Rural communities who display a high ceiling of autonomous capacity generally faired better in the COVID-19 responses than those who did not (27). Fostering autonomous capacity in rural settings is understandably difficult to assess, as it requires sensitive tools in accounting for changes in behaviours, attitudes, and services (28).

One of the reasons for this difficulty in ascertaining ability to change is that there are abstract concepts which play big roles in guiding autonomous capacity. Some of them can be relatively consistently measured, such as front-line ownership (FLO) (29) and the presence of

agents acting as champions for a specific cause (30). Others are more difficult to observe. These abstract factors have entire methodologies dedicated to understanding them. In the case of understanding who the champions are within a system, agent-based modelling is an effective way of demonstrating relationships between people. Facets which are more conceptual in nature, such as imagination creativity, and inventiveness must be approximated from qualitative approaches, such as grounded theory or phenomenology. It is hard to empirically measure conceptual influencers and the effects they can have on aspects important to implementation, but their effects are real, nonetheless. This is a suitable prelude to the discussion on the outputs of my doctoral work which attempt to articulate these concepts through rich qualitative methodology (Chapter 5 and Chapter 6). The mechanism of change introduced by an intervention exists in the 'real' whether we are aware of it or not (31). Defining what that mechanism is, and measuring it, can be approximated by realist methods (32), but there is no perfect or reliable way of doing so. Unlike measuring pH content of a solution, sociological phenomena require a diversity of methodologies to reasonably approach the reality of an intervention's effects. Therefore, it is up to researchers to postulate about what facets of autonomous capacity like imagination and creativity can add, with the allowance that a rigorous definition could exclude conceptual aspects in autonomous capacity from context to context.

**Figure 1** is a simplified model of the relevant stakeholder groups who all can influence innovation within rural communities in Canada. Interactions between federal policymakers, provincial policymakers, and municipal policymakers dictate the structure of service provision at

**Figure 1:A diagram of rural health system innovation. Stakeholder bodies interact with each other through various channels and pipelines, ultimately contributing to the factors present in the middle of the diagram and influencing the services/community duality.**




the local level within rural communities. Powerful professional bodies as well influence these relationships, such as nurses' union, physician colleges, and allied health unions. Further, non-local health services can also influence the local level distribution of care, as the complexities of politics and cyclical political slates and priorities constantly change. This change in policy undermines the stability needed to see through large-scale change of care proposed by reformers. Further, iterating best practice to reflect the complexities of contemporary medical care also suffers from the constantly roiling nature of the political landscape. While innovation is a

sought-after outcome in many rural contexts, it is hard to measure, difficult to promote, and even trickier to sustain and scale.

To make measuring innovation easier, the adoption of electronic (or eHealth) initiatives has been used as a relative proxy to gauge the ability of rural communities to adapt to change autonomously and thrive in the face of uncertainty. While comparing innovation to eHealth adoption may seem like an incomprehensive measure of holistic health service change, it is important to note the peripheral factors which must accompany eHealth adoption in order to facilitate its incorporation into standard practice. One of these peripheral factors is the change in attitudes and beliefs regarding the effectiveness of eHealth schemes, and the willingness of both patients and providers to interact over an electronic medium (33–35). Changes in beliefs and attitudes, as well as the politics and values associated with these beliefs, are often a major focal point of improving uptake of a given intervention or initiative (36,37). By adjusting these beliefs, there is room for innovative practices to take hold and become incorporated into the standard practice of these rural health centres, without a rollback being inherent in their implementation.

While eHealth has seen increased adoption from both sides of the patient/provider dichotomy (4,22), there is also significant difference in broadband infrastructure which limits the deployment of eHealth into areas which stand to benefit from electronic interventions. This 'digital divide' reflects the geographical gap which keeps rural residents from accessing the same quality of care as their urban counterparts (38). Therefore, any adoption of eHealth can be associated with an improvement of infrastructure, or novel usage of existing infrastructure, which can lead to innovation outside of not only an individual eHealth intervention, but to other areas of health service provision and even other organizations or institutions outside of healthcare altogether.

By improving broadband infrastructure and addressing the digital divide, this can open other opportunities for rural communities – especially in a post-pandemic labour environment where many companies have revised their work from home policies. Discussing the issue of access to the internet as a right is outside of the scope of this research, but the Canadian government has recognized the importance of connectedness in the modern world. The CRTC has announced a $10 Million dollar fund (CAD) to update infrastructure in rural communities to have minimum download speeds of 10Mb/s and minimum upload speeds of 5Mb/s (39). This initiative will hopefully signal other governments to do the same and begin to bring rural and remote parts of Canada up to date with regards to broadband infrastructure with more urban communities.

Further, adoption of eHealth initiatives requires changes to organizational structure, informational flow, and leadership modalities. Some of the barriers to implementing novel health programs or interventions include primary points of contact change, prominent privacy concerns regarding patient data, and clouded immediate program oversight (40). All of these problems require thought and diligence in addressing them, as in rural communities there is little precedent for the full-scale implementation of eHealth initiatives into practices and service. By adjusting organizational capacity to create a more flexible structure, fostering resilience at the system level in the process, and subsequently limiting friction costs to eHealth uptake (and other novel programs). The relationship between organizational restructuring and flexibility coincides well with innovative capacity and potential of rural contexts. Of course, this innovative capacity is tied to an improvement in health access, which is realized in better outcomes in rural communities. Section 2.1 discusses the difference in healthcare access between rural and urban

communities in the settings of interest, and how that difference impacts higher levels of age standardized all cause mortality in rural places (41).

Lastly the appropriateness of eHealth adoption as a proxy measure for innovation can be made because eHealth implementation from a grassroots level shows semblance of an ability to, and comfort with, change (27,42). Change in general is laborious for many, but especially in healthcare. Evidence-based medicine (EBM) is the dominant paradigm within health policy, and for good reason. A consequence of this is the (sometimes necessarily) slow transition of research from bench to bedside. Rural communities which develop eHealth services 'in-house', without being prescribed protocols from top-down urban centres, show an ability to embrace change. Like the first point of changing attitudes, the ability to embrace change can be closely tied with the ability to innovate. While the implementation of eHealth may not be able to effectively capture the entirety of innovation, it is a suitable proxy and will be referred to as such throughout this dissertation. Certainly, advocating for and documenting innovation is a complex undertaking.

This sociological complexity is the focus of a discipline called complexity science. Complexity science develops frameworks and perspectives to approach the wicked problems of today's healthcare system, and posits solutions grounded in sociology, psychology, statistics, and mathematics (43). Traditionally, complexity science has been seen as a descriptive tool to frame problems, but not necessarily solve them. Complexity science can identify and codify leverage points within a system, which can then be acted upon by individual interventions, or *levers*. In systems thinking terminology, *levers* are <u>interventions which can be introduced at certain intersections of a system to have a desired effect.</u> For example, a way to improve follow-up of dermatology appointments among rural residents could be a secure portal wherein patients could

view test results and have confidential correspondence with their physician. The lever in this case would be the patient portal, targeting the outcome of poor follow-up rates.

This section of the introduction has been meant to briefly familiarize the reader with the key concepts which will be commonly referenced throughout the dissertation. It has set the stage of the need for rurally derived implementation and evaluation frameworks to confront the inequities of access experienced by rural communities. It has also signalled the importance of innovation, in the form of electronic health integration, and how this could address these inequities. The next sections will further analyse the backgrounds of relevant disciplines, including complexity science and antifragility, rural health system planning, and electronic health.

## 2.1 Background of Rural Health System Planning

Canada, and countries like it (Australia, Sweden) operate under a universal healthcare paradigm. That means that all citizens who pay taxes are eligible for health care; free of charge (44). In practice, that largely means that hospital-based physician and nursing care is covered under the universal healthcare mandate, while other services exist on a fee for service basis (44). Many of the largest hospitals in industrialized western nations exist in population centres – such as cities and towns. These hospitals provide the highest level of care for patients, such as high-level trauma centres and specialists which patients see from other parts of the province, and even other parts of the country. The concentration of highly specialized care to certain areas within Canada and abroad means that service cannot possibly be spread in equal parts. Citizens who live outside of these specific urban settings have a tougher time receiving care, despite being both promised the same care of other citizens by the universal healthcare mandate and paying income tax to the same effect.

Rural communities have long been the centre of agriculture and industry within Canada (45). Industries such as logging, the fur trade, and mining have done much to help mould Canada's international reputation as a destination of immigrants for well over a hundred years and have helped build the foundation of development that Canada continues to enjoy today (45). In contemporary times, there has been a steady trend of urbanization which has left many rural communities struggling to maintain their viability (46). Shifts in industry, globalization and immigration have all combined to produce an environment where cities dominate Canada's population centres (45). Therefore, most of the health policy is dictated from an urban seat – including policy ostensibly serving rural communities.

This is akin to putting a square peg into a round hole. Rural Canadians suffer more adverse outcomes than their urban counterparts and must wait longer for specialist care (47). In addition, loss-to-follow up is an ongoing problem which exacerbates the poor health outcomes seen in rural Canada (48). If a patient neglects their follow-up visit with a clinic or specialist, an otherwise benign condition could worsen (48). Due to a lack of research to shift rural health system policy from urban centric to rural tailored, rural communities' risk being further marginalized inadvertently by a lack of appropriate investigation. In addition to this under representation in research, policymakers are specifically trained to only consider the most rigorous of research when informing health policy. Rural communities would greatly benefit from policymakers considering different forms of investigative research when they are crafting policy – including rich case studies analysed through qualitative methodology.

There are notable discrepancies in health outcomes between rural and urban communities (41). These health outcomes differ in age-standardized all cause mortality and health access. While it is likely the issue of access is the larger contributor to poor health outcomes, there are

other factors which mediate these relationships as well. Notably, rural communities have lower socio-economic status that urban communities (47). Rural communities too have less opportunity for training and employment for their inhabitants, which necessitate either moving or adjusting for young people within the communities (49). This has an overall effect on these rural environments, as the overall age within these communities is older than national averages, as well as urban averages (41). This further perpetuates the feedback loop of youth aversion to these communities and makes it difficult for these communities to thrive.

Health access is the largest difference between urban and rural individuals within Canada. The largest barrier in effective access to health services is distance (48,50,51). Distance is a major aspect in the loss to follow-up seen in patients within rural communities. It is difficult for patients to commit to hours of transit time for a physician visit, especially if the visit is for a wellness check or another perceived low acuity event. Canadian communities vary in their degree of rurality as well as remoteness, but even communities within driving distance of larger care centres can still struggle to see patients make their appointments or tests. Canada is the 2$^{nd}$ largest country in the world by square kilometer, however according to census data 4 in 5 Canadians live in an urban centre (52). For the Canadians who live in the rural and remote areas of Canada, healthcare access is much more difficult.

The most remote communities rely on care in a fly in, fly out capacity (FIFO). FIFO (or drive in drive out communities, DIDO). Remote nurses, physicians, and allied health professionals travel to FIFO or DIDO communities to provide almost all of the healthcare access available for these places. While most of these communities have large Indigenous representations, and healthcare reflects the cultural safety required for Indigenous communities, the fact remains that care within Canada has a massive amount of fluctuation. Within this

fluctuation lies problems of inconsistent quality of care, varied levels of access, and poor policy dictating protocol for rural and remote communities. This fluctuation has been further exacerbated by the COVID-19 pandemic and has brought into focus the need for adaptability within rural health systems (53).

The COVID-19 pandemic has pushed Canada's health system is on the brink. Provinces like Alberta have acknowledged that their healthcare system is *'a week away from collapse'* according to premier Jason Kenny due to an ICU bed shortage and a staffing shortage accompanying it. In metropolitan Toronto, there are zero ambulances available in the entire city, with catchments needing emergency coverage from surrounding suburbs. This is a common theme across Canada, as many professional bodies and policymakers are sounding off regarding the state of the healthcare system. This five-alarm fire was already building well before the pandemic, but COVID-19 has sorely exposed the beleaguered structure of the healthcare system nationally. Without significant reform, widescale collapse (in the form of cancelled procedures, decade-long wait lists for primary care, and emergency departments overburdened to the point of stagnation) will become normal.

### 2.1.1 Shifting Rural Health Policy to a Place Based Focus

Place-based health is a paradigm of health policy suggested by the Canadian Medical Association as a priority for Canada moving forward post COVID-19. The Canadian Medical Association (CMA) has recognized the need for granular health approaches to address niche challenges that blanket policy fails to account for. Outcomes in urban centres can vary greatly from neighbourhood to neighbourhood, as well as the already discussed discrepancies in urban and rural Canadians. Aiming for the temporal goal of 2040, the CMA is seeking to create a health system (54) which "*is sustainable, more accessible and patient partnered*", adjusting medical

culture so it "*is focused on physical and mental well-being and one that embraces equity and diversity*" and lastly contributing to a society where "*every individual has an equal opportunity to be healthy*." In order to achieve these admirable goals, EBM has to begin adjusting the evidence they build on to create health policy for Canadians to create place-based health (55) policy suitable for rural communities.

Place has been considered by other researchers, and its role in health system access and interaction, especially in rural settings (56). From an ethical perspective, respecting the place a patient is from benefits both providers and patients, and shifts the treatment paradigm from paternalistic to patient centred (57). People have connections to place for a diverse number of reasons, and this connection has an impact on their health. Referred to as 'place-attachment' by psychologists, the role of place in crafting effective and nuanced health policy has been highlighted by rural health ethicists (13). They define place as the geographical environment in which people feel a poignant connection and have meaningful interaction (58). This connection is sometimes underappreciated in treatment options or therapy recommendations by healthcare professionals.

Benefits of a place-based health approach are ample in the literature. Humer et. al note:

> "*Furthermore, being cared for at their home site enables the patient's family and support network to be present. This positive response from patients shows the normalized acceptance of their telemedicine experience in their home community* (59)*.*"

The gains of receiving care in a setting familiar to patients can help improve outcomes (60). eHealth initiatives can help bring specialist care to rural and remote places, mitigating the problems of distance, time, and cost many rural patients have to overcome in order to receive the care they need. Rowell observes with regards to rural patients with disabilities:

"*However, we propose that even greater benefit may be obtained from telehealth consultations involving patients with a disability, where the cost and inconvenience of patient transport is considerably higher* (61).

Having sick patients (and the families) travel long distances for care can only exacerbate an illness or condition. eHealth, through antifragile deployment, can help place-based policy become the pervading paradigm on service provision in universal healthcare systems.

## 2.2 Background on eHealth and it's Influences on the Rural Health System

*Electronic health* has many definitions, but the working definition for this dissertation is the provision of medical service through an electronic medium including but not limited to: telephone, video-conferencing, or another electronic source. eHealth has seen a steady uptake in medical settings and has seen widespread adoption over the COVID-19 pandemic (1,62). In Canada, this uptake is mediated and regulated by a federal body known as the Canada Health Infoway (CHI). CHI serves as an attractor for vendors, policymakers, providers, and patients to discuss policy as it pertains to the use and implementation of eHealth technology, while providing incentive to vendors with lucrative contracts and exclusivity rights for schemes such as the creation of a pan-Canadian telehealth line, or platforms for virtual service for physician or nurse practitioner visits. Besides the federal leadership provided by CHI, there are several provincial level and local level organizations which also provide guidance in implementing and utilizing eHealth.

One of those provincial organizations is the Ontario Telehealth Network (OTN). This organization does considerable work with the rural and remote communities in Ontario's geographical north, including many Indigenous communities. They provide consulting, technical support, and strategy to rural health units investigating the viability and fidelity of implementing eHealth schemes. They also help these same units integrate eHealth projects which are mandated

from a provincial level. While the OTN is a provincial organization, there is still some disconnect between OTN consultation and the realities of working with rural communities. This disconnect is exacerbated when attempting to communicate initiatives at a national level, usually under the guidance of the federal regulatory body Canada Health Infoway. Although the OTN is aware of the context specific characteristics and cultural norms within rural Ontario, and therefore are better suited to address barriers specific to eHealth implementation in the rural Ontarian context, they still lack the tools which aim to make explicit the complexities and tacit knowledge inherent to these sites. The antifragile design portfolio, comprised of the CDCT and MS, can address these concerns, allowing for richer implementation processes and better reception by communities and providers. The CDCT and MS are discussed extensively in Chapter 6.

Generally, eHealth has been recognized by both patients and providers as a suitable method of health service delivery (34). The advancements made with regards to technology, administration, and patient privacy with regards to their records have reasonably addressed the common concerns of patients and providers regarding the feeling of disaffection which arose when interacting over electronic mediums. On the provider side, addressing issues of workflow, especially for physicians, seemed to slacken the resistance towards implementing eHealth into standard practice (63). In rural communities, the introduction of eHealth will help address the tyranny of distance experienced by patients and becoming comfortable with electronic health can help foster a robust, antifragile health system enjoyed by all stakeholders. While these benefits were lightly researched pre-pandemic, the widespread adoption of eHealth through necessity has put these assertions to the test.

eHealth use in Ontario, Canada exploded in the first three waves of the COVID-19 pandemic (1). Healthcare contexts can implement eHealth when the tension to do so outweighs the hesitation which previously dominated the discussion of adoption (62). This builds on previously discussed findings of the positive impacts that eHealth has had on rural health service provision. They can contribute to addressing the equity gap in healthcare access present between rural and urban communities (64). Further, if they are integrated into existing service structures in a way in which providers do not undergo a drastic change in course of work, they can help reduce the limited specialist and primary care referrals seen in rural contexts (65–68). In summary, eHealth initiatives can strengthen rural health systems, providing benefits to both rural providers and patients through their implementation and integration into standard care models.

Rural health systems are the aggregates of institutions, organizations, and individual primary care practices. Their investment in eHealth interventions is a key axis of determining the overall success of a project and ascertaining the potential of the eHealth initiative to scale up and spread. Projects can display remarkable levels of antifragility, however if there is little to no institutional investment, rate of non-adoption or abandonment will be high. Like antifragile operators, which are discussed in depth in 2.3, five institutional investment indices were identified through ethnographic observation and thematic synthesis. The methodology for their inclusion in the institutional investment axis of the matrix of scale is discussed in detail in Chapter 3. **Table 2** below summarizes the five indices of interest which designate institutional investment into electronic health initiatives within rural contexts.

| Institutional Investment Index | Definition | Example in Practice |
|---|---|---|
| *Follow-up and Support* | *Follow-up and Support* is defined as the structures, channels, or protocols prescribed and maintained by institutions and organizations to facilitate support for the eHealth intervention. In the context of institutional investment, it pertains to both patients and providers at the individual (micro) level as well as at the system (meso) level. | 1. Relieving staff of usual duties to receive training, and ensuring management is supported to issue and evaluate software training (69).<br>2. Identifying a specific person to become a full time trouble-shooter, problem solver, and co-ordinator of the program (70). |
| *Policy Alignment* | *Policy Alignment* is defined as the adherence or reference of an eHealth intervention's targeted population or outcomes to broader organizational policy. In the context of institutional investment, policy alignment can be seen by linkage to initiatives undertaken at other organizations and at the recommendation of provincial or national guidelines. | 1. Provincial directives to focus efforts of hospitals on implementing eHealth projects (71).<br>2. Professional associations support for broader healthcare access for a specific patient population (33) |
| *Champions* | *Champions* are individuals, usually healthcare providers but sometimes patients, who advocate, promote, and support an eHealth initiative's implementation. In the context of institutional investment, champions are important in influencing institutional investment because of the pressure they can apply through personal and professional relationships. | 1. A senior psychiatrist applying for physician privileges at a new setting for an implementation, displaying to local physicians there is support and buy-in (70).<br>2. Manager champions who lend legitimacy to a project in the eyes of providers (71). |
| *Utilization* | *Utilization* is the tangible rates or quantitative measures of the patient and provider interaction with a given eHealth intervention. In the context of institutional investment, utilization outcomes are important in determining the return of investment institutions are evaluated by at broader levels of funding. | 1. Improved utilization depends on informed and willing staff (69).<br>2. Tailoring the need of a service to it's patients and providers improves utilization (50). |
| *Funding* | *Funding* is the monetary commitments by organizations to eHealth investments. In the context of institutional investment, establishing consistent funding sources and schemes is important to determine the confidence an institution has regarding an eHealth project's ability to impact outcomes. | 1. Establishing the cost-effectiveness of tele-surgical interventions compared to traditional travel for rural patients (72)<br>2. Linking organizational initiatives to broader federal funding priorities and bodies (71) |

**Table 1:The institutional investment indices. The presence of Champions, Policy-alignment, funding, follow-up and support, and utilization indicate the investment of an organization or institution has for a given eHealth project in a rural community.**

These institutional investment indices will be expanded on further, including how they were compiled and analysed in Chapter 3 and 4. Their application to the antifragile design portfolio is discussed in Chapter 5 and Chapter 6. For now, it is important to understand the presence of theses indices and how it can impact rural eHealth implementation. In section 2.3, rural health systems are conceptualized as complex adaptive systems (CAS). These institutional investment indices are important to leverage within an implementation process to mitigate the difficulty of deploying an eHealth project within a CAS. Together, with the antifragile operators also discussed in 2.3, they form the parameters of evaluation operationalized through the Matrix of Scale.

This section has provided evidence and discussion about eHealth integration into rural communities. Even before COVID-19, where the tension for change was low and some health systems seemed locked in stasis regarding adoption of novel care models, attitudes towards eHealth from both patients and providers were positive. These positive attitudes coupled with eHealth's ability to provide specialist and primary care which shrinks the tyranny of distance seen in healthcare in rural communities contributes to the argument that eHealth can reasonably address the inequities of rural healthcare access. The COVID-19 pandemic necessitated widespread adoption of eHealth, and the lessons learned from this will be explored in the next section.

## 2.3 Antifragility in Rural eHealth Project Design

*Antifragility* has been mentioned as a guiding principle for implementing eHealth into rural communities, which may improve their ability to scale and sustain to other contexts. Antifragility as a concept was first introduced in the 2012 book ***Antifragile*** by Nicholas Taleb. Taleb posits that <u>an antifragile unit stands to gain, rather than be harmed from volatility</u> (73).

Examples of antifragility include bones becoming stronger from small stressors, our immune system building strength from fighting off viruses, and muscle mass being built through continuous use. This analogy can be extended to rural eHealth interventions, where small failures would strengthen the system as it learned from past mistakes, rather than making it weaker and leading to overall failure. The future of health services delivery in rural communities could depend on being able to effectively implement eHealth interventions and see them scale-up to regional initiatives.

Antifragility in eHealth project design is centreed around five core principles. These principles, and their tangible presence and effects can be found in **Table 2**. Briefly, antifragile eHealth design is the incorporation of one more of *optionality, non-linear evaluation, hybrid leadership, starting small,* and *avoiding sub-optimization*.

| Antifragile Principle | Definition | Example in Practice |
|---|---|---|
| *Optionality* | *Optionality* is simply defined as the ability to make choices. In the context of antifragile eHealth project design, optionality for both patients and providers increases the use of an eHealth intervention. | 1. Secure technology for other purposes (legal, educational) - Virtual Health Rooms in Slussfors, Sweden (15)<br>2. Choice in how patients can access their information - Carné Santé in Quebec, Canada (15) |
| *Non-linear evaluation* | *Non-linear evaluation* is defined as surveillance and assessment of an intervention outside of traditional 'success' or 'failure' labels. In the context of antifragile eHealth project design, non-linear evaluation seeks to understand the impacts an intervention has on other aspects of the system. | 1. Descriptive and explanatory evaluation of a telepathology program in Quebec, Canada (42,71) |
| *Hybrid leadership* | *Hybrid Leadership* is defined as both bottom-up, grassroots influence as well as top-down, traditional guidance on system direction. In the context of antifragile eHealth project design, hybrid leadership requires input from both front-line providers and management level decision-makers. | 1. Bottom-up leadership in technological, clinical, and organizational facets in a telepathology program in Quebec, Canada (71) |
| *Starting Small* | *Starting Small* is defined as limiting initial implementation process to small-scale roll outs. In the context of antifragile eHealth project design, starting small requires an iterative approach, with more components of an intervention included with each iteration of implementation. | 1. Small scale roll out of a teleophthalmology program in Canada (74) |
| *Avoiding Suboptimization* | *Avoiding Sub-optimization* is defined as avoiding the maximization of efficiency of one aspect of a system at the expense of another. In the context of antifragile eHealth project design, avoiding suboptimization requires sufficient understand of the system and intervention is influence, so as to account for its changes in system function post implementation. | 1. Building in latency to simulate the delay as part of satellite communication as part of a telesonography program in Alberta, Canada (75)<br>2. Ensuring electronic wound care documentation aligns with previous pen and paper models in Western Australia (69) |

**Table 2: The antifragile operators which can help an initiative have potential to gain stability through uncertainty. The operators include Optionality, Non-linear Evaluation, Hybrid Leadership, Starting Small, and Avoiding Suboptimization.**

**Table 2** represents the salient antifragile operators whose presence in eHealth project design improves the lifespan of said projects. Together with the institutional investment indices, rural eHealth implementation can be understood as a function of these two parameters. The presence of institutional investment and antifragility increases the potential of an eHealth initiative to scale and spread. Antifragility is an appealing principle to apply to rural eHealth implementation for other reasons as well. One of those reasons is the receiving environment rural communities are for antifragile values. The capacity for antifragile design is discussed in depth in Chapter 5: Research Findings

Although the term 'antifragile' may be new to the members of rural communities, the facets of it are certainly not. Antifragility aligns with the strength based approach advocated for by rural researchers and residents (5).When the term is explained with concrete examples accompanying it, many rural residents agree with the labeling of their town as such and accept the antifragile nature of their community as self-evident. It seems intuitive then that electronic health initiatives implemented in these communities can gain from the strength of the population already present. By designing eHealth initiatives to be inherently antifragile, aligning them with the rural environment they are being introduced to, more projects could be sustainable in the long term, and have the potential to scale to broad levels of health organization. The consequence of this better healthcare access, and ultimately better health outcomes for rural communities and populations.

The increasing complexity of implementation and evaluation in contemporary health systems has made it difficult for decision-makers under a universal healthcare paradigm to achieve the goal of universal care: equitable and equal access for every qualifying resident who

seeks healthcare (44). Within Canada, and other developed nations with a universal care mandate (Sweden and Australia) there exists a gap in service quality and availability between urban and rural residents (76,77). For Canada to overcome their problems of sustaining and scaling promising pilot projects, they must confront complexity head-on. The COVID-19 pandemic has produced a background which has highlighted the importance of eHealth uptake. eHealth implementation in turn has provided intriguing indicators regarding which organizations, institutions, and communities are capable of innovating and adjusting their services to match the requirements of a dynamic and high-leverage situation. Implementing within a complex adaptive system (such as the health system) requires complexity informed frameworks and nuance.

Antifragile design as a viable principle for rural eHealth implementation is the focus of *paper one* (Appendix A) of my doctoral research. Through rich case studies as well as ethnographic observation, antifragility and its incorporation into project design is associated with an improved ability for eHealth projects to scale and sustain within rural contexts. Operationalizing antifragility as a concept is the focus of the antifragile design portfolio, discussed in 6.3. Through designing eHealth projects in rural communities to gain stability from uncertainty, by incorporating antifragile operators, these initiatives have better potential to sustain and scale. This results in better health access, and ultimately better health outcomes, of rural communities and places.

### 2.3.1 Antifragility and Organizational Change

Complexity theories have been discussed as possible framework for organizational change starting in the early 2000s (78). Complex adaptive systems were first formally described as living beings, such as organisms, and later that metaphor was extended to organizations (such as hospitals or the healthcare system as a whole) (19). Ralph Stacey was the first academic to

seriously apply complexity theory to organizational change, in a strictly business context (78–81). Stacey argued that in order for organizations to innovate, adapt to change, and ultimately succeed, they needed to exist in on 'the edge of chaos'. This poetic phrase is used to describe a state wherein an organization has sufficient room for emergence and self-organization that innovative practices are efficiently diffused, but enough simple rules-based integrity that the organization does not devolve into a state of pure chaos and dysfunction. In this state, organizations can freely institute practices borne out of the sense-making efforts of their agents, while also having parameters (rules) in place which contain practices which do more harm than good.

This approach to organizational change is consistent with the 'third kind' of change management strategy identified by scholars at the time (26). This third kind was different and distinct from small incremental change, and top-down wholesale organizational overhaul. Rather, the edge of chaos theory aligned with the emergent change, which was seen more as a continuum, rather than a step-by-step prescription of applying organizational transformation. Effective change techniques instigated by employees because of grass roots efforts were facilitated by organizations and adjusted as needed as they progressed from context to context. Emergent change is a reality of organizational change – regardless of if the alteration is endorsed or promoted by leadership (in this case, management). At the time, there was criticism regarding the validity of emergent change strategies and complexity theories as guiding frameworks in organizational change management (82). Much of this debate is almost twenty years old, and its applicability is still mostly relevant to a business setting. What lessons about complexity and organizational change can be appropriate to healthcare, innovation, and implementation? How can antifragility help translate these findings?

Establishing the edge of chaos advocated for in business to facilitate innovation runs counter to the rigid, structured paradigm of healthcare and healthcare organizations. The Naylor innovation report commissioned by the federal government of Canada examined the question of how to better unleash healthcare innovation in Canada and recommended establishing organizational direction congruent with organizational culture (20). Flatly put, healthcare organizational culture in Canada is stagnant, re-running proven failed tactics (addressing family physician shortages by increasing seats in medical schools (83)). If organizational change needs to align with the cultural traits engrained within it, then innovation is mitigated from the start. Conversely, a complete breakdown and removal of the rules-based system of healthcare provision in Canada is inappropriate. While eroding the disciplinary silos and evidence-based policy paradigm inherent to healthcare system and healthcare provision would promote the free flow of information and bottom-up knowledge, there is no guarantee this knowledge is useful, and it could be even outright counter productive to a systems-goals.

Like organizational change in business, antifragile design is a 'third kind' of change management. Antifragile design can be seen as a set of rules which allow for sufficient deviation and flexibility in how they are employed, but still bounds an organizational approach to implementation to a set approach. Epistemically, it sits as a mid-level theory (84). One which is different than the piece-meal, pragmatic strategies used in individual projects, and the larger unified theories (such as the CFIR (85)). Antifragile design, and its associated frameworks to assess readiness and adherence, sit in a comfortable middle spot. They are theories with practical guidelines for their operation in rural electronic health implementation and contribute to the need for evidence-informed policy addressing digital equity. the antifragile design portfolio is more generalizable than the specific ways a single implementation was undertaken in an individual

context, but not so generalizable that they seek to explain the implementation of *all* eHealth projects in a rural context.

## 2.4 Background on Complexity Science and it's Influence on Pilot Project Design

Pilot projects are a necessary first step in any successful implementation of a social intervention (86). They allow a researcher or research team to iterate and tinker with their programme, ascertaining what works and what doesn't ahead of a full-scale implementation. Within this context of tinkering and iterating, there are several guiding disciplines which offer insight into the nuanced nature of a successful implementation. One which features the study of CAS, such as healthcare systems, is complexity science. A close cousin of complexity science is implementation science, which seeks to disseminate frameworks, theories, and protocols which are successful (in the broad sense) in effectively motivating research to action within healthcare (87). There is significant overlap between the theories of complexity science and implementation science, and these will be further explored in Chapter 2 (Review of Literature) and Chapter 3 (Methodologies).

Exploring some salient terminology common to both complexity science and implementation science will illustrate the difficult waters pilot projects (and their implementation teams) must navigate to achieve a successful implementation. Implementation of a given program (in the context of my doctoral research, an eHealth initiative) is much more sociological than it is biological, meaning there is no linear path for an implementation. You cannot pipette implementation frameworks and theories into a particularly onerous implementation and expect the outcome to be favorable. Massaging the barriers to implementation requires an understanding of the complexities facing a given context, how they can be addressed, and what can be done to guard against them in the future. Further, agreement between stakeholders regarding appropriate

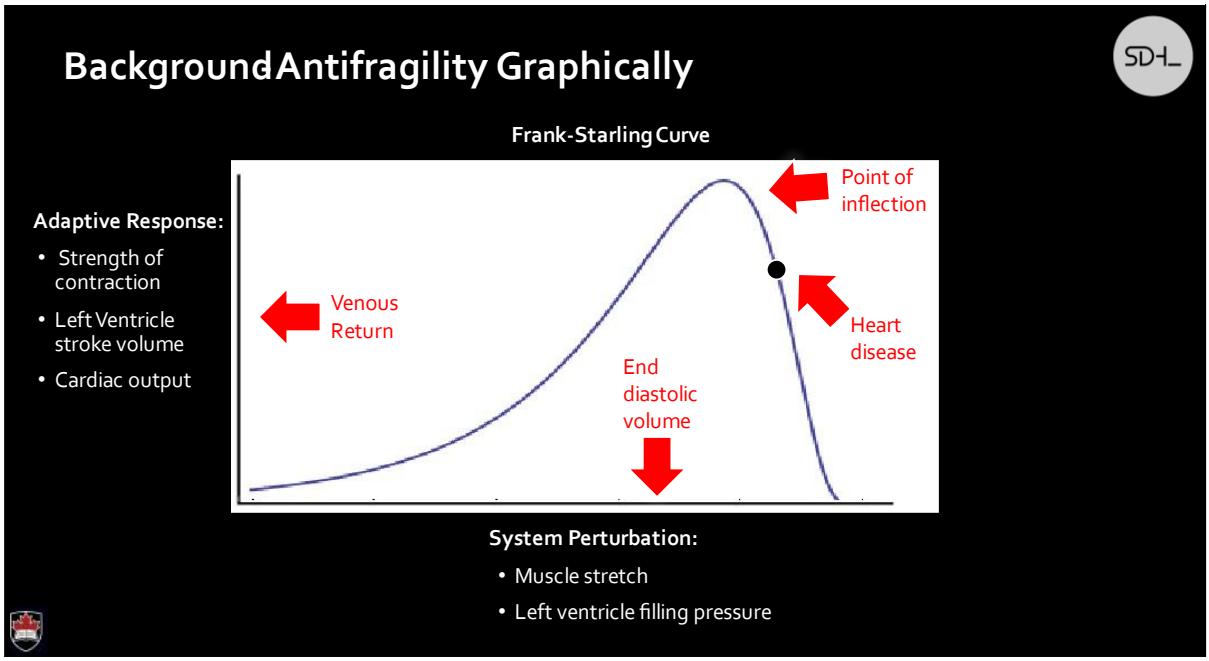
ways to approach the problems implementations regularly face can be hard to achieve. This adds to the layers of complexity common to implementations of interventions into health systems and can be one of the main contributors to pilot project abandonment and non-adoption. Exploring the presence of complexity and its impact on healthcare is the focus of *paper two* (appendix A) of my doctoral research.

A common criticism of complexity science is that it is useful in framing a problem, but not necessarily in solving it. This limitation sees complexity science as more descriptive than proscriptive, as it lacks the necessary tools to effectively address the problems it describes. While the ability of complexity science as an implementation tool is still in debate, there is no question of its usefulness in defining the nuances and intricacies of particular challenges to rural eHealth implementation. As technology has advanced, so too has the complexities surrounding modern-day issues. As Albert Einstein noted: *"How we formulate a problem is far more impactful than it's solution."* He further stated that if he had 1 hour to solve a problem, he would spend 55 minutes thinking about the problem, and 5 minutes thinking about the solution. All that to say, that unless you understand the problem to best of your ability, your solution could in fact introduce more problems than it solves. That is the niche of complexity science as a discipline: allowing researchers and decision-makers to peel back the layers of wickedness that accompany program implementation and target them precisely. Using complexity science to help frame the problem of rural eHealth implementation helps ensure the solutions to this problem are nuanced, refined, and impactful in their deployment.

There are several complexity science insights which can be applied to the pilot project lifespan and can be seen in the figures below. Antifragile project design, discussed in 2.3, can help shift a pilot-project outcomes and provide it with the agility required to thrive in a complex

adaptive system. The Frank-Starling curve is a graphical representation of cardiac output over time. Cardiac function is expressed as a function of adaptive response (measured in venous return) and system perturbation (measured in end diastolic volume). In a normally functioning

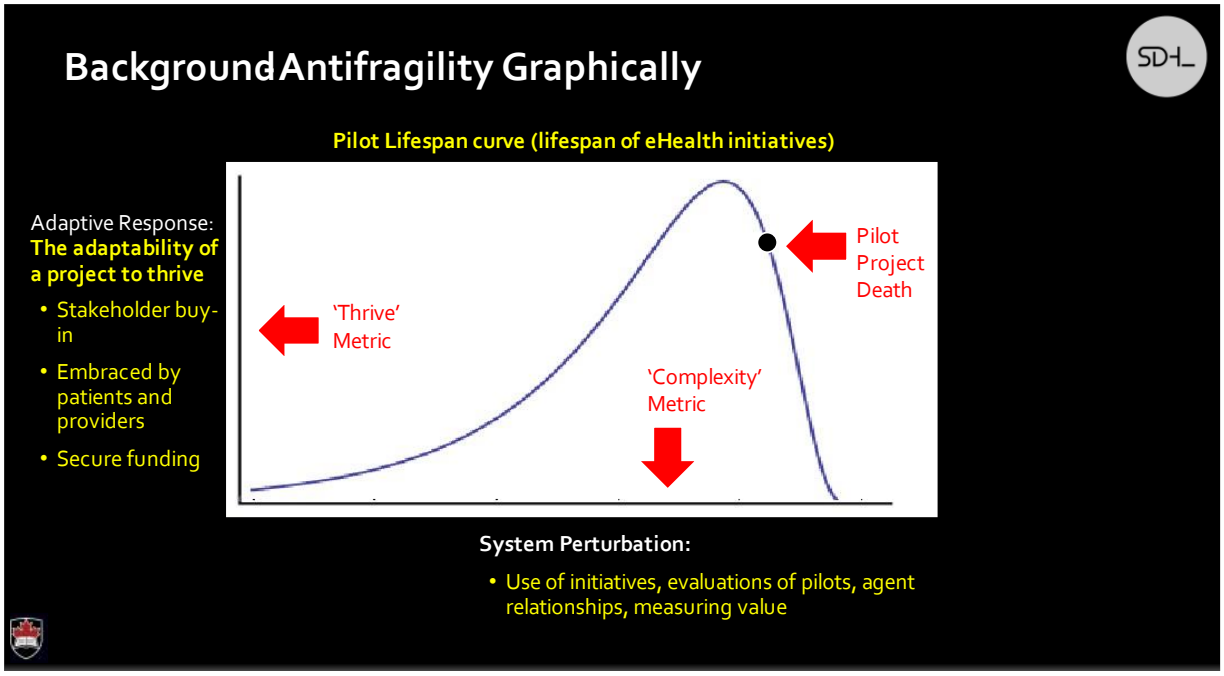
**Figure 2: A Frank-Starling curve. Cardiac health is measured as a function of adaptive response and system perturbation.**




heart, as system perturbations increase (muscle stretch and left ventricle filling pressure) an adaptive response occurs to account for these changes in the system (strength of contraction, left ventricle stroke volume, and cardiac output). In heart failure patients, eventually the system perturbation outstrips the adaptive response, which causes a point of inflection in cardiac function, and eventually heart failure and (system) death. If this curve is borrowed to reflect pilot project lifespans, there are some striking similarities to better understand why an antifragile project would fair better where system perturbations are commonplace.

Keeping the same axes, a pilot project's lifespan can be seen as the function of its adaptive response to the context it is introduced into, and the system perturbations it experiences throughout the implementation process (**Figure 3**). Adaptive responses can be measured though

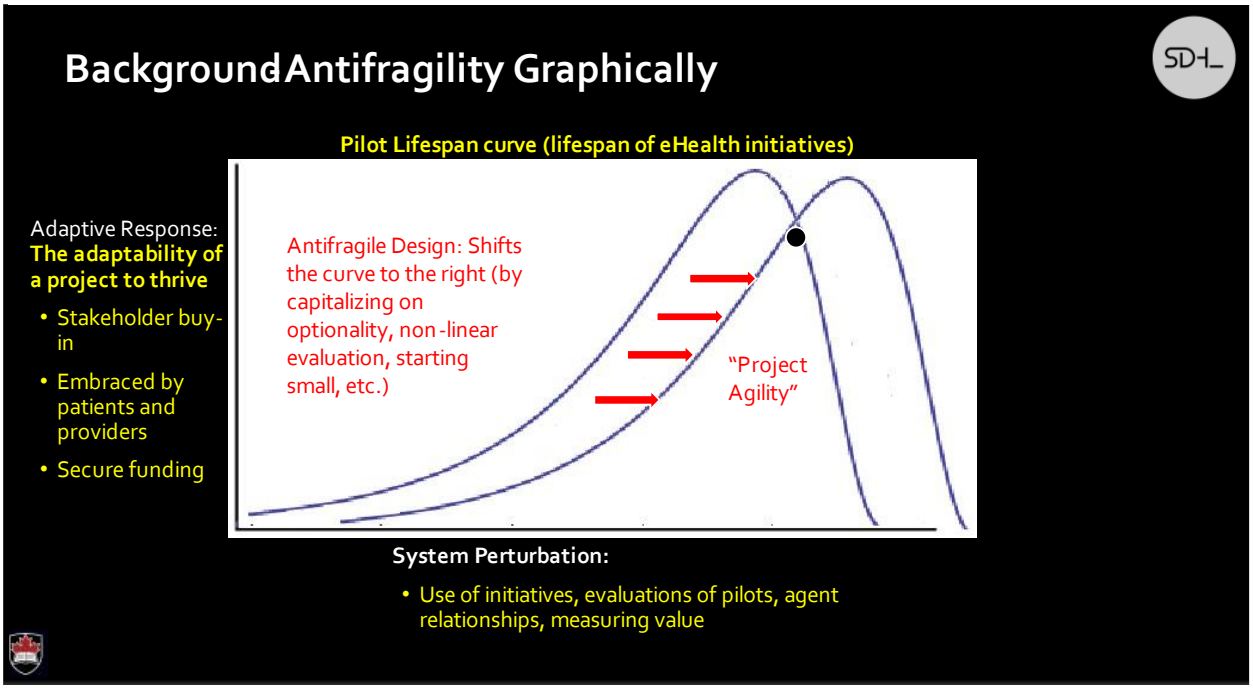
**Figure 3: A pilot project lifespan curve. Pilot project lifespan is measured as a function of adaptive response (stakeholder buy-in) and system perturbation (use of the project).**




stakeholder buy-in, the extent to which it is embraced by patients and providers and how secure funding is for the implementation. System perturbation can be measured through the use of the initiative, evaluations of the pilots, agent relationships, and how the initiative is measuring value-add to the system. A component of successful pilot project implementation is the capability of a project to have sufficient adaptive response relevant to system perturbation. As an implementation progresses, there will be inevitable problems and challenges which must be managed and mitigated by implementation teams. The degree to which it can possess an adaptive response is a reasonable predictor for the levels of system perturbation it can effectively handle. Pilot project 'death' or failure occurs when the system perturbations occur so frequently or in such magnitude, that the adaptive response of the project cannot match them.

Designing a project to be inherently antifragile (including optionality, prioritizing hybrid leadership models, incorporating non-linear evaluation mechanics, avoiding suboptimization,

**Figure 4: The function of antifragility. Applying antifragile operators allows for project agility, and where before there was pilot project abandonment, there is now room for further sustainment.**

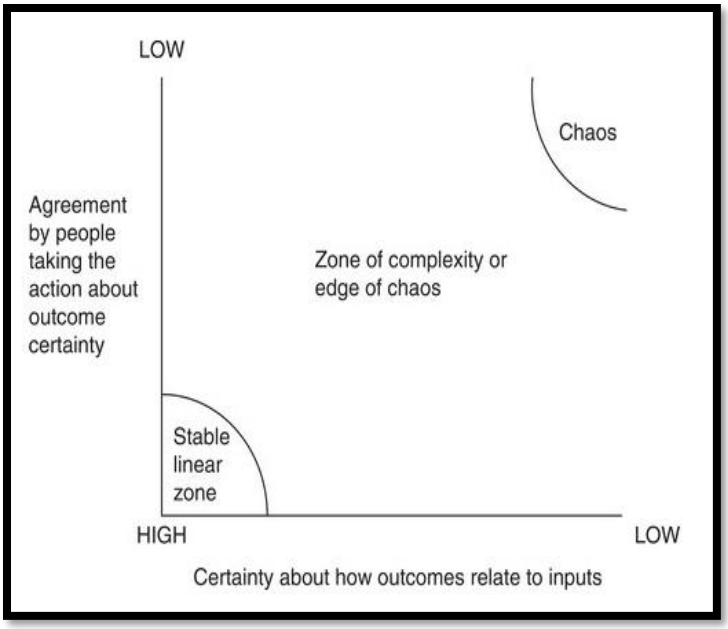



starting small) shifts the curve to the right (**Figure 4)**, allowing for a greater level of system perturbation before pilot project death occurs. It is of note that antifragile design is not a silver bullet. There is still a level of system perturbation which exists that can drive a pilot project to not succeed in its context. What antifragile design can do however is maximize the adaptive response aspects of the project, allowing for greater system perturbation before it starts to negatively impact the core functions of the intervention. In other words, the curve isn't getting bigger (more adaptive response) but rather shifted (greater tolerance for system perturbation).

Antifragile projects also perform better in the 'zone of complexity' (88) in which health care organizations exist. Consider **Figure 5** which broadly considers the organizational structure 'zone' as a function of agreement by people taking an action about outcome certainty, and the certainty to which outcomes relate to inputs. When there are high amounts of both agreement and certainty, organizations operate in a stable linear 'zone' of structure. Decisions can be made with

almost complete assurance that outcomes will be positive, as decision-makers will have all saliant information on hand, with the added benefit that they have chosen the correct variables to control for or concerns of stakeholders in an implementation (80). Conversely, when agreement and certainty are low, the organization exists in a state of chaos. There is no evidence

**Figure 5: Organizational complexity as a function of agent agreement of action and outcome certainty, and certainty regarding how outputs relate to inputs. Adapted from Stacey et. al.**



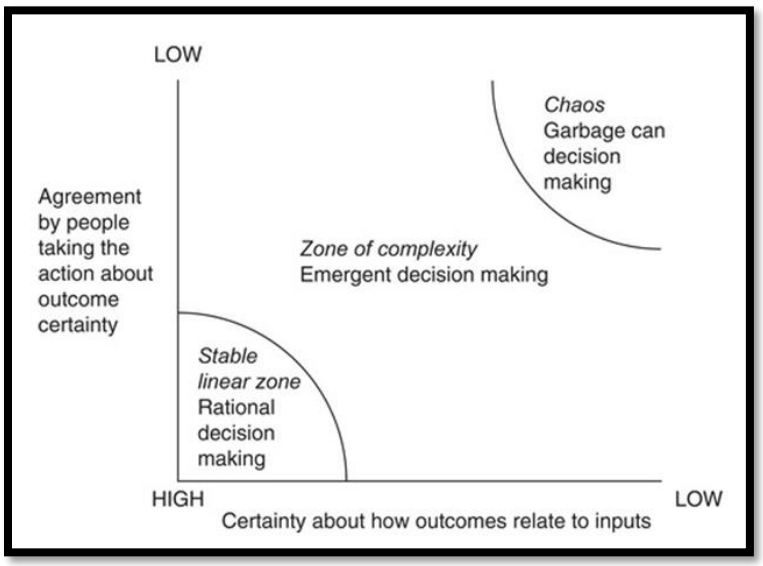

that the variables chosen effect outcomes in any discernible manner, and there is no agreement between stakeholders on the direction of the intervention. Predictably, decision-making in this structure is almost impossible.

These two structures are rare in nature. If an organization exists in a stable linear zone, then it will almost certainly be for a short period of time before there is a significant event which makes either certainty or agreement harder to maintain. Likewise, organizations can only exist in chaos for so long, before there is widespread reform, or the organization ceases to function, and it collapses with regards to its previous identity. Most commonly, organizations exist in the

larger middle zone, or the 'zone of complexity'. This zone occurs where there is middling agreement between stakeholders, and middling certainty regarding the relationship between inputs and outputs.

Of course, this figure is an oversimplification of organizational structure as it exists but is an effective model for considering the role complexity science can have in providing value for implementation teams. There very well may be contexts within an organization where things are linear – in a surgical ward for hip replacements for example – but their existence in a healthcare organization does not change the fact that a vast majority of the organizational structure must exist in this zone of complexity (79–81,88). This is due to several factors, chief among them the inconsistency and incompleteness of information available to any one part of the system, values inherent to organizational culture, and emergent properties of human interaction and complex adaptive systems.

**Figure 6: Decision-making paradigms associated with organizational complexity. Antifragile design allows implementation teams operating the zone of complexity more flexibility in their approaches and strategies in rural eHealth implementation. Adapted from Stacey et.**



For the purposes of this research, this exploration of organizational structure helps illustrate the importance of an antifragile approach to pilot project design. Decision-making in healthcare is extremely difficult the broader the decision is. Again, clinical decision-making can be straightforward and rational – in the case of evidence-based protocol for a knee replacement, or differentially diagnosing a bacterial infection – but broader questions of health policy, intervention efficacy, and resource allocation become increasingly complex and tangled. Decision-makers and policymakers at broader levels of healthcare organization often engage in the process of decision-making through a rational (linear) lens.

This follows the evidence-based medicine paradigm, where health policy must be rigorously tested through systematic review and randomized control trial before it is incorporated into standard practice. Again, for clinical interventions, this is preferred. No one wants their laceration treated with a salve concocted by a particularly intrepid nurse or physician. When decisions affecting larger swaths of the organization are being discussed however, the process must be adjusted. Unfortunately, healthcare organizations do not exist in a stable, linear zone. Therefore, rational decision-making is inappropriate for the complex facets which must be weighed in the decision-making process. Instead, as seen in the below figure on the previous page, decision-making should follow an emergent paradigm.

As the COVID-19 pandemic has made painfully clear, systems across Canada and the world are on the verge of outright collapse and failure. Systems are perfectly designed to achieve the results they consistently achieve. In the case of the health system, it was one which was already burdened with volume issues, recruitment, and retention concerns, failing infrastructure, and inadequate surge capacity. In part, the state of the health system post COVID-19 can be attributed to the sum of decisions made prior to the pandemic. These decisions have manifested

into the uncertainty and concern for system integrity as the pandemic has progressed and should be evidence enough that the decision-making process when operating in the zone of complexity must be altered. When making decisions in this zone, it is better to be vaguely right than precisely wrong (88). With the information on hand regarding how variables relate to outcomes and the varying level of consensus among decision-makers about a path forward, the decision-making process should reflect that. This paradigm is called 'emergent decision-making'.

One of the key differences between emergent decision-making and linear decision-making is the recognition of working in a complex adaptive system. In a CAS, Situations are dynamic, with outcomes having a non-linear effect, and unintended consequences of decisions are common (43). Leadership needs to reflect on this organizational murkiness, and the degree to which it can impact decision-making. This is where rational decision-making falls short, as it approaches insoluble complexities in a reductionistic fashion, searching for a silver bullet solution. Emergent decision-making requires a near constant updating of beliefs, theorizing on appropriate ways forward, and incorporation of a diversity of perspective and opinion. It is through this approach that systems can be more readily understood, and the outcomes of an intervention can be appreciated at a (near) system level.

Healthcare decision-making is a demanding process. There is accountability to numerous stakeholder groups, a tension for change which reflects the high standards of the Canadian system, and the never-ending political cycle which keeps policy direction in a permanent state of turbulence, and little long-term stability in system goals. Truthfully, the healthcare system needs to be at arms length from the political apparatus which 'governs' it, like the Federal Reserve governing monetary policy regardless of political will. But that is a topic for another dissertation.

Ultimately, complexity science is an effective methodology for framing the problems of implementation, sustainment of pilot initiatives, and scaling of these successful projects to other contexts. Antifragility is an effective principle to leverage to mitigate problems associated with a implementation within a complex adaptive system. The Composite Design Cycle Theory (CDCT), the first component of the antifragile design portfolio, acknowledges the strengths and weaknesses of complexity science, and other methodologies, when engaging with implementation efforts in rural communities. Complexity science is particularly powerful at *informing* implementation teams about organizational history, relevant theories, and decision-making process. It provides a solid footing for teams to wade further into the implementation, and sturdy ground to return to when they inevitably run into a nasty wave.

These sections have shown the potential of complexity science to frame and think about challenges to implementation. By endorsing complexity science as an instrument of problem formulation, implementation teams are better equipped to articulate and overcome intricate problems which present during an implementation. Coupling this conceptual mapping of implementation challenges with principles designed to mitigate them (antifragility) can improve implementation success over the long term. Subsequently, this implementation success will be seen in better access for rural populations, and over the long term an improvement in rural population health outcomes.

## 2.5 Definitions of Terms

Every healthcare system operating today can be defined as a complex adaptive system (19). Complex adaptive systems possess characteristics such as *irreducible complexity*, *non-linearity*, *unpredictable consequences*, and *high levels of interdependency* (89). As such, implementing a new initiative into complex adaptive systems is unlike deploying interventions

into reducible, linear systems. The outcomes of an implementation may be unpredictable and cascading. For implementation teams, the distinction between linear, predictable interventions and those that are complex, can provide new methods for evaluation and additional insights into how projects may (or may not) progress.

*Irreducible complexity* is the idea that an outcome cannot be traced back to a single factor retrospectively. For example, if a team decides to implement a tele-dermatology initiative in a rural community that ultimately fails, it is very hard to identify one specific cause for the failure and adjust the model for future iterations. Feedback loops (both positive and negative), multiple moving parts, and the volatility of human interactions are just few of numerous factors which combine to make the investigation of a failed project extremely difficult. Most methods of evaluation and monitoring are developed with linearity in mind, and thus will be inappropriate.

*Non-linearity* is the idea that a change in one part of the system does not lead to an equal change in another part of the system. A small change to a system could lead to drastic changes in outcome, while similarly a system overhaul could yield small or non-existent changes. Non-linearity is a feature of health systems, as complex adaptive systems are greater than the sum of their parts. In a typical hospital for example, many different services (oncology, dermatology, cardiology, etc.) and groups of professionals (physicians, nurses, paramedics, allied health) work together to create the healthcare system as we know it. Any one of these groups would not exist in isolation and create a similar system; they each work with the other groups to collectively produce a rich and diverse system (90).

*Unforeseen consequences* occur whenever a new intervention is placed into a complex adaptive system, and implementation teams must be cognizant of them. No matter the level of due diligence done by the research team prior to implementation (interviews, site visits, census

analysis) there are always consequences which could not have been predicted (90). This is due in large part to the factors already discussed above. Therefore, throughout the implementation process, researchers must diligently monitor their intervention, and try to gather the appropriate data related to the intervention as holistically as possible. This holistic evaluation will yield better identification of so-called *leverage points* within the complex adaptive system which can then be targeted to change outcomes.

*Leverage points* are a key element of complex adaptive system that need to be understood when considering system implementation from this perspective. Leverage points typically exist where one part of the system overlaps with another; say a group of nurses interacting with paramedics, or patients with care providers. Donella Meadows outlined 12 leverage points which can be found and exploited within a complex adaptive system (91), and outlined the importance of understanding why working with these leverage points will yield better results than naively attempting to monitor smaller parts of individual systems. On this list of points of influence to change system outcomes, among other things, are items such as 'rules of the system', 'gain of driving positive feedback loops' and 'the power to transcend paradigms'. If a researcher can correctly look at their system and identify one of these 12 points, they may be able to influence the outcome of the system in a desired direction.

Another commonality to complex adaptive systems is *sense-making*. Sense-making generally refers to the gap between how things are done, versus how things are professed to be done. For example, in an emergency department triage the protocol may be to page the emergency physician regarding an urgent case. But, in reality it could be much easier for the nurse or paramedic to walk through the emergency department and speak to him or her face to face. The official 6 protocol in this case would hinder efficient care. Sense-making is important

to understand, because if an intervention is designed for how the protocols are laid out, it could risk rapid decline and failure as that is not how work is accomplished in that context.

At its root, sensemaking the process through which people assign meaning to experience (92). Because sensemaking is a social activity, interdependencies affect sensemaking. Interdependencies which are trusting, attentive to new ideas, and mindful of differences between ideas are more likely to result in effective sensemaking than interdependencies that lack these qualities. Facilitating effective sensemaking can help people understand interventions. Sensemaking can also help people understand a intervention as it unfolds. These real-time insights may be crucial for effective implementation. One important aspect of sensemaking is its connection to action (92). Effective sensemaking is more likely to lead to productive action than ineffective sensemaking. Take the following example of sense-making in action: complication rates in low vs. high mortality rate hospitals were the same, but complications were faster seen and diagnosed in low mortality rate hospitals. This 'failure to rescue' can be seen as ineffective sensemaking.

*Self organization*, and the *emergent* behaviours which arise from it, are other key attributes of complex adaptive systems (71,93). *Self-organization* is commonly defined as the agent-based movement or alignment with other agents of similar characteristics, whether characteristics defined by the hospital that the agents work in (such as nurses self-organizing with other nurses, or ICU staff self-organizing within the ICU) or other characteristics which are held by a broader population (religious affiliations, recreational interests, etc.). When agents encounter other agents within the complex adaptive system, they tend to form rich relationships with one another, which then inform the structure of the organization in higher levels. Already

we have seen how the interactions between triage staff informs the structure of the triage system overall.

For the purpose of this research, *rural* refers to population centres under 2 000 people, with at least 2 hours of automobile transit time to a population centre of 20 000 or more. The discussion to define rural is the focus of section 4.1. *Urban* is defined as a population centre of 100 000 or more. *Remote* is defined as communities requiring FIFO or DIDO health services, or by having a population of less than 1000 in an incorporated centre.

*Antifragility* is the antonym of fragile. An antifragile entity gains stability from volatility. Factors which can make something antifragile are outline in **Table 2.** Antifragile individuals, or programs, thrive when experiencing uncertainty. As a guiding principle in rural eHealth implementation, it makes intuitive sense that programs having antifragile facets built into them at the project design phase should fare better when confronted with the uncertainty common in healthcare systems. Antifragility as a theoretical framework has seen use in a variety of disciplines, including computer science (94), engineering (95), health sciences (96), and biology (97).

This section has provided several terms and their context of origin which will be referred to throughout this dissertation. These terms are important, because the antifragile design portfolio recognizes the presence of these phenomena and actively tries mitigating their impact on implementation process. Simple awareness of a concept such as emergence can help implementation teams plan their project design to account for this, among other, complex adaptive system traits. The remaining sections of Chapter 2 summarize the problem in 2.6, partition the investigation of the problem into 3 distinct research questions in 2.7.1, and assert the importance of the study in 2.7.2.

## 2.6 Statement of the Problem

*Rural communities within universal healthcare systems experience poorer health outcomes than urban centres, especially with regards to equal and equitable access to health services. This poorer health access is reflected in poorer health outcomes compared to urban communities. eHealth projects could address this health access inequity, but routinely end in a failure to spread and scale, which means their potential benefits are rarely realized outside of the context of their original implementation.*

## 2.7 Purpose of the Study

*To create a rurally derived framework for the implementation and evaluation of electronic health programs in universal health systems. In turn, address the equity gap in rural healthcare access in universal health systems through better sustainment and scale of electronic health programs.*

### 2.7.1 Research Questions

The central theme of my doctoral research is better understanding the facets salient to improved implementation of eHealth in rural communities, and how to effectively articulate and measure them. To investigate these aspects, three key research questions will be explored:

1. *Can eHealth address the planning challenges of rural health systems? (Practice)*
2. *Can antifragility provide insight regarding implementations in organizations and allow for initiatives to scale and sustain in other contexts? (Theory)*
3. *Can the link of theory and practice in the form of a design portfolio comprised of an organizational readiness tool and evaluation*

The above three research questions will be referenced to help guide the methodology used to frame and investigate them. Chapter 3 discusses how research designs were used to

frame the problem of rural eHealth implementation, and how ethnography, components of a realist evaluation, and thematic synthesis were used to investigate them. The findings associated with these research questions are then discussed in Chapter 5 and operationalizing these findings within rural communities is the focus of Chapter 6.

### 2.7.2 Significance of Study

The significance of this research is multi-faceted. Firstly, growing the slim body of literature surrounding rural responses to the COVID-19 pandemic is important as contemporary documentation of rural vignettes is useful for posterity and creating a robust literature base of rural research. Representation matters, and at the time of writing, no *distinctly* rural implementation framework exists in the literature to my knowledge. To that end, the publication of an ethnography exploring successful innovative techniques exhibited by rural communities in four different countries helps amplify the successful strategies in confronting the COVID-19 pandemic and is seen in Appendix A as *paper three* of my doctoral research. Further, the results of my doctoral research will identify mechanisms of effective change and provide evidence for future and sustained system transformation in rural communities. This will lead to the design of rural health policies and practices which is community derived, unique to rural contexts, and sufficiently evidence-based to facilitate sustained innovation, and ultimately better health outcomes of rural populations.

Additionally, this research will create an effective framework (in the form of the antifragile design portfolio) to follow in the face of necessary and urgent systems change, such as was needed during the pandemic. While guidance and leadership varied from country to country, with mostly positive outcomes with regards to service provision, there was no precedent or

guidelines to follow. Establishing a frame of reference such as a holistic framework grounded in a realist review of rural communities will better serve innovators of tomorrow and create robust rural health systems of the modern era.

## 2.8 Conclusion

Complexity science, antifragility, and eHealth implementation dovetail nicely together in terms of their methodology, findings, and synergy to create a holistic, rurally derived portfolio for eHealth implementation. The subsequent chapters of this dissertation will explore how complexity science, eHealth implementations, and rural health system planning relate through antifragile design. By using complexity science insights to guide rural eHealth implementation, rural communities can implement, sustain, and scale eHealth initiatives in a variety of disciplines.

Ultimately, this dissertation can be distilled into 10 bullet points, which will be reiterated throughout:

1. There is a **rural health access equity gap** (especially for specialist care)
2. **Electronic health** can address that gap, but pilot projects rarely scale nor sustain
3. **Antifragile design** and **complexity informed principles** can improve pilot project lifespans
4. To investigate this, **qualitative methodology** is required
5. Quantitative methodology can be incomplete or impartial in demonstrating relationships between populations and variables, due to small sample size and diversity of the sample.
6. Findings derived from qualitative methods reflect rural nuance, and tacit knowledge of **rural implementation processes**
7. Output 1: **CDCT** – organizational readiness tool for antifragile design deployment

8. Output 2: **MS** – evaluative framework to assess antifragility and institutional investment
9. Together, these outputs comprise the **antifragile design portfolio**, and help eHealth programs **sustain and scale** in rural communities
10. This work contributes to addressing the health equity gap in rural communities, **improving health outcomes for these populations.**

Chapter 3 explores the background literature regarding complexity science, including its origins and applications, electronic health as a viable therapy in universal health care systems, and influential implementation science frameworks which were leveraged throughout my doctoral research. Chapter 4 discusses the designs used to frame the problem of rural eHealth implementation (complexity science, implementation science, realism) and the methodologies used to investigate this problem (ethnography, components of a realist evaluation, and thematic synthesis). Chapter 5 will outline the results of ethnographies, components of a realist review, and thematic synthesis regarding rural eHealth implementation, and what it can tell us about strategies for other contexts when viewed from a complexity science perspective. Chapter 6 will discuss these results and provide a way to operationalize them: the antifragile design portfolio, comprised of the CDCT and MS. Chapter 7 discusses the role of the antifragile design portfolio in organizational change, as well as its ability to sufficiently mitigate risks to rural communities undertaking eHealth implementations. Chapter 8 offers conclusions based on the research, recommendations for policymakers, and potential prospective deployments of the antifragile design portfolio in post-doctoral work.

# Chapter 3: Review of Literature

To better understand the relationships between the three disciplines of interest, a literature review was conducted with regards to complexity science, implementation science, and eHealth programs in rural communities. Each discipline in and of itself contains massive amounts of peer reviewed publications, white papers, and grey literature exploring best practice. The volume of literature increased exponentially during the COVID-19 pandemic, as practitioners, policymakers, and other organizations sought to understand the risks and rewards of electronic health, as well as effective implementation strategies therein. The literature search explored each discipline separately, but particular attention was paid to papers or material which blended two or even all three of these disciplines. Interestingly, papers which included perspectives from complexity science, implementation science, and electronic health became more common as the COVID-19 pandemic progressed.

While the disciplines of interest have an incredible amount of published literature, the other purpose of conducting this literature review was to temper the lessons learned with their relevance to rural health systems. Rural health systems have a reputation of being disadvantaged, one which needs to be changed in order for beneficial rural characteristics to be foundational for rural health system reform. The perspective on rural communities should be shifted to acknowledge rural health systems are starkly different than urban health systems and rural systems suffer from being labeled as disadvantaged instead of having their distinction acknowledged by policymakers. Within universal healthcare paradigms, rural and urban health systems are often conflated with one another, and the struggles of rural health systems attributed to the fact that they are disadvantaged and hard to work with. Instead, the nuance between the

systems, and focusing on where they diverge, would serve rural health systems and implementation efforts better in the future. That is the purpose of the antifragile design portfolio (6.3), the main output of my doctoral research, to institute rural health system derived frameworks to better assist eHealth implementation.

It is generally agreed that rural health systems appear more fragile than their urban counterparts (98). Urban health systems will always be the centres for specialized care, critical care, and acute trauma. Urban centres too will also have access to more resources, more funding, and more robust models of care than rural systems. Complexity science principles however puts an emphasis on diversity, and the importance of redundance and resilience within the system. Recall, resilience at a system level is something which should be prioritized by all policymakers and administrators. Resilience at the individual level can have negative connotations, as individuals (people, organizations, institutions) are sometimes retrospectively expected to have higher levels of resilience to deflect responsibility or acknowledgement of barriers and challenges.

The COVID-19 pandemic required resilience at every level of the system. As expected, most of the emergency funding and resources released at the federal level within Canada were diverted to urban health systems. This intuitively makes sense, as urban contexts have higher population sizes, greater risk of community spread, and a higher chance COVID-19 could become endemic within these communities. Rural communities were positioned to adjust to the initial wave of COVID-19 better than urban places. The initial protocols of social distancing, stay at home orders, and regional lockdowns prevented the exponential spread seen in most urban centres within Canada. Consequently, rural health systems were allocated funding which

was less than their urban counterparts, and saw a significantly lower level of the resources afforded to urban centres, especially for vulnerable groups (99).

Under the disadvantaged, not different, perspective of rural health, wherein rural health systems had been viewed as fragile, it would follow that a significant system stressor such as a pandemic would result in widespread system collapse. Without resilience and adaptability, lack of resources, inherent fragility and poor resilience, rural health systems *should* collapse. Many local clinics, family practices, and eventually regional hospitals would close their doors, and health service centres would become even more concentrated in urban communities.

Contrary to what was thought to occur, many rural health systems displayed remarkable autonomous capacity to adapt to the system stress applied by the COVID-19 pandemic (27). In some cases, this was the adoption and promotion of eHealth services to supplement or replace traditional in person care, and in others it was becoming a multifunctional centre for health promotion, healthcare provision, and social programming. In an ethnographic study conducted by members of the Free Range research group (*paper three* (27)), field research showed the diverse capabilities of rural health systems in response to the challenges of the pandemic. Rural communities displayed antifragile indicators consistent with those displayed across the globe in rural contexts in Iceland, Canada, Australia, and Sweden (28,73). As the uncertainty regarding appropriate protocol and policy mounted throughout the progression of the pandemic, rural communities exhibited antifragility both at a micro and macro level.

Therefore, this literature review is most prominently influenced by peer-reviewed publications, white papers, and reports which discuss the relationship between complexity science, implementation science, and eHealth interventions in a way which are most salient to rural health system function. Rural health systems are different in their structure, organizational

values, and culture. Literature which acknowledges that and works under the assumptions that the system is different are not numerous in nature, but there has been a shift in conversation regarding rural implementation and appreciation of the facets which makes working in rural contexts unique. Although this change in approach is encouraging, studies and investigation into rural implementation and health systems is still in the convergent phase of research, and a collation of comprehensive rural health system reform recommendations is still unclear. The main output of this doctoral research, the antifragile design portfolio, contributes to the principled reform of rural health systems.

While there is agreement in some instances of best practice, much of the literature is sorting through the theoretical lenses and frameworks abundant within complexity and implementation science. To develop holistic reform with regards to rural health system policy, in the form of the antifragile design portfolio, methodological variation is required. eHealth literature is likewise making a case for adoption and spread of eHealth programmes to mitigate some of the burdens seen in pandemic service provision. eHealth literature is also arguing for its inclusion in standard practice post-pandemic, however there are instances where implementation of eHealth was done with the idea of a roll-back inherent in the implementation. Complexity science frameworks supports the argument that eHealth can (and should) be integrated fully into universal healthcare systems, while implementation science provides some guidance on where (and how) eHealth can be implemented the most efficiently.

The gap then lies with an effective strategy to evaluate and assess readiness for rural eHealth initiatives with complexity informed methods, which will yield promising implementation outcomes. This gap in literature is the target of my dissertation work, as the use of the matrix of scale tool will provide information to policymakers and decision-makers, while

organizational readiness work guided by complexity science will assess the ability of an organization to implement novel and innovative strategies effectively. Both of these components are discussed in section 6.3. Both the matrix and the organizational readiness assessment will provide policymakers and administrators important information in a 'zone of complexity'(88), where decision's must be made without key information available. Recall, operating in the zone of complexity requires a certain comfort with ambiguity and having knowledge that a given eHealth intervention or program possesses a high degree of antifragility could be a sign of its ability to thrive in the context it is implemented into, as well as an ability to scale effectively to separate contexts.

This chapter then will comprehensively explore the disciplines of complexity science in health research, implementation science and its relevant frameworks and theories within healthcare, and lastly eHealth literature in rural health systems and the recommendations it can make to an adapting healthcare system. Additionally, the argument will be introduced that antifragile project design (in the form of organizational readiness work as well as the matrix of scale) can help prepare organizations in both rural and other contexts to effectively implement eHealth as standard practice. The gaps in literature in all three disciplines will then be addressed by the antifragile approach advocated for by this dissertation.

## 3.1 Complexity Science Literature (Tempered by Rural Health System Planning)

Complexity science has its roots in business management, where it was first formally described in 1979. It attempts to understand, articulate, and research the intricacies, dependencies, and structure of complex adaptive systems (CAS). A complex adaptive system can be best understood as "an interconnected set of elements that is coherently organized in a way that achieves something" (91). Generally, it is agreed that there are three types of systems:

simple systems, complicated systems, and complex adaptive systems. These three systems present differently in rural communities, and complicated systems are often conflated with complex one's. It is here that language and semantics play an explicit role in formulating problems with rural health service delivery. For example, establishing at the outset what the community itself identifies as (within the urban – rural dichotomy) is an important, and sometime overlooked, first step in any implementation efforts within rural communities. In implementation practice, complexity science has strength as a descriptive instrument, and can create metaphors which effectively communicates conceptual facets of an implementation and their influence on an implementation process.

Simple systems are linear, reductionistic, and intuitive. They are subject to the superposition principle, where if A and B both lead to the evolvement of the system, then the same is true for A + B (89). This implies that the system can be broken down into its component parts, and the total system can be derived from these discrete parts. For example, turning a light on or off depends on a switch, which when interacted with closes or breaks the current of electricity to the lightbulb. Understanding this simple interaction between switch and circuit break follows the superposition principle and confirms the linearity of the system.

Complicated systems have hundreds, thousands, or even millions of parts, sub-systems, and inputs. In these complicated systems, it is still known how every input affects an output. The component parts of a complicated system still follow a simple set of rules and they do not deviate from these parameters. This makes associating outcomes with acknowledged change within the system easy to follow, with the proper knowledge of these rules and how component parts interact. For example, a large commercial airplane is a complex machine, with instruments, electronics, and mechanical parts numbering in the thousands. Although it is a complicated

machine, there is still consensus and knowledge regarding how parts fit together, what their use is, and how they interact to make the complicated system (i.e. airplane) function.

Complex adaptive systems are opaque, non-linear, irreducibly complex, and unintuitive. They have many component parts, like a complicated system, but the key difference is the incomplete knowledge regarding how these component parts interact to achieve outcomes. Complex adaptive systems are greater than the sum of their parts, and do not follow the superposition principle outlined when discussing simple systems. Complex adaptive systems more closely relate to functions such as $y = x^3$. It is impossible to break down a complex adaptive system into its component parts and understand the complete function of the system. The result is a non-linear system, where large changes to inputs can have little effect on outcomes. Further, relatively minor or ostensibly innocuous changes to inputs could drastically alter outcomes (for better or for worse) (28). Complex adaptive systems are dynamic and resemble an ecosystem: constantly fluctuating between equilibrium and uncertainty, with changing rules, structure, and interaction between component parts occurring regardless of surveillance or knowledge of other parts of the system. Complexity science is the investigation of how to effectively work within these complex adaptive systems, with a particular emphasis on effective implementation strategies, knowledge mobilization, and generalizable frameworks and theories in approach problems exacerbated by complex adaptive systems and it's associated traits. As was established in Chapter 2, rural health systems are complex adaptive systems, which makes implementation difficult, and antifragility important as a principled approach to rural eHealth implementation.

Brainard and Hunter examined whether complexity science is a potentially valuable tool for working within and between systems (93). They assert that:

"*Merits of a perspective informed by complexity science in public health appear to be strongly supported by pragmatic acceptance of the nature of real-life solutions, and also a useful counter-balance to the weaknesses in reductionist perspectives, and perhaps the overly optimistic reliance on the evidence-based approach [to policy and medicine]*" (93)

Complexity science recognizes the large number of known and unknown elements common in a complex adaptive system. To reiterate, some of the common elements of a CAS include: nested and interdependent networks, non-linearity, unclear pathways of cause and effect, the presence and impact of emergence and self-organization, unplanned or unforeseen structures which arise from processes and interaction between elements and the self-perpetuating nature of complex adaptive systems (89,100).

Paradoxically, Brainard and Hunter noted that complexity science has value in appearing useful when conducting an evaluation but has uncertain impact when applied to help steer an implementation process. They sought to answer the question: is it possible to show that interventions purposefully designed which deploy complexity concepts exhibit effectiveness? To do this, they scanned for empirical papers which explicitly cited complexity frameworks and theories in both the design and evaluation stage of the implementation process. They then evaluated papers on a 5 criteria scale, including the consistency of evaluation, how changes were observed, and sensitivity to unintended consequences following implementation (among others).

Brainard and Hunter found that interventions informed by complexity science usually took the form of consultative workshops or training sessions (93). There was also a cultural divide, as Canadian and United Kingdom studies sought to change opinion, values, and beliefs in a general sense. American studies however focussed on a particular outcome or goal. This could be a result of the rather fragmented nature of the American healthcare system, and the latent spectre of competition threatening budgets of these independent health entities. Competition

breeds innovation and agility, because of the small mobile clusters which can be sustained and fostered in this type of fragmented environment (101). Barriers were seldom discussed by the complexity science papers reviewed, but recommendations on macro level changes to health system culture were common, especially regarding entrenched behaviours, values, and beliefs.

Ultimately, there were numerous benefits listed from using a complexity science approach in implementation of interventions. These varied from "*better communication, more confidence in meetings or speaking with colleagues*", to "*faster prescription refill*", to a "*turnaround time for hospital bed [decrease] from 210min to 54min*". The diverse nature of interventions which utilized complexity science, and the documented benefits, speaks to the potential of complexity science to address problems across a complex adaptive system such as healthcare. This is encouraging, as eHealth implementation in rural communities would benefit from the conceptualization of health systems as CAS. It was also noted that simple goals led to more tangible positive impacts in the final report. However, some literature did not account for unintended consequences of their implementations, which may reflect a misunderstanding about characteristics inherent to complex adaptive systems and the function of complexity science. It is also a sign of the importance of correctly interpreting results, as outcomes derived from complexity approaches which fail to account for the unforeseen consequences of the intervention risk misunderstanding a relationship.

To summarize, complexity science seems to improve the likelihood an intervention can be successful. There are biases in this conclusion, chief among them being that published literature must be successful to a certain degree to meet publication standards. The nature of a peer-reviewed literature scan limits the pool of literature which is analysed. By excluding unsuccessful interventions or initiatives, this skews the sample size to papers which all exhibit

some sense level of success. From the papers collected and analysed, the recommendations of the authors be that complexity informed interventions find some form of consensus with senior administrators and decision-makers. Additionally, because of the difficulty of establishing cause and effect within a CAS (102), potential end-states of interventions should be expressed in probabilities instead of absolutes. This dissertation follows this recommendation by qualifying the antifragile design portfolio as a collection of complexity informed tools which can improve pilot project performance within a complex adaptive system (rural health system) but doesn't guarantee it.

In a rural health system planning and design capacity, complexity science, and complexity informed frameworks such as the antifragile design portfolio, can help make explicit tact knowledge and assumptions as relevant to implementation processes. Further, it can help articulate the influence conceptual tenets such as invention, creativity, and innovation and the impacts these principles can have on patient and provider interaction with the intervention. Complexity science can help frame direction for implementation teams in future iterations of implementation, ensuring that the populations of interest begin to utilize the intervention. It is from the use and interaction with an intervention that data points can be captured, and implementation teams can better understand the core and peripheral components of the intervention to promote within their given context. Complexity science's strength then is in *informing* implementation teams on relevant facets of an implementation in complexity science terms. Complexity science as a research design is discussed more in section 4.4, and how it was applied to understand the problem of rural eHealth implementation.

### 3.2 Implementation Science Literature (Tempered by Rural Health System Planning)

Implementation science is best described as the study of the dissemination, up-take, and sustainment of proven healthcare interventions as they transition from context to context (87). Implementation science's chief concern is moving research from it's demonstrated value in pilot studies of feasibility projects into standard models of care. *Implementation practice* (or process) is the use of strategies by individuals to implement interventions which improve outcomes in some measurable manner, supported by a robust evidence base. *Implementation science* differs from that by studying the methods in which interventions are consistently implemented, sustained, and scaled (87). Implementation science does not consider the fidelity or impact an intervention has on changing outcomes, but rather the utilization rates of the intervention in its context. The strategies promoted by implementation science literature could differ from other contexts, but not necessarily. *Dissemination practice* is the practice of actively sharing information regarding successful interventions and the impacts on patients and providers. Part of practicing dissemination is opening and maintaining channels of information, ideally with bilateral flow (information travels both from top-down and bottom-up within organizational structure.) *Dissemination science* is the study of the most effective methods of sharing information within a given organization or institution. Dissemination practice should then be informed by dissemination science regarding salient strategies of allowing informational flow.

Bauer et. al discuss implementation science for the non-specialist in their introductory paper (87). Non-specialist communication is important, as the pragmatic strategies of implementation science can be sometimes inaccessible due to poor knowledge translation and integration. While the pervading thought is rural communities are disadvantaged, and, frankly, slower than their urban counterparts, the reality is different. Rural leaders and community

members understand best what works. Communicating frameworks and evaluative methods which work is best done in simple terms, not for the community's sake, but for the sake of an intervention being able to scale, spread, and sustain. Introducing implementation science frameworks and theories in rural settings usually applies academic terminology to grassroots efforts already being undertaken in rural communities. Nevertheless, talking about implementation science with non-specialists can foster consistency in how implementation is approached, and create consensus regarding the best way to proceed with a given intervention.

At its core, implementation science can be seen as the concentrated devotion and investigation into moving evidence-based practices into routine practice. Implementation science can facilitate the spread of evidence-based practice, such as electronic health initiatives in rural communities. The systemic uptake of research findings and evidence-based practices would be reflected in the outcomes of patients within the healthcare system, less burnout and stress on healthcare providers, and an antifragile healthcare system capable of grappling with extreme system stress such as a global pandemic. Methodology in implementation science is necessarily diverse, with both qualitative and quantitative methods having niche use in validating implementation science theories and frameworks (103,104). These methods seek to identify factors which impact uptake across multiple levels of the healthcare system, including patients, providers, clinical, facility, organizational, institutional, and the broader social and policy environment implementation occurs in. Implementation science is necessary as under increasingly strained fiscal conditions, healthcare systems need evidence-based practices which help increase the efficiency of research to patient outcomes.

The drive for the recognition of implementation science is largely undertaken on the part of biomedical funders. Funders are concerned regarding the lag in time (on average, 17 years

(105) it takes for evidence-based practice and clinical research to make it's way down the policy pipeline into widespread usage within a healthcare system. Multiple interventions spanning biomedical, sociological, and psychological disciplines progress down the pipeline of research, and encounter blockages along the way. Implementation science articulates these blockages and creates recommendations on how to clear them and avoid them, leading to smoother and faster deployment into routine practice. While the focus of implementation science is commonly clinical in nature, a well-balanced implementation science team is inherently multidisciplinary. Academics and implementors need diverse backgrounds to fully appreciate the scale and complexity of barriers and challenges many interventions face in a standard implementation process. Embracing implementation science also requires recognizing that you can only ever be a partial expert in an implementation process. Effective communication, teamwork, and leadership is required from a multidisciplinary team to help guide implementation efforts in a principled manner. The antifragile design portfolio leverages implementation science to introduce a principled framework with vision regarding effective implementation strategies in rural communities. The sustainment and scale of eHealth pilot projects will be realized in addressing health access equity gaps, and ultimately health outcomes in rural populations.

Implementation science has significant overlap with quality improvement and dissemination science. *Quality improvement* (QI) research typically involves a singular problem within an individual context and explores appropriate ways to approach that problem within that context (106). QI is pragmatic in nature, as it explores methods to better implement evidence-based research in a distinct context with little focus on how it can scale to other settings (106). Further, QI rarely considers the broader impacts of implementation issues, as creating sweeping frameworks for different contexts is outside the scope of quality improvement as it is defined.

Implementation sciences goal is making it explicit that efforts to improve implementation should be generalizable knowledge which could be widely applied outside of the individual system under study. Further, implementation science differs from dissemination science as dissemination refers to the sharing of information, usually supplemented by concrete educational efforts and integrated knowledge translation structures. Implementation science usually utilizes dissemination science techniques, such as integrated knowledge translation, but they are embedded in more comprehensive, targeted, and active efforts to spread a given evidence-based practice.

Implementation science has identified and disseminated several principles and methods which are generalizable across most implementation processes. Implementation facets are a singular method or technique to facilitate change. *Implementation strategy* refers to an integrated set, bundle, or package of discrete implementation facets ideally selected to address specific identified barriers to implementation success (87). Evaluation of these implementation processes have three separate perspectives: process evaluation, formative evaluation, and summative evaluation.

### 3.2.1 Consolidated Framework for Implementation Research (CFIR)

Damschroder et. al established multiple domains relevant to implementation through snowball sampling of the most cited and utilized implementation frameworks (85). This widely cited paper, known as the consolidated framework for implementation research or CFIR, has been applied broadly since it's publication in 2009 (107). The CFIR posits that there are five common domains to consider during an implementation. **The first domain** is the intervention itself. Interventions are normally seen as a poor initial fit within a setting and are resisted by individuals who will be affected by its implementation. They are usually complex with many

interacting components. Of these components, there are two general categories: peripheral and core components. Core components of an intervention are integral to its success and structure. Peripheral components can be adjusted from context to context without undue effect onto an intervention's integrity. When examined through the perspective of antifragility, limiting the scope of core components, while having many peripheral ones, create an intervention which does not rely on the structure of any one or more core components too heavily. Having many adjustable facets (or peripheral components) makes a project agile when scaling to different contexts or broader levels of health organization.

The intervention then most contend with the inner and outer setting, **domains two and three respectively**, of an organization. The outer setting is the economic, political, and social environment within which an institution resides. The inside setting is the structural, political, and cultural contexts through which the implementation process will proceed. It is not always clear how to distinguish between the outer and inner setting, as it is possible that these settings can blend with one another. The interface between the settings is often dynamic and fluid. Usually however, the inner setting mediates the interactions and effects the outer setting has on a given implementation initiatives. Influence from the outer setting must percolate through the inner setting of an implementation effort, which can result in the change of factors relevant to implementation. It is important for implementation teams to recognize how these settings can influence and drive an implementation process and respond accordingly.

The outer setting **(second domain)** of the implementation of an intervention is dominated by patient needs and resources. What patients prioritize, and the resources already available to help patients satisfy those needs, will guide intervention design and implementation. Patient-centreed care (and, increasingly, patient partnered care) is seen as a model of service which

yields both high levels of patient satisfaction as well as efficient care delivery. PRISM is an evaluation framework which delineates six core facets to assess the degree of which patients are at the centre of organizational processes and decisions. Some of the most salient of these facets, as it relates to rural eHealth implementation, are cosmopolitanism, social capital, peer pressure, and external policies and incentives.

Cosmopolitanism refers to the degree to which an organization is networked with other external organizations (107). Organizations with higher number of agents can be brokers and bridges allowing for the implementation of newer interventions more rapidly. Social capital refers to the quality and quantity of relationships of agents within an organization and their ability to navigate multiple networks. Organizations with high amount of social capital observe more success in implementing change. Peer pressure is the mimetic or competitive pressure to implement an intervention, typically because most other peer organizations have already done or are considering doing so. Lastly, external policies and incentives are broad constructs that encompass external strategies to spread interventions, including policies and regulations from government or NGO entities.

The inner setting **(third domain)** is difficult to conceptualize, resulting in a latent complexity from which many barriers and challenges can proliferate if not identified definitively. The structural characteristics of the inner setting, such as the social architecture, age, maturity, and size of an organization are all important factors in driving successful implementation. Low staff turnover, lower ratio of staff to managers, and low levels of organizational centralization have all been correlated with higher rates of implementation success. Additionally, the nature of endemic networks and communication pathways within an organization influence implementation success. Relationships between individuals could be more important with

regards to implementation than individual attributes of agents. Fostering these relationships could positively drive implementation.

Another foundation of the inner setting is organizational culture. Organizational culture is another important aspect of implementation which needs to be addressed throughout the process. Most change efforts are targeted at visible and objective components of an organization which include things such as work tasks, structures and behaviours. One explanation for why so many novel implementations fail to sustain and scale is the inability to change less tangible organizational assumptions, thinking, or culture. A sublevel of culture is the climate of change within an organization. The absorptive capacity for change includes the shared receptivity of involved individuals to change and the extent to which an intervention will be rewarded, supported, and expected within the organization. The readiness for implementation is certainly influenced by the climate for change and can be evaluated through immediate indicators of organizational commitment to change such as leadership, available resources for implementation support, and the access to information. The COVID-19 pandemic escalated the tension for change and receptiveness to novel interventions to a fever pitch and was certainly responsible for the rapid deployment of virtual care and eHealth at all levels of the health system.

The **fourth domain** are the individuals themselves who are involved with the implementation process. While individuals and their emergent behaviours can account for the second and third domains of implementation, that is outside the scope of the fourth domain. The fourth domain specifically targets the individuals who are involved with the implementation personally, and how their choices, values, and interaction can influence the implementation process. Relatively innocuous phenomena could have consequential effect on implementation, and conversely concentrated efforts by powerful agents could have little effect on an

implementation process. The fourth domain then examines how individuals involved in the implementation process can effect said programme.

Lastly, **the fifth domain** is the implementation process itself. Successful implementation usually requires an active change process aimed to achieve individual and organizational level use of the intervention as designed. Socially constructed perceptions in the local inner setting (second domain) can have a profound effect on implementation success. Formative evaluations of implementation efforts must carefully consider how to elicit, construct, and interpret findings to reflect the perceptions individuals and their organizations have. If care is not taken to prioritize these values and perceptions, then the evaluations could be skewed by the opinions of outside researchers or experts, which will hinder implementation efforts by obscuring the barriers and challenges identified by individuals.

Further, attention must be given to the origin of the intervention. If the source of the intervention is internal, that can have different inherent effects on implementation process than if the source is external. Both the origin as well as the legitimacy of the source steers the implementation process. In addition to this, ensuring the intervention is both adaptable and 'trialable' is important. Assessing adaptability can be done through a component analysis which identifies the core and peripheral components of an intervention. The more peripheral components, or the more a component can be adjusted to become peripheral, associates closer with an intervention which can scale and change from context to context. Trialability is the potential of an intervention to be implemented at a small scale and rolled back and iterated if prominent barriers and challenges arise. Keeping initial implementations small and agile avoids problems of path-dependence, wherein implementation processes throw good money after bad pursuing the fallacy that a sizable amount of resources have already been invested, meaning

changing course is not a viable option late in an implementation process. Path dependence is discussed in depth in section 6.3.2.4, as well as how the MS (component 2 of the antifragile design portfolio) can mitigate becoming path dependent as an implementation team.

The implementation process contains four essential activities common across organizational change models (85). These activities include planning, engaging, executing, and reflection and evaluating. While these activities are usually done through formal channels, they can also be evaluated informally. Planning constitutes the degree to which a scheme or method of behaviour and tasks for implementing an intervention are developed in advance and the quality of those schemes or methods. The fundamental objective of planning is to design a course of action to promote effective implementation. Engaging comprises attracting or involving appropriate individuals in implementation, and the showcasing the intervention through an appropriate mixture of social marketing, education, role-modeling, training, and similar endeavors. First users of the intervention should be carefully selected or allowed to arise naturally from the pool of users.

Implementation processes usually have distinct leaders who separate themselves within the organization from other users of the intervention. Generally, there are four categories of leaders within an implementation effort. Opinion leaders are individuals within an organization or institution who have formal or informal influence on the attitudes and beliefs of their colleagues with respect to implementing the intervention. Formally appointed implementation leaders are individuals who have been officially designated by leadership or administration to bear much of the responsibility for implementing an intervention. Champions are individuals who dedicate themselves to supporting, driving, or marketing an intervention, with or without formal support or direction. These champions sometimes risk informal status within an

organization because of their conviction regarding the importance and impact of a given intervention. Lastly, external change agents are individuals associated with an entity different from the organization in question who can formally influence or facilitate intervention decision-making.

The execution of the implementation process is the carrying out or accomplishment of the implementation according to the strategies agreed upon in the previous stages. The probability of an implementation succeeding requires an execution to be non-linear in nature, and the importance of trialability and starting small should be built into the execution of a given intervention. Having the ability during the implementation process to 'return to the drawing board' if there is a fatal flaw within an implementation effort gives an intervention the agility needed to navigate the complex environment of healthcare organization. This is reflected in the antifragile operator of *starting small*, which allows implementation teams to tinker and iterate, during an implementation process to identify and moderate flaws in an intervention or implementation.

The last step in an implementation process is reflection and evaluation. While this step is traditionally done *after* an implementation is complete, it is important to reflect and evaluate across the duration of an implementation. Reflection can yield nuance into a specific context which can then be leveraged in a further iteration of the implementation process. Without reflection and evaluation during the timespan of an implementation, it becomes difficult to distinguish between salient facets of a specific implementation, how the intervention should be adapted to meet the challenges of a given contexts, or how to better involve individual agents or leaders within the implementation.

To summarize, the CFIR framework as put forward by Damschroder et. al identifies key facets which need to be addressed to improve the likelihood of a successful implementation. At the macro level, the CFIR can be used to promote synthesis of research findings, studies, and settings, using clear and consistent language and terminology. It can help decisionmakers by providing common terms to barriers and challenges encountered during a standard implementation process and locating them within the constructs of domains and implementation process lifespans. The Damschroder paper is a heavily cited (almost 8000 citations) and has been incredibly influential on how implementation science separates itself from simple implementation efforts.

### 3.2.2 Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM)

The RE-AIM framework developed by Glasgow et. al is another influential paper which has seen widespread adoption and application within implementation science since it was first developed in the late 1990s (108,109). The RE-AIM framework was unique at the time in that in went beyond analyzing an interventions internal or external measure of validity and fidelity and considered relevant contextual factors which can act as barriers or facilitators for implementation. The motivation for it's comprisal was the lag in time it took for research to impact practice and the lack in effective strategy to guide practitioners to integrate research findings into standard routines. RE-AIM consists of five dimensions – Reach, Effectiveness, Adoption, Implementation, and Maintenance. These dimensions then have several indices which are aggregated under one component. For example, under the maintenance dimension, both individual-level training and support are considered as well as system level maintenance such as infrastructure and funding (108). RE-AIM has seen such widespread application (110) in part

because of it's focus on the sociological, conceptual, and abstract facets which influence an implementation.

Although when it was first introduced RE-AIM's emphasis was on quantitative measures of implementation success under it's 5 dimensions, a need has been recognized for a more mixed methods approach. To quote a review analyzing RE-AIM application to interventions:

> "*Second, mixed-methods should be used across framework components to identify explanatory processes across RE-AIM dimensions. To date, quantitative measures alone have been insufficient to strongly predict dissemination (reach and adoption), implementation, and maintenance outcomes*. (109)"

This aligns well with both the organizational readiness tool of the CDCT and the evaluative framework of the MS, the two components which comprise the antifragile design portfolio. By advocating for qualitative methodologies in implementation and dissemination research, rich descriptions can be formulated, and lessons learned better translated to other contexts.

Rural implementation science needs to pay particular attention to the history of interventions in each rural context. Every intervention has a history, and that history can impact opinions, culture, and values in future implementation efforts. Rural contexts disproportionately suffer from reputations of being 'hard to work with' or difficult settings to implement in. This is due to several factors, but key among them is the assumptions of researchers and policymakers about working with and within rural communities as handicapping an implementation at the outset due to inherent disadvantages of rural sites. This narrative is self-confirming, as little research into the differences of rural contexts as opposed to urban settings is done. If these differences are considered, rural settings are no more difficult to work with than urban

communities, but require a specific set of methodologies, evaluations, and outputs to meaningfully impact standard practice. The antifragile design portfolio follows the different not disadvantaged perspective of rural communities, and is a strengths-based approach to rural eHealth implementation.

Rural contexts invariably have had experience and interactions with unsuccessful implementation of a given intervention. The challenges and barriers often cited by rural decisionmakers include recruitment and retention of skilled personnel, lack of community buy-in, and lack of resources. Routinely, the body or group looking to implement an intervention are not 'in-house' and have little experience working and discussing the particulars of rural healthcare. Further, rural stakeholders feel they are victims of 'tokenism' wherein they are included at the table merely to satisfy grant requirements or directions from leadership to have rural opinion shape an intervention. Implementation teams should attend to the history of their context, as this is an effective method to build trust with their stakeholders. Without significant trust between a context and the implementation team, latent attitudes will be difficult to change regarding implementation, and the reputation of a 'problem-site' will be self-perpetuating.

To assess readiness for an intervention, models are a common starting point. Models include inputs and outputs, usually mediated by prominent variables like rates of illness or funding and are useful in determining the priorities in an implementation. George Box, an English statistician, summarized models succinctly when he said: "*all models are wrong, but some are useful*." Modelling a complex adaptive system can be a self-defeating exercise. CAS are not a sum of their parts, so consequently any model of a CAS will misconstrue interactions, outputs, and variables within them. Additionally, introducing more variables to create a holistic representation of a CAS (such as a rural healthcare system) creates a model whose output

becomes harder to understand, not easier. Every variable introduced within the model will have an associated model error, as it approximates a conceptual value (such as culture) (111). This model error must be accounted for in the outcomes of the model. Therefore, any output of a model with hundreds or even thousands of variables has an accompanying model error which is so broad it calls into question the authenticity of the value itself.

To understand and utilize models, they must be accompanied by qualitative investigation regarding organizational culture, attitudes, beliefs, and values. If a readiness assessment regarding a virtual health room implementation in a rural community is done, and a model is introduced into the assessment which approximates a rate reduction in late-stage cancer diagnosis due to increased personal health scanning by patients, this information would be seen as justification enough to undertake an implementation in that community. What this model is missing however, or what it fails to account for, is the history of implementation within that community. Rural health systems have longer memories than their larger urban counterparts, and stakeholders require assurance form implementation teams that their concerns will be well respected and listened to. Urban health systems have more elasticity in their implementation schemes, owing to their larger size, pool of agents, and funding. This focus on history in rural communities is perceived as a weakness, but must be recast as a difference, and implementation teams need to recognize and account for this difference in their project design.

Ultimately the RE-AIM's emphasis on conceptual facets of an implementation, and recognizing their influence on an implementation's success, has been leveraged within the antifragile design portfolio. Incorporating qualitative methods within the CDCT helps codify and record informal beliefs, attitudes, and culture which can then be targeted by rural implementation teams to increase uptake of an intervention. The impact of implementation science, and the CFIR

and RE-AIM frameworks as heling to frame the problem of rural eHealth implementation is discussed in more in section 4.4.

### 3.3 eHealth Literature (Tempered by Rural Health System Planning)

Electronic health has seen increased deployment in rural health systems, even before a global pandemic necessitated pivoting to many different eHealth initiatives across the globe (34). Increasingly, patients and providers have recognized the demonstrated impact eHealth projects have on the ability to manage illness, adhere to follow-up, and negate the tyranny of distance which has created access gaps between rural and urban communities (38). Post-pandemic, the champions who endorsed eHealth have been galvanized by system function, change in attitude, and adjustment of beliefs regarding eHealth and its place within a rural health system. Based on a report compiled for the federal government of Canada regarding eHealth implementation throughout the pandemic, 'recommendation 0' was "*maintaining and fostering the environment for change for as long as we can"* (62). eHealth initiatives helped address the problems to service access which occurred during the first wave of the pandemic, and iterations of eHealth strategy helped address these challenges as the pandemics progressed. Metaphorically, eHealth as a medium served as a retaining wall for the health system as the unrelenting waves of the pandemic eroded traditional health service and access.

Much of the background establishing eHealth as an effective way to mitigate problems in rural health access was described in Chapter 2. Indeed, *paper four* (appendix A) of my doctoral research was a scoping review of patient and provider perspectives regarding eHealth integration into rural health systems. That paper was a literature review of peer-reviewed publications regarding implementation of rural electronic health projects. The findings of that review

highlighted prominent levels of acceptability and diverse benefits attributed to eHealth by both patients and providers (34).

eHealth in rural places varied from context to context and differed temporally as pre-pandemic hesitation gave way to dealing with a progressing pandemic, and as vaccination numbers continue to climb, eHealth will have to find it's niche in the post-pandemic system. eHealth can be seen as sparking systems change, with many rural communities implementing eHealth as a mechanism of coping with the tension for change at an all time high. Pre-pandemic, eHealth in rural communities needed strong leadership, origins from the local context, abundant funding, and a mixed-methods approach to implementation and evaluation. Only through the interaction of these variables did the implementation of an eHealth initiative have a reasonable chance of success. An example of pre-pandemic rural eHealth implementation is the implementation of the virtual health rooms (VHRs) within the Vasterbotten region of northern Sweden.

Ultimately, *a priori* knowledge regarding eHealth function in rural health systems was mostly negative in nature. This hesitation and pushback made implementing and observing eHealth effectiveness difficult for researchers and policymakers. The global COVID-19 pandemic was in many ways an uncontrolled experiment which forced decisionmakers across rural contexts to adjust their beliefs regarding eHealth potential, as the alternative was a complete vacuum of service and guidance when it's need was most acute. While the COVID-19 pandemic has been an unquestioned burden, and has directly killed millions of people, while indirectly causing increases in substance abuse, mental health problems, and similar illness, it has brought into focus the need for system reform, and the role eHealth can have in providing services at the same, or sometimes better, level of in-person care.

### 3.3.1 Non-Adoption, Abandonment, Scale-Up, Spread, Sustainment framework for Health and Care Technologies (NASSS framework)

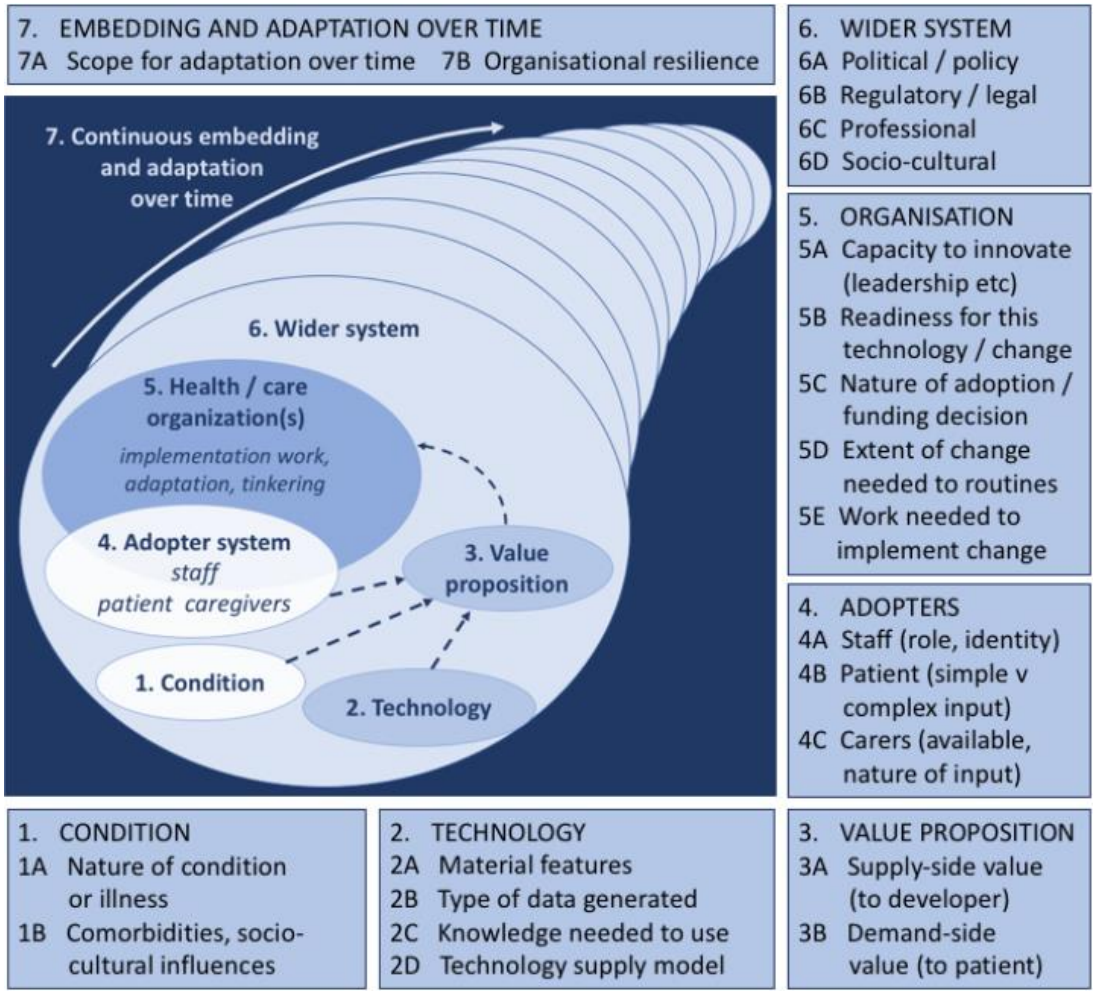
The NASSS framework created by Greenhalgh et. al is unique in both it's design as well as it's focus (112). Influenced heavily by implementation science, it's consideration of primarily technological interventions in healthcare provides nuanced results regarding domains which should be addressed throughout an implementation process. It has been widely cited and applied since it's publication in 2017 and has influenced other evaluations and implementations (24). **Figure 7** represents the NASSS framework (adapted from Greenhalgh et. al)

The NASSS framework recognizes 7 central domains important for the scale and spread of technological health interventions. The first domain is the condition the technology addresses, including the symptoms of the disease and the broader socio-cultural impacts of disease status. The second domain is the technology itself, including its material features and the knowledge required to use it. The third domain is value proposition, to both the patients and developers of the technology. The fourth domain is the adopters of the technology, including patients, providers, and carers. The fifth domain is the organization implementing the intervention, including the organizations capacity to innovate and the work needed to implement change. The sixth domain is the wider system, including political, regulatory, professional, and sociocultural influences. The seventh domain is the embedment and adaption of the technology over time, including the scope for adaption and the organizational resilience displayed of the technology's implementors.

The NASSS framework, and its domains, were influential in synthesizing the antifragile design portfolio by informing the institutional investment indices and antifragile operators necessary for antifragile projects within the MS. Further, the domains established within the

NASSS need to be articulated in order for implementation teams to understand challenges and barriers to implementation as they arrive in rural communities. This has guided in the inclusion of powerful qualitative methods in the CDCT to provide rich descriptions of antifragile operators in rural implementations. Together, with the CFIR and RE-AIM frameworks, these leading implementation strategies have served as empirically validated reference points for ethnographic data and helped create the *a priori* coding protocols deployed in the thematic synthesis. This will be examined in depth in Chapter 4.

**Figure 7: The NASSS Framework. 7 domains comprise the NASSS framework for technological scale and spread. In order: Condition, Technology, Value Proposition, Adopters, Organization, Wider System, and Embedding/Adapting over time. Adapted from Greenhalgh et. al.**



## 3.4 Collation of Relevant Frameworks and Theories

**Table 3** represents a collation of the relevant theories and frameworks which were discussed in Chapter 2 and Chapter 3. For each theory, the discipline of origin is briefly stated, and the application of the theory and it's influence on the antifragile design portfolio is explained. Chapter 4 contains much of the discussion regarding methodology of antifragile design, and how the outputs and approaches highlighted in Chapter 4 contribute to antifragile design.

Considerable research has been done regarding implementation, complex systems, and eHealth utilization. What the antifragile design portfolio supplements is applying these theories and frameworks to rural eHealth implementations and is one of a handful of tools with complexity considerations inherent in its deployment. Instead of attempting to control for or otherwise eliminate complexity from an implementation process, the antifragile design portfolio includes complexity as self-evident in any implementation and offers strategies to mitigate it based on rural characteristics and established practices. Through the utilization of the CDCT and MS, implementation teams in rural communities can better understand relevant facets of the implementation of an eHealth program, increasing the likelihood that program sustains and spreads to other contexts.

| Framework or Theory | Discipline of Origin | Application to Antifragile Design Portfolio |
|---|---|---|
| Antifragility | *Finance* | • Antifragility, and its application through associated operators, is the core focus of this doctoral research.<br>• Understanding how to incorporate antifragile values into the design of eHealth projects so they can sustain and scale in rural contexts is the central research question of this analysis. |
| Consolidated Framework for Implementation Research (CFIR) (85) | *Implementation Science* | • The CFIR is a widely cited and applied implementation framework (107), which recommends the distinction between interventional components as core or peripheral.<br>• Assigning these labels to interventional aspects clarifies which can be adjusted when an intervention is scaled from context to context.<br>• Ensuring as many components are peripheral as possible in the interventional design phase correlates well with an antifragile approach. |
| Reach, Efficacy, Adoption, Implementation, Maintenance (RE-AIM) (108) | *Implementation Science* | • The RE-AIM framework is another influential implementation framework focussed on the evaluation of an intervention, and how to incorporate that information into future iterations.<br>• The RE-AIM framework has influenced the matrix of scale, the evaluative tool part of the antifragile portfolio, in what aspects of antifragility and institutional investment are most important to measure following an implementation. |
| Non-adoption, Abandonment, Scale-up, Spread, and Sustainability (NASSS) (113) | *Implementation Science, eHealth Literature* | • The NASSS framework is unique in that it is derived almost entirely from technological implementations.<br>• It provided much of the foundation of electronic health implementation facets and how they should be monitored and explored for the Composite Design Cycle Theory of Organizational Readiness within the antifragile design portfolio. |

| | | |
|---|---|---|
| Complex Adaptive Systems (CAS) (19,90,114) | *Complexity Science* | • Understanding health systems as complex adaptive systems, and the associated traits these systems have, builds the theoretical basis for much of the assertions of the antifragile design portfolio.<br>• The existence and influence of emergence, self-organization, non-linearity, etc. on implementation are all addressed by the CDCT and MS. |
| Realist Intervention Model of Context, Mechanism, and Outcome (C,M, and O) (31) | *Realist Evaluation* | • The Realist model of C,M, and O to describe interventions is crucial to understanding the CDCT.<br>• This interpretation posits that every intervention is some combination of it's context, mechanism, and outcome, and these three components are not distinct from one another, but rather influence each other and change throughout an implementation.<br>• This model serves as the foundation for the application of the CDCT, and understanding this description is key to understanding the antifragile design portfolio. |
| Dirt Research Methodology | *Ethnography* | • Dirt research methodology has impacted the antifragile design portfolio by emphasizing the importance of lived experience, especially in rural settings.<br>• Secondary analysis of rural data and phenomenon can yield insight, but it is through lived ethnographic experience and research residencies that these insights can be applied in productive fashions.<br>• This is a key recommendation of the portfolio, which prioritizes qualitative methodology (Chapter 3) to measure and assess antifragile operators within an implementation. |

**Table 3: Collation of theories and their synthesis into the antifragile design portfolio. Theories include: RE-AIM, CFIR, NASS, CAS, Realist Evaluation, Dirt Research, and Antifragility.**

## 3.5 Identification of Knowledge Gap

Through the study of complexity science, implementation science, and eHealth in the context of rural health system planning, it is clear there is a gap in effective ways to implement eHealth rurally, so it sustains and spreads. Leveraging rural traits to aid implementation is difficult because there is a limited amount of research regarding effective rural implementation frameworks and strategies. Therefore, the knowledge gap is two-fold: how to improve equity in rural healthcare access, as well as how to effectively implement eHealth into rural communities (which subsequently addresses the first gap). This research addresses both these gaps and considers their relationship tangential to one another. It is shown through this analysis that eHealth can reasonably address the problems in equity of healthcare access experienced by rural communities, particularly with regards to specialist care. Further, this research puts forward a framework derived from rural eHealth implementation which is tailored to the sustainment and spread of eHealth in the form of an organizational readiness tool and principled evaluation (the antifragile design portfolio).

To reiterate, the knowledge gaps addressed by this research are as follows:

1. Research regarding improving equitable access to health services in rural communities
2. Frameworks and theories regarding rural eHealth implementation

Through qualitative data analysis (ethnographic typology and components of a realist evaluation) as well as a thematic synthesis of a robust body of rural eHealth literature, the outputs of this doctoral research will help determine appropriate avenues of creating equity in healthcare access in rural communities. Through an analysis of implementation science literature, complexity science literature, and eHealth implementation a closely related two-fold gap was identified, which the outputs of this doctoral research will address.

# Chapter 4: Methodology

This dissertation has followed a mixed-methods, discursive approach to knowledge generation. Qualitative evidence review methods were prioritized, with quantitative approaches, such as cluster analysis of coded content, done to assess strength of relationships. A qualitative approach was selected given the nature of rural research. Relationships or results obtained from traditional quantitative methodologies can be challenging due to the small sample sizes of rural communities. As such, randomized control trials, systematic reviews, and detailed descriptive statistics are often inappropriate for framing problems common to rural health policy and health service access (115). Tacit knowledge of rural standards of practice are generally difficult to articulate due to cultural, organizational, and personal attitudes and behaviour. Trying to make this knowledge explicit or tangible for the purpose of actionable intervention by demonstrating need through quantitative methodology can further distort the nuance critical in all systems-oriented research, but especially critical in rural settings. In rural health research, descriptive statistics can only be relied on so far, and the bulk of the knowledge created through this dissertation was derived from qualitative approaches.

This chapter will explore the main methodologies which were deployed to gather qualitative data from which the antifragile design portfolio is derived. Chapter 5 summarizes these findings. The methodologies used for this dissertation research include ethnography, realist evaluation, narrative inquiry, and meta-analysis.

These methodologies and their relation to the dominant disciplines used throughout the research process (complexity science and implementation science) will also be examined. Following this, thematic synthesis will be described and its role in formulating the matrix of scale (MS) will be elaborated. Thematic synthesis is an effective way to retrospectively analyse documentation in an inductive manner(116). Finally, the specific research questions addressed by this research will be stated, as well as how the mixed-methods methodology contributes to findings satisfying them.

## 4.1 Defining rural

Defining rurality is more difficult than it at first appears. Rural and rurality are both contested definitions, with multiple measures persisting in the literature as viable options (117,118). Most scholars agree that there are several key aspects which formulate the identification of a community as 'rural', and even more which separate these settings from 'remote' (119). The first, and perhaps most obvious, is the population of a community. Recall in Chapter 2 rural was defined as those communities which have less than 2 000 people inhabiting them and are a 2 hour automobile ride from an urban centre. As a population approaches 0 it is more likely the community is remote. While this is a straightforward way to define rural, there is more nuance to the ongoing debate than simple population data (120).

Other population-based categories are included must be included in the assessment, such as the incorporation of a community under a charter of towns and villages. A second consideration is proximity to an urban centre or larger population centre (121). There is no standardized methodology for measuring or evaluating access, but it is recognized that the longer the travel distance a community is from an urban centre, the greater the likelihood it is rural. Further still, and the community is likely remote. This is a tricky metric however, as the comfort

with travel varies from culture to culture. A three-hour drive in Canada or Australia is a common occurrence for rural populations, but in Sweden it is less so. Nonetheless, geographic distance is still a prominent gauge for defining rural and remote.

A third attribute relevant to assessing the rurality of a community is access to services. Social services, such as education, law, and civil as well as healthcare service helps frame a community as urban, rural, or remote. If a community has a relatively larger population and is in closer proximity to an urban centre, but as little or no access to basic services required by its population, it may qualify as a rural setting. If travel to access these services is lengthy, then the community is likely remote.

A fourth consideration is the assumptions and opinions of the residents themselves. Regardless of the mostly quantitative metrics discussed above (population, distance, etc.) understanding the assumptions of residents within the community should also factor into how a context is defined (35). The definition of rural within a boardroom in an urban policy-making office building will likely vary from the self-identified assignment of residents. While dividing up a map for the sake of policy is a required exercise in drafting mandates and protocols, for individual implementation (the focus of my doctoral research) it is important to include resident consultations on the nature of their community. Working under the assumption a setting is rural or remote because of how it is framed in health policy literature could occlude nuance derived from candid assessments by people most familiar with the context of an implementation – namely, residents themselves.

To summarize, defining rurality requires a balance of four central components:

1. The population of the community,
2. The geographic distance of a community from a larger urban centre,
3. Access to essential social and health services, and the

4. Assumptions and definitions of residents themselves.

This list is not exhaustive, and likely simplifies other salient considerations in delineating rural and remote. Defining rurality must be done so on a case-by-case basis, and with deviations from policy-making definitions, research definitions, and resident definitions. Within the scope of my doctoral research, leaving room for interpretation is the preferred approach. While standardizing a rules-based algorithm in defining rural may be useful for broad reaching policy, it obliterates any semblance of sensitivity or appreciation for rural differences in the context of implementation.

No two implementations are the same, and while the outputs of this research advocate for an approach which can be applied to every rural eHealth implementation, inherent to that method is evaluating the uniqueness of the rural setting within which the implementation takes place. Defining rural must appreciate the socio-cultural and socio-economic differences between rural contexts and must go beyond defining rural as simply 'non-urban'. Striking a balance between having an agreed upon list of rurality associated characteristics, while putting the onus on an implementation team to supplement this list with their own assessment, will aid implementations in defining rurality relevant to implementation. Antifragile eHealth design promotes fact-finding and transparent discussion to help bring tacit knowledge into focus, including how a community thinks and approaches rural definition. This is reflected in the two components of the antifragile design portfolio, the CDCT and MS.

## 4.2 Research Setting

The setting of this research was rural contexts in three countries: Canada, Sweden, and Australia. All three of these countries have universal healthcare systems, wherein patients obtain a vast majority of their healthcare free of charge through taxation schemes. Further, these three

countries have similar geographic distribution of populations, where there are several major urban centres, and hundreds of rural and remote communities in Canada's hinterland, Sweden's north, and Australia's outback. Particularly Canada and Australia have similarity when it comes to the presence of communities hundreds of kilometers from urban centres, with the need of FIFO or DIDO access. These communities were largely outside the scope of this research, as remote communities requiring DIDO or FIFO have a large indigenous population. These indigenous centres require sensitive research methodology, with care taken to ensure research is done in a culturally appropriate manner. My doctoral research focussed instead on the more rural communities than remote, and the settings considered for eHealth implementation are less likely to be FIFO, DIDO or indigenous in nature.

Further, while communities from Sweden and Australia were visited and consulted through residential scholarship, much of the findings of this research are embedded in concern with Canadian contexts. The recommendations and future directions highlighted in the discussion portion of Chapter 7 are done so which acknowledge the Canadian context first, and rural communities in the broader (i.e., international) sense second. Using Australia and Sweden as comparative cases enhances the generalizability of the antifragile design portfolio and provides further evidence towards viewing rural contexts as different, and not necessarily simply disadvantaged. Through this comparative analysis, several characteristics and traits of rural settings were found to be common across all contexts visited, regardless of international origin. These qualities helped influence the strengths-based approach advocated for by the antifragile design portfolio, as capitalizing on rural competencies builds absorptive capacity within the community, allowing for adaption to change.

## 4.3 Participants and Data Collection

As part of my research residencies in Canada, Australia, and Sweden, hundreds of hours of ethnographic observation were collected. This ethnographic observation led to the formulation of the CDCT, one of the components of the antifragile design portfolio. Data collected included interviews, focus group themes, and reflection on lived experienced derived from these research residencies. Due to COVID-19, expert opinion on eHealth integration in rural health systems, and health systems in a broader sense was collected from secondary sources. These sources include federally published reports in Canada regarding virtual care integration into rural communities and how to implement electronic health in an equitable fashion. The basis of my thematic synthesis to inform the matrix of scale was 89 peer-reviewed papers which were collected for the scoping review of patient and provider perspectives on integration of eHealth in rural communities (*paper four)*.

The primary sources of data then were:

- Ethnographic observation
- Documentation analysis and literature review

Together, these sources provided material from which the antifragile design portfolio was derived. The data from ethnographic observation was codified through reflection and vignettes regarding facets relevant to rural eHealth implementation, including rural characteristics, system structure, and the role of informal attitudes and beliefs. This data was then integrated into the CDCT. Documentation analysis and literature review data was distilled through a thematic synthesis, following *a priori* code stemming from ethnographic observation and case study analysis, resulting in the formulation of the MS. Lastly, a sentiment analysis of a report

compiling dozens of expert interviews was done to frame the results of ethnographic observation and literature review in the broader policy landscape.

### 4.3.1 Experts from Health Systems

Due to logistical complications stemming from the COVID-19 pandemic, primary data collection in the form of interviews and surveys of health system leaders was not feasible. A secondary sentiment analysis completed through NVivo © of a Canadian federally commissioned report regarding eHealth utilization during the pandemic was a suitable alternative given the circumstances. The Falk report is a collation of over 80 interviews with senior health system executives, clinicians, and administrators and explored the uptake, implementation, and sustainment of eHealth projects across Canada in response to COVID-19 (62). These interviews show that most health system decision-makers view eHealth as beneficial to the overall system, and that it possesses potential for continued deployment as COVID-19 measures begin to be rolled back.

The Falk report is a strong primary source of decision-maker sentiment and opinion regarding the position of eHealth in a contemporary system. The motivation for eHealth deployment was highest during the 1st wave of the COVID-19 pandemic, erasing years of hesitation and postponement of eHealth implementation. Having the health system effectively having to adapt or fail during an unprecedented system stressor yielded objective and candid appraisals of eHealth as it supplemented or supplanted face-to-face interaction within the healthcare system. The report identifies four main perspectives on eHealth implementation as of the third wave of the COVID-19 pandemic. These perspectives include:

1. eHealth as an emergency life raft,
2. Low rules environment accompanying the pandemic,

3. A stress test of our existing pilot systems, and the
4. Beginning of the shift to consumer-oriented healthcare.

These perspectives are important to understand, as it frames the consensus of decision-makers regarding eHealth as Canada begins to emerge from the COVID-19 pandemic. Primary data collection completed before the COVID-19 pandemic in Sweden, Canada, and Australia included interviews with healthcare providers, system administrators, and townhall consultations with communities. This qualitative data enhances the Falk report by framing the four perspectives collated by Falk and applying them relevant to *rural* health systems. For example, the low rules environment identified as a theme from the interviews is a common operating paradigm within rural communities and rural health systems. Rural implementations can differ in process compared to urban implementations, in part because of a lack of rurally distinct centric implementation framework and strategy. Consistency in eHealth integration opinion between rural and urban environments is an encouraging sign that lessons learned in the COVID-19 pandemic could be transferable to rural settings.

### 4.3.2 Literature Collected Through Scoping Review

The basis of the matrix of scale, the second component of the antifragile design portfolio, was 89 papers collected between 2018 and 2020 regarding eHealth implementation in rural communities. These papers were collected as part of a scoping review analysing rural opinion and attitudes from patients and providers regarding eHealth implementation and utilization. These papers ranged from retrospective evaluations of large-scale eHealth implementations to smaller-scale pilot projects of various rural initiatives and programs. These papers provide a robust body of literature in Canada, Australia, and Sweden, which address the challenges of rural eHealth implementation in three closely related international contexts. The scoping review, as

well as the inclusion/exclusion criteria and it's findings, can be seen in it's entirety in *paper four* (Appendix A).

This literature reviewed served as the basis of a thematic synthesis to inform and create the matrix of scale. The reason for using this body of literature, instead of compiling another repository of more contemporary papers focussing on the COVID-19 response, was multifaceted. The first reason is the papers collected for the scoping review detailed projects and initiatives which had been implemented pre-COVID-19. Therefore, these projects better reflect rural health systems *in the absence of* sever stress which would have been caused by the pandemic. Therefore, the discussions and recommendations of the authors of these papers would more closely align with their *real* beliefs and attitudes regarding eHealth integration. Understanding implementation of eHealth during COVID-19 would not be as generalizable, in part because of the perspectives discussed in the previous section. The low rules environment accompanying the first wave of COVID-19 and viewing eHealth as an emergency life raft are two motivating aspects of rapid implementation and deployment of eHealth which will unlikely be replicated post COVID-19.

The second reason for utilizing the extant literature compiled for the scoping review was its convenience. The 89 papers collected detailed eHealth projects in rural Canada, Australia, and Sweden, the three settings of interest of my doctoral work. Further, these papers rather explicitly discuss implementation of eHealth in rural communities, and their content was the perfect focus for the coding protocol deployed as part of the thematic synthesis. Additionally, because these papers had been collected pre-pandemic, there were tight temporal bounds which served as logical parameters in data collection. The rapid integration of eHealth which occurred during the first wave of COVID-19 correlated with an explosion of literature. A consequence of that is

including more contemporary papers was an incessant process, with a body of literature being out of date two weeks after being compiled. Instead of drawing an arbitrary temporal line in the collection of eHealth literature, the original scoping review repository was coded, and results compiled through a thematic synthesis.

### 4.3.3 Case Study Selection and Inclusion in Implementations Teams

One of the contributing sources of the Composite Design Cycle Theory (CDCT), the first component of the antifragile design portfolio, were associated case studies of rural eHealth projects, as well as recursive-discursive exercises with professional implementation research groups and teams. Recall, the CDCT is an organizational readiness tool which is used to assess the degree to which a given organization can implement antifragile eHealth projects in rural communities. Dirt research (discussed in section 4.5.1) was used as the guiding design to analyse and develop the methodologies which together form the parts of the CDCT. The data which served as the basis for the inclusion these methodologies were formal, informal, and reflective conversations with researchers, community members, and providers regarding their experience with rural implementation. Two of the most influential research bodies which provided insight into the CDCT were the Office of Spread and Scale (OSS) and the Free Range research group. The office of spread and scale is an organization associated with the Women's College Hospital Institute for Health System Solutions and Virtual Care (WIHV). The Free Range research group is a multidisciplinary team of international rural researchers who have lengthy publication histories together about a variety of rural issues from immigration to tourism to healthcare.

Free Range provided the bulk of the experiential learning opportunities afforded to me throughout my doctoral research. These ethnographic experiences in Sweden and Australia provided qualitative data through interviews, lived experience, and anthropologic phenomena

which also contributed to the creation of the CDCT. Brief inclusion in the virtual health room implementation team provided valuable insight regarding antifragility as a viable design principle and served as one of the case studies in *paper one* (appendix A). The OSS is an implementation consultation group formed of researchers, scholars, clinicians, patient partners, and trainees who have an interest in implementation science and spread and scale. Through discussions with seasoned implementation researchers within the OSS, the CDCT was comprised of methodologies which can approximate the complexity present in rural implementations, and inherently accounts for and prioritizes complexity within a health system. Placing complexity at the centre of any decision mitigates some of the unforeseen consequences present in implementation and gives implementation teams the ability to approach unique implementations with flexibility in their methodology.

The case studies which identified antifragility as a viable design principle (*paper one*) also raised the question of which methods would be best suited to express these markers in cohesive terms. Antifragile gauges such as *non-linear evaluation* and *starting small* are relatively straightforward to monitor and measure – by limiting the scope of the initial pilot roll out or incorporating interviews and surveys from the agents towards the bottom of the organizational pyramid, for example. Other values are harder to discuss as abstract concepts – namely *optionality*, *hybrid leadership*, and *avoiding suboptimization*. The data then for the formalization of a framework to explore these indicators were the ethnographic accounts and thematic synthesis outputs asserting the effectiveness of antifragile design explored in Chapter 5.

Secondary to establishing antifragility as a viable design principle in rural eHealth implementation is understanding appropriate methods to incorporate antifragile values. Although the original analysis of these case studies did not include an investigation regarding qualitative

methods included into the design of said projects, through retrospective analysis – and coupled with the thematic-synthesis of other rural eHealth initiatives – the assortment of relevant methodologies for conceptualizing the more abstract antifragile values became clear. The main body of data then from which the CDCT was created were the ethnographic experiential learning opportunities through the Free Range residential research program, recursive-discursive dialogue with expert implementation scientists, case studies regarding rural eHealth implementation, and components of a realist evaluation regarding research in rural settings.

## 4.4 Research Design

The research design of this dissertation contributed to *understanding* the problem of rural eHealth implementation. The problem of implementation is a unique one, as it is pursuant on many variables and external influences which can be difficult or even impossible to effectively control or eliminate. Further, abstract concepts such as creativity, innovation, invention, attitudes, beliefs, values, etc. can all have *real* influence on an implementation, but not be necessarily *observable* (122). That is why one of the designs used to understand rural eHealth implementation is realism, which frames knowledge as partial. The other two designs which have helped structure the problem of rural eHealth implementation are complexity science and implementation science. Both domains have been described in detail, relevant to my doctoral research, however this section will briefly apply realism, complexity science, and implementation science to rural eHealth implementation as a way of framing the problem. The result is a conceptualization of barriers, facilitators, and themes which are then investigated by ethnographic typology, components of a realist evaluation and a thematic synthesis using data from ethnographic observation, literature scans, and program logics to formulate the antifragile design portfolio (6.3).

Complexity science is extremely powerful descriptive tool. Chapter 2 and Chapter 3 defined and applied terms common in complexity science and associated them with rural eHealth implementation. Rural health systems can be thought of as complex adaptive systems. These systems have traits such as *emergence*, *non-linearity*, *irreducible complexity*, etc. which makes implementation an arduous task. Complexity science offers implementation teams metaphorical instruments to better understand these facets of complex adaptive systems, and descriptive power regarding their impact on an implementation. Being aware of a trait such as *non-linearity* aids implementation teams by providing diversity in how outcomes can be interpreted. Knowing that a large-scale overhaul to an intervention's deployment does not necessarily correlate with a drastic change in interaction or uptake of the intervention is important. Information about complex adaptive systems allows for targeted adjustments and appropriate leveraging of resources to maximize potential impact within an implementation process. In the context of this dissertation, complexity science was used to understand the problem of rural eHealth implementation by conceptualizing rural health systems as complex adaptive systems and developing a strategy (the antifragile design portfolio) which can sufficiently mitigate traits common within a complex adaptive system.

Implementation science is the second design used to understand the problem of rural eHealth implementation. It seeks to provide generalizable frameworks for implementation strategies. Analysing the entirety of implementation science literature is outside the scope of this project, however the relevant and influential implementation science frameworks (CFIR, RE-AIM, NASSS) have been discussed in Chapter 3. These frameworks have helped frame interventions (in this case, eHealth projects), including their component parts, the influence of abstract concepts on an implementation, and the domains important to maintaining technological

fidelity as interventions scale from context to context. Understanding rural eHealth implementation requires a grasp of what formulates an intervention in a general sense. In section 3.2.1, the CFIR is discussed. This widely cited framework posits that interventions have two components: core components and peripheral components, and that these components must transcend multiple domains of an implementation. Understanding which components of a given intervention (in this case, an eHealth project) are central to the fidelity of the intervention, and which can be adjusted from context to context is important to ensure an eHealth initiative can scale. In section 3.2.2 the RE-AIM framework is examined.

This framework puts emphasis on accounting for and incorporating the effects of abstract concepts (such as invention, innovation, etc.) on an implementation. This emphasis complements the descriptive power of complexity science, which also acknowledges the importance of these tacit traits on implementation. Lastly, the NASSS framework (discussed in 0) exclusively analyses the method in which technological interventions scale and spread. Comprehension of the seven domains and sub-domains collated by the NASSS framework which must be prioritized to maintain an interventions fidelity as it moves from one setting to another has helped structure the problem of rural eHealth implementation, particularly the MS component of the antifragile design portfolio (discussed in 6.3.2). In summary, widely cited implementation science frameworks have been distilled, and their salient recommendations have been synthesized, in order to cement the approaches these influential implementation frameworks utilize. These approaches were then applied to a rural setting.

Lastly, realism was leveraged to better make sense of rural eHealth implementation. As mentioned, realism posits that what exists in reality is not always observable (123). As the philosopher of science Karl Popper notes: *"We do not know, we can only guess"*. Tangibly, this

sentiment is important to understand rural eHealth implementation. As it frames knowledge as partial, realism promotes and advocates for multidisciplinary and interdisciplinarity within an implementation process. Accepting that you can only ever be a partial expert as it pertains to implementation is important in diversifying your perspectives of ambiguity and paradox. These two factors can arrive at any point during an implementation process, and how they are handled can dictate the success or failure of an intervention. Approaching knowledge through a realist lens means that implementation teams will not just feature academics, but also pragmatic providers, empathetic policymakers, and engaged patients. Through this interdisciplinary approach, an implementation process will possess requisite variety in perspectives to engage with paradox and ambiguity productively when they arise.

Complexity science, implementation science, and realism have all helped frame and understand rural eHealth implementation in impactful ways. The collection of these three designs can help articulate the unique challenges which must be addressed in order to facilitate a transition to place-based health policy to better serve rural communities. The rest of Chapter 4 is dedicated to the methodologies used to investigate this problem, as understood by the research designs discussed in Chapter 3 and section 4.4. The first of these methodologies is ethnography. The second is components of realist evaluation. The third is thematic synthesis. Collectively, these methodologies have resulted in the formulation of the antifragile design portfolio, comprised of the CDCT and MS, which will help guide rural implementation teams in their antifragile deployment of electronic health initiatives. The antifragile design portfolio is discussed in depth in Chapter 6.

## 4.5 Ethnography

*Ethnographies* are defined as research in which investigators embed themselves culturally, personally, and scientifically to better understand a certain group's interactions, social relationships, and connections (124). Ethnographies were first utilized in the field of anthropology but have since made their impacts in a diverse range of disciplines, including healthcare (125,126). Broadly, ethnographies are important methodologies within the social sciences, and their type can vary between research contexts. Sometimes, ethnographies take an observer-subject dichotomy, where the observer (usually the investigator) attempts to understand causal mechanisms and cultural nuances by observing and mapping their observations onto agreed upon frameworks. Other researchers take the approach of comprehensively embedding themselves within a group of interest and living with their subjects. This relationship is much closer to an observer-participant dichotomy, wherein the observer is expected to contribute to the moral economy of the community of interest.

This approach to social interaction and codifying social interaction through interviews, observational documentation, and participatory research comes close to approximating the causal mechanisms of social interventions which can exist independent of our knowledge of them. Ethnographies are a potential tool to build and acknowledge the context of which social programs, such as eHealth interventions, are borne into. When an implementation team immerses themselves into the setting in which their intervention is being placed, they expose themselves to tacit knowledge usually reserved from outside actors. For example, when implementing a tele-dermatology initiative in a rural community, interaction with that community should be as informal, frequent, and transparent as stakeholders are comfortable with. It is difficult to grasp implementation facilitators and barriers unique to the setting of interest while being divorced

from the context (geographically and ontologically). Therefore, having an ethnographic principle inherent to an organizational readiness tool mandates that implementation teams keep abreast of relevant phenomenon to the context of interest. This in turn increases the probability tacit knowledge is captured, and outcome data for the intervention can be interpreted with these assumptions built-in to their assessment.

In health research, and particularly rural health research, ethnography as a methodology has been utilized in numerous forms. Rural health research requires a diversity of methods to better understand rural issues and ethnography is an appealing method given the appreciation for complexity, richness in detail, and potential explanative power in articulating mechanisms of behaviour and action. Further, ethnographic typologies do not need robust sample sizes to derive observations about behaviour or knowledge of a population in question. Relevant to rural implementation efforts, ethnography can make explicit the assumptions held by stakeholders who figure prominently in an interventions target. These assumptions can be further leveraged by organizations to make an eHealth intervention more appealing, dispel hesitation towards engaging with health access via an electronic medium, or simply opening the door to dialogue about a particular issue.

### 4.5.1 Dirt Research

The foundational perspective to rural knowledge generation employed was *Dirt Research*, which places and emphasis on lived experience of the *researcher* through ethnographic research residences (127,128). In the context of my doctoral research, through these research residencies and lived experience, an appreciation for qualitative domains to investigate rural eHealth implementation has been reached. These qualitative domains have been collated and structured, forming the CDCT (6.3.1). Dirt research is a methodology which first

was described by Harold Innes, a pioneering rural geographer in Canada. Innis prioritised immersion in the rural research process and established that the assertions one can make regarding relationships or influence can only be so refined without intimate knowledge of the context from which data originates (128). In other words, in order to provide impactful research recommendations, you must become part of the community you are consulting, not as a researcher, but as a resident.

The primary attraction of dirt research is its experiential element. Resident scholars eat, travel, play, work, and *live* in the communities in which they conduct their research. Through these entirely human experiences, scholars come to understand rural challenges through a new perspective - not as a researcher analyzing census data in an urban university library, but as a rural resident subject to the realities of rural living (5). Researchers have an obligation to participants and institutions that knowledge derived from their activities is done so in an ethical and fair manner. Dirt research satisfies this necessary and important demand of research by making clear the role resident scholars play within a community.

This experiential approach to rural research has a profound effect on framing problems and the methodologies employed to explore rural phenomena. Experiential scholarship is particularly powerful in helping researchers internalize contextual aspects most relevant to their subject of interest. Dirt research then can be considered a systems-oriented research perspective, where recommendations are collectivist in nature and address the salient worries of rural residents, practitioners, and leaders.

Building on this important facet of experiential learning central to dirt research, reflection and a discursive approach also helped iterate and polish theories of rural health policy and eHealth project design in my doctoral work. Reflection, from a personal as well as research

perspective was important throughout the research process as it codified and structured tacit knowledge (in the form of heuristics, assumptions, and culture) borne out of *emergence* and *sense-making* by agents within a complex adaptive system. The systemic agreements on 'how things are done' in organizations are usually abstract, value-laden, and dynamic. They are also some of the most important constatives within organizations and institutions. Interventions (in this case, eHealth initiatives) can thus benefit from understanding the compiled implicit knowledge articulated through reflective exercises.

My doctoral work explores and contends with implementation of eHealth in rural health systems. The variables and considerations pertinent to such an implementation are numerous, and an exhaustive list collating all the relevant parts is not feasible. Nor would it be possible to understand how system variables influence and act on one another. Ethnography then provides rich descriptions of lived experience, of both the population of interest and through dirt research of the researcher themselves. These descriptions can then be thematically analysed to understand how an intervention (in the context of my doctoral work, eHealth) changes the behaviour of a given community or population. It helps address the complexity inherent to rural eHealth implementation, provides important qualitative insight on the interaction and uptake of intervention in a specific context, and engages populations in the research process. Applying ethnography has helped structure the CDCT, which is discussed in 4.7.

### 4.6 Realist Evaluation

The second methodology leveraged to investigate rural eHealth implementation, as understood through the collated research designs, was realist evaluation. The purpose of a realist evaluation is to attempt to ascertain 'what works where, and for whom'(129). Realist evaluations are a subset of a larger realist perspective on cause and effect that places the *context*, *mechanism*,

and *outcome* of an intervention as central considerations of analysis. Conceptualizing a given intervention as an interaction between these three aspects has helped structure the CDCT and helped identify methodology which can provide implementation teams with crucial information regarding a rural eHealth implementation process. In this section, the context, mechanism, and outcome relationship will be explored in depth, and its relevance to rural eHealth implementation made clear.

In the realist interpretation of an intervention, the context represents the inner and outer settings of an intervention, that together account for the culture, values, beliefs, resources, politics, and conceptual factors which interventions are bound to confront throughout the implementation process (32). More appreciation is arising for the role context plays in a successful implementation of an intervention. Context has been traditionally viewed as a meddling variable which had to be normalized or stabilized in some way to ensure a smooth implementation (130). Recently however, context has been seen as an integral aspect of implementation and is just as important to an intervention as the mechanism through which an intervention seeks to change outcomes (31). The context of an intervention is one of the central factors contributing to the variety of implementations – even if the intervention in question (an eHealth project) remains unchanged as it scales to other settings. The variance in implementation is similar to the *terroir* of a wine. Each environment an eHealth project is implemented into has its own facets which combine to create a sense of place unique to that community, a fact which an eHealth project can adjust to by being inherently antifragile. Realist evaluation can evaluate these environments by asking, and answering, the question of what works where and for whom.

The mechanism is the way or method in which behaviours or standard practice changes in relation to the outcome. For example, creating an eHealth initiative which serves as the primary

triage step in an emergency department changes the way in which patients are admitted to the department, and could result in lower wait times to receive treatment. The mechanism is often the facet of interest within an intervention, as replicating and effective and successful mechanism in a different context is the basis for knowledge translation and mobilization. It is worth noting that no intervention is ever implemented the same way twice. If an intervention such as a remote dermatology consultation demonstrates value to both patients and providers, the implementation of such a consultation will vary from setting to setting.

In this implementation dynamism, care must be taken that the mechanism of the intervention fluctuates and adjusts to the changing implementation strategies which will have to be relied upon throughout the process of scaling and sustaining. By preparing for the difference in implementation technique necessary to scale an intervention from one context to another once constant can help make the transition smoother: introducing antifragile indicators to both the project as well as the implementation teams. Being familiar with antifragile operators, working it into a programs design from the outset, and having the confidence to make decisions within a CAS relieves the pressure of having to have the required foresight of every eventuality or challenge. Bertrand Russel noted in 1950 that "*the central problem of our age is how to act decisively with the absence of certainty*". Becoming antifragile is a start and understanding the impact of antifragile operators on the mechanism of an intervention through realist evaluation is important.

The outcome is the end-state or priority of an intervention. The outcome varies based upon the nature of the intervention, but in health it is usually tied to increasing or decreasing rates of indicators of condition treatment (increasing) or absence (decreasing). Successfully demonstrating a change in outcome is paramount to securing funding, continuing an initiatives lifespan, and scaling to other contexts. Raw outcome data is difficult to interpret, as there are

usually conflicting views on what the outcome data represents, and how to best leverage it in future policy or implementation. Outcomes themselves can be broken down and subject to 'outcome mapping' which adds the importance of context to their interpretation. As already noted, understanding a complex adaptive system in its entirety is not feasible. Therefore, any outcome which is borne out of such a system must also be referenced with caution and knowledge of that fact. Outcome mapping can help researchers and implementors understand the relationship between inputs, outputs, relationships, outcomes, and impacts.

Although the context, method, and outcome variables are represented as discrete components to an intervention, in practice they blend, with parts of the contexts being integral to the mechanism, and outcomes tied similarly with an intervention's context and mechanism. This is the basis for the realist argument in approaching complex social interventions. Mechanisms can occur 'in reality' regardless of our knowledge of them – and these mechanisms do not always yield observable measures or indicators. Conceptualizing a mechanism can be hard; establishing tangible values to measure such a mechanism even harder. Social interventions, such as eHealth initiatives, possess such a sheer number of interfacing parts, that cataloguing, collating, and analyzing them all is self-defeating. Further, establishing the relationships between parts in a dynamic, fluid, non-linear setting is near impossible, especially with the limited complexity informed tools available to researchers currently.

Realism recognizes the inherent complexity within interventions and implementation efforts and follows perspective of complex adaptive systems and complexity science. Namely, knowledge of the entire system is not feasible because a complex adaptive system is greater than the sum of its parts. Understanding how a subsystem functions does not mean another ostensibly similar subsystem functions in the same way, or that the relationship between subsystems

behaves an intuitive manner. *Non-linearity*, *emergence*, and *self-organization* are apparent in realist evaluations, and recommendations based on realist evaluations account for these hallmarks of a CAS.

Consider a hospital, a large system in and of itself, but a smaller subsystem of the overall healthcare system. Within a given hospital, the difference in organizational structure, culture, and behaviour from, say, the emergency department to the internal medicine ward could be so vast that meticulous knowledge of one could be non-transferable to another. Mechanisms which exist in reality may only be partially articulated, and their components approximated when scaling an intervention from context to context. Realist evaluations acknowledge this by describing an intervention in context, mechanism, and outcome terms, highlighting the salient aspects of a successful intervention, and where possible asserting the relationship between an interventions context mediating it's mechanism, and lastly how that may effect it's outcome. Using the realist evaluation approach in rural eHealth implementation is perceptive due its sensitivity to the effects a context can have on an intervention, acknowledging the sometimes unclear nature of the interventions mechanism, and the importance of associating outcome data with relevant accompanying background information.

The catchphrase of realist methods (understanding what works where and for whom) is intuitively appealing. Generally, it is better to under promise and over deliver within an implementation process. This is particularly true in a complex adaptive system, where the unknown unknowns out number the known quantities of a system considerably. Unfortunately, the layered complexity of modern health systems is probably immune to a 'silver bullet' of implementation planning or theorizing. Interventions will fail due to the *reality* of implementation. Put another way: sh*t happens. Evaluators and implementation teams have an

impossible task of knowing every interaction and facet of an intervention. Implementation efforts will fail for reasons that are only partially understood, or misunderstood completely. Realist methodology accepts complexity as a given in any implementation, and advocates becoming comfortable with it as a productive way forward. The antifragile design portfolio reflects this thoughtfulness in implementation promoted by realist evaluation. Ethnographic research residencies also helped show the importance of context, including the history of the rural community and previous implementation process, in dictating whether current implementations will succeed.

The main output of realist evaluation is the 'program theory' of how an intervention can function. It underpins the assertion of 'what works where, and for whom' by phrasing components as reliant on others, with the sum of these factors establishing what works for whom and in what context. Program theories begin with a series of assumptions, usually derived from literature surrounding the intervention, best practices in other contexts, and meetings with important stakeholders. These assumptions are then collated and made explicit, formatted in such a way that each assumption can stand alone, and be tested in some method (empirically or qualitatively). Program theories are then iterated and tested, and the assumptions and factors adjusted based on new information. Section 4.7.2 discusses how components of a realist evaluation were deployed to investigate rural eHealth implementation.

While a realist evaluation adhering to established reporting protocols, such as RAMSES II (131), was not completed, using components of a realist evaluation to investigate rural eHealth implementation was done as part of the ethnographic research residencies through the Free Range program. The development of a program logic for antifragile eHealth design (Table 4:

Program theory for a realist evaluation of antifragility within eHealth project design in Canada, Australia, and Sweden.) significantly informed the structure of the CDCT.

Realist methodology also provides an appealing alternative to investigate rural eHealth implementation which differs significantly from experimental logic. Reductionistic methods intrinsic to the experimental methods is the dominant dogma of lab-based science, and for good reason. Experimental logic dictates that there is an identical and stable control and experiment conditions applied to a single variable, and differences in outcomes can be directly attributed to the adjustment, change, or mediation of other independent variables. This makes investigating, say, gene expression as a function of mineral exposure, rigorous in nature, as any experiment delineating cause and effect can be replicated in other labs using the same techniques, variables, and research design. Consequently, these claims can be proven time and again by independent research teams, which could eventually lead to drug regimens to combat certain pathologies or disease.

Social research methods do not lend themselves as readily to experimental logic. Ray Pawson, a leading realist researcher, notes that

> *"What experimental logic treats as a single and stable treatment is actually a long and ceaselessly changing implementation process. What experimental logic treats as stable and identical experimental and control conditions are actually complex and ceaselessly changing social systems. (132)"*

Cause and effect are impossible to separate in an environment where the variables are changing, never mind the conditions they are being exposed to. The experimental and control comparison in experimental logic follows roughly the linear pattern of introducing variable A to stable and linear system B, and comparing it to stable and linear control system C. In complex adaptive systems, this pattern changes to implementing a sociologically complex and changing

intervention A into a complex and changing system B and compared to a complex and changing system C. It is clear in the second example that any conclusions drawn from such a shoddy attempt at linear reasoning would have caveats so large it would render the conclusions useless.

## 4.7 Structuring the Composite Design Cycle Theory from Ethnography and Realist Evaluation

Both ethnography and components of realist evaluation were prominent methodologies which helped shape the CDCT. As I progressed through my ethnographic observations and creation of program logic for rural eHealth implementation, the need for an organizational readiness tool for rural institutions to reference during an implementation became clear. This framework is unique in its distinction for *rural* implementation recommendations, as well as being derived entirely from peer rural eHealth interventions and rural communities. Indeed, ethnography and realist evaluation are so powerful with regards to their descriptive abilities, they were included in the CDCT as salient methodologies organizations can deploy to assess their organizational readiness to deploy antifragile projects. The rest of this section discusses the impact ethnography and components of a realist evaluation had in structuring the composite design cycle theory.

### 4.7.1 Ethnography Structuring the Composite Design Cycle Theory

Ethnography is particularly adept at exploring the subtleties of different settings and help implementation teams prepare for their setting of interest by articulating the important facets of their unique intervention. It is a powerful descriptive tool and can help articulate antifragile operators (Table 2: The antifragile operators which can help an initiative have potential to gain stability through uncertainty. The operators include Optionality, Non-linear Evaluation, Hybrid Leadership, Starting Small, and Avoiding Suboptimization.). As the CDCT is an organizational

readiness tool, understanding the presence of these antifragile operators is crucial to its function. Ethnography has many typologies, and these parameters are accounted for in the CDCT, as ethnography broadly defined is an appropriate strategy for interpreting the outcome data of an intervention. Ideally, data is from a mixed-methods approach – wherein quantitative data can drive funding requests, and qualitative data can make explicit leverage points for teams to target. The outputs of an ethnography (thematic analysis, interview transcripts, observational protocols) help frame raw output data (adherence rates, attitudes, surveys) and can help implementation teams better interpret, and in turn, iterate, an intervention.

Ethnographic typologies are an important methodology when considering how best an organization can employ antifragile project design. Through ethnographic research residencies and case study analysis, it was clear there was a need to assess the influence of informal and conceptual factors can have on rural eHealth implementation. Using the ethnographic observation data collected though my research residencies, the structure of the CDCT was composed to account for qualitative assessments of antifragile operators within an implementation process. Ethnographic typologies are included in the CDCT as one of the six recommended methodologies to assess organizational capacity for deployment of antifragile interventions. This was done in part because the focus on the lived experience of stakeholders interacting with an eHealth intervention provides important context, nuance, and subtlety to outcome data. When interpreting data through an ethnographic lens, implementation teams will then have a profounder sense of leverage points for iterations in their current and future settings.

### 4.7.2 Realist Evaluation Structuring Composite Design Cycle Theory

The CDCT applies the realist interpretation of interventions – namely, that these interventions are some interaction between it's context, mechanism, and outcome, as the model

which the CDCT is built on. Each phase of the CDCT recommends different methodology to understand the context of the intervention, the mechanism the intervention uses to change behaviour, and the outcomes of the initiative. Through leveraging a realist evaluation perspective on interventional components (context, mechanism, outcome) the CDCT can help answer the question 'what works where, and for whom'.

Based on the implementation of virtual health rooms in rural Sweden, a program theory was created analyzing the salient factors for antifragile project design. These pertinent indicators were then shown to other researchers, stakeholders, and practitioners. From their expertise, as well as deploying this program theory in other settings and projects, the components of antifragile project design first identified through a literature analysis and ethnographic observation were reformed. In a typical realist evaluation pathway, the iteration and tinkering of a program theory can take dozens of attempts before a logic is derived which suitably answers the question of 'what works where and for whom'. From there, the program logic is an important piece of documentation in understanding how best to approach implementation efforts in other settings and serves as realist posterity in evaluating an intervention based on its complexity.

| | |
|---|---|
| IF | Rural eHealth projects are designed with antifragility[1] as the guiding principle. |
| IN THE CONTEXT OF | Multiple interdependent stakeholder groups.<br>Limited fiscal and human resources, with high tension for change in health service provision.<br>Broad strategy for rural health service design and provision, including protocols adapted or tailored from urban policy.[2]<br>Some degree of buy-in from local authorities, communities, and providers that eHealth can provide full or partial solutions to health care needs. |

[1] The principle of *antifragile* was first articulated by Nicholas Taleb (2012). It stipulates that some systems gain stability from volatility; hence are the antonym of fragile – antifragile.
[2] So called 'urban-normative' rural health policy planning is detrimental to rural communities. Instead of viewing rural communities as disadvantaged, they should instead be seen as inherently different, and treated as such.

| | |
|---|---|
| | Presence of one or more wicked problem(s).[3]<br>Uncertain funding, responsibility, or leadership of the project after the pilot stage. |
| THEN | The eHealth project will have inherent resilience to volatile environments.<br>The likelihood that the project will thrive[4] in rural communities is higher than their fragile counterparts. |
| BECAUSE | Volatility is inherent to every health care system in the three regions of interest.<br>Antifragile eHealth projects gain stability as an intervention through exposure to volatility;<br>Evaluations of eHealth projects change from linear to complex.[5]<br>Emphasis on iterations can be achieved through smaller, compact, patient-partnered programs.<br>Antifragile project design can be prospectively validated and followed. |
| WHICH MEANS | Researchers adhering to antifragile project design will produce eHealth interventions which can be implemented more easily<br>Complexity science can be used to definitively plan interventions and is not merely a descriptive tool.<br>Volatility within a health system can be seen as something to embrace and work with, instead of trying to control and work against. |
| AS A RESULT | ***Rural eHealth projects thrive, increasing the likelihood of scale-up and spread across contexts, embracing traditional barriers to implementation.***[6] |

**Table 4: Program theory for a realist evaluation of antifragility within eHealth project design in Canada, Australia, and Sweden.**

Within my doctoral research, realist methods have heavily influenced the structure of the CDCT. The realist mantra which acknowledges both the effects and importance context has on an implementation, as well as the opaque nature of operating within a complex adaptive system,

[3] A wicked problem is a challenge with seemingly no solution.
[4] Thrive in this case means the project will have: Enthusiastic use of intervention by practitioners, use of technologies by a diversity of stakeholders, frequent and positive use by patients, movement from a 'pilot' to part of routine health services framework, secure funding source identified, and potential to 'scale-up' services and expand to other locations.
[5] Complex evaluations consider peripheral factors not traditionally included in linear markers of success (pathways of influence).
[6] Barriers which previously prevented implementation could potentially be promoters of implementation (lack of infrastructure).

offers a synergistic method of validating and exploring antifragile eHealth project design. Further, realist methodology offers a concrete output based on theoretical research – the program theory. Conducting realist research requires the confrontation of complexity, instead of complacency of its presence. Accounting for complexity through antifragile design and comfort with ambiguity has support in realist research and confirms the potential antifragile design could have on sociological implementation.

Realist evaluation is a suitable methodology to include in the *interpret* part of the CDCT as it asks the questions "what works where, and for whom? (32,132,133)". This question is supplemented by data collected in the previous phases of the CDCT and helps frame the interventional outcomes in the context of their setting. Further, it aligns with the qualitative approach advocated by the CDCT in understanding effects which are conceptual in nature and the influence these can have in rural eHealth implementation. By using realist research to evaluate outcomes against the background of their context instead of in a vacuum, implementation teams can have more confidence when they iterate their implementation process that they are addressing the salient behaviours targeted by the intervention of question.

By applying realist evaluation approaches, the implementation team can articulate what worked in once context against another and analyse the component parts of their intervention to better understand one which could be promoted to increase uptake in another setting. It requires implementation teams to recognize that every implementation is different and will require unique and clever strategies. Realist evaluation ensures that implementation teams are framing their data, and hence their problem, correctly, and mitigates some of the downfall of assigning importance to relationships would be spurious or coincidence.

## 4.8 Thematic Synthesis

Thematic synthesis is the process of systemically analysing data sources (such as interviews, project documentation, or peer-reviewed literature) to create a theoretically saturated framework of analytical and descriptive themes derived from targeted information (134). Thematic synthesis is an in-depth qualitative methodology which can sufficiently convey latent and explicit knowledge present in data sources. *Explicit knowledge* is defined as connections or relationships which can be interpreted or understood as self-evident from data. For example, the decrease in lung cancer rates associated with decrease in smoking is considered an explicit connection. *Latent knowledge* or tacit knowledge is behaviour, problem-solving, or sense-making strategies which may or may not be codified and is not necessarily easily expressed.

A thematic synthesis can provide a cohesive way to formulate both explicit and latent knowledge, and the relationship this can have in the process of interest. It is an inductive approach which starts with a set of observations and creates a generalizable theory from them. Thematic synthesis outputs include frameworks and theories built upon *a priori* understanding of phenomenon, which are then made robust by analysis of experience. In the context of my doctoral research, thematic synthesis was deployed by creating coding protocol through ethnographic observation and case studies, which was then applied to 92 peer reviewed publications pertaining to rural eHealth interventions. The result of this thematic synthesis is the matrix of scale, the second component of the antifragile design portfolio. This evaluative framework provides rural implementation teams with a principled tool to help guide future eHealth implementations as a function of antifragility and institutional investment and is discussed in depth in 6.3.2.

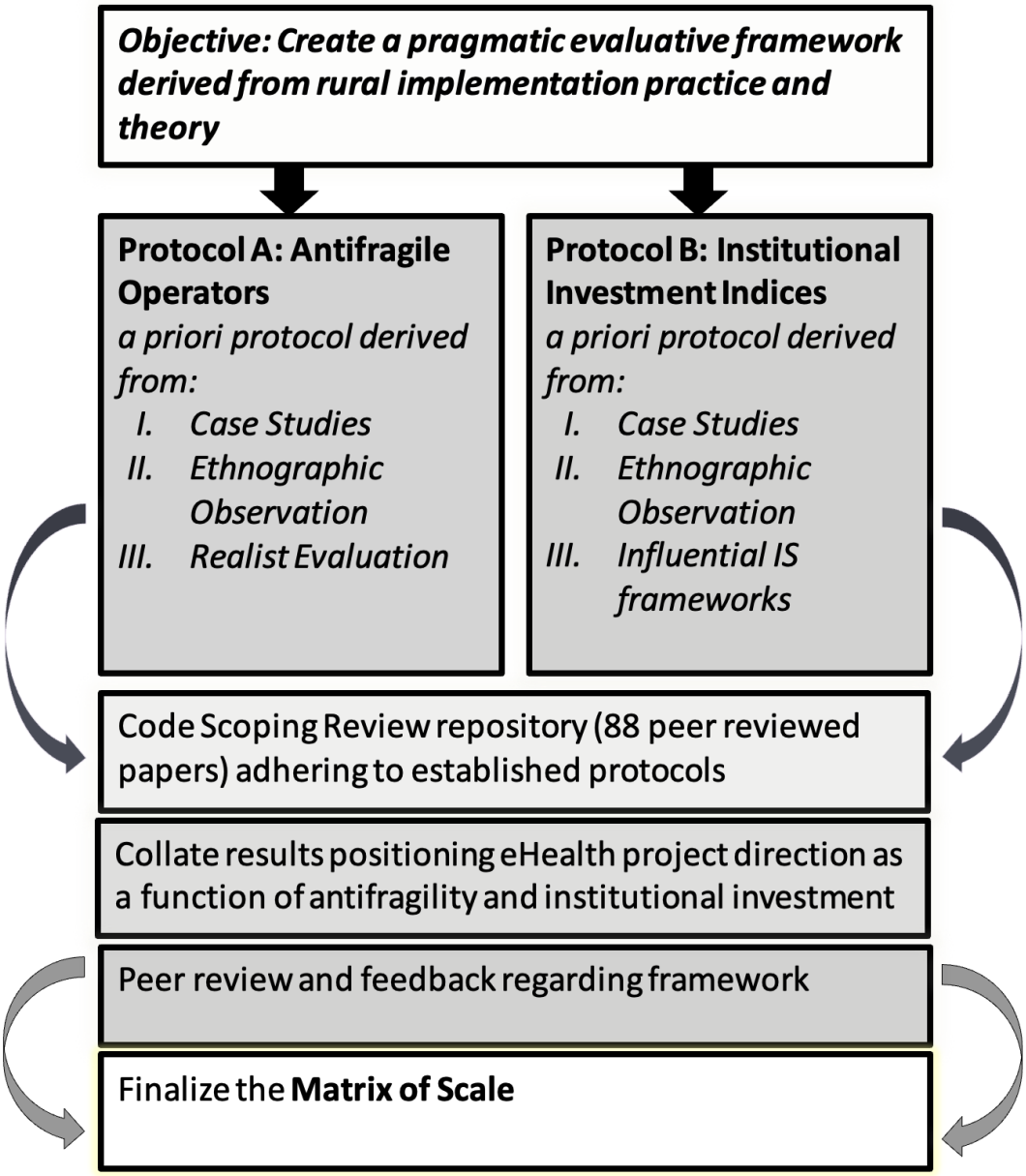
Thematic synthesis is a more rigorous form of thematic analysis, and has seen increased deployment in health sciences and services literature (116). In the context of rural research, thematic synthesis is an important methodology in a rural researcher's toolbox, as it can provide rich description of interaction, intervention utilization, and sociological relationships which cannot be completely explained by quantitative methods. With the complexity of implementations being more widely accepted, and a recognition of the shortcomings of reductionistic evaluations as well as implementations (90), thematic synthesis has emerged as an appropriate approach to provide coherence to contemporary implementation process and the facets which can influence them. Through the integration of complexity sensitive methods such as thematic synthesis, implementation teams are better equipped to manage challenges and barriers to effective implementation process.

### 4.8.1 Applying Thematic Synthesis to create the Matrix of Scale

Thematic synthesis was applied to a previously collectedd body of literature which was analysed to inform a scoping review regarding patient and provider attitudes about eHealth in rural communities (34). **Figure 7** represents the protocol of the thematic synthesis which culminated in the creation of an evaluative framework for rural eHealth implementation: the Matrix of Scale. Thematic synthesis relies on *a priori* protocol regarding the principle or phenomenon of interest, which is then strictly adhered to throughout the coding process. The protocol for the thematic synthesis in this dissertation was split into two parts, A and B. The coding protocol in its entirety can be seen in appendix B. Protocol A referred to the antifragile operators and their presence in peer-reviewed literature regarding rural eHealth implementation. This protocol was derived from case studies, ethnographic observation, and components of realist evaluation. The second protocol, protocol B, referred to the institutional investment

indices required for project success. This protocol was derived from case studies, ethnographic observation, and influential implementation science frameworks (Table 3: Collation of theories and their synthesis into the antifragile design portfolio. Theories include: RE-AIM, CFIR, NASS, CAS, Realist Evaluation, Dirt Research, and Antifragility.)

**Figure 8: The thematic synthesis protocol followed to create the matrix of scale.**



## 4.9 Association of Methods to Research Questions

Following the discussion regarding appropriate methodologies and research design advocated for in this dissertation, it is important to explicitly link them to the three research questions outlined in Chapter 2. This brief section will underline how the methodologies discussed helped address the research questions of interest and frame the components of the antifragile design portfolio (CDCT and MS) in the context of these questions.

**Can eHealth address the planning challenges of rural health systems (Practice)?**

This research question seeks to address the gap in equitable access experienced by rural communities. In order to do so, a scoping review of patient and provider attitudes towards eHealth was conducted. This scoping review was further augmented by ethnographic research residences and interviews conducted with administrators, rural stakeholders and providers as part of the Free Range International knowledge exchange. Together, the outputs of these methods in the form of a peer-reviewed paper (34), multiple reports, interview transcripts, and thematic frameworks have helped to show that eHealth can address the inequities of access experienced by rural communities and populations.

**Can antifragility provide insight regarding implementations in organizations and allow for initiatives to scale and sustain in other contexts (Theory)?**

This research question pertains to the nature of antifragile design, the operators which should be included in project planning, and the ability of these projects to scale and sustain to other contexts. In order to address this question, multiple case studies in diverse contexts were used in a comparative fashion. Analysis of these case studies utilized ethnographic methodology, complexity science, realism, and implementation science. Expressing antifragile design principles as important to eHealth implementation leveraged much of the concepts common to

the research designs explored in this chapter. The outputs of deploying these methods include two peer-reviewed papers (15,28), a report, and multiple conference posters and presentations. Together, they show that complexity informed concepts, in particular antifragility, can be integrated into rural eHealth design to positively impact implementation process.

**Can the link of theory and practice in the form of an organizational readiness tool and evaluative framework help organizations and policymakers establish a baseline for iterative implementations (Theory and Practice)?**

Having shown that eHealth is beneficial to rural health systems in terms of providing better equity in healthcare access and confirming antifragile design has inherent value as a guiding principle in rural eHealth implementation, the last research question aims to understand how researchers and implementation teams can use this knowledge in the form of an organizational readiness tool and evaluative framework. Through ethnographic research residencies, reflection on lived experience, and experiential learning, methodologies which create rich descriptions were prioritized to convey the influence these tools can have in bridging theory and practice. Narrative inquiry was not deployed in this dissertation, but its value in measuring the presence of antifragile operators was found through ethnographic data and methods. Thematic synthesis of the scoping review collection of papers informed the matrix of scale. The MS was supplemented by the case studies asserting antifragility's importance in project design, and realist evaluation interpretations of interventions. The outputs of the CDCT and MS will serve as the basis of theoretical reference for future projects relating to rural eHealth implementation, such as the deployment of a digital therapeutic into rural Ontario health teams as part of a post-doctoral project.

## 4.10 Conclusion

To allow for the impacts of the global COVID-19 pandemic on data collection, retrospective analysis of key themes to consider for successful eHealth implementation into rural contexts was prospectively strengthened by partnerships with the OSS and Free Range. Through ethnographic research residencies completed before the COVID-19 pandemic, supplemented by a recursive-discursive method of reflection on lived experience, three qualitative methodologies and three research designs were collated to create the basis of the composite design cycle theory.

The methodologies include ethnographic typology, thematic synthesis, and realist evaluation. The research designs include complexity science, implementation science, and realism. These ways of creating and analyzing knowledge about rural eHealth implementation are not exhaustive, and future implementation teams should not feel a need to strictly adhere to them. Rather, they are the suggested methodologies teams should consult first when conducting an implementation, with room for flexibility should the context require another approach.

While using six methodologies to determine readiness may be construed as obscuring how data is collected and introducing too many lenses in its interpretation, consider again the central problem of complexity. It has been noted that **"***If the environment can disturb a system in a wide variety of ways, then effective control requires a regulator that can sense these disturbances and intervene with a commensurately large repertory of responses.* (135)" This idea is known as *conceptual slack* (136). Essentially, <u>it is the idea that having a repository of theories to reference when confronted with complexity, ambiguity, and paradox increases the requisite diversity in how it can be interpreted.</u> The CDCT accounts for the importance of conceptual slack and its ability to improve coherence of intricate problems in implementation. Applying the CDCT outlines an important aspect of implementation: readiness for adoption of innovation and ability to sustain interventions (137,138).

Data for the creation of the CDCT was largely experiential and codified in the form or reflective discussion and writing. Inspiration for creating an organizational readiness tool logically followed from being unable to prospectively validate antifragile operators in a nascent eHealth project due to COVID-19 restrictions. Recommendations for evaluating and measuring antifragile design principles was also informed from the thematic synthesis which formed the basis of the creation of the MS. Data for the MS were peer reviewed, published journal articles collected as part of a scoping review to assess eHealth attitudes of patients and providers. These papers were then analysed using a thematic synthesis approach, wherein content pertaining to one of the five antifragile operators, or one of the five institutional investment parameters, was coded using *a priori* coding protocols (appendix B). The result is a robust body of 89 papers which highlight keywords, semantic structure, operator or index distribution, and related concepts which implementation teams can consult when they perform an analysis of their own project documentation.

# Chapter 5: Research Results

This chapter serves as a collation of ethnographic and thematic synthesis data that establish the presence and potential of antifragile operators and institutional investment indices in rural communities and discrete eHealth implementations. The ethnographic data is in part presented in the form of a reflection on rural research, demonstrating the need for a principled design philosophy which can be applied in rural communities. Further ethnographic data is captured through five vignettes, which are compiled and offered as accounts of the importance of antifragile operators and the capacity of rural communities to integrate antifragile design. Following this, further ethnographic evidence is presented in the form of results from a rural town hall discussing rural challenges and strengths as they pertain to health access. This broadens the presence of antifragile markers and need of antifragile design operators in rural implementations. This ethnographic data is then summarized, and its antecedent influence on the development of key-word analysis and coding context within the thematic synthesis made clear.

As discussed in Chapter 4, ethnographic data serves as a written account of the cultural life of a social group, organization, or community which may focus on a particular aspect of life in that setting (139). Ethnographic data is a thick description of interactions, phenomena, and sociological relationships which lead to generative cause and effect (such as in implementation). Thick description is different than the sometimes-quick descriptions which can occur in guarded ethnographic approaches, where the researcher is protected by chaperones or other structures which limit the interaction a researcher has with a context or population.

As noted in an influential ethnographic study of heroin addicts in San Francisco "*Participant-observation is by definition an intensely subjective process requiring systematic self-*

*reflection. Collaborators have the advantage of being able to scrutinize one another's contrasting interpretations and insights* (140)." Through the reflection on the Free Range research residency provided below, my time in Sweden certainly meets the requirements of thick description, as I lived alone in a cabin in Storuman for 2 months between March 2018 to May 2018. Altogether, reflecting on the residency made possible through Free Range allows for formative interpretations of phenomenon and productive theorization of ways to address challenges and problems in rural eHealth implementation.

To supplement the Free Range reflection, five further vignettes are provided discussing experiences in Canada, Australia, Sweden, and Iceland. These experiences serve as an international comparison in rural living between the settings of interest. Further, they provide information regarding the key facet of ethnographic study – namely, understanding 'how things work' in the setting of interest (139). Before exploring these vignettes and discussing their antecedent influence on the thematic synthesis informing the matrix of scale, it is worth noting that ethnography runs against traditional, reductionistic methodologies. Ethnographers need to be good craftsmen, "*avoid the fetishism of method and technique*", and allow for theory and practice to become part of the craft (139). Rural communities cannot be placed in a sealed vacuum and fed variables to understand how and why implementation reacts to various influences. Through *plain* (defined as a traditional social science account of events occurring within the investigation of a single case) and *enhanced* (defined as an account of events occurring within a single case which uses the presentation techniques of a novelist (139)) vignettes, the presence of traits within rural communities which facilitate antifragile implementation, as well as a need for antifragile principles which can help guide implementation is established.

After acknowledging and identifying the antifragile operators and institutional investment indices present through ethnographic accounts, the results of the thematic synthesis are then

presented. A thematic synthesis was completed as a retrospective analysis in lieu of a prospective embedment due to COVID-19 complications associated with my doctoral research (discussed in Chapter 4). The body of literature subject to thematic synthesis is outlined, including the results and methodology from a scoping review assessing patient and provider perspectives on eHealth, which was the original purpose of collecting the papers.

Furthering the scoping review, data visualizations are presented regarding the presence of antifragile and institutional investment content in the resultant large body of literature, including tree maps of coded content, cluster analysis of word similarity between codes, and a density diagram which maps coded papers as a function of unique coding references regarding antifragile content and institutional investment content. Complete charts are included in Appendix D, Appendix E, and Appendix F which measures the presence of intersecting code in each paper (D and E) and the Pearson correlation coefficients of separate code (F).

Taken together, the ethnographic and thematic synthesis results provide the basis for the Matrix of Scale, which is discussed further in Chapter 6. The results presented here establish the importance of an antifragile approach to eHealth implementation and offer tangible avenues to do so (decision-maker checklist, Appendix G).

## 5.1 Free Range Scholarship and Dirt Research

Central to this dissertation is a "Dirt Research" approach, which places an importance on the lived experiences of the researcher embedded in the population of interest. This approach goes further than the baseline of ethnography, which places an emphasis on the importance of the lived experience of the research population of interest. Through a transformative two-month research residency in Storuman, Sweden in early 2018, my understanding of rural health, policy challenges, and ascertaining 'how things are done' in rural communities changed. As part of the

Free Range field research, a reflection was completed codifying my experiences. Reflections are an important part of the learning process, as they offer the trainee an opportunity to associate phenomenon with meaning and appreciation of the broader scope of minute detail (141). The following reflection is also part of the body of ethnographic data and evidence of rural strengths from which an antifragile approach was derived – as well as demonstrating a need for antifragile operators to combat challenges unique to rural implementation and community.

### 5.1.1 Dirt Research Reflection (2018)

The Free Range scholarship program was an opportunity for myself and several other trainees to visit the Center for Rural Medicine (CRM) in Storuman, Sweden to undertake various forms of field research. As part of my doctoral work, I went to Storuman to learn more about the e-health models that the Västerbotten region had implemented over the past 15 years. My goal was to better design pilot projects, specifically e-health initiatives, so that they are better suited to survive in a complex adaptive system. The Free Range program provided an extraordinary possibility to not only further my own research, but also gain a broader understanding of lifestyles within rural communities, create lasting relationships with likeminded scholars, and come to a deeper understanding of what 'rural research' actually means to myself, and the populations the research will ultimately serve. As such, this reflection will be divided into 3 distinct parts: A reflexive discussion surrounding the research process within Storuman, the broader context of doing research within rural communities, and the relationships I built with other scholars and with the locals of Storuman.

The reflexive discussion section will primarily contain considerations of being physically present in a well-connected center of research, the importance of gaining insight into the context of what you are researching, the lack of sufficient distractions, and the feeling of accountability

which develops as you progress through your research. The broader context of rural community section will include deliberations on the importance of the research to the rural community in general, the surprises or alterations you may have to the preconceptions of rural communities, and a discussion of context as the single most important factor to consider when undertaking implementation research. The last section will be a reflection on the connections I have made; both in the community and with the other scholars who were present at the CRM, *as well as the importance of networking between scholars, technicians, physicians, and citizens to gather as much of a holistic approach as possible to your research (and to try to encompass the context already mentioned above).* Finally, the conclusion will summarize the reflection by tying the three sections together and highlighting the importance of leveraging an antifragile approach to implementation, while providing structure in understanding the presence of antifragile operators in rural communities.

#### 5.1.1.1 The Research Process within Storuman, Sweden

Before leaving for Storuman, my doctoral research relatively unstructured. Complexity science (the analysis of complex adaptive systems and the entities within them) was something that had interested me in the past, but I wasn't sure how to best integrate into my doctoral studies. Similarly, e-health initiatives and the transitioning of 'emergency departments' in Canada to 'collaborative care centers' was another thing that I wanted to investigate, as I saw it as further marginalization to an already marginalized population. Before I left, I met with my supervisor to try and work out a direction for my research, and we agreed that the Free Range program would offer me a substantial opportunity to examine the e-health initiatives already in place in Storuman, and to try and work out why some had worked while others had not, from a complexity science perspective. With this broad idea in mind, I set off for Sweden, and shortly

after arriving, knew that my topic was both important to the ongoing efforts of care providers in Sweden, and the people associated with Umeä University and the CRM.

As a novice researcher, sometimes the question of 'so what?' starts to creep into the back of your head. Is my project something that is *really* worth looking into? Does anyone else *actually* care about the results? *This sense of doubt is easily fostered when much of your research is conducted shut away in a quiet campus library, with little interaction with other stakeholders or researchers, and seemingly endless amounts of literature ahead of you* (contributing to the thought that 'it has all been done before'). Removing myself from that environment and being physically present in a place such as the CRM was extremely beneficial for my research and provided me with ample motivation to continue with my studies. Even simple encouragement such as hearing your research is interesting, or having a colleague request an article you are reading, provides a sense of purpose and direction which can be difficult to muster when you are removed from other people conducting similar research.

*This sense of purpose goes further than simply providing you with future direction, but also begins to instill in you a sense of accountability***.** It can be rather easy to convince yourself that what you are doing can be done tomorrow. Once you begin to have other stakeholders start to show interest in what you are doing, the quality of your work begins to improve, and you develop more ownership of the research you are involved with. I think that this accountability I began to feel after my first week at the CRM would definitely have developed had I never taken part in the Free Range program, but probably only when there was the pressure of a deadline, or some other such evaluative process, months later. *Accountability arose organically because of the attitudes towards my research that my colleagues had, which greatly influenced the quality of*

*my work, as well as the considerations I put into readings or meetings.* This would not have been possible without the Free Range opportunity.

Besides the effect of physical presence helping you develop meaningful interactions with likeminded colleagues, it also helps give you a better understanding of the context your research will be introduced into, and the everyday lifestyle of your study population. *Meanings of subject populations (such as attitudes and beliefs regarding electronic health implementation) are not pristine objects simply discovered, rather these meanings are interpretive constructions assembled and conveyed by the researcher.* It is one thing to read about rural communities and populations in scientific literature; quite another to live in a small cabin engrained within one of these communities. You begin to understand common challenges rural populations face, whether that be transportation time, a decreasing number of services, or the reluctant acceptance of the declining population (a trend which as a whole is not true; but this will be discussed in broader detail in the 'rural communities' section). At a recent conference, a patient advocate spoke about the 'Petri dish to patient' phenomenon that she experienced when she met a scientist working on an extremely rare disease her daughter had. Much of the same happened to me, except a more apt phrase may be 'publication to population'. Understanding that your research, if conducted well, will have real impact on the everyday lives of a marginalized population provides further motivation to produce a high-quality investigation.

Lastly, the lack of distractions within Storuman made being productive much more attainable than at home. By nature of being a small town, there are not too many places to go after 5pm. This facet of rural living is one that seemed important to some, and a burden to others (such as the comparatively large population of teenagers that would spend their nights doing doughnuts on their ATVs in the town crossroads.) *As a result, much of my time outside of*

*regular work hours was spent with my fellow researchers from the CRM, which provided occasions for 'off the record' conversations about anything from our respective projects to life in general.* The lack of distractions and tranquil nature of rural life created a productive atmosphere, that was not prone to the sometimes problematic factors of a more urban center. I found that I spent time more wisely than I would have at home (Ottawa, Canada) because I knew that my time in Storuman was limited, and that people were counting on me for results (as discussed above). Distractions turned into fruitful conversations helping focus my research and come to a finer understanding of what the research means to myself and others.

Through this section of reflexive writing, it became clear to me those rural contexts were different in their challenges and strengths, and not fundamentally disadvantaged. Discussed previously was the strengths-based nature of the antifragile design portfolio. A key aspect of delineating disadvantaged from different is the acknowledgement of diversity and variance in rural settings (142). **There are strengths of rural places, such as the development of stronger social ties, as evident through the building of relationships with my fellow researchers and rural residents of Storuman.** Further, the interest and engagement with health research was clear, especially through the consultations with patient partners and rural stakeholders. This signaled to me that a design philosophy for rural places needs to build on these strengths and acknowledge the differences between rural and urban settings (and indeed, rural and rural settings). Framing a context as disadvantaged can lead to latent tension between an implementation team (outsiders) and rural stakeholders (insiders). **Sensitivity to understanding difference in small sample size is most readily done through qualitative methods. This also led to the early decisions to use rich descriptive methodologies such as ethnography,**

**narrative inquiry, and complexity science to better prepare implementation teams for the differences within rural settings and how to productively work with them.**

#### 5.1.1.2 The Broader Rural Community

Touched on above was the importance for me to get out of the library and into a community to realize that my research was of more importance than I initially realized. Rural populations are populations which have already experienced a vast amount of marginalization in recent years. Loss of critical services, less political and industrial power, and mass migrations of youth have resulted in a feeling of uncertainty at best, and at worst, hopelessness about the future. eHealth initiatives are a possible way to decrease the issue of remoteness, and to bridge the gap between access to healthcare between urban and rural communities. Much along the same themes mentioned previously, putting yourself into the actual environment your research could impact, further provides meaning to what you are doing. *Seeing the centers for care in rural communities and how they can be improved makes you realize how you can improve healthcare experiences on a person-to-person basis.*

*Before going to Storuman, I certainly had many perceptions about rural communities that were then proven incorrect.* In keeping with the general narrative of rural decay, I envisioned broken windows, vacant businesses, and tumbleweeds rolling down main street. The actual community was much different. The refugee crisis of the early 2010s resulted in a large number of refugees coming to live in Storuman, and I saw many of these families grocery shopping, out for a walk, or simply stopping to chat with friends on a street corner. *This dispelled the preconception of vacancy and decay that I had before I came, and I was surprised to find a vibrant and seemingly thriving community of young families; not the typical demographic you envision when you think of a modern rural community.* In addition to this, there were two

superstores, a school, a pool-hall, and a sports complex including a basketball gym and ice-rink. All this infrastructure resulted in a relatively bustling center of commerce and recreation.

I also had the opportunity to coach basketball in the community, which gave me great insight into the lives of the youth and children within Storuman. If I were to be transported into the Storuman gym from the outside, I would not be able to differentiate the basketball practice from rural Sweden to urban Toronto. Around 25 children came once a week for basketball practice, and they all seemed to greatly enjoy it. Certainly, the ideas I had of the youth in rural places wasting time in any number of ways seemed to be wrong, as basketball was run one night, while there was floorball another and soccer on another night as well. Keeping them engaged with athletics seemed to be a good way of ensuring that they did not spend their time getting up to trouble.

Before going to Storuman, I may have written an introduction or article discussing the many challenges facing modern rural settings. Having lived in one of these communities for 2 months, I can now speak on the context of rural living with more authority than simply reading about it. *Understanding the broader context of the environment you are targeting your research towards is invaluable in creating more nuanced insights and better-informed recommendations***.** Although I was generally aware of the importance of context before I left for Sweden, living there and trying to get involved with the community helped immensely in developing an appreciation for the phrase *'context is king'*.

The appreciation of context and its effects on an implementation is not a new realization (143–146). **What this section of writing shows is that measuring the effects of context needs to be flexible and an acknowledgement must be made on the part of the implementation team that every implementation is different.** This is further evidence of the requirement of a

collection of research methodologies which can suitably sense differences in granular context. Often, policymakers require specific information which can be rolled up into macroscopic policy governing broad levels of organization. This granular analysis, or referencing a collection of methodologies to achieve nuanced analysis, is difficult to achieve under the reigning paradigms of evidence-based medicine. This traditional approach requires reform (as the outcomes of rural populations can attest) **and the antifragile design portfolio can present policymakers with important information – which can still have effect at a macroscopic level – but is derived from a granular (microscopic) level injecting contextual concern.** Instead of evaluating every rural community as functionally the same, is a key facet of the antifragile approach and its importance is demonstrated through the correction of rural perceptions I had previous to my research residency.

#### 5.1.1.3 Networking and Building Relationships

When I arrived to Storuman, I knew nothing about my colleagues besides their names, perhaps their research interests, and what I had heard second-hand from my supervisor. It is safe to say in retrospect that everyone I met there, from trainees involved in the Free Range program through to the professors at the CRM and associated personnel at Umeä, were fantastic researchers and people. I learned a lot from them, both from a research perspective and from a rural living perspective that would not have been possible if I had been in Ottawa. The relationships I made with other student researchers were especially rich and transformative, and I found it beneficial to my own research to sit down with other students and work out problems they were encountering with their projects. The relationships I formed were not one-off encounters, and I look forward to working with both the professors and students involved in the program in the future.

Establishing this community of practice was formative on my research for a number of reasons. *First, having a peer-group of trainees lessened the feelings of imposter syndrome and doubt which can accompany novice researchers. Having peers to informally and formally discuss methodology differences, comprehension of material, and sharing in everyday challenges of rural research builds strength and resilience within the body of researchers and contributes to better understanding of phenomena in rural places.* Second, disseminating my research for peer assessment within this group led to several insightful recursive-discursive conversations regarding the role antifragility could have in eHealth project design, and the importance of grass-roots initiatives to sustainment and eventual scale of eHealth projects*. For example, having multiple reflexive conversations with an experienced qualitative interviewer made the importance of framing a problem – especially in terms familiar to stakeholders – clear in an antifragile approach to eHealth design.* The multidisciplinary team of trainees and scholars available to me through the Free Range residency enhanced my work by providing nuanced understanding of rural challenges and facilitators to implementation, and how to account for them in my own research. Third, the support network established by this community of practice allowed for strong informal bonds to develop. *These bonds galvanized the group of trainees present and help to contribute to powerful understandings of their own work within the larger context of rural research.*

Further, working with the youth basketball team also allowed me to take on a mentorship roll with the boys and girls who came to the weekly basketball trainings. *I found this role extremely fulfilling, especially when the kids would see me in the town and shout out a hello or seek my advice for their jump shots***.** Building these relationships with both my colleagues as well as the people of the town transformed my research from an outsider's perspective to a more

holistic and encompassing approach. I wasn't performing research on a population anymore, but working with friends, future NBA stars, and colleagues to understand rural challenges and facilitate reform to rural health policy. This transition from 'researching on' to 'researching with' helped me further appreciate the nuance needed in rural research approaches and helped to better position an antifragile approach to eHealth implementation as something which can build upon existing rural system and societal infrastructure.

The importance of forming relationships with the rural setting primed for an implementation became clear through my interactions with other Free Range researchers and the youth basketball program in Storuman. **A need to develop an integrated knowledge translation channel, where facilitators, barriers, and results could be freely discussed between rural implementation teams and in consistent terms was clear. Part of the strength of the antifragile design portfolio had to be the ability to provide transferable information in accessible format.** The matrix of scale, which places eHealth trajectory as a function of antifragility and institutional investment, is a key piece of knowledge translation material. It's simple structure and terms allows teams to discuss their experiences using the tool, how they corrected for better institutional investment or antifragility on subsequent implementation iterations, and the qualitative approaches they used to measure antifragile operators or institutional indices. **The simple structure of the matrix allows for rich understandings, including the avoidance or mitigation of path dependence (high institutional investment, minimal antifragility) and facets of antifragility which can be tangibly applied to pragmatically improve an intervention (and subsequently, an implementation.)** Avoiding path dependence may be the single biggest contribution of the matrix of scale, as costs can cascade and severely hamstring organizations, to the point of non-viability (147,148).

#### 5.1.1.4 Conclusion

In conclusion, the Storuman Free Range ethnographic research residency and subsequent reflexive exercises imparted the need for sensitive qualitative methodologies such as Dirt Research, the creation and maintenance of an integrated knowledge translation channel for rural research, the prioritization of understanding context, and establishing rural communities as different and not disadvantaged. An implementation design for rural communities had to suitably address these considerations. Antifragility, which had been a concept which had been applied in other contexts, seemed a suitable candidate to operationalize. It's intuitive appeal of creating stronger systems through uncertainties coupled with its pragmatic approach to achieving those ends (introducing optionality, having varied perspectives in decision-making through hybrid leadership and non-linear evaluation, starting small) aligned with the prioritization of context and a strengths-based approach to rural implementation. Detecting the presence of both the antifragile operators and the institutional investment indices, as well as system side capacity to integrate them, became the focus of subsequent ethnographic accounts, described below.

## 5.2 Ethnographic Data (Vignettes)

The first vignette which will be discussed is the field visit to the Virtual Health Room in Slussfors, Sweden. The second is a description of a meeting our research group had in Iceland with the headmaster of a local village school, and the rural themes which became apparent through that meeting. The third is a description of the rural response to COVID-19 through a grass-roots initiative known as the CVTAC. The fourth offers an account of field visits done in Burra and Robertstown, Australia where it was seen that electronic initiatives are not always heralded as a good thing, and indeed can sometime runs counter to what a community may consider innovative. Lastly, results from an ethnography regarding rural response in Canada,

Sweden, and Australia to COVID-19 will be highlighted, summarized into the 'WHAT' framework of rural COVID-19 health system reaction. Throughout the presentation of these ethnographic accounts, *italicized* and **bold** text is utilized to help the reader differentiate between the important recorded information and the reflexive voice of the ethnographer. *Italicized* text denotes important information from the account. **Bold** text denotes the interpretation of this information.

### 5.2.1 Virtual Health Room Site Visit (2018)

I had the opportunity to see a Virtual Health Room (VHR) in a small village about 60Km from Storuman. The highlight of this visit was having a chance to hear about an elderly woman who found out that she was diabetic specifically because of the implementation of this VHR. Travelling to the VHR, seeing how it is used, as well as being a part of the large group, which was present to discuss it, signalled the interest and indeed ownership the community had regarding the VHR. *This site visit helped put the implementation of eHealth initiatives in human terms. It also illustrated the importance of having a diversity of stakeholders present to consult during an implementation and the importance of allowing patients and providers to have options in how they access it.* Further, the iterative rollout of the VHR allowed for the team to tinker with their projects, reflecting concerns and suggestions from the aforementioned stakeholders.

The virtual health rooms were meant to be multi-functioning rooms within several hand-picked communities in northern Sweden whose distance from regional 'cottage hospitals' (smaller collaborative health centres, usually composed of a handful of physicians, nurses, and allied health personnel) was seen as prohibitive in seeking care. The virtual health rooms were self-serve rooms in nature and were promoted to encourage residents to keep track of their baseline health attributes such as blood pressure, heart rate, and blood sugar. These rooms also

had secure video conferencing technology, so if there was an urgent problem patients could contact a provider who was contracted to be on-call for the health rooms. There was little to no other technical support available, and the rooms remained (for the most part) unwatched and with little security. The initial utilization of the virtual health rooms was sparse, with many residents seeing it as a poor replacement for in-person healthcare which they were accustomed to receiving. In typical complex adaptive system fashion, the outlook of these rooms changed with the arrival of a local champion.

A well-respected and well-known older woman in one of the VHR contexts felt weak one day and decided to use the room to check herself out. She found she had high blood sugar, and so called one of the on-call physicians to consult regarding her condition. She was booked for a follow-up appointment, diagnosed with diabetes, and began managing her condition successfully. *From this interaction, she began to describe the importance of the VHRs to her peers and colleagues within the village and surrounding area.* After this interaction, the implementation team observed much better reception of the room, with increased use by all demographics and a sense of 'ownership' being transferred from the implementation team to the community.

In addition to the presence of a champion, the VHR allowed for its technology to be used for other functions besides healthcare. *These functions included secure videoconferencing infrastructure for legal consultations, as well as education and training. As members of the community began using the technology, which was ostensibly present to help manage health issues, they became more comfortable with the VHR.* This ultimately led to better uptake and utilization of the room for its original purpose, as patients began to feel comfortable with their interactions with this technology. If the implementation team had forbidden the use of their

technology for anything rather than health, it is unlikely that the room would have seen the uptake and use it did.

While one context enjoyed success with regards to bettering patient outcomes and increased utilization of the technology available to the community, other communities had differing results. In these contexts, the outside nature of the implementation, as well as the perceived erosion of in-person resources dedicated to these rural communities, contributed to poor uptake of the initiative and little change in the behaviours and beliefs of the communities involved with the project. While there are documented benefits of integrating eHealth into a rural health system, care must be taken to understand the semantics of a given context. *Against intractable opinions regarding electronic mediums, it is hard to galvanize a patient group that technology and broadband infrastructure can address challenges, when they are characterized as a challenge in and of themselves.*

This vignette shows the potential and presence of the antifragile operators of optionality, non-linear evaluation, and starting small. Further, evidence regarding the presence of institutional investment indices of champions and follow-up and support is seen. This site visit was important because it demonstrated the impact of including options in an electronic health project deployment. **By providing the patients using the VHR an option in how they interact with the technology, the implementation team allowed for interaction with the technology outside of it's intended scope.** This is important, as it is through the use of an initiative that the meaning patients derive from interactions can change. As Alami et. al note: "*Technology should be thought from an open-ended perspective: needs and uses are what gives value to the technology (eg, end users may find and adapt other applications not originally foreseen)* (71)." **This interaction led to eventual comfort with utilization of the components of the VHR and led to the uptake of the intervention in its original purpose.** Additionally, the extensive group which was present

as part of the evaluation and showcasing of the VHR signals the importance of multidisciplinary and integrating perspectives within the evaluation approach. **Integrating the perspectives of a wide range of stakeholders allows for more sensitive surveillance of the entire system – leading to a better understanding of an intervention's effects within the system.**

The team also started small but slowly introducing different modalities of care into the room as the intervention progressed. **This led to a better understanding of how the subject population interacted with existing technology and allowed for them to incorporate findings from smaller scale role outs – such as the importance of the video conferencing software – into expansions of the room.** Starting small provides implementation teams with flexibility in their approaches and guards against path dependence.

The presence of a patient champion also greatly influenced the uptake of the project. **The older woman who used the room and discovered her diabetic status was instrumental in promoting and advocating for the benefits of the VHR**. As Smith et. al establish: "*Telemedicine applications and sites should be selected pragmatically, rather than philosophically. In developing a telemedicine service, identify telemedicine champions who are keen and prepared to participate in the service* (149)." **The effect of promotion and advocacy of this champion through informal channels has a demonstrated impact on uptake of the intervention (as seen in the vignette).** Lastly, the importance of follow-up and support is clear from this vignette. Having appropriate partners, such as the Centre for Rural Medicine and Lycksele Hospital (the regional hospital providing physician support to the room) gives the commission and implementation of the project credibility and instills confidence in the patients who use it.

The ethnographic data captured through this site visit provided information of the pragmatic effect applying antifragile operators and institutional investment can have on a discrete implementation. The following vignette on a small village in Iceland provides an

ethnographic account regarding the social infrastructure of rural places, and the system side capacity (and individual presence) of antifragile traits.

### 5.2.2 Ólafsfjörður, Iceland (2019)

Ólafsfjörður is a small village of about 800 people in Northern Iceland. Through a brief windshield inspection (wherein the research team get a 'first impression' of a town through their car windshield), the town seems to be static, if not declining. There is little to no tourist attractions, small amounts of people could be seen going about daily chores, and the native industry (fishing) seemed silent. Most homes seemed neat and well kept, as is the standard in Iceland, with a clear distinction of more affluent appearing dwellings situated on a bluff overlooking the town and harbor below. The lone café at the centre of town which we located in our brief inspection was open, and so we stopped for a coffee. Seven North Americans stopping in for a coffee in early October is a bit of a rarity in Ólafsfjörður, and the woman who operated the café was delighted to speak with us and share more about the town.

She revealed that the café is unsurprisingly busier in the summer, but also highlighted another season which sees a strong showing of tourists: surfers in the winter. *The fjord at Ólafsfjörður creates perfect conditions for large rolling waves in the wintertime, and the surfing there is some of the most unique in the world.* This was intriguing for our entire group; on the surface, Ólafsfjörður appeared to completely shut down in the winter, when fishing fleets resided in the sheltered windbreak of Ólafsfjörður's harbor. *Little did we realize that one of the largest tourist attractions in Northern Iceland couldn't be seen from our car.* After we spoke a little longer, she also elaborated on some of the other things she does in the town. *She taught Spanish 3 times a week at the secondary school in Ólafsfjörður, and also operated a canteen during the*

*lunch hours where students could purchase meals and refreshments.* She offered to take us to the school, an offer which we accepted.

The fact that the café owner is also a Spanish teacher and caterer is not unique to Northern Iceland. At their best, rural communities across the globe exhibit an impressive level of agility. Smaller populations require people to be proficient in a wide array of skills. In an urban centre, these skills are siloed into professions and trades. If the dishwasher is acting up, you would call a plumber. If your car's transmission is making a strange sound, you would take it to the mechanic. *In rural communities, it is often the case that on top of the one (or two, or sometimes three) 'official' roles people adopt, they have the skills and know-how to operate in a dozen of fields.* The effect of course is a level of pliability which is missing in larger urban centres.

Unfortunately, no level of agility can change the fates of some communities when a dominant industry closes, youth continually migrate to other cities and towns, and/or resources are scarce. Given the challenges associated with rural living, rural populations have steadily increased in recent decades. In the face of the challenges they face, what is more surprising is the fact that rural communities continue to be viable at all. One reason for their viability could be the close-knit nature of many rural places. Another, as discussed above, is the effect that an individual having the sufficient knowledge in several disciplines has on the town as a whole.

Although it is difficult to describe in explicit terms, the pliability of rural villages and towns allow them to meet modern challenges easier than more rigid urban centres; all things being equal. The theme of multiple proficiencies was continued when we met with the headmaster of the secondary school, Lara, that afternoon. *Lara is the headmaster of the school,*

*but also a team lead for ICESAR, the volunteer organization which operates search and rescue missions year-round in Iceland.*

Lara spoke at length about the school, her methodology as its leader, her past, and what she hopes Ólafsfjörður's future generation can achieve after their tenure at her school. Lara spoke about how she took the job following the global recession of 2008. She had just completed her MA in Art Photography but found the demand for the position to be rather sparse in the wake of an economic recession. Searching for work, she came across an opening for a headmaster position within Ólafsfjörður. Although the position was not something she wanted to do from an education perspective, there were other mitigating factors which compounded the difficulty of moving to Ólafsfjörður.

This was the home village of her estranged husband – a detail she felt comfortable sharing in our approximately three hour meeting we had with her in her office within the school. Being a small village, her presence was almost surely known to most residents, and it also would be fair to say they may have had negative preconceptions of her. In addition, the school she had agreed to lead had a low rate of graduation and had seen many past students fail to secure a high school diploma at the end of their schooling. To say the situation was unstable would be an understatement. Lara showed remarkable composure in not only accepting the position, but thriving in it, and turning the school in Ólafsfjörður into a model place to work. Virtually all students who attend the school now graduate with a high school diploma, and the school has been recognized by the government of Iceland as a top place to work. *Lara has had a large influence on this fact, encouraging her staff to attend international conferences, devising methods to highlight her staff's strength, and allowing her teachers to create their own path.*

At the conclusion of our meeting, Lara told us how she was considering retiring in the coming year. When asked if she was mentoring or teaching one her staff to fill her role similarly to how she had operated, her response was fascinating. She asserted that it is not her place to tell *anyone*, including students, how to approach their work or studies. *She is a firm believer that people must determine their own course based on their strengths, interests, and ability. This is a perfect example of embracing the emergent properties ubiquitous in human systems.* Emergence is evident within health care systems as well, and organizations who embrace it and work with it are more successful at implementing interventions than those who are not.

When we finally shook hands and took a picture to commemorate and close the meeting, Lara had unwittingly shone a light on the antifragile aspects of rural communities which allow them to continue to be viable in the modern day. The comfort with ambiguity, incorporation of multiple perspectives in decision-making, accounting for emergence – all contribute to creating an environment primed to capitalize on uncertainty to become stronger. I use 'rural communities' in broad strokes, because these antifragile properties are common to not only Ólafsfjörður, but also Golden Lake, Canada, and Burra, Australia. *Collaborative efforts can only truly thrive if the people or agents working together can sufficiently address the weaknesses of the other people within their group – something which requires a breadth of knowledge across disciplines.*

This enhanced vignette displays the presence of the antifragile operators of hybrid leadership and optionality. Additionally, there is evidence of the institutional investment indices of follow-up and support and champions. **The key aspect of this vignette is demonstration in the sociological infrastructure of this rural community to integrate antifragility in a cohesive sense. Having a breadth and depth of knowledge, as well as a comfort in 'figuring it out' as displayed by Lara results in a resourceful population capable of innovation**. This

includes capitalizing on the emergence of social organizations common in small places, engaging agents which are 'T shaped' in their proficiencies – meaning they have a breadth of knowledge in multiple disciplines but are especially adept at one – and lastly leveraging the increasing comfort with ambiguity rural communities have to incorporate into their outlook on implementation efforts.

The collaborative nature of rural places facilitates the integration of multiple perspectives on issues and challenges. This signalled the importance of hybrid leadership, as well as its presence within these communities. **By encouraging and enrolling bottom-up knowledge within an implementation, ownership of the intervention can be facilitated, and a greater sensitivity to an intervention's effects can be accomplished.** As Bhandari et. al note: "*Several prior studies in community health research involving rural areas have found that positive community health results from professional–layperson partnerships engaged in capacity building, diverse leadership development and comprehensive multi-sectoral planning* (150)." Further, Barret notes: "*Clinical drivers and telemedicine users must own their own systems* (151)." **Hybrid leadership, as seen through Lara's encouragement of her staff and the multiple roles rural individuals fill within the community, is important for creating accountability within an implementation and community ownership, enabling successful implementations.**

As a consequence of this breadth and depth of knowledge within rural places, they have optionality in response to system stress. Being proficient in several tangible domains – such as languages, management, survivalism, etc. – allows for a requisite diversity in response to paradox and ambiguity. It also allows for suitable understanding and interaction with emergence, a trait common to sociological systems**. Lara displayed her comfort with emergence through her assertion that people cannot be 'forced' into one role or another, but rather given the tools to make their own choice. They will naturally gravitate towards a position which best**

**suits their skills, position, and ambition.** The comfort with emergent properties of systems is one then which can be leveraged through optionality in rural eHealth implementations.

This vignette also provides evidence of how implementation teams can enroll follow-up and support within a community. Usually, outside support is required for an electronic health intervention (such as technological or clinical support). This vignette shows the versatility of rural populations and the importance of implementation teams performing due diligence before immediately seeking outside help. **Logistical, organizational, and perhaps even technical support and expertise could exist within the community in which the intervention is being implemented.** Enrolling this support would further increase interventional ownership sentiment within the community**, as well as improve the capacity and repository of skills within the given rural context.** This could facilitate easier implementations in the future. As Bradford notes: "*The shift away from paternalism and towards self-advocacy and empowerment has occurred across many aspects of society. There has been a societal change with the questioning of authoritative services, a move to more consumerist model with greater accountability and focus on quality* (152)." Enabling rural communities through self-advocacy shifting from paternalistic support improves the community, or system, as a whole.

Finally, Lara's advocacy and promotion of electronic means of education led to increased graduation rates, and the recognition of her school as one of the best in Iceland. This reaffirms the importance of enrolling a champion within an eHealth implementation (or any other implementation, for that matter.) **The formal and informal status of a key agent can have beneficial impact on the attitudes and values of other individuals important to a successful implementation.** Identifying such an agent should be a priority of implementation teams.

This Iceland vignette shows the system side capacity for leveraging antifragile operators and the importance of institutional invest indices of enrolling champions and local follow-up and

support. The following CVTAC vignette displays further evidence of rural innovative capacity, and the impacts and presence of antifragile operators and institutional investment indices within a discrete rural electronic health implementation.

### 5.2.3 CVTAC in Canada (2020)

One very encouraging practice which came out of Ontario was the County Virtual Triage Assessment Center (CVTAC), which was developed in an effort to redirect patients using the emergency department/hospital for things that can be provided by a family practitioner, such as prescription refills. The goal of the implementation of CVTAC was to strengthen access to primary care, as per the county's webpage. *Its goal was to reduce the demand on the emergency department, and its prolonged implementation can only be beneficial in combatting emergency department overcrowding into the future post COVID-19 pandemic.* Without the CVTAC, the primary care which was available in rural Ontario was difficult to access before the pandemic and became near impossible during it.

To alleviate emergency department crowding, and to provide acute care to those who need it in a time of stringent hospital rules and regulations, a virtual triage network was implemented in a small county hospital in Canada. *This virtual triaging process was meant to assist rural patients in navigating their symptoms and the system and provide them the information necessary to understand if a visit with the emergency department was needed.* While the implementation of a CVTAC is contingent on other factors relevant to health system function (such as high numbers of patients with a family physician who can follow-up with their patients) its initial reception was positive from both patients and providers.

Having sufficient vision, creativity, and resourcefulness to implement a grass-roots project such as a virtual triage centre warrants further investigation. COVID-19 required a

delineation between rural communities who were desperately coping with rapidly changing conditions and those who were productively flourishing in the face of unprecedented adversity. *These abstract facets such as creativity and imagination are central to a community's innovative capacity. Measuring these concepts is difficult through quantitative approaches however and can be more readily understood through qualitative means.* Successfully applying local knowledge regarding access challenges served the CVTAC well and this practice should be disseminated to other rural contexts to aid in generalized eHealth implementation in rural places.

Evaluating reception of an eHealth initiative can be difficult, as it can be biased by many factors. One major factor is the reality that there was simply no other service for patients to access which abided by public safety protocols at the time. Emergency departments were kept secure to the point of obstruction, as only the sickest of patients were being admitted with non-COVID-19 related symptoms. Many patients who had relied on the emergency department as a safety net for complex social needs were also seeking care elsewhere. *When the implementation of an alternative method of access gained support, the evaluations of such an effort will be positive in nature, simply because the result of not receiving access in a timely fashion for emergencies would likely lead to poor outcomes for patients.*

There have been endless calls for moves away from 'one size fits all' service models, with assertions that policy which focuses on outcomes (accessibility and health outcomes) is likely to be more effective than policy which focuses on inputs. *There also needs to be local leadership and champions, as seen in this implementation of the CVTAC, where imagination and creativity allowed local actors to recognize good ideas when they see them and coordinated their implementation and ongoing operation*. This leadership is central to what is known as innovation

capacity. Building innovation capacity in rural communities allows for grass-roots initiatives and local thinking to develop impactful solutions which suitably address rural nuance and difference.

Unfortunately, the funding which support CVTAC is tied to COVID-19 and will likely be re-evaluated once pandemic mandates are fully repealed. *Technology and innovative strategies like CVTAC need clear funding sources moving forward, as creating an inherent clause in their implementation to roll them back post COVID-19 is damaging to the overall rural health system they were introduced into.*

This vignette provides evidence of the antifragile operators non-linear evaluation and hybrid leadership. Further, it provides the importance of securing the institutional investment indices of funding and utilization. **It also provides evidence of the importance of leveraging conceptual aspects which are important to the development and success of an implementation – namely creativity, imagination, and leadership.** Capturing the impact of these concepts is difficult through quantitative measures but can be done through qualitative approaches. **This reaffirmed the basis of the antifragile design portfolio requiring sensitive qualitative methods to inform implementation teams on the presence and extent of influential concepts within a rural context.**

The importance of non-linear evaluation is seen through the dispersion of complex medical and social patients when restrictions were imposed on a regional emergency department. These patients were taken on by other services who did not have the sufficient expertise nor resources to effectively treat them, resulting in poorer outcomes. Further, routine visits – such as prescription refills – also became more difficult, risking progression of otherwise benign disease. Establishing the CVTAC helped alleviate these problems, which risked cascading throughout the system, threatening its integrity. **Providing better access to health services for complex**

**patients and routine patients alike through the virtual triage system allowed for an evaluation of patients across a spectrum of complexity, protecting other services, and maintaining the integrity of the system.** Understanding these effects through non-linear evaluation was an important motivator for the CVTAC, including its presence in this rural health system moving forward.

The grass roots nature of the CVTAC also highlights the importance of mobilizing local knowledge through hybrid leadership. The particular site where the CVTAC was developed is unlikely to be seen as a suitable candidate by urban policymakers when dividing funding for a virtual care initiative due to its rural location and perceived lack of innovative capacity. Through local knowledge and skills – also seen in the Iceland vignette – as well as capable leadership, the CVTAC arose to address problems of rural health access at the height of the COVID-19 pandemic. **Successfully integrating bottom-up information and drive within an implementation allows for nuanced responses which can successfully address challenges and barriers unique to a rural context.** Employing hybrid leadership modalities is again valuable to the successful implementation of the CVTAC and **measuring the presence of these leadership typologies is best done through qualitative methods.** According to Volpe: "*Thick description involves capturing the meaning and experience in a situation in a rich and detailed manner, creating the conditions for interpretation and understanding* (153)." Qualitative methods are optimized for capturing this thick description.

Funding and utilization are two self-evident indices of institutional investment. **Nevertheless, establishing secure funding streams, as well as ensuring utilization of an intervention is effectively captured (employing non-linear methods if needed such as supplementing usage rates with semi-structured interviews) is critical to an intervention's success.** The current funding for the CVTAC relies heavily on COVID-19 grants provided by the

federal and provincial government. Maintaining this funding level post COVID-19 to further derive benefit from the CVTAC should be an important priority of the implementation team.

The CVTAC vignette has further shown the importance of leveraging sensitive qualitative methods in implementation, the effect of abstract concepts such as leadership, creativity, and imagination, and the importance of incorporating hybrid leadership and non-linear evaluation within a design process. Further, the establishment of utilization and funding presence within a project is shown to be self-evident to its viability. The following enhanced vignette of field visits in Australia provides evidence of another salient aspect of antifragile design – avoiding suboptimization.

### 5.2.4 Burra and Robertstown Field Visits (2019)

As I stepped out of my room, I was immediately stopped by the oppressive sun which had only just crested the horizon. I glanced at my phone – 8AM and the temperature was already hovering in the low-twenties degrees Celsius. For someone native to Canada, these December temperatures were bizarre, and hard to adjust to. Returning briefly into my room to drop off the sweater I planned on bringing, I put my sunglasses on and prepared for a long hot day in the back of a bus.

I crossed the small creek separating my accommodations from Burra town hall, where the field-visits were to begin. *I had been in Burra for a week already and was pleasantly surprised at the relative bustle I could sense within the town early on a weekday morning.* Trucks were making deliveries to the several cafes and restaurants on the main road, and people milled about the central square, greeting each other as they passed. *The sense of community was strong – even from a casual observer.* A pillar which served as the notice board in the middle of the square was crowded with notices. These ranged from farmers looking for locum labourers to promotion of

musical events and reading groups hosted by local groups and establishments. As I perused these notices to kill time waiting for other members of the Free Range group to materialize for our field visits, *I was surprised to see many of the notices were fairly recent. Contrary to the clichéd understanding of a rural town as a place which has been passed by, the cultural, social, and economic connections and relationships were clear from just a simple bulletin board.*

I slowly detached myself from the material in the square and returned to the town hall, which was only about 50 paces away. Our group had gathered and was to visit Robertstown, which was about 45KM away, among some other local places of interest, in a day-long excursion meant to educate ourselves on the greater context of rural Australia. I made my way to the back of the bus and glanced warily outside the window at the asphalt which split and bunched in ways which suggested to me it's structural integrity would be put to the test by a bus full of 20 or so people. As we pulled out form in front of the Burra town hall, an older adult gentleman stood up at the front and introduced himself as the 'tour guide'. He had lived and farmed in Burra and the surrounding regions his entire life and said he was excited to share its history with us. *I took note of the genuine pride and enthusiasm he displayed, as well as the sense of ownership he imparted when discussing his experiences within rural Australia.* As the sun crept higher and we merged onto the highway, I settled back into my seat to listen to our guide as he imparted decades of wisdom distilled by his wit and humour.

Our route followed the Goyder line, a geographic border which separates arable land from the beginning of the outback. Land north of the Goyder line receives less than 250mm of rain a year we learned, and so is untenable with farming practices. *Geographically, this line represents a contrast from rural to remote, as townships and villages north of the Goyder line are few and far between and rely on the raising of grazing animals (such as sheep) as the main*

*economic driver.* South of the line, traditional farming (crops, vegetables, grains, etc.) was more common, and the number of incorporated townships more prevalent. The line was named after George Goyder, a surveyor in the 1860s who was tasked with discovering land viable for farms and land which was liable for drought. When he submitted his report in 1865 establishing the line and labeling the lands north of it only suitable for grazing, he was largely ignored. Years of abnormal rainfall levels immediately following his report led many farmers to believe the land was suitable for crops. By the mid 1870s however, rainfall levels had returned to normal, and the farmers who had stretched north past Goyder's line had to abandon their properties. *Their ruins still scatter the highway which largely follows the line from Burra to Robertstown, stern reminders of hubris and trying to force the issue of progress.*

As we arrived in Robertstown and disembarked from our bus, I had a chance to stretch my legs and massage by joints. The roads were as bad as I had feared, and I had been roughed up in the back as we barrelled down the highway. The sun was truly at its apex now, and the temperature felt to be in the low to mid 30s. Sweat beaded on my brow before I had been outside of the air-conditioned protection of the bus for 5 minutes. We were to meet a group of local stakeholders who had been influential in several 'local-thinking' initiatives in Robertstown. Before we ventured into the community hall where the meeting was to take place, I found our guide to ask after his opinions on electronic initiatives becoming more common in rural places. *He was approachable and handled my questions with the straight-forward nature he had developed following years 'in the bush'.* When I asked about electronic health projects and his general thoughts, he frowned. *"Robertstown used to have a bank branch here, you know. Only branch for several hundred kilometres." He scoffed, "Until, of course, online banking came along. We were told everything we could do at the branch could now be done online. Of course,*

*that's not true. The branch packed up a week later."* I nodded in solidarity. "Shame too, it was the most handsome building in Robertstown." He motioned to an early 20th century brick and stone building in the centre of the town. It was clearly vacant, however still retained the charm which our guide referred to. I thanked him for his time, and we followed the group into the community hall.

The hall was full of people, mostly older, and mostly women, who seemed excited to receive us. It was a largely unstructured event, as conversations broke out across the hall after some brief introductions. I sought out informal opinions regarding electronic health from several incredibly kind older women who had clustered in the middle of the hall around a table. After rebuffing several of their attempts to provide refreshments or pastries of various diversity, they shared their thoughts. "Electronic access is great – I used one of their tele services the other week when I visited the hospital." I smiled and asked the second member of the trio what she thought *"I think telehealth is an opportunity to move nurses around. That's what happened in another community close to here don't you know. They introduced a telehealth service, and the nurse was taken away from the community*!" *For the second time that day, I learned that electronic initiatives do not always correlate with progress. The third woman echoed the sentiment of the second:* "Electronic health is fine – just so long as they don't use it as an excuse to take services from us and redistribute them". After a second round of coffee, tea, and croissants was politely refused, our group said our good-byes and exchanged information with several of the stakeholders. We boarded the bus and prepared for a return trip to Burra.

**Figure 9: The unstructured conversations in Robertstown, Australia between rural stakeholders and the Free Range research group.**

The return trip offered a chance to debrief and reflect on the conversations of the day and what peer trainees of the Free Range group had learned. Conversations bounced across the bus in an excited pace, as connections and meanings were discussed from the thoughts and concerns of these rural stakeholders. When we finally pulled back into the front of the Burra town hall, our group was motivated by the events of the day. As I returned to my room that evening, I paused on the bridge spanning the creek and reflected in the tranquil South Australian evening.

This enhanced vignette provides evidence of the need for integrating the antifragile operators of avoiding suboptimization as well as non-linear evaluation. Further, the institutional investment indices of follow-up and support are seen. Lastly, there is evidence of the importance of dispelling assumptions or biases regarding rural settings and shifting perspectives of rural communities to different and not disadvantaged. It also provided further evidence of prioritizing context – including a context's history. **Incorporating sensitive methodologies to explore a**

**contexts history, and the effect that history could have on future implementations, is a focus of the organizational readiness component of the antifragile design portfolio.**

Avoiding suboptimization is a guarding against the improvement of efficiency of one part of the system at the expense of another. Implementing electronic health initiatives can have the effect of improving health access to rural communities. As identified first by our guide and then the three community stakeholders, this transition to electronic mediums of access can also have unintended consequences. **Indeed, instead of being seen as innovative, the provision of service through an electronic option was seen as harmful – first in online banking, and again in telehealth resulting in the redistribution of nursing resources.** As Alami et. al note: *"This said, the sustainability of [the eHealth initiative] is partly dependent on whether the organizations and other professional actors are able to accept, recognize, and formalize this new role of [the project]* (71)." **It is important then for implementation teams to monitor the opinions and attitudes of key stakeholders throughout an implementation to avoid suboptimizing the entire system.**

**This further motivates the integration of hybrid leadership modalities and non-linear evaluation approaches in an antifragile approach. In order to guard against suboptimization, appropriate information must be gathered and interpreted from diverse sources within the system.** Indeed, eHealth evaluations which only consider the opinions of senior policymakers or decisionmakers (who are likely heavily influenced by the improved bottom line of the system by replacing a paid nurse with an eHealth system) miss the negative sentiment of the community. This negative sentiment is important to capture, as it has been established that attitudes and beliefs are major barriers to implementation of eHealth initiatives (154). **While a singular eHealth initiative displays 'success', future implementations will be unsuccessful, costing the system money (and patients quality of life) over time.** This vignette

then further shows value in integrating bottom-up leadership in an implementation to guard against suboptimization and to facilitate smoother future implementations.

Follow-up and support is also displayed as an important institutional investment index for implementation teams to prioritize. When the bank closed its physical branch, an assumption of the banking corporation was that simply because a system is present, it will be used. Instead, consumers begrudged the bank for leaving, and found much of the service they were accustomed to could not be complete in the newer, online medium. Enrolling local support to facilitate the change may have eased the transition, allowing for rural community members to better familiarize themselves with the novel nature of online banking. **Ensuring appropriate follow-up and support structures are present is integral to an implementation's success; even more so if these structures are local in nature.**

This vignette serves to establish the importance of avoiding suboptimization and the role non-linear evaluation and hybrid leadership can have in doing so. It also further determines the critical role of follow-up and support, especially locally derived follow-up and support structures. The final vignette on rural responses to COVID-19 across the settings of interest show the capacity for innovation in rural communities which exits in environments for high tension for change, and how the antifragile design portfolio can further build on and augment this capacity.

### 5.2.5 Swedish, Canadian, and Australian responses to COVID-19

The following three sections highlight the response to COVID-19 rural communities displayed during the third wave of the COVID-19 pandemic. The goal of this data collection was asking (and answering) the question: what works where, and for whom? This is the fundamental inquiry of realist evaluation (32). Although strict protocols were not followed interpreting this data to satisfy realist evaluation requirements (131), it nevertheless did help answer the

ethnographic aim of ‘how do things work?’. The analysis serves as a comparison between the three settings of interest (Canada, Sweden, Australia), including organizational and cultural differences which can influence an implementation. They also show the innovative capacity of rural places under the right conditions and provide further evidence of the presence and potential of both antifragile operators and institutional investment indices.

#### 5.2.5.1 Canada

The Canadian rural response to COVID-19 was measured in two separate contexts from a qualitative, ethnographic perspective (to analyze actual practices implemented to expanding and changing care). The province of Ontario and the province of Nova Scotia were chosen as suitable candidates to draw sites from, mostly due to the proximity of our research group to these provinces, and the access to existing contacts and circles already established in previous research projects. It is worth noting that at the time the ethnographic data was collected, Nova Scotia and Ontario have had much different experiences in managing the COVID-19 pandemic. Nova Scotia has seen great success ’bubbling’ with neighbor provinces in the Canadian Maritimes. Besides the odd outbreak over the summer of 2020, trends of COVID-19 spread in Nova Scotia have been extremely small. Ontario however began it’s third wave of COVID-19 spread in early March 2021 and entered a 28-day provincial wide lockdown on April 3rd 2021 to flatten the curve of COVID-19 transmission. *Acknowledging this is important, because much of the services in Nova Scotia could be provided mirroring their service prior to COVID-19 disruption.*

With regards to service provision, both provinces responded to the COVID-19 pandemic with changes to service protocols, but Ontario was far more drastic and longer-lasting in their approaches. For example, In Nova Scotia cancer care was continued, while in Ontario, some treatments and surgeries were delayed. Many elective surgeries were delayed in Nova Scotia at

the outset of the pandemic, but as they successfully flattened the curve treatments which had been postponed were rescheduled promptly. Ontario had to postpone much of their elective surgeries, and as Ontario enters a third wave, many services which had been postponed over a year prior still have not seen a return to their implementation prior to the pandemic. *Further, Nova Scotia has one web domain with all health centers throughout the province included, with updated information during COVID-19. While Nova Scotia had one web domain for most major hospitals and clinics, this domain was not linked to most family physician offices.* Family doctor offices provided links to governmental resources for patients, but rarely did they update their own websites. *Ontario has individual websites per health centre which are updated at the discretion of that health centre, meaning some haven't been updated in years. This has made getting service in rural communities difficult, and there is no clear avenue to see who the appropriate person is to approach about getting information regarding up to-date information for health centers.*

Centralizing health center informational streams on one domain expediates the process of informational exchange, and allowed for current displays of protocols, progress, and changes to service provision. The response from larger urban health centers were generally the same in both Ontario and Nova Scotia. No visitors and redirection of patients to other services. Non-urgent medical tests were pushed. These include screenings and medical imaging. Many centres stopped taking drop-ins but were still seeing appointments. Group services, much as in Sweden and Australia, saw a pause in most communities, *but there were some progressive community groups which relied on volunteers to perform group activities which existed before the pandemic, and create novel activities during the pandemic to combat social isolation.* These community volunteer groups were usually (but not always) faith based and did not have external funding.

*There was minimal guidance or recruitment for official group activities run by either health authorities or public health offices in rural Ontario and Nova Scotia.* While Nova Scotia has a smaller population, the concept of having one health information source (one website) ensures that the entire province is on the same page, in terms of response to COVID-19. It also ensures that there is up to date and clear communication from all health centres, as they all fall on the same website. This also lessens the confusion as to what is a reliable source. While health centers benefitted from uniform messaging across sites, individual physician offices or webpages did not update their information regularly. Most sites were out of date, and those which were current did not provide any specific information for their context, and instead referred patients to the larger Nova Scotia web page for health centers. In Ontario each health centre has their own individual website (much like each individual family physician office in rural Nova Scotia).

*This was a problem in Ontario as health center websites are more prominent and were consulted more frequently for information. Many of the websites being looked at in the ethnographic data collection were dated and unreliable, with no current information on COVID-19*. Many had more reliable and up to date social media accounts (Facebook, Instagram and Twitter). There were also instances of social media accounts for the health centres that were run by members of the public, not associated professionally with the health centre. *While most of these accounts were run in good faith, there is of course the possibility that these accounts could post information to craft a narrative of disinformation, which existed during the pandemic if not monitored by an official source.* This makes for a more difficult search to find information, leading people to call or go to centres to find out more information. Or avoid centres even if they are sick, due to the unknown measure put in place to protect those without symptoms of COVID-19.

The COVID-19 response in rural communities in Canada featured both positive and negative aspects. Some communities displayed initiative in transitioning their care into online modalities and took pride in becoming centres of information for patients. This transition of care was aided by strong leadership and organizational agility in their response. **A rural implementation strategy should build on these positive findings, which is part of acknowledging the difference and not disadvantaged perspective of the antifragile design portfolio.** The negative aspects of the response – as seen in NS and ON where certain websites had not been updated in months and featured no information regarding COVID-19 – could be avoided by applying antifragile operators. For example, incorporating hybrid leadership (such as enrolling volunteer groups to disseminate information) could help ensure information channels are kept current. **All told, the Canadian rural COVID-19 response shows capability of rural systems to innovate and adapt to unprecedented system stress, as well as display leverage points where antifragile operators could be deployed to yield better results.**

#### 5.2.5.2 Australia

*In Australia, the most striking phenomena was the contrast in responses from primary care facilities that were quite proximate to one another, and in one case even had clinics in the same town. In one case, all that was offered was a handwritten sign on the clinic door saying to call for an appointment or attend during reduced hours.* No website or social media presence, no further information. Once you called the number or presented in-person, you got the treatment you were looking for—renewing a prescription or a similar service—but it did seem like the clinic was somewhat divorced from the community. *In contrast, we saw other clinics who seemed less narrowly concerned about their own business (making sure they had access to their patients) and more concerned about their role in the community.* They became the main sources

of credible local information about COVID-19 and about how you could navigate the health and care system while the pandemic restrictions were in place.

Improving their visibility in the community meant having clear signs at the clinic, on community noticeboards, on their own websites and social media, and on other websites and social media that the community were likely to use. *We also saw some of these clinics expand their scope of practice, or at least engage in different activities or do them in different ways to what they had done previously. The "public health consultant" role was a clear one—in the past this may have been a passive role involving brochures and posters at the clinic, but now was a service you could access by calling the clinic and getting advice about community-based services and their operations during COVID-19.* There were also cases of local services delivering public health messages in novel ways (through musical performance, for example) which increased the reach of information.

This was particularly important for mental health related issues. There were other forced changes that had the potential to be handled better. One was the interruption of group-based treatments. *Groups obviously couldn't meet face to face, but the only alternatives we saw were instructions to call a certain number for a one-to-one consultation if you felt you needed it.* Similarly, patient transport services were interrupted, and people who did have to travel for advanced care either went without that care or had to find an alternative with not much help to do that. We saw something similar with respite care suddenly being inaccessible and obviously creating problems for patients and their caretakers.

Aspects of navigation through the system did seem to be well addressed. *A particular example is the apparent streamlining of processes between the clinic and the pharmacy. In the past, the patient needed to take the prescription physically from the clinic to the pharmacy, and*

*then the pharmacist might have to check with the physician and so on. But at least in a couple of cases we saw the clinic communicate directly with the pharmacist, so everything was ready for the patient when you arrived at the pharmacy.* Again, this worked well for people who were well known by the clinic and the pharmacist but may not have been so functional for more marginalized members of the community and was not standard practice across all clinics. We also saw an increase in whole-of-family services, the most notable being scheduling influenza vaccines for the whole family at once rather than one person at a time. Often, this was done on a "drive-through" basis with clinic car parks and public spaces becoming temporary consulting rooms. In general, we saw that clinics could and did do a lot to ensure that their own services to their own users were not just maintained, but even enhanced by things like teleconsultations and streamlined referral processes. *We saw that clinics could and did assume roles as community leaders in the provision of local and general information about the pandemic and how to access care during the pandemic.*

We saw more use of telehealth rather than eHealth, in the sense that virtual consultations were by telephone and audio only rather than by videoconference. *In summary, the evidence we had was that primary care services which were well-connected with the community and who saw their responsibilities as extending beyond providing their normal fee-for-service activities were able to exercise leadership and implement new ways of doing things.* This not only minimized disruption but enhanced quality of care and efficiency of care provision within a short time frame. Further research is needed to understand how vulnerable or marginalized populations were supported, and to see how local services managed their relationships with provincial health departments, distant specialists, and other external actors. *Our impression from the limited*

*exposure we had to these latter was that they were simply waiting for things to "return to normal" rather than investing too much in adapting their services during the pandemic.*

In some ways, the Australian rural COVID-19 response was similar to the Canadian one. There were differences in how clinics (sometimes in close proximity) handled the rapid onset of restrictions and changes to standard practice. **This further demonstrates the importance of context and having methodologies sensitive to the differences between contexts. These methods can help implementation teams understand why one clinic was able to adapt to the stressors of COVID-19 and others didn't.** In other ways, the response was different, such as clinics taking on a much more active role in providing health information to the community. Providing options in how patients can interact with their clinics – in the form of updated information or adopting a leadership role within the community – is one way positive responses differed than negative ones. **The Australian rural COVID-19 response further demonstrated organizational capability – with the presence of leadership and creativity being necessary – to respond to system stress in productive ways.**

#### 5.2.5.3 Sweden

Parts of rural Sweden is known for its history of health service innovation, particularly in the use of eHealth. There's documentation of eHealth developments over at least the last 30 years (155), and in recent times the region has received academic attention for novel methods of delivery primary care services in communities without health services (156) and for local engagement in medical education (157). *Some of this innovation has come "top down" from the provincial health department, but quite a lot of it has come "bottom up" from local health services, particularly in the municipality of Storuman, where a physician established a "Centre for Rural Medicine" some 10 years ago* (158).

In some ways, then, services in this region were reasonably well set up to deal with the challenges presented by the pandemic. *Teleconsulting was already common, including teleconsulting for emergency and primary care. Most health services already had high-quality video-conferencing facilities. Electronic prescriptions, electronic referrals (and teleconsulting with distant specialists), digital platforms for booking appointments, remote imaging (ultrasounds, dermatology etc) and other "doctor at a distance"* techniques were widely used and quite well-understood by service providers and users. Health and care services in this region have been used to operating in crisis mode and this, along with the relatively late arrival of the COVID-19 virus in the rural communities here (very few cases until October 2020) perhaps contributed to a complacency among providers and users.

Adapting to recommendations to limit physical contact was quite easy since the sorts of techniques to facilitate that were already widely used. Nevertheless, we did see some of these practices become more entrenched in locations which had not used them so much previously, and more support came from provincial and national health authorities for embedding these practices in primary care services. *One of our research team noted that stakeholders were somewhat surprised at how quickly health authorities were able to change procurement procedures and other administrative aspects that had contributed to a reputation of a slow-moving public health and care system.* Those central innovations then allowed some local services to enter partnerships with technology providers and trial models of service delivery (including virtual clinics with the physicians located in other parts of Europe) that might have taken much longer to put in place prior to the pandemic. *Generally, though, what we saw at the local level was not so much innovation as extension of practices that were already being established.*

The process of moving from heavy reliance on expensive locums to provide in-person services to increasing use of digitally mediated services as a COVID-19 response to local workforce shortages had already begun but was accelerated by the pandemic. While this meant that local services could continue to mediate "good and close care" (in terms of limiting the need for patients to travel) as required by the Swedish national policy, it also meant that the physical distance between communities and care providers increased. There were some signs of breaking down of barriers between municipal and provincial services. *In one case at least, provincial staff were redeployed to municipal-run aged care facilities rather than the municipality being forced to acquire increased debt to bring in "emergency" staff from outside the region*. This did mean that other parts of the system were left unstaffed, or staffed by unqualified personnel.

This was particularly difficult in municipalities which had previously invested heavily in supporting in-home aged care through frequent home visits by district nurses and others. *Nevertheless, it demonstrated that cooperation between levels of government was possible, and that such cooperation could be initiated locally.*

The Swedish response to COVID-19 brings up interesting organizational and cultural differences which should be accounted for in rural eHealth implementation design. Swedish rural health systems had already engaged in the implementation of several virtual care projects and initiatives and so the baseline comfort for these projects within patients and providers was relatively higher than in Canada and Sweden**. This is the power of building research capacity within rural health systems, something which the antifragile design portfolio can contribute to and facilitate (by engaging stakeholders through hybrid leadership, provide patients and providers with options in how to use technology, etc.)** As stated in the ethnography, the grass roots innovation which was required in Canada and parts of Australia wasn't as needed in

Sweden, as the adaption and roll out of already in place eHealth initiatives eased the adaption to the system stress caused by COVID-19. The formation of policy prioritizing innovation within Sweden also shows the importance of the institutional investment index of policy alignment. **Projects which can explicitly tie their intervention with existing federal, municipal, or provincial policy will have higher levels of institutional investment and more flexibility in approaching challenges or problems within an implementation.**

A common theme between all three rural responses was the erosion of administrative protocols regarding procurement, testing, and implementation of eHealth. **Implementing eHealth initiatives at speed (as required within the COVID-19 response) requires a design philosophy founded in building on uncertainty and ambiguity – which antifragility thrives on.**

#### 5.2.5.4 The WHAT Framework of Rural COVID-19 Response

The WHAT framework is a collation of the various strategies which were deployed to maintain continuity of service during the COVID-19 pandemic in rural communities. The pandemic brought with it changes in models of service delivery mandated by government health departments (1,159). Largely these were around minimizing physical contact between service providers and users, so there has been a lot of attention paid to eHealth applications, automating paperwork processes (such as electronic prescriptions in places which were not already using those), and reducing drop-in type services. *Even here, though, there is scope for locally diverse action to ensure that implementing pandemic-inspired regulations did not unnecessarily reduce access to care and quality of care.* Similarly, public health guidelines (such as minimum distances between people in various settings, conditions under which one might seek a COVID-19 test, maximum number of people for group-based activities) have needed to be interpreted at a

local level. *A question for this analysis was not just 'what sort of responses might local services implement?,' but 'what sort of responses would be visible to communities/service users?'*. The innovation literature in rural health (119,160) identifies three main types of local action –

1. Adopting (and very occasionally inventing) eHealth technologies;
2. Changing service structures
    a. Having different services or types of professionals change how they work together
    b. Changing how physical infrastructure is used
    c. Establishing a configuration of services targeted at specific populations or health conditions
3. Changing funding models or how funds are used locally. In 'normal times,' these changes tend to occur over long periods of time, favoring 'prudence' over 'speed' (23).

With the pandemic, however, rapid change was required, meaning that service managers had to quickly draw on their innovative capacity. There were cases where health services (such as group counseling services) closed completely for a period without an alternative offer, indicating low levels of preparedness, and other cases where information about new processes and procedures was provided to the public almost as soon as new regulations were announced. This provision of information is the cornerstone of WHAT local actors could do effectively. Information provision responses were of two types.

The first was to inform community members about changes in how services were provided and accessed. *One barrier to accessibility of rural health services is a division in the community between those who have the tacit knowledge about how the system works and how to*

*access it, and those who do not.* At the start of the pandemic, this division temporarily disappeared. We could then observe how local services distributed guiding information. *The second information impacts were local services taking on new or expanded public health information provider roles. Typically, public health information exists as standard (i.e., sourced externally in a standard format) brochures or posters inside health and care facilities or on community noticeboards.*

Rural communities are also often engaged in externally funded public health campaigns which may be implemented through local services, but typically involve outsiders visiting 'the community' (school, aged care facility, community group) and doing presentations or workshops. These sorts of 'pre-packaged' approaches were not able to keep up with community need for quickly provided information about the pandemic and its local impacts. Guiding information was often necessary because of the physical and procedural changes that were made to service delivery.

Within a care facility, this might have entailed new methods for scheduling consultations (from a distance rather than in person), new ways of managing appointments (arrival and departure procedures, uses of waiting rooms), and changing the physical layout of the facility. There could also be changes in how care activities were distributed among the set of facilities that exist in a community (including non-care specific facilities like schools, meeting halls and so on). The provision of timely, locally relevant, and broadly accessible information could of course be facilitated by changing how digital communication technologies were used.

*There was also a sense in which the pandemic 'released the shackles' on using digital technologies in the actual process of care provision.* Long persistent barriers to employing eHealth such as provider and user reluctance, regulatory and financial structures, concerns about

quality of video and audio links and so on were swept aside as if by magic and non-contact care models were not just encouraged but mandated situations. *Locally, service providers needed to quickly develop their own eHealth skills and help users to do the same. Local services could also choose to employ eHealth beyond the minimum if they saw opportunities to go beyond what was mandated.* Physical and procedural changes in service provision models and changing use of eHealth impacted coordination between service providers (and other stakeholders) within the community and external to the community. From a user perspective we could observe how 'journeys' which involve a number of different providers were managed and the role of local actors in facilitating those journeys.

These rural COVID-19 responses, collated in the WHAT framework, together represent ethnographic evidence of the presence and strength of antifragile operators and institutional investment indices. **The abrupt requirement of alternative service modalities adhering to mandated distancing policies required optionality in their function. These service changes were rolled out integrating support structures in the community – such as volunteer groups – which necessitated hybrid leadership typologies**. **Providing COVID-19 information through improved presences within communities avoided suboptimizing the system.**

Further, the investigations of what works where, and for whom**, illustrates the requirement of sensitive qualitative methods to measure the presence of antifragile operators and cement the importance of context as the primary concern for implementation teams.** The Golden Lake focus group data presented in the next section concludes the ethnographic accounts of the presence of, and the need for, a structured design portfolio which operationalizes antifragility and institutional investment.

## 5.3 Golden Lake Focus Group

In the fall of 2019, a town hall was conducted in Golden Lake, Ontario. Golden Lake is a rural community about an hour and half car ride north-west of Ottawa, Ontario. Unsurprisingly, it is named after the lake on which much of the town is situated. During the summer, Golden Lake (like many rural communities) has many seasonal residents and tourists drawn to the natural beauty of the surrounding area. The presence of these seasonal residents and tourists means that the community is rather more affluent than proximal communities during the summer. The focus group was carried out as part of the Free Range international knowledge exchange on rural research, and featured trainees, researchers, and patient partners who are members of the group.

27 members of the golden lake community were present for the focus group. Of these 27 community members, 16 were retirees and 11 were not. Common reasons for their presence at the focus group meeting was their interest in health, their advocacy for rural living, and their interest in volunteering. Indeed, of the 27 members who were present at the town hall, 9 reported being active volunteers within the community. Gender and sex information was not recorded. The group of 27 were divided further into six smaller groups to facilitate discussion, usually using the people at the table where they were already seated to ease the process of forming a group. Members of the Free Range party then spread out through the six smaller groups to better listen, understand, and enable discussion.

Groups were given five guiding questions regarding challenges and strengths of rural living, with regards to healthcare access. These were meant to spark discussion among group members and allow for identified challenges or strengths to arise organically through group discussion. The five questions to guide the challenges discourse were as follows:

1. What are obstacles, or factors relating to overcoming obstacles?
2. What are some general service concerns (access, etc.)?
3. What are future concerns about the continued viability of rural health and community?
4. What are some policy concerns specific to politics and governance?
5. What are community concerns specific to the Golden Lake community?

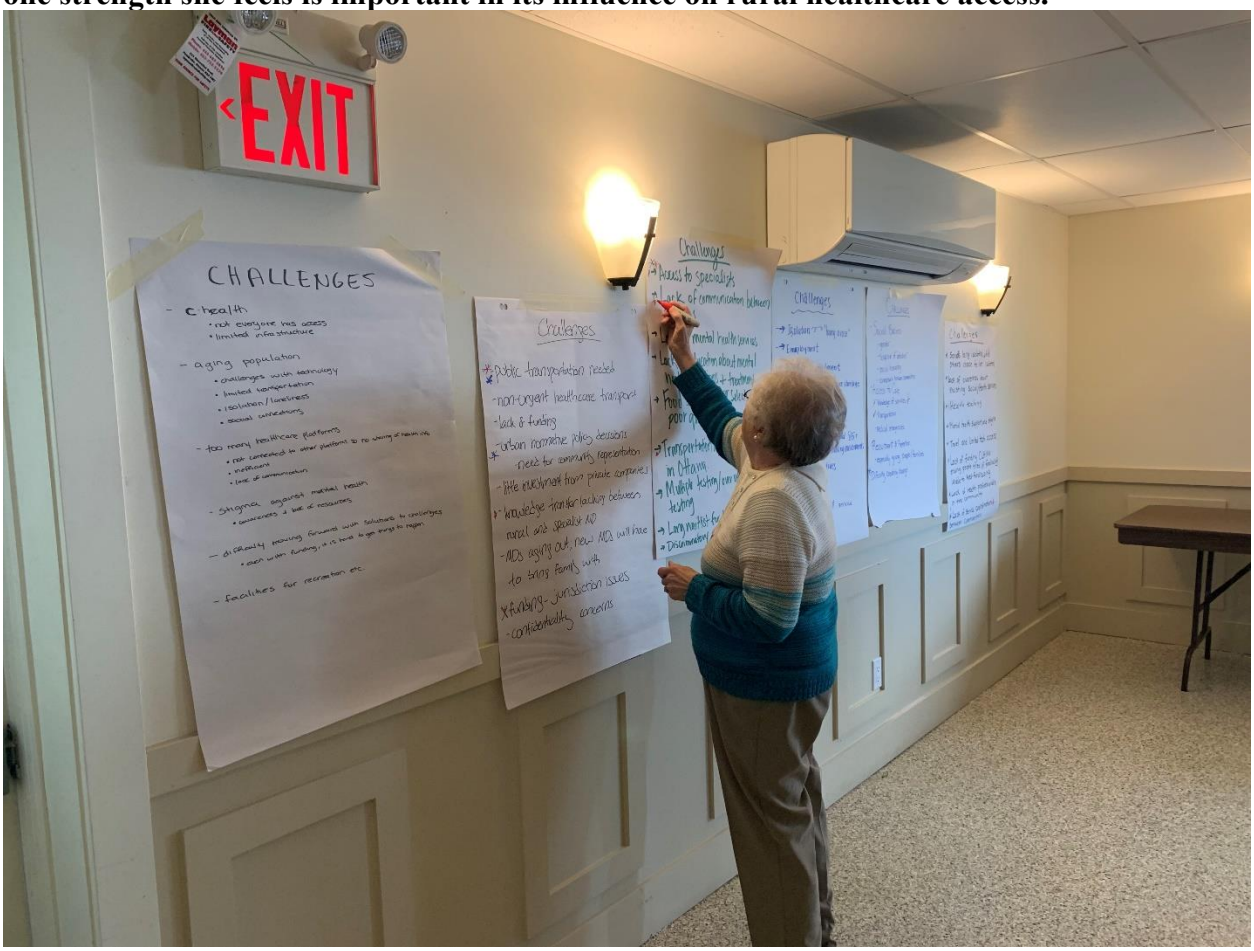
The five questions to guide the strengths discourse were as follows:

1. What approaches work within Golden Lake?
2. What are the characteristics of the people living here?
3. What are the strengths of the community?
4. What are the strengths of the people living here?
5. What does the above say about healthcare in Golden Lake?

Following thirty or so minutes of facilitated discussion, the compiled strengths and challenges lists were brought to the front of the room. Members from other groups were then given a chance to design ate challenges or strengths they thought were important by placing an asterisk next to the themes. Participants were limited to two asterisks (one for strengths, one for challenges) to allow more time for group reflection.

**Figure 10: Community members of Golden Lake discuss challenges and strengths of rural living and how these can impact healthcare access.**

**Figure 11: A community member of Golden Lake places her asterisk on one challenge and one strength she feels is important in its influence on rural healthcare access.**




The results of this divergent – convergent exercise is summarized in the next two sections. This divergent-convergent approach to focus group data is a common method to obtain generalizable themes while accounting for diversity of opinion. Connections are drawn between the results of these discussions and exercises, the ethnographic data presented above, and the social infrastructure present to facilitate antifragile operators and institutional investment indices.

### 5.3.1 Challenges to Rural Communities

The following chart represents challenges identified by the 6 groups. The challenges with asterisks (*) were agreed upon by other group members to be important). The darker the cell, the more other groups agreed regarding the challenge of rural health in Golden Lake. The compiled

challenges residents of Golden Lake felt they were facing included: **public transportation, mental health resources, lack of coordination between communities, lack of medical professionals, health literacy, and a lack of rural specific health policy.** Integrating antifragile operators into rural implementation can mitigate or outright address several of these important challenges.

| Group 1 | Group 2 | Group 3 | Group 4 | Group 5 | Group 6 | Compiled challenges |
|---|---|---|---|---|---|---|
| Public transportation needed | Access to Specialists*** | Isolation | Social barriers (gender, suspicion of 'outsiders', social hierarchy, connections between communities) | Seniors being isolated while some choose that isolation | eHealth (not everyone has access, limited infrastructure to build on) | Transportation (public) |
| Non-urgent healthcare transport | Lack of communication between services*** | Employment | Access to care (knowledge of services, transportations, medical emergencies)** | Lack of awareness regarding existing social/health services | Aging population (challenges with technology, limited transportation, isolation and lonliness, social | mental health resources |
| Lack of funding | Lack of mental health services | Physician recruitment | Recruitment and Retention (especially young people/families) | health teaching* | too many healthcare platforms (not connected to other platforms, no sharing of info, inefficient, lack of communication)** | lack of coordination/communication between communities |
| Urban normative policy decisions | Lack of education about mental health conditions | Mental health resource shortage***** (telehealth complaints) | Difficulty creating change* | mental health support and combatting stigma* | Stigma against mental health (awareness and lack of resources) | lack of medical professionals |
| **need for community representation** | Food security/poor selection/poor quality | Lack of primary care** | | Travel and limited tech access | Difficulty moving forward with solutions to challenges (even with funding, hard to get things to happen)* | health literacy |
| little investment from private companies | Transportation acess for appointments in Ottawa**** | Engagement of youth and 85+ in community decision-making envirionements | | Lack of funding (LHINs ending, people tired of fundraising, unable to sustain fundraising | Facilities for recreation | rural specific policies |
| Knowledge transfer lacking between rural/specialist MD | Medical Testing appropriateness | Sustainable initatives* | | Lack of health professionals in the ocmmunity* | | |
| Rural MDs aging out, new MDs reluctant to come | Long waitlist for long term care | Loss of living (?) | | Lack of service coordination between communities(working in silos)* | | |
| Funding/jurisdiction issues | Discriminatory practices | Reliable internet and cell service | | | | |
| confidentiality concerns | | | | | | |

**Table 5: Compiled challenges to rural living. The darker the cell, the more consensus agreement on the challenge by focus group members.**

Many of these challenges are reflected in the literature, particularly the issue of **transportation in rural communities**. Lack of transportation can have impacts on access. As Bradford notes: "*Equity of access to healthcare in rural locations is compromised by geography, time and distance* (152)." This impact is doubly so without reliable public transportation, necessitating ownership of a private vehicle. Having hybrid leadership channels as well non-linear evaluative approaches could help capture the importance of providing public transit to rural places, even on an infrequent basis. If such transit is supplemented by the government, this could ultimately save money in the long run. As Host et. al state: "*Eliminating the costs associated with travelling to an urban centre to receive ophthalmological care removes a significant barrier to seeking care. This may also further improve patient access and follow up* (161)" Public transportation is a cost-effective method to travel and using antifragile operators in an implementation can sufficiently demonstrate that.

**Lack of coordination between communities** is another challenge which can be addressed through an antifragile approach. Antifragile design prioritizes multidisciplinary and relies on the maintenance of communication channels which can help distill information from both bottom-up and top-down origins. It has the added benefit of putting rural implementation efforts into consistent terms, allowing for sharing and learning in a community of practice for rural communities. Further, the emphasis understanding 'what works where, and for whom' through the integration of realist evaluation methods promotes the collaboration between rural communities as strategies are pragmatically contrasted in separate implementations.

**Lack of rural specific policies** is another challenge which can be addressed through including institutional investment indices and antifragile operators within implementations. Policy reform does not occur over night, it requires sustained drive and vision. A collection of rurally derived strategies, under the umbrella framework of pragmatic antifragile design, could

from the basis of rural health policy reform. Through this reform, other challenges can be addressed: **lack of medical professionals, lack of mental health resources,** and **health literacy** concerns can be met through rural health system reform – made possible through antifragile approaches.

### 5.3.2 Strengths of Rural Communities

The following chart represents strengths identified by the 6 groups. The strengths with asterisks (*) were agreed upon by other group members to be important (upon sharing of the strengths with other groups). The darker the cell, the more other groups agreed regarding the strength of rural health in Golden Lake. This divergent-convergent approach to focus group data is a common method to obtain generalizable themes while accounting for diversity of opinion.

The collated strengths of rural communities as identified by the Golden Lake focus group participants were: **volunteerism, social connections, community/ collaborative approach to improve health access, impact, grass roots or ground up development, quality of life benefits from living rurally,** and **connection with nature.** These strengths are further evidence of the capacity of rural communities to incorporate antifragile operators within an implementation, as well as the need for qualitative measure to assess their presence and impact.

**Volunteerism** and **social connections** both provide an implementaiton team with a pool of resources to leverage through hybrid leadership, follow-up and support strucutres and non-linear evaluation. Further, it gives implementaiton teams options with regards to how a technological intervention can be implemented to reflect the concerns or priorities which can be understood through volunteering and social connection channels. Social capital is important in influencing an implementation, and implementaiton teams can leveraging existing capital in diverse ways.

| Group 1 | Group 2 | Group 3 | Group 4 | Group 5 | Group 6 | Compiled Stregnths |
|---|---|---|---|---|---|---|
| Very welcoming | Cooperation | Rainbow Valley health center | Fitness Programs** | Interdisciplinary teams (shared committees/resources, integration)****** | Volunteerism***** | Volunteerism |
| Everyone knows everyone* (Multigenenerational interests) | Integration into the community | Pikwa'kanagan community health center (healthy living for chronic conditions) | Community Group* | Referrals | Community based programs (professionals being mobile e.g meals on wheels) | Social connections |
| Family connectedness and support | Valley Net: Centralized for all events | Nurse Practitioners | Shared Values* | Interdisciplinary rural ethics committee as a valuable resource** | Community connectedness** | community/collaboration approach towards improving healthcare acceess |
| Strong values and beliefs | Centralized health network | Renfrew county community Paramedics (wellness checks) | Helping neighbours, persistence | Grass roots / "ground up" development, leads to interorganizational collaboration***** | People coming back to retire | scale (impact) |
| Faith-based/strong faith in the community | Volunteering/community involvement | Pharmacist (delivery) | Volunteering | Community/**collaboration** approach towards improving healthcare access (example: planting seeds program) | Welcoming to newcomers | Grass roots/"ground up" development (leading to inter-organizational collaboration) |
| resilience | Self-reliant, think outside the box, persistant* | Senior Center (meals on wheels) | | | Knowing who to trust | Quality of life benefits of living rurally |
| Community based arts and social programs*** | Solid mental health services | Friendliness of hospitals (barry's bay) | | | | Connection with nature |
| | | Volunteers/neighbours* | | | | |
| | | Senior/Demoestic/ Sexual Violence Team* | | | | |

**Table 6: Compiled strengths to rural living. The darker the cell, the more consensus agreement on the strength by focus group members.**

Simarly, a **community/collaborative approach to improve health access** and **grass-roots or ground up development** also show promise as system-side social infrastructure which can effectively integrate antifragile operators. Bottum-up information already has dedicated channels which are inherent to rural communities. These channels should be monitored and integrated into an implementation process so that nuances of rural eHealth implementation can be represented in appraoches deployed. Non-linear evaluation and hybrid leadership can readily be leveraged using existing connections or partnerships. This likely includes local knowledge

about the imoprtance of starting small as well as how to best avoid suboptimization within an implementation.

The other strengths of living rually – **impact, connection with natures, and quality of life benefits of living locally** should be incorporated into an implementation on a pragmatic basis. As seen in other ethnographic accounts, it is important that the differences in rural communities are acknowledged and framed correctly. Shifting from the perspective of disadvantaged to different when discussing rural implementation is something foundational to an antifragile approach.

### 5.4 Summary of ethnographic data and antecedent influence on thematic synthesis

The assessment of ethnographic data has been a point of debate in the past. Truth is sometimes subjective and can be distorted through research as biases, interpretations, and assumptions are applied to phenomena recorded through ethnographic accounts (139,140). Ultimately, my doctoral research subscribes to the Humphrey's and Watson understanding of ethnographic truth. They posit that while truth exists on a spectrum, truer ethnographic data is accounts that can prepare someone entering the area of life summarized by the account to better cope than by reading a different report (139). To that end, the reflection, vignettes, and focus group accounts aim to prepare the reader for undertaking an implementation of an eHealth initiative in a rural community. That undertaking should make the reader feel appropriately uncomfortable, as the complexity of these implementations is clear. The bracketed analysis of the presence and need of antifragile operators and institutional investment indices following these ethnographic accounts helps the reader understand why a principled design philosophy is needed – and why antifragility is an appropriate candidate in that regard.

The reflexive exercise completed after a two-month research residency in Storuman, Sweden, supplemented by the five vignettes of rural implementations and characteristics as well as the Golden Lake focus group, establish the presence and potential of antifragile operators and institutional investment indices in a diverse array of rural communities. Further, the ethnographic data demonstrates sufficient capacity of rural communities to engage with an antifragile approach, as well as the salience of using qualitative methodologies to measure the impact and presence of antifragile operators within a rural implementation. Also seen was the importance of establishing an integrated knowledge translation channel, where rural implementation teams can share experiences in consistent terms. While the ethnographic data has shown that the identified operators and indices exist, and can be leveraged by rural communities, the generalizability of these findings needs to be augmented. A thematic synthesis to detect tangible representation of antifragile operators and institutional investment indices was then completed on a body of 89 peer reviewed papers. The coding protocol (Appendices A and B) was developed based on the ethnographic data and informed by other implementation literature. This retrospective synthesis was done in lieu of prospective validation due to logistical concerns from COVID-19.

As mentioned in Chapter 1, several partnerships were initiated pre COVID-19 to prospectively validate the value of an antifragile approach in eHealth implementation. One was through a Health System Impact Fellowship application with the IWK health sciences centre in Halifax, NS. This project would focus of the roll out of a clinical information system from an urban centre to partner regional hospitals. This opportunity did not materialize after the funding for the HSIF opportunity was suspended in the summer of 2020 and reallocated to COVID-19 concerns. The second partnership was with the Ontario Telehealth Network, deploying a teledermatology initiative in a remote northern Ontario setting. Overseen by a retired family

physician, this project too would have provided a chance to deploy antifragile operators in a prospective project and record sufficient data about an implementation's response. With the onset of COVID-19, the funding dedicated to this project was also reallocated to other time-sensitive projects. The third opportunity to apply antifragile design facets was through a nascent virtual triage project. The project was spearheaded by an emergency physician at the Ottawa Civic campus. Again – like the other two opportunities – the stress of the COVID-19 pandemic resulted in the termination of the virtual triage initiative through the Ottawa Civic (although the idea was a good one – as seen the CVTAC developed in a different setting.) In lieu of prospective validation, a retrospective thematic synthesis was done to record the presence of antifragile operators and institutional investment indices in discrete rural implementations.

Fennel et. al note that, in reference to creating a rural cancer resource website: "*Demonstrating that working flexibly and utilising both the literature and lived experience to guide the development of resources can foster trust, empower participants, [and] help deliver results that are acceptable to those in both the academic and "real" worlds* (162)." Capturing the lived experience through ethnographic data has been the object of this first section of the research results. This satisfies the requirement of findings being applicable to the 'real word'. To understand the impacts of antifragile operators and institutional investment indices in distinct rural eHealth implementations, a thematic synthesis was conducted using coding protocol derived from the ethnographic data. The results of this synthesis are discussed in the second section of this chapter.

## 5.5 Electronic health scoping review and thematic synthesis

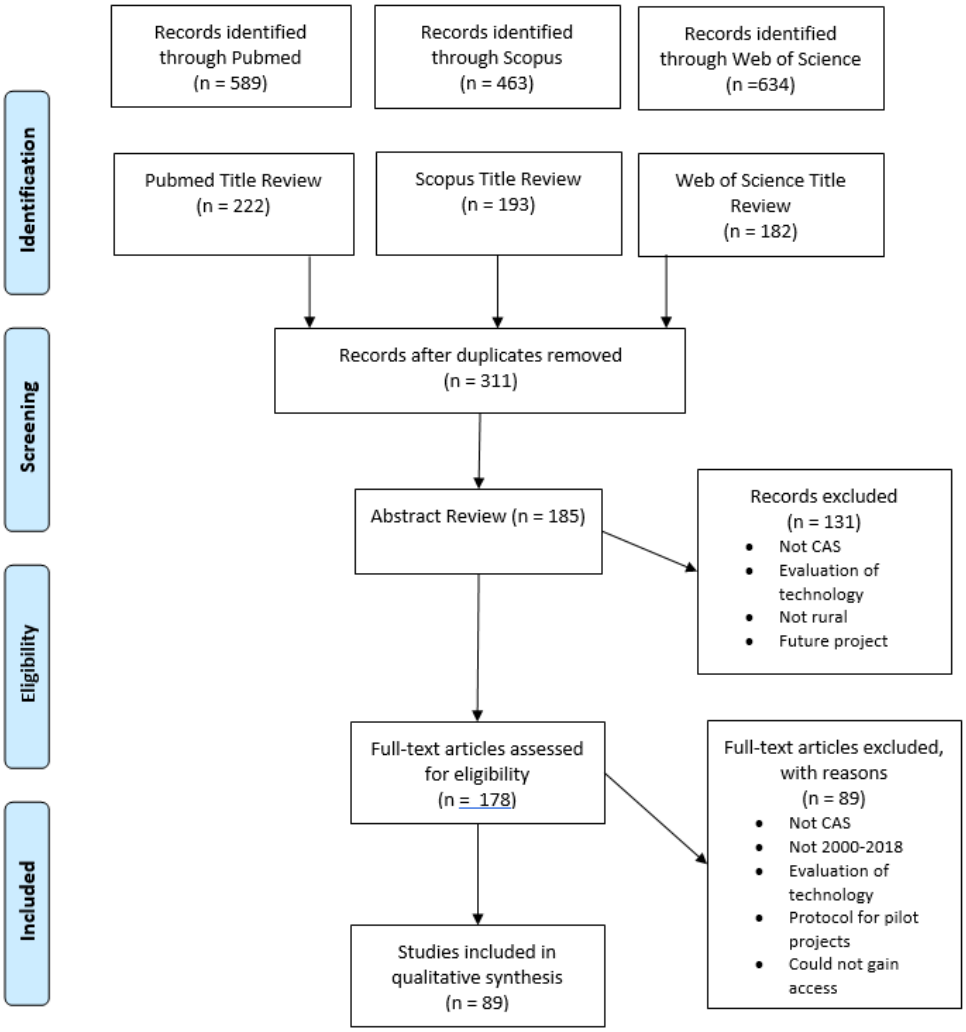
### 5.5.1 Scoping review and patient/provider perspectives on eHealth

A structured scoping review was undertaken to identify the patient and provider perspectives on the benefits and challenges for rural eHealth initiatives in Australia, Canada, and

Sweden. Although studies have previously identified benefits and challenges of specific eHealth projects, no comprehensive review of perspectives from all studies has been undertaken in rural communities. The scoping review was guided by the Arksey and O'Malley framework: identifying the research question; identifying relevant studies; study selection; data charting; and gathering, reporting, and analyzing results (163). The researchers also followed the guidelines specified in the PRISMA-ScR guide (164). This scoping review was part of a larger project to examine rural eHealth implementation in Australia, Canada, and Sweden.

Through this project, researchers reviewed literature for rural and remote eHealth more broadly, with the objective of identifying the broad scope of eHealth interventions implemented in rural areas of three similarly developed countries that have placed a priority on rural and remote health. Following the broad-based scoping review, the overall findings of the eHealth review were narrowed to only literature where patient and/or provider perspectives were presented. Because the broader eHealth scoping review included all relevant eHealth studies in Australia and Canada, the eHealth database included all studies involving patient and provider perspectives that met the search criteria. Thematic analysis of articles and direct patient/provider quotations were then undertaken to synthesize and report on the resulting literature. The results were then collated, summarized, and reported.

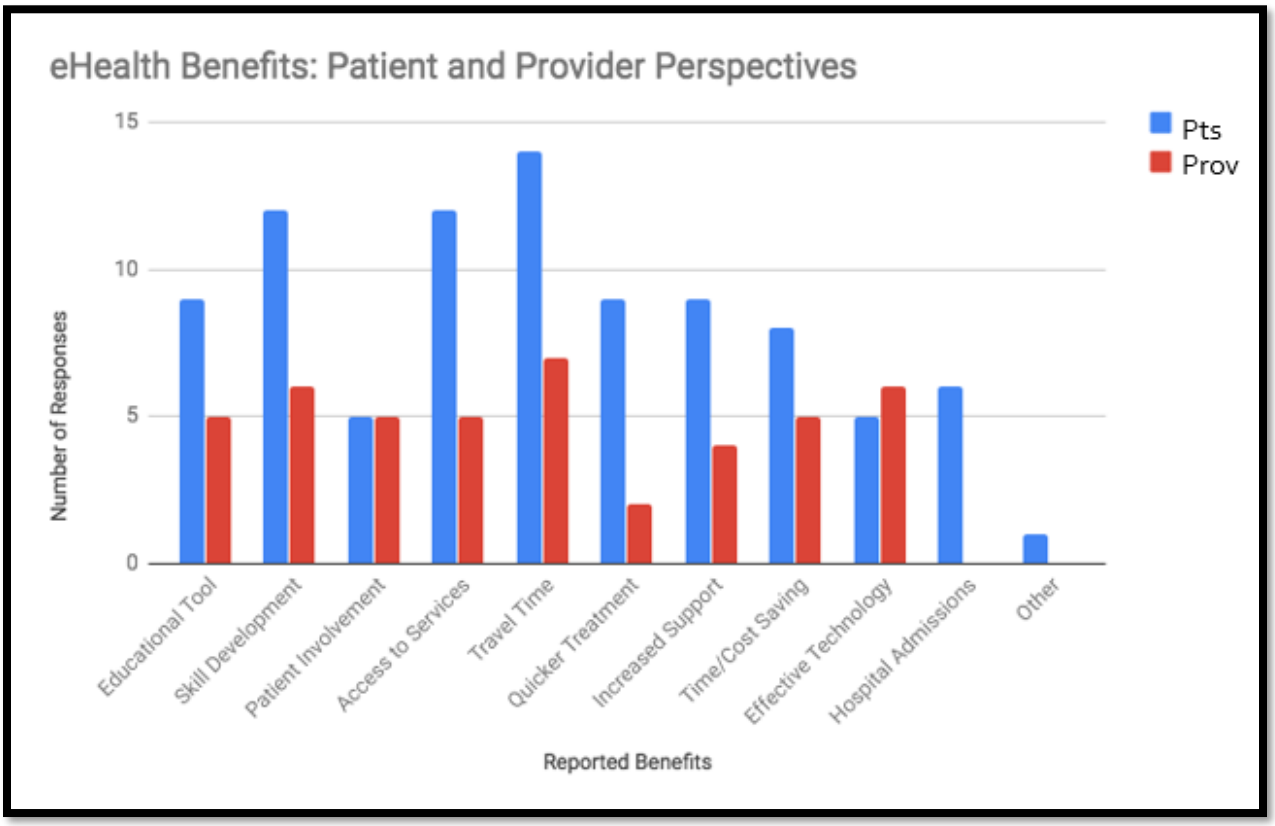
**Figure 12: Inclusion and exclusion criteria for papers included in a scoping review regarding patient and provider perspectives of eHealth in rural communities.**




A total of 89 papers were included for review. The inclusion and exclusion criteria can be seen in **Figure 12.** The results of the scoping review highlighted the benefits of eHealth in rural communities from the perspectives of both patients and providers. eHealth can mitigate the problems of distance experienced by rural patients. It can also build research capacity within rural places, by improving access to continuing education, broadening the scope of practice in

rural places, and contribute to breaking the negative feedback loop which can develop through a lack of rural health policy.

**Figure 13: Reported benefits of eHealth from patients and providers.**




eHealth was seen as an educational tool which can improve skill development. It also can improve patient involvement in treatment regimens, which is important in shifting health systems from paternalistic to patient partnered (which has benefits to patient outcomes). As has been stated it also mitigates travel time to access health services. The time saved also correlates with cost savings on both the side of the patient as well as the system. Ultimately the benefits of integrating eHealth into the rural health system has numerous explicit and latent benefits for both the patient and system.

### 5.5.2 Thematic Synthesis Results and Visualizations

The aggregate results of the thematic synthesis are collected below. The thematic synthesis was conducted on the same 89 papers collected for the scoping review. Protocol for the thematic synthesis can be seen in . Findings of the thematic synthesis are visualized via word clouds for the antifragile content and institutional investment content respectively, tree maps to provide a breakdown the presence of each operator or index within the aggregate antifragile operator (AO) code or institutional investment (II) code, a cluster analysis analyzing word similarity (assessed through Pearson correlation coefficients), and lastly a density diagram which analyses the presence of intersecting code within project items (papers). Following the presentation of these visualizations, important quotes from the literature are pulled out and contextualized to provide further evidence of the value of integrating operators and indices within distinct rural eHealth implementations.

#### 5.5.2.1 Institutional Investment Word Cloud

The institutional investment code resulted in 574 references across all 89 papers analysed. The most common words were ‘health’ appearing 276 times, ‘telehealth’ appearing 180 times, and ‘patients’ appearing 179 times. Other interesting words included ‘support’ (93 mentions) ‘use’ (79 mentions) ‘training’ (65 mentions) ‘access’ (60 mentions) ‘network’ (60 mentions) ‘time’ (56 times) ‘local’ (51 mentions) ‘management’ (32 mentions) ‘education’ (30 mentions) and ‘development’ (24 mentions.)

**Figure 14: Word cloud of the institutional investment coded content. The larger the word, the more often it appeared in the content.**


### 5.5.2.2 Antifragile Operator Word Cloud

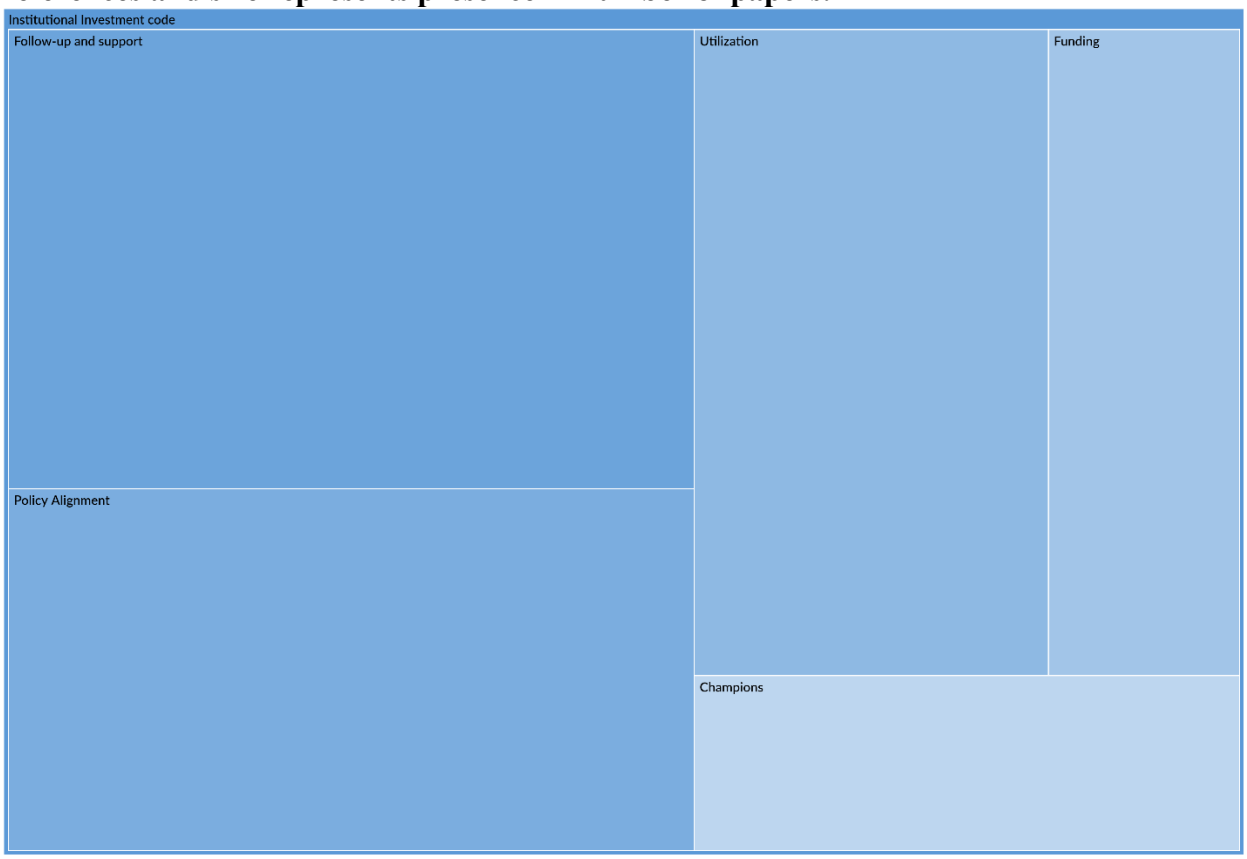
The antifragile operator code resulted in 486 references across all 89 papers analysed. The most common words were ‘health’ appearing 178 times, patients and patient occurring 145 times and 136 times respectively, and care 117 times. Other interesting words included ‘access’ (61 mentions) ‘use’ (56 mentions) ‘system’ (48 mentions) ‘support’ (42 mentions) ‘information’ (36 mentions) ‘local’ (33 mentions) ‘communication’ (31 mentions) ‘network’ (30 mentions) ‘management’ (27 mentions) and ‘feedback’ (17 mentions).

**Figure 15: Word cloud of the antifragile operator coded content. The larger the word, the more often it appeared in the content.**

#### 5.5.2.3 Institutional Investment Tree Map

The institutional investment code is the aggregate of the five institutional investment indices previously discussed. The shading of the tree-map below represents the presence of references within the greater aggregate code. The size of the square represents the number of papers II codes was found in. Follow-up and support content contained 179 references in 78 papers. Policy alignment content contained 141 references across 69 papers. Utilization content contained 130 references across 58 papers. Funding content contained 70 references across 46 papers. Champions content contained 54 references across 30 papers.

**Figure 16: Institutional investment code tree map. Shading represents more individual references and size represents presence in number of papers.**



#### 5.5.2.4 Antifragile Operator Tree Map

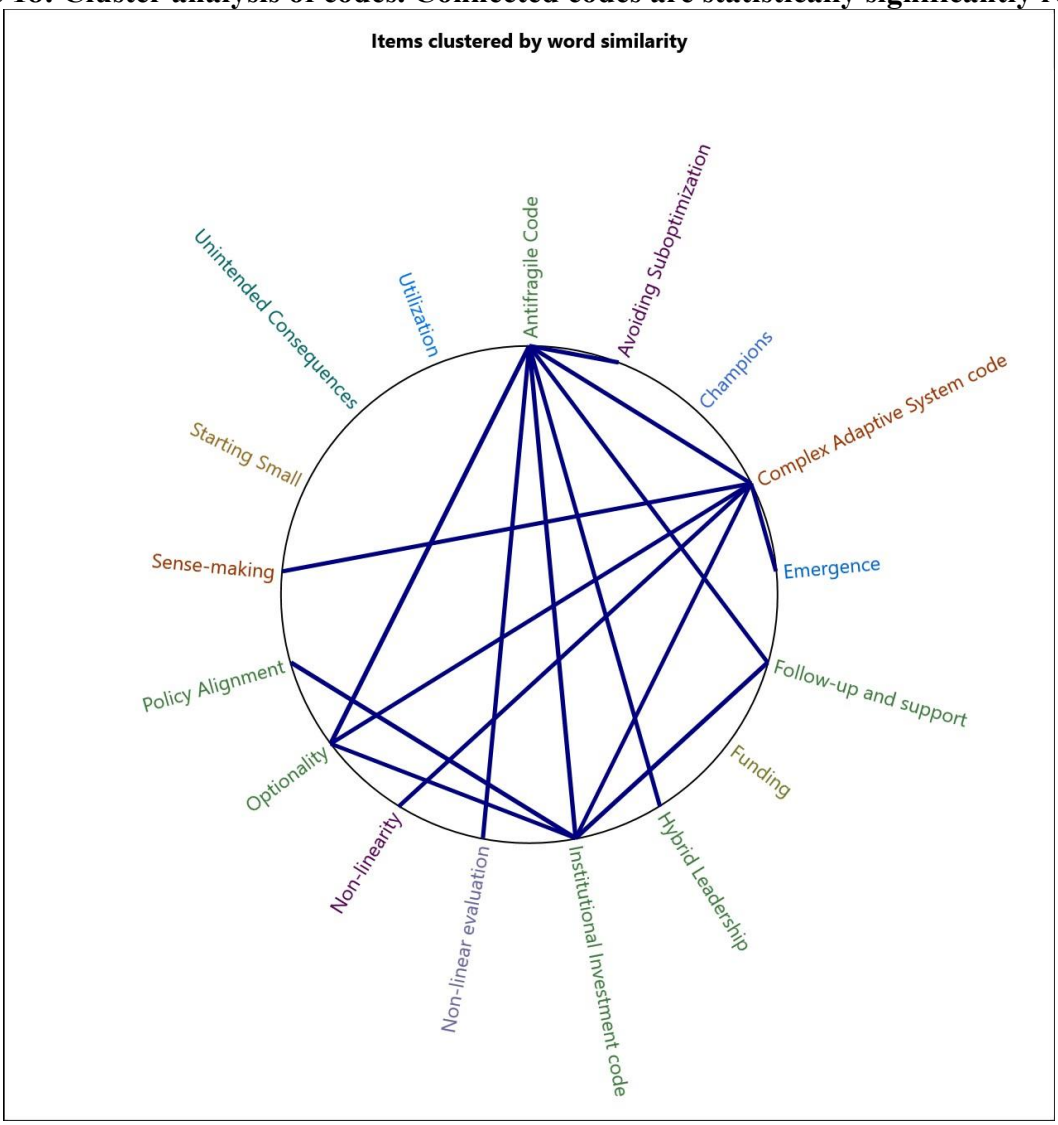
The antifragile operator code is the aggregate of the five antifragile operators discussed previously. The shading of the tree-map below represents the presence of references within the greater aggregate code. The size of the square represents the number of papers AO codes was found in. Optionality content contained 164 references across 73 papers. Non-linear evaluation content contained 104 references across 53 papers. Avoiding suboptimization content contained 94 references across 57 papers. Hybrid leadership content contained 89 references across 47 papers. Starting small contained 35 references across 29 papers coded.

**Figure 17:Institutional investment code tree map. Shading represents more individual references and size represents presence in number of papers.**

#### 5.5.2.5 Code Cluster Analysis (by Word Similarity)

A cluster analysis was carried out comparing different codes on the basis of word similarity. AO content, II content, and CAS content was assessed through Pearson correlation coefficients. CAS code was content which was coded based on my interpretation of complex adaptive system traits such as non-linearity, emergence, sense-making, and unintended consequences as they appeared in the paper repository. Connections between codes in the form of blue lines represent statistically significant relationships.

**Figure 18: Cluster analysis of codes. Connected codes are statistically significantly related.**

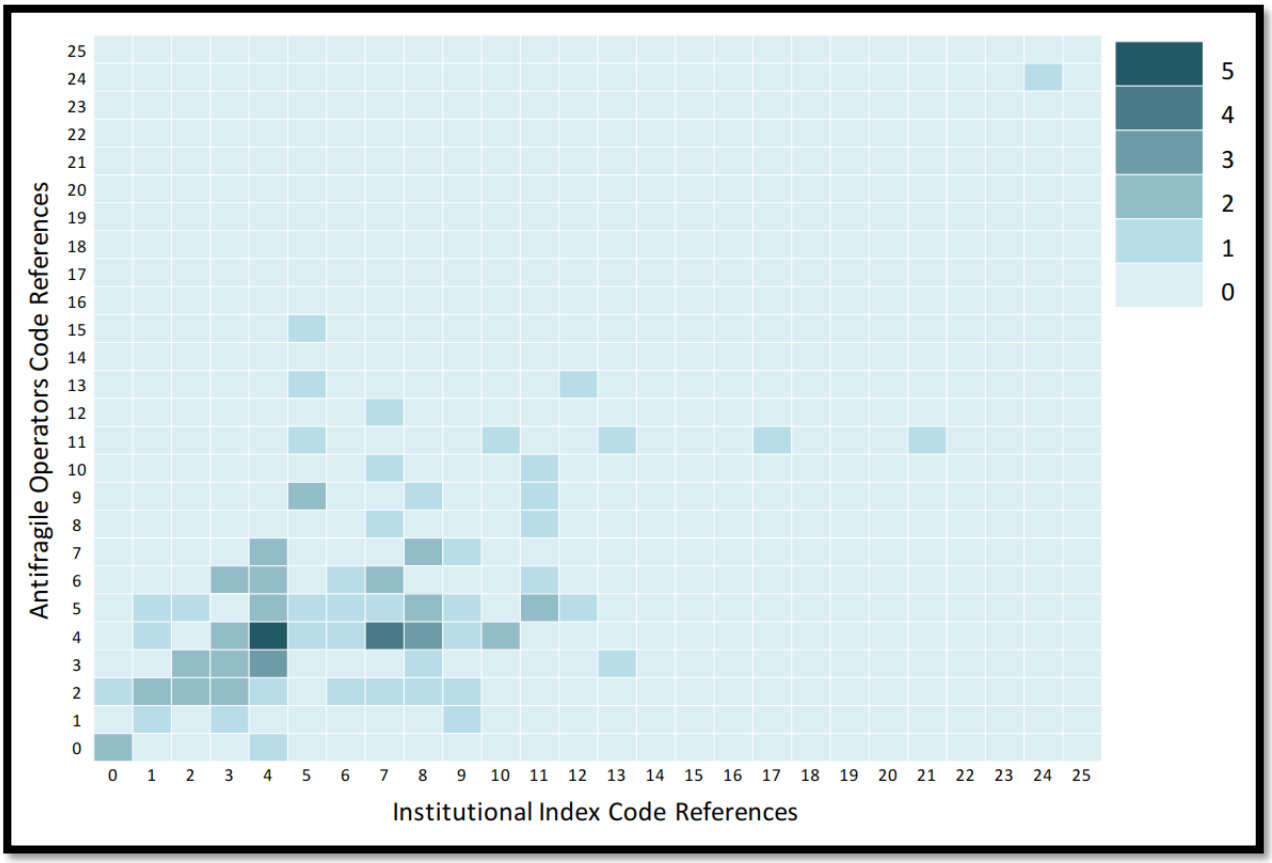


A Pearson correlation coefficient value of over 0.8 implies codes are statistically significant in their association. Some interesting statistically significant relationships include optionality being associated with complex adaptive system code (Pearson correlation coefficient of 0.833) and follow-up and support content being associated with antifragile content (0.825). All three aggregate codes were statistically significantly related (CAS code and AO code – 0.865, II code and AO code – 0.884, and II code and CAS code – 0.814). Please refer to Appendix F for a complete list of Pearson correlation coefficients.

#### 5.5.2.6 Coding Density Diagram

A coding density diagram was created which visualizes the amount of unique coding references per paper within the thematic synthesis. Through this density diagram it is clear that coding references were balanced, with the biggest clusters between 4-6 references of both AO code and II code respectively. Although the II code had almost 100 more references (576 II references compared to 486 AO references), the number of papers which contained AO content was higher (as seen in the shading of cells towards the higher end of the AO axis). One paper (Alami et. al) had more than 20 unique references for both AO code and II code. It was a model paper which served as a project retrospective of a telepathology project implemented in rural Quebec. While more papers had unique AO code, there were a collection of papers clustered around 6-9 II coding references. This suggests that when II code is present, it is displayed and communicated in more robust ways. The density diagram serves as first iteration of the matrix of scale, which is discussed further in Chapter 6.

**Figure 19: A density diagram representing presence of unique coding references from antifragile operator content and institutional investment content. The darker the shading, the more papers are present within the cell.**




### 5.5.2.7 Antifragile Operator Code Examples

The aggregate visualizations presented above provide evidence of antifragile operator content and institutional investment content present within the selected 89 papers. Particularly insightful quotes as they pertain to each antifragile operator and index were extracted and further contextualized. They provide information and an understanding of how to operationalize operators and indices in discrete implementations, providing important information to future rural eHealth implementations.

#### 5.5.2.7.1 Optionality

Optionality is the ability to have choice and is one of the key facets of antifragility. Choice is important because it facilitates the utilization and uptake of a technology or an intervention. It is through this utilization that behaviours or attitudes can be altered. As previously stated, Alami et. al note:

> *"Technology should be thought from an open-ended perspective: needs and uses are what gives value to the technology (eg, end users may find and adapt other applications not originally foreseen) (71)".*

They further remarked on other uses technology which were unforeseen:

> *"Our evaluation showed that several teams used the technology for applications that were not initially planned, including for emergency biopsies, macroscopies, routine histologies, immuhistochemistry, cytology, education, and even teleautopsy (11)."*

This ability of choice in how a technology is deployed improves the agility of a project and allows implementation teams to better handle paradox, uncertainty, and ambiguity.

Al Kadi et. al identify another benefit of integrating optionality within their project:

> *"During the study, one instance occurred where the most senior Banff physician was extremely busy caring for multiple patients. In this situation the initial ultrasound examination was delegated to a trainee who was supervised remotely, and the Banff physician verified the results subsequently. This allowed the trainee to learn with less pressure of time, allowed the Calgary physician to work with a remote novice, and freed the responsible Banff physician to care for a greater number of patients simultaneously while still teaching (75)"*

The presence of a remote clinician to supervise the ultrasound done by the trainee had a cascading positive effect within the system.

Optionality also facilitates better communication. Rowell et. al reported:

> *"Of equal benefit to telepaediatric patients with a disability and their family is the potential for local clinician presence at consultation. As these patients often present with complex orthopaedic and social problems, it is advantageous to have the local paediatrician and treating physiotherapist at these consultations. This allows for greater interdisciplinary communication and understanding of these complex pathologies. This can only serve to improve patient care and clarify treatment plans (20)."*

In this example, having the ability to include the local clinician in specialist consultations allowed for better communication and appreciation for complex pathologies and social issues. This improved communication is ultimately realized by the patient though better care.

#### 5.5.2.7.2 Non-linear Evaluation

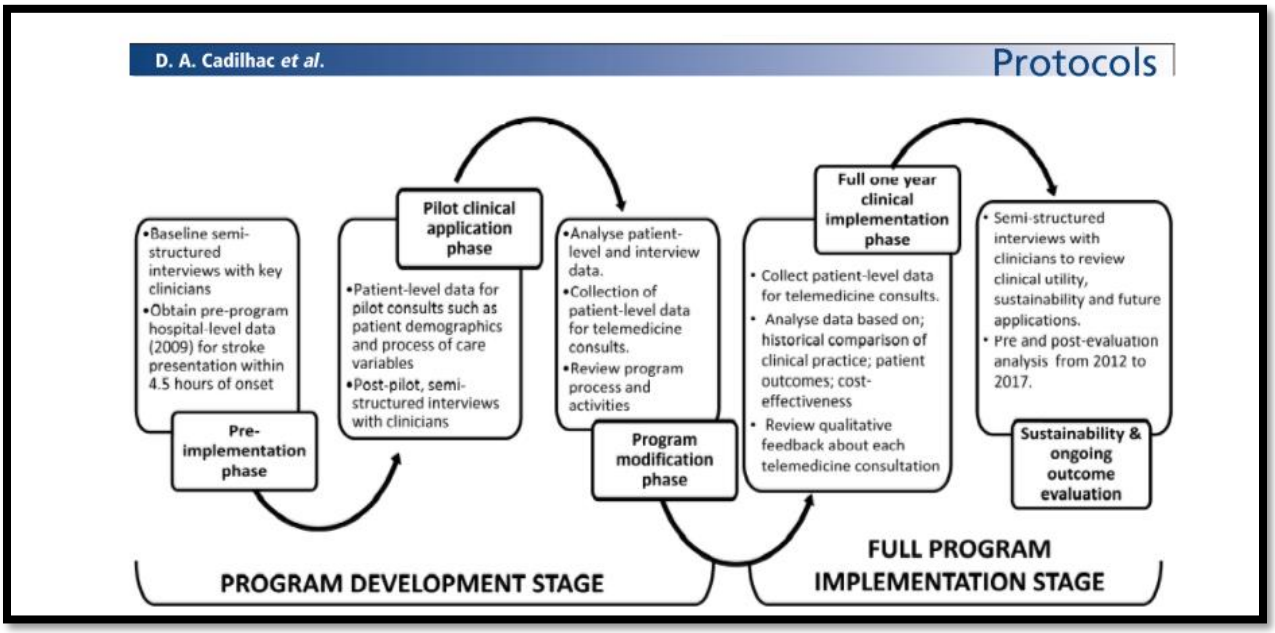
Non-linear evaluation is the assessment of an initiative which avoids reductionistic approaches or labeling. It seeks to understand the system-wide effects of an implementation. Alami et. al note why non-linear evaluation is important in rural eHealth implementation:

> *"This project cannot moreover be separated from its spatial and temporal context. Indeed, the project has evolved in light of new knowledge acquired on the ground and from other international experiences along the way, and it has been affected by regulatory and technological factors. As such, the project requires capacities, means, and leeway for action and reaction to deal with unpredictable events and developments at the clinical, organizational, political, and technological levels (11)."*

Technological, organizational, and political aspects are dynamic and change often during an implementation process. Non-linear evaluation techniques are required to capture these changes and sufficiently evaluate their impact on implementation.

Doing so requires multiple methods – something advocated for in the antifragile design portfolio and accomplished by Cadilhac et. al. Their approach to evaluation, delineated into a program development stage and then a full program implementation stage, incorporates semi-structured interviews with key stakeholders, patient-level data (demographics, triage data, etc.), and hospital-level data (expenditure, rates of admission, etc.). This mixed methods approach can provide nuanced data for the implementation team which can help them understand and assess their project outside of traditional 'success' or 'failure' designations. (165)

**Figure 20: Overview of VST program stages and phases (147).**




Non-linear evaluation also requires diverse perspectives and input – which is advocated for by having hybrid leadership modalities within an implementation, another antifragile operator. Moffatt et. al incorporate varied perspectives by having a diverse sample of evaluators:

> *"This sample consisted of: five medical practitioners who were employed to provide telemedicine services; two medical practitioners who did so in a voluntary capacity; two academics with a history of conducting research in this area; one internet specialist employed to set up systems for telemedicine; a trainer who conducted the training using telemedicine infrastructure; and a national body which intends using this technology to increase access to their area (166)."*

The diversity of opinion present in this sample will provide perspectives from across the health system, instead of a sample with only clinicians which may miss saliant impacts an intervention can have outside of a clinician's domain.

#### 5.5.2.7.3 Hybrid Leadership

Hybrid leadership is the inclusion of both top-down and bottom-up leadership modalities within an implementation. It can help facilitate non-linear evaluation and the two operators are related. Alami et. al notes why hybrid leadership is important, especially in creating clinician buy-in:

> *"Some clinicians explained their refusal to use telepathology given this "top down" approach where they were not consulted, nor sufficiently integrated into the project: "(...) Physicians refused telepathology because it was imposed from the top [the Ministry and the organization] and they were not consulted beforehand (11)."*

Further, the significance of bottom-up leadership was recognized in its role of easing innovation:

> *"The bottom-up expertise was validated and recognized, thanks to a vitality of local teams, which can be considered as innovation laboratories that integrate clinical, organizational, and technical dimensions (71)."*

The multifaceted benefits of hybrid leadership improve the ability of eHealth implementations to handle system stress and indeed become stronger because of it.

Hybrid leadership also prioritizes the inclusion of patients and community members and helps shift the paradigm of medical treatment from paternalistic to patient partnered. As seen in Gibson et. al:

> *"First and foremost, any ways forward for community telemental health initiatives need to be community driven and community led. This will increase the likelihood of initiatives being successful and experiencing a higher level of engagement, and the community experiencing positive benefits from using the tool (24)."*

Having community members occupy a seat at the implementation table has benefits for both the community as well as the implementation team. It also facilitates the shift to a place-based health system which has shown benefits to patient outcomes.

Newman et. al also astutely acknowledge the role of including support or auxiliary staff within an implementation and the effect it can have:

> *"Clearly in our study, administrative staff had an equally important role in facilitating telehealth use but some rural teams felt unsupported by management and*

*policy. For example, a key issue requiring attention was staff availability to support DTN use by privately practicing GPs. (167)"*

Administrative staff are important to any organization, especially so in an implementation. Their inclusion or integration of their opinion within and implementation process can only aid an implementation team in deploying a successful intervention.

#### 5.5.2.7.4 Starting Small

Starting small is simply limiting roll-outs of projects in scope until appropriate due diligence is done. Starting small offers implementation teams the chance to tinker and iterate with their project to better reflect the context it is situated in. An example of the importance of starting small is seen in Bradford et. al:

> *"Other participants had misconceptions regarding the process of telehealth consultations, commonly thinking the patient would need to have equipment in their own home, be computer literate and to organise their own appointment. Once these misconceptions were clarified, and a model of telehealth explained, participants expressed relief that they were not expected to manage the technical aspects of a consultation. This has potentially important implications for home telehealth services (152)."*

The misconceptions of the participants likely reflect the extensive resources required in eHealth interventions. Starting with less hardware or pre-requisite technical know how allowed the program to progress smoothly.

Khalil et. al also observed benefits in starting small:

> *"This initial stage is likely to identify the necessary equipment needed to facilitate data entry and the training model needed to accompany it. Funding for the purchase of equipment, up-skilling staff and training them is necessary for the success of this stage to ensure compliance with data entry and for overcoming problems with software and hardware (168)."*

Non-linearity and emergence within systems means that things are seldom straight forward in an implementation. Starting small allows an implementation team to account for these traits without expending high amounts of project resources.

Simpson et. al also perceive the importance of starting small:

> *"The ideal model for expanding into rural areas in our experience is to start in one area and to extend on a gradual basis. This project began with a regular tele-web psychology clinic between Adelaide and Port Augusta. Once systems were established, it then became possible to extend the project to include an additional remote location (169)."*

Establishing infrastructure, whether that be social or technological, is a key first step in including more sites within a project. Trying to include multiple sites from the outset of a project without understanding capacity or the presence of infrastructure in each context is likely to lead to poor outcomes.

#### 5.5.2.7.5 Avoiding Suboptimization

Avoiding suboptimization is the evasion of maximizing the efficiency of one part of the system at the expense of another. The antifragile approach makes clear the presence of unforeseen consequences and how avoiding suboptimization can mitigate them. Hoffmann recognized the importance of their project and keeping their patients in their home environments:

> *"To facilitate the attainment of optimal occupational performance, it may be most appropriate to address aspects of rehabilitation such as instrumental ADL, community access, and the resumption of social, leisure and work roles in the client's home environment. Again, home-based telehealth applications may be able to assist rural and remote therapists to provide these services without the therapist (170)."*

The inclusion of peripheral aspects important in a patient's recovery (from an occupational therapists perspective) ensures that the patient can re-integrate effectively within their setting. Margolis et. al also state the importance of avoiding suboptimization in their discussion of medical chests in rural and remote Australia:

> *"The RFDS medical chest has evolved over many years to cover a number of medical conditions, not just emergencies, which it would be difficult for people living and working in remote areas to otherwise treat. Apart from pharmaceuticals, the chest contains a variety of equipment including bandages and dressings of various types and sizes, hypodermic syringes and needles, a scalpel, dressing scissors, a kidney dish, urinary catheter, first aid manual and a video on how to give intramuscular injections (171)."*

Originally exclusively designed for emergencies, the kit was expanded to treat more routine problems in remote places as well. The irony of having a medical kit which can't be used for a majority of non-emergency medical needs is self evident.

Lastly, a pragmatic method of avoiding suboptimization is seen in Al Kadi et. al's paper regarding a telesurgery intervention:

> *"The system was established as part of a project to study the potential of telesonography conducted by communications satellite. Thus, some latency was built into the system to simulate the delay via a satellite link. The videoconferencing system was thus configured to add delay to the IP packets (270 ms one way) and constrained to a bandwidth of 2 Mbit/s using commercially available software (75)."*

Building latency into the system to account for poorer broadband infrastructure in rural communities is a simple (yet ingenious) way to avoid suboptimization.

#### 5.5.2.8 Institutional Investment Indices Coding Examples

Like the antifragile outputs seen before, this section of the results is meant to contextualize the aggregate outputs with contextualized quotes regarding how other researchers leveraged institutional investment indices in their implementations. The following quotes represent the importance of integrating institutional investment into rural eHealth implementations.

##### 5.5.2.8.1 Champions

Champions are agents who have either formal or informal status within an organization and so can influence the attitudes and values of other agents. Bhandari et. al observe the importance of identifying a single agent to serve as support within an implementation:

> *"We identified a staff support nurse at each campus to share accountability for trouble shooting, co-ordination and problem-solving of issues. We designated a staff support nurse who obtained immediate feedback on the process/experience, shared feedback with physicians and all other team members, shared feedback with Mental*

*Health Leadership Team and congratulated staff after each telehealth crisis intervention session (70)."*

The presence of a staff support nurse allowed for the streamlining of feedback, dedicated support, and incentivization of successful telehealth consultations – all to the benefit of the project.

Bhandari et. al further enrolled a clinical champion in the following way:

*"The chief of psychiatry applied for and received hospital privileges at LDMH, which convinced the local physicians that he or she would be available to them if they had problems or were dissatisfied with the service. He was named the chief of psychiatry at LDMH and became an important member of the medical staff (70)."*

The presence of an important agent who support the intervention influenced other agents within the system, leading to confidence in the project's scope and aims. This again benefited the programs implementation.

Jennet et. al also recognize the importance of champions:

*"This may be one reason for the importance of champions and change agents. Creating Readiness involves proactive attempts by a change agent to influence the beliefs, attitudes, intentions, and behavior of change participants (172)."*

Part of ensuring organizational readiness for a rural eHealth implementation is identifying patient or provider champions which can help shift perspectives or attitudes regarding technology or eHealth.

Lastly, an emphasis is again put on clinical champions by Sevean et. al:

*"Managing technological change is difficult and policy makers must strategize to ensure: the focus is to solve clinical problems not deploy technology; the system should have strong clinical leaders; a plan to overcome system barriers (i.e. funding, organisation, scheduling, physical remunerations, jurisdictional issues) (173)."*

Having a clinical champion greatly improves the sustainability of the program, allowing it a chance to scale to other contexts.

#### 5.5.2.8.2 Policy Alignment

Policy alignment refers to how well a program adheres to mandates prioritized by hospital, municipal, provincial, or Federal priorities. Addressing problems or challenges identified by policy-makers and decision-makers as important improves the probability a program is institutionally invested. Mcgregor et. al communicate their policy alignment well:

> *"This 'Bush Babies Broadband' project is part of a wider research and development initiative, 'e-Baby' (McGregor et al., 2002; McGregor et al., 2005a), being pioneered by Health Informatics Research (HIR), School of Computing and IT, University of Western Sydney (UWS) in conjunction with Nepean Hospital's NICU (174)."*

By positioning their intervention within a larger call for action, the amount of institutional investment increases.

McWilliams et. al also signal the integration of their intervention into larger policy concerns:

> *"Expansion has been facilitated by integration of the service into the state-wide model of care, increased awareness and demand from rural/remote clinicians, state-wide telehealth burns education sessions and the establishment of a Burns Clinical Nurse Consultant, who conducts over 97% of wound reviews for this service (175)."*

Their telehealth burn initiative became integrated into a state-wide model of care and received permanent resources to sustain it – proof of the importance of becoming standard practice.

Finally, Saqui et. al underline the importance of establishing a project as it aligns with a hospital's strategic plan:

> *"Telehealth at University Health Network (UHN) in Toronto, Ontario, Canada, was initiated in January 2002 as part of the hospital's corporate strategic plan, with a view to provide regional, national, and international clinical telemedicine. The Telehealth Program facilitates video consultation and follow-up care to patients who live significant distances from UHN. The program includes a partnership with NORTH, the largest videoconferencing-based network in Ontario (176)."*

Building partnerships with provincial organizations as well as aligning their project with a strategic plan facilitated institutional investment.

#### 5.5.2.8.3 Follow-up and Support

Follow-up and support are the structural designs which can provide guidance, troubleshooting, or logistical resources to patients and providers interacting with an intervention. These mechanisms can have many forms – be they automated telephone support lines to the presence of an agent (technologist, nurse, specialist etc.) who can help make sense of problems and challenges as they arise. Johansson et. al incorporate follow up and support in the following way:

> *"District nurses [DNs] said that when a specialist physician talking about, for example, treatment compliance with a patient face to face via VC, DNs considered that a nurse must be present. They meant that the physicians sometimes used a language that could be difficult for the patients to understand. The DNs thought that if they were present they could explain the information for the patients (177)."*

The presence of a district nurse during a video consultation allowed for smoother communication between specialists and patients. This led to better compliance with treatment regimens and ultimately better patient outcomes.

Volpe et. al also remark on the importance of follow-up and support in establishing telepsychiatry interventions:

> *"The study found a number of factors that facilitated or hindered the process and content of a consultation-based telepsychiatry program and its effect on building capacity among frontline staff. Four main themes emerged related to the delivery of psychiatric services via televideo: gaining access, ensuring culturally appropriate services, providing relevant continuing education, and offering stable and confidential technology (178)."*

Of the four themes identified, providing relevant continuing education and offering stable and confidential technology both require sufficient levels of follow-up and support. Sustaining an initiative in a rural community requires dedicated planning regarding the adjustment of a program for future conditions – and the provision of adequate follow-up and support is a key facet of that.

Lastly, Khalil et. al also identified the importance of providing (local) follow-up and support:

> *"An efficient training model was devised in response to the need of the study participants. Initially each site identified a leader in its nursing group. This person was given a full study day to attend training on MWC. A web-based training site that mirrored the live scene was set up and each leader was given access to the level required to train other staff. Each site then had 3 weeks to train the nursing staff that would be entering the data at their site. Several sites expressed the need for extra training support, so the regional wound consultant travelled to these sites to coordinate and undertake extra training (168)."*

Enrolling local agents to provide follow-up and support with an intervention has a two-fold benefit. Firstly, it increases buy-in with local agents for the intervention of question. Second, it leverages local knowledge to combat challenges and problems within the context. Wherever possible, implementation teams should look to integrate local resources for follow-up and support before going outside the community.

#### 5.5.2.8.4 Utilization

Utilization is simply the rates or raw usage of an intervention within a context. Those interventions with higher rates will have higher corresponding investment. Krum et. al reported their rates as follows:

> *"There was also a reduction in the utilization of general practitioners, with the control group visiting their general practitioner more than twice as often as the intervention group. This may be due to compliance (in 65%) with the automated telephone support system in the intervention group, reducing the need for participants in the intervention group to visit their general practitioner (179)."*

Note that changes in rates does not always have to be increases – in this case, a decrease in GP interaction was beneficial to the entire system.

Nagao et. al reported the uptake of their telestroke intervention in rural communities:

> *"One hundred and forty-five acute stroke patients presented in control year and 130 patients in intervention year. Fifty-four patients in intervention and 36 patients in control group were eligible for thrombolysis. In intervention group, 24 patients had*

*Telestroke activated and 8 patients underwent thrombolysis. There was no thrombolysis in the control group. There were neither symptomatic intracerebral haemorrhages nor deaths attributable to thrombolysis. Median door-to-computed tomography time did not significantly differ between eligible patients in control and intervention groups (180)."*

Here, we see the number of patients who underwent treatment through two different arms of a telestroke intervention. The results indicate that the telestroke intervention was just as safe as traditional thrombolysis pathways (control v. experimental arm.)

Lastly, Sabesan et. al observe the uptake of a teleoncology program:

*"Between 2009 and 2011, TCC provided cancer care to 70 new patients from Mt Isa. Of these new patients, 93% (65/70) were seen within one week of referral. All 17 patients requiring urgent reviews were seen within 24 hours of referral and managed locally thus eliminating the need for inpatient inter-hospital transfers (67)."*

The utilization of their teleoncology program again led to a decrease in patient transfers – to the benefit of patients and the system.

#### 5.5.2.8.5 Funding

Funding, like utilization, is a self-evident index. It refers to the identification of monetary amounts or sources dedicated to a project. Three examples from the literature communicate this point sufficiently. From Conn et. al:

*"The District Mental Health Services Older Adults Program (DMHSOAP) is a program of the Canadian Mental Health Association based in Fort Frances, Ontario and funded through the Provincial Ministry of Health and LongTerm Care through the North West Local Health Integration Network (LHIN) (181)."*

From Greenberg et. al:

*"In July 2000, a pediatric telepsychiatry program was initiated by the Division of Child Psychiatry at the University of Toronto and was administered through The Hospital for Sick Children in Toronto, Ontario. Funded by the provincial Ministry of Children and Youth Services, the program was given a 3-year mandate to explore the feasibility and effectiveness of extending telepsychiatry services to 10 sites in remote and rural areas in Ontario (182)."*

Finally, Liddy et. al note:

*"The eConsult service began as a small proof of concept in 2009–2010 and has grown into a full service funded by the Ontario Ministry of Health and Long-Term Care and research funding (66)."*

All three quotes reflect sufficient funding is required for a program's implementation.

## 5.6 Conclusion

This chapter serves as the collection of research findings from which the antifragile design portfolio is derived. The need for a principled design philosophy was established through reflexive ethnographic writing and the Golden Lake focus group. The presence of antifragile operators and institutional investment indices was demonstrated through ethnographic vignettes. Further, system side capacity to innovate and incorporate antifragility was recorded – as well as innovative capacity displayed during the COVID-19 response. The need for sensitive qualitative methods and the importance of prioritizing context was also seen from this ethnographic data. The interpretation of this data then informed the thematic synthesis coding protocols, which were applied to a repository of 89 papers detailing rural eHealth implementation.

The results of this thematic synthesis include the aggregate coding references which create the antifragile coding content and institutional investment coding content. Cluster analysis showed the statistically significant relationships between AO code, CAS code, and II code (based on word similarity, measured in Pearson correlation coefficients). A density diagram also shows the presence of intersecting items and the coding references which exist within specific papers, with clusters around 4-6 coding references in both AO code and II code. Finally, selected quotes were pulled from the thematic synthesis which offer insight regarding the application and value of antifragile operators and institutional investment indices in distinct rural eHealth implementations.

The following chapter serves as a synthesis of these results and operationalizes antifragility through the antifragile design portfolio. It is based on the ethnographic data and

thematic synthesis results presented here and, to echo Fennel et. al again, aims to provide a resource which is accepted by both academic standard while being applicable in the 'real world'. To that end, the results of the combined approach of incorporating lived experience into rigorous literature review shown in this chapter provide a firm basis for the central output of this work: the Antifragile Design Portfolio.

# Chapter 6: Synthesis of Findings

## 6.1 eHealth Integration into Rural Health Systems can Address Health Access Inequities

The results from the scoping review discussed in Chapter 5 scoping review indicated that both patients and providers have generally positive feelings regarding utilizing eHealth as a substitute for face-to-face service (34). Patients and providers within the papers included for review indicated that eHealth was valuable to minimizing distance travelled for care, broadened their access to specialist services, and reduced the amount of money spent on costly interventions in rural places. Further, the extent of services which utilized eHealth initiatives in their practice was not limited to a handful of services. There was breadth and depth in the medical and clinical applications of eHealth, which signifies interest, support, and drive to integrate eHealth interventions into standard practice across medical disciplines.

These results are particularly important for this reason: they reflect an environment which is more likely to be mirrored in the future as COVID-19 mandates and restrictions are slowly repealed across the world. The attitudes and beliefs rural patients and providers had regarding the effectiveness and place of eHealth in rural health systems may be altered by the COVID-19 pandemic. Regardless, there is potential that temptation to return to previous modalities of care provision will likely lead to the abandonment of eHealth interventions in many settings. Understanding why eHealth saw such widespread adoption in the early days of the pandemic has been completed by others (62), but a caveat of those findings is of course the unprecedented tension for change, influx of funding, and pointed interest in transitioning care from physical to virtual. Future eHealth deployments are unlikely to have such an environment, so

implementation teams looking for precedent in those deployments would be better served considering research completed pre-COVID-19.

Besides the scoping review, ethnographic observation (summarized in Chapter 5) and case studies (15) have shown the acceptance and impact successful integration of eHealth can have on a rural health system. Ethnographic research residencies completed in Sweden, Australia, and Iceland displayed the potential of electronic initiatives, in healthcare but also in disciplines such as education and recreation, can have in addressing rural inequities. In particular, interviews and focus groups in Golden Lake and the Icleandic vignette made clear the basis in which eHealth integration could be found.

## 6.2 Antifragility is a Viable Principle to Guide eHealth Project Design in a Principled, Strengths-Based Manner

Antifragile design is a principled, strengths-based approach which is derived from rural eHealth implementations and formulated to accommodate challenges of rural implementation. Through a thematic synthesis, case-study analysis, (15) as well as ethnographic observation, antifragility has shown it can positively drive rural eHealth implementation processes. Although not deployed in a strictly implementation fashion, antifragility has also been used in comparative analysis of health systems in Bosnia and Croatia (96) as well as an example of community resilience during times of stress – such as COVID-19 (16,183). Evidence of its applicability to healthcare problems is growing, and this research positions antifragility (operationalized through the antifragile design portfolio, 6.3) as a nascent implementation framework aimed at rural eHealth deployment. Through ethnographic observation, characteristics of rural communities saw consistency, regardless of international domain. Rural places in Canada, Australia, and Sweden all possessed remarkable levels of altruism, breadth of knowledge, as well as personal

and system level resilience. These strengths are rarely recognized when rural research is discussed – instead there is a focus on the disadvantages which are present in rural communities (lower levels of resources, perceived disinterest of local residents by out-group research teams, and poorer support of innovative projects and initiatives.) The antifragile design portfolio builds on the strengths of rural communities, in a principled and rules-based manner, and provides rural implementation teams with a framework uniquely tailored for rural settings. Ultimately, through case studies, ethnographic observation, and components of a realist evaluation, antifragile design is a principled, strengths-based approach to rural eHealth implementation.

Establishing that antifragile operators can positively influence implementation is the first step in operationalizing antifragility within rural communities. The next section discusses the link between practice (establishing eHealth as a potential method of addressing access inequities) and theory (antifragile design as a viable principle for implementation) by the formulation of a two part, rural implementation toolkit. This toolkit, the antifragile design portfolio, is comprised of two parts, which uniquely synthesizes powerful qualitative methodology, findings of a thematic synthesis, and ethnographic observation to provide rural implementation teams with a framework of organizational readiness and evaluation for eHealth interventions unique to rural communities.

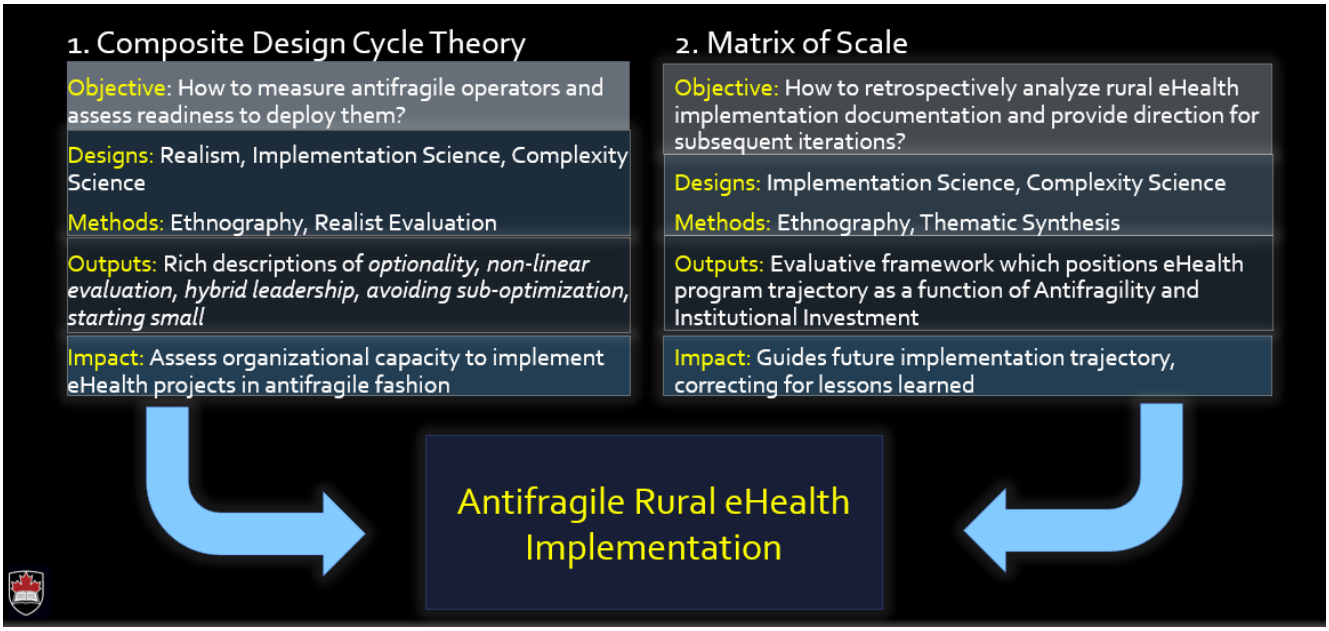
## 6.3 Antifragile Design Portfolio

There are two core components of the antifragile design portfolio, which are used in tandem and contribute to the deployment of antifragile eHealth pilot projects in rural contexts and settings. The first component is the *Composite Design Cycle Theory*, or *CDCT*. The CDCT is an organizational readiness tool for the use of implementation teams and policymakers to understand the degree to which an organization could engage with antifragile project

deployment. To implement an antifragile project, it depends on the organizations ability to *inform, influence, interpret,* and *iterate* during the implementation process. Each module of the CDCT has proscribed methodologies to help organizations assess their capability in employing an antifragile project, with stipulations that each implementation is unique, and thus may require different methods than the ones outlined. Complexity science, Realism, Implementation Science, Narrative Inquiry, Realist Evaluation, and Ethnographic Typology are the composite methodology of the inform, influence, interpret, iterate cycle. The last part of the cycle, iteration, involves implementation teams reflecting on initial success and failure, adjusting their delivery of the project, and incorporating feedback mechanisms to gather more data. This is where the *Matrix of scale (MS)*, the second component of the antifragile design portfolio, is utilized. **Figure 9** succinctly summarizes the antifragile design portfolio.

The *Matrix of Scale (MS)* is a matrix derived from an NVivo analysis of 89 of peer-reviewed literature regarding the implementation and evaluation of eHealth initiatives across the world. The MS maps pilot project outcomes at the iteration stage of the CDCT as a function of antifragility and institutional investment. There are four quadrants a project can fall into, each with different recommendations in how to proceed in the next iteration of the implementation process. It is a tool meant for implementation teams as well as policymakers to understand where an eHealth initiative is strong, where it requires more thought, and potential challenges or barriers which could appear as the implementation progresses.

**Figure 21: The antifragile design portfolio. The objectives, designs, methods, outputs, and impacts of both components are delineated and stated.**




The chief concern is steering implementation teams away from path dependence (184,185), wherein a project has high institutional investment, but low degrees of antifragility. Path dependence is the least desirable outcome of a pilot project, as it signifies warning that a program could result in throwing 'good money after bad'. In other words, a path dependent project will continue to demand resources because of the sunk cost already associated with it, and the opinions or values associated with the project succeeding. These bloated projects sap already limited resources from an overburdened system and do more harm by being maintained than scrapped and reformed altogether.

Combined, the two components provide implementation teams with an approach to installing antifragile eHealth initiatives in rural communities which have potential to scale and spread to other contexts. This scale and spread addresses the healthcare equity gap seen in rural places and is eventually realized in better health outcomes of rural populations. The CDCT provides a framework for gauging organizational readiness in applying antifragile principles in

program design, and the MSS provides feedback in actionable terms depending on where a program falls within the matrix. These tools have been tailored to provide guidance when working within a complex adaptive system, where emergent decision-making is required. The antifragile projects which see concentrated implementation efforts as a result of reference to the CDCT and MS stand a better chance of sustaining and scaling from context to context. To reiterate, rural residents will then benefit from the presence of eHealth options for care within their community, and the gap in service access between urban and rural residents will become that much closer to being filled.

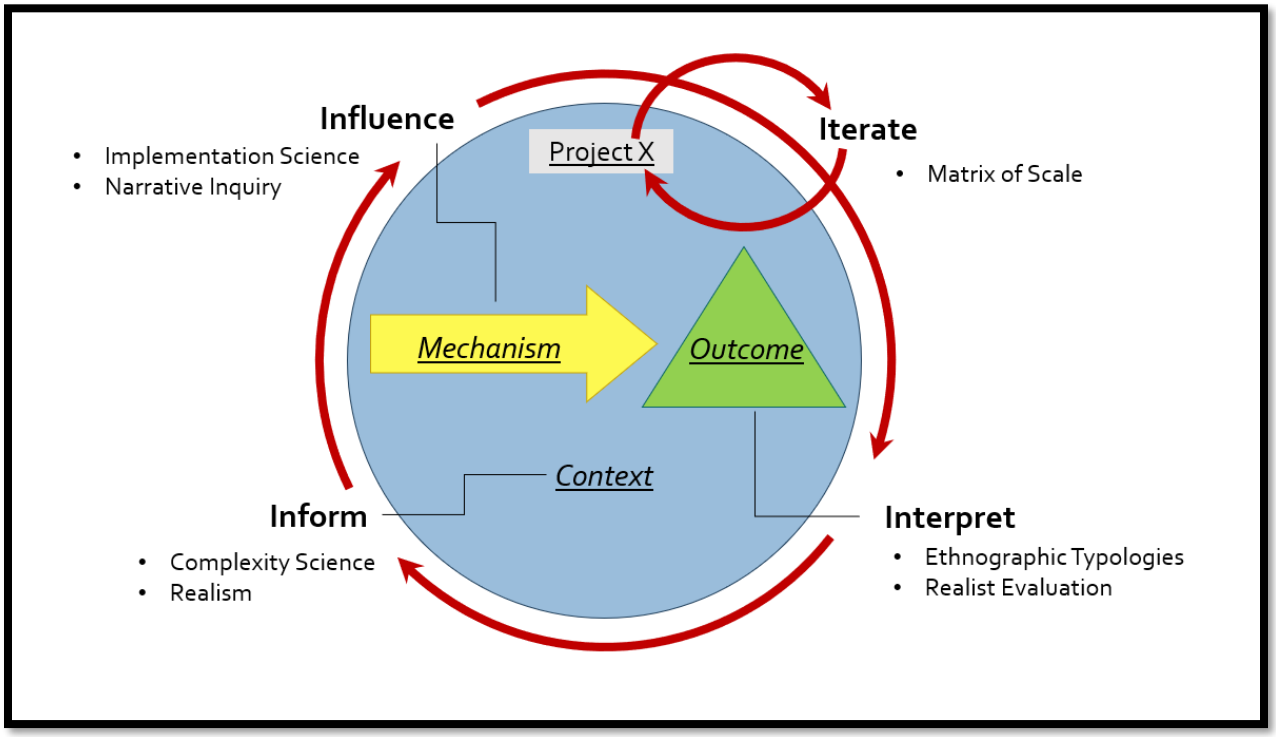
### 6.3.1 Component 1: Organizational Readiness to Deploy the Antifragile Design Portfolio

*Organizational readiness* is the capacity of an institution to foster, utilize, and leverage an evidence-based framework, theory, or recommendation into standard practice (186). It is important to understand the ability of an organization to incorporate innovative strategies, as organizations need to adjust to dynamic challenges which can acutely surface with little forewarning. By staying agile and having the structure and culture to incorporate novel approaches, organizations can better respond to widespread system stress without a noticeable reduction in service provision or quality. In the context of my doctoral research, understanding how an organization can promote antifragile project design, and further how to implement projects in an antifragile manner, is an important piece of sociological research which can help shape project policy and frame priorities for organizations such as rural communities.

The CDCT (**Figure 9)** is a *composite* organizational readiness tool, with leniency in the methodologies used to ascertain ability of antifragile deployment by a given organization. Already, this leniency addresses the camps which can form around certain ideology being superior to another, or more rigorous in its approaches. Instead of lacking methodological rigour

by expanding ways implementation teams can theorize about phenomena, this allows for a polarity approach when conflict inevitably arises during an implementation (187). Instead of stubbornly advocating for or adhering to a strategy which is not yielding tangible results, the CDCT would recommend reflection, evaluation, updating beliefs as a collective team, and using another qualitative protocol (for example, a different ethnographic typology) to examine a sticky challenge or barrier. Indeed, part of using the CDCT is accepting that you can only ever be a *partial* expert, and a requirement of comfort with interdisciplinary teams and ambiguity with respect to consensus pathways of implementation. That is why implementation is a *team* sport, if

**Figure 22: The composite design cycle theory. Based on the realist evaluation interpretation of an intervention, the ability of an organization to *inform, influence, interpret,* and *iterate* through an implementation process aligns with an antifragile initiative.**




there is one clear finding from this doctoral research it should be that individuals are worse at implementation than teams. Teams bring a diversity of perspective, allow for emergence of novel

ideas, and are incubators for innovation under the right conditions. Appreciating complex adaptive systems and implementing within them is harder from an individual standpoint.

Further, the CDCT subscribes the pragmatic approach to complexity advocated by evaluation scholars. Pragmatist complexity entails approaching implementation and evaluation on a case-by-case basis and installing methods and evaluation strategies contingent to the context of the implementation (188). While this appears intuitive and superficial, it warrants asserting because of it's inherent simplicity. Pragmatic approaches to complexity include such a sheer volume of evaluation techniques and implementation frameworks that listing *every* one is a self-defeating exercise, and is far outside the scope of this project. The flexibility of the CDCT however appreciates the pragmatic origins of accounting for complexity within an implementation. Relevant to rural organizational readiness, the methods listed in the CDCT approximate the antifragile indicators which influence the performance of a pilot project over

time. It is still understood however that each implementation is unique, and the CDCT allows for deviation from the primary methodologies when necessary.

The CDCT relates to the design of eHealth projects for their immediate deployment into complex adaptive systems – such as rural health systems. It is composite because it is formulated by the interaction, consultation, and outputs of six research methodologies: *complexity science, realism, implementation science, ethnography, realist evaluation,* and *ethnography*. At it's base, composite design theory builds on the realist approach to interventions: namely, every intervention is some interaction of the context, mechanism, and outcome attributed to it (133). The main takeaway of composite design cycle theory is that successful implementation of a complex intervention depends on the organizations ability to **inform**, **influence**, **interpret**, and **iterate** an intervention. An organization who can perform the 'four I's' of the CDCT in a

comprehensive manner stand a better chance of deploying antifragile eHealth solutions into rural communities. These initiatives in turn then have a greater potential to scale and sustain.

An important note about the CDCT is the temporality of the four I's is not distinct. There is no 'step-by-step' protocol, wherein an organization must influence a mechanism of action before interpreting the results of an intervention. Rather, these stages of the cycle often overlap, and implementation teams would be well served to incorporate changing values in one part of the cycle with another. As an example, if an implementation team is struggling to influence the mechanism of a given interaction, manifested in poor levels of uptake, hesitation in adoption by clinical or patient leaders, or disinterest from policymakers and decision-makers, then they should instead turn to the outcomes they *do* have, and work retrospectively to understand better the intervention module(s) which are limiting the interventions efficacy. From there, implementation teams can make a convincing argument to change a module (usually a peripheral constituent to the intervention) as evidence to stakeholders the intervention can change and adapt to criticisms and feedback. The CDCT is designed to be non-linear in nature, with strict avoidance of path dependence. Path dependence leads to bitterness, resentment, wasted monetary and human resources, and usually poorly conceived and delivered interventions.

#### 6.3.1.1 Inform

To understand the ability of an organization to deploy an antifragile initiative, implementation teams should seek to inform themselves of all relevant contextual facets of the intervention. To do so, they should reference complexity science and realist perspectives on theorizing, conceptualizing, and appraising the context into which the intervention will be implemented. Complexity science and realism are situated especially well to understand context,

as they put an emphasis on the nuance and relationship between stakeholders, sociological constructs, system infrastructure, and organizational dynamics. Implementation teams which are cognizant of the fact that sometimes capturing the reality of how an intervention interacts and changes behaviour of a target population is not possible are that much more prepared to work in a complex adaptive system and develop an antifragile initiative which can account for this uncertainty and instability. Context is king and should be ignored or minimized at the risk of the implementation team. Settings have a history, and implementation efforts in the past still impact the efforts of current or future teams.

The use of complexity science and realism in the inform stage of the CDCT reflect the need for a multidisciplinary implementation team and the effect of a setting's history (understood in complex adaptive system terms) on an eHealth intervention. A full list of guiding questions which should be asked by implementation teams during this stage of the CDCT can be found in Appendix G. Interpreting information using realism when *informing* oneself of the context of an intervention is crucial to using multiple feedback mechanisms within a system. Framing this information in complex adaptive systems terms leads to better integration of abstract components to an intervention which are real but not necessarily observable – such as creativity, leadership, and imagination.

Practically, the outputs of complexity science and realism, such as checklists (Appendix G), reports, and interviews set the context for an intervention. At this design stage, the implementation process is informed of the cardinal considerations conceptualized in clear terms by complexity science and realism which stand to become prominent throughout an implementation effort. Realism is important at this juncture because of its ability to construct theories regarding stakeholder interaction, interventional direction, and implementation

challenges before concentrated efforts are begun. Theories assign value to prominent pieces of an implementation effort and provide a starting point for teams to begin their project design.

Questions asked by the implementation team at the inform stage of the CDCT to assess antifragility include:

1. To what extent do historical implementations (if present) influence current beliefs or attitudes regarding electronic health initiatives?
2. What inherent groups, structures, or supports exist within the community that have been involved in a research process in the past? How can these groups be integrated into the implementation?
3. What are the latent beliefs, attitudes, and values of the stakeholders within the community regarding electronic health?
    a. For example, implementation teams can ask "Do you consider your community rural?" "What is your perception of effective electronic health access?" "What are the strengths of your community with regards to access to healthcare?"

These example questions are meant to be guiding in nature, with other questions relative to the inform process applied in a pragmatic capacity. The central aspect of asking questions meant to inform the implementation team is to theorize a structure and relationship map of the rural community primed for an eHealth implementation, to better understand how latent relationships could affect an eHealth intervention. It is here benefits of starting small and avoiding suboptimization should be clearly articulated and incorporated into program design.

Theorizing is a necessary step in implementation, as it is a creative exercise which is accessible to everyone – not just reserved for academics or clinicians. Communities should be

encouraged to theorize and engage in research collaboration from the outset of an implementation, as there is an abundance of literature which associates patient partner approaches with increased satisfaction in both patients and clinicians (189,190). It is through this theorization exercise too that subtle or implicit assumptions or historical happenings can be made explicit and discussed. Information such as this is vital to an implementation team, as it provides posterity which can be referenced throughout a contemporary implementation effort and inform future design. Patient and community collaboration also overlaps with the dirt research methodology in rural investigation, which again places lived experience at the apex of importance when conducting and communicating research within rural contexts.

Further, theorizing allows for stakeholders to engage with two rather intangible concepts which are important in gauging an organizations *creativity* and *inventiveness*. Creativity in this context refers to the abstract approach to wicked problems, utilizing novel methodologies, outputs, or systems. Creativity is a foundational aspect of innovation, but one which is difficult to accurately measure or articulate. Theorizing about deploying interventions in ways which have no been previously explored, or perhaps revisiting methods which failed in the organizations past can provide much needed nuance in when implementing in a complex adaptive system. *Inventiveness* in this context refers to the reimagining of old approaches to fit contemporary requirements, and the creation of new protocols. These two concepts are important in maximizing an organizations absorptive capacity, or the ability of the organization to recognize change to standard practice as beneficial and implement that change in a meaningful way. Sustaining and scaling that change is a secondary outcome to a successful intervention affecting standard practice.

Recommendations by implementation teams should be done with the ability to vertically scale inherent within them. Realizing this ambition though requires navigation of numerous complex and intractable barriers. Chief among them is the typologies of power and politics which exist in every organization. Although there have been recent acknowledgements of the need for further research regarding equality and equity in implementation (104), power dynamics must be made explicit in the early phases of an implementation effort in order to sufficiently deal with them as the implementation progresses. Antifragile projects call for a hybrid leadership model – one which puts weight into the opinions and thoughts of the front-line as well as senior decision-makers.

#### 6.3.1.2 Influence

An intervention does not exist in a vacuum, but rather arises as a product of the interactions between users of the intervention (patients, providers, administrators, etc.) (32). It is at this point of the composite design process that influence on the mechanism of an intervention is paramount. This influence can be wielded in any number of ways but is done so on the basis of the information gathered about the context first (inform). This 'look before you leap' approach can help sort though the abundant strategies outlined in implementation science. Tacit understanding that complete system inquiry is not possible is intrinsic to an attempt to influence mechanism and will be done so concurrently with monitoring outcomes and informing oneself on context.

Narrative inquiry and relevant implementation science frameworks are well suited for the *influence* stage of the CDCT. A full list of guiding questions which should be asked by implementation teams during this stage of the CDCT can be found in Appendix G. Narrative inquiry and the implementation science frameworks discussed previously (CFIR, RE-AIM, and

NASSS) provide crucial data which can then be leveraged by implementation teams. Narrative inquiry is a qualitative research methodology which aims to develop rich descriptions of an individual or group of individuals, usually marginalized in some way, regarding their lived experience as a member of the group of interest (191). Crafting a rich description of an eHealth intervention's impact on a rural community through narrative inquiry provides implementation teams with a holistic appreciation of an intervention's wider impact, as well as well articulated leverage points to target which can influence an implementation as-it-happens. The implementation science frameworks which have seen deployment in multiple contexts and can help frame the information obtained from narrative inquiry in ways relevant to implementation.

When discussing the mechanism of an intervention, implementation science and narrative inquiry are leveraged as the methodologies of choice. Implementation science frameworks can help an implementation process by articulating challenges or barriers to implementation and incorporate pragmatic steps to combat them. Narrative inquiry can help elucidate a mechanism through the sentiment of an intervention's population.

Questions to be asked and answered during the *influence* component of the CDCT include:

1. Given the current state of the intervention, how would your interactions change with more choice in access or use of the initiative?
    a. This question is relevant to both patients and providers.
2. Do you feel your feedback as a user of this intervention is being sufficiently addressed? If not, is there a channel or method of feedback provision you would like integrated into the intervention?
3. Which components of the intervention are most important to your use of it?

These example questions are meant to be guiding in nature, with other questions relative to the *influence* process applied in a pragmatic capacity. The key question to be answered during the *influence* component of the CDCT is how can optionality, non-linear evaluation approaches, or hybrid leadership be introduced into the implementation to better improve the uptake of the intervention?

Narrative inquiry is a qualitative research methodology which aims to develop rich descriptions of an individual or group of individuals, usually marginalized in some way, regarding their lived experience as a member of the group of interest (191). Narrative inquiry differs from ethnography as ethnographic lived experience is usually ascertained through observational methods by the researcher. Narrative inquiry can be seen as one step further regarding richness of description, where in-depth interviews with knowledge partners help explain behaviour or attitude from the perspective of the interviewee. This is a strong way to develop vivid depictions of an interventions effect on a target population, when the population is small (making statistical analysis incomplete or difficult to rely on).

#### 6.3.1.3 Interpret

Interpreting outcomes is the third key facet to composite design theory. To do so, realist evaluations and ethnographies are used to gain a wide a perspective as possible with regards to how cause and effect. As the value of ethnography and realist evaluation was covered extensively in Chapter 4, it does not bear repeating. To briefly reiterate, organizations which engage in these methodologies and their outputs, such as program theories and narrative accounts, can leverage these outputs to further influence the mechanism of action of an intervention, such as a rural electronic health initiative.

Ethnographic accounts and realist evaluation are two methods which offer implementation teams conceptual slack in their interpretation of outcome data. A full list of guiding questions which should be asked by implementation teams during this stage of the CDCT can be found in Appendix G. Adhering to the non-linear evaluation recommendation of antifragile design, an ethnographic account puts emphasis on understanding the lived experience of patients and providers as it is relevant to an intervention. Qualitative information captured through ethnography can suitably supplement quantitative data (such as utilization rates) and help implementation teams guard against suboptimization, emergence, and non-linearity.

Similarly, realist evaluation seeks to answer the question *what works where, and for whom?* The strength of this method is conceptualizing an intervention as a function of its context, mechanism, and outcome. Indeed, the basis of the CDCT is predicated on this interpretation of an intervention, with the *inform, influence,* and *interpret* stages of the CDCT associated with the context, mechanism, and outcome respectively. A program logic derived from data collected during the *inform* and *influence* components of the CDCT also helps answer the question *what works where, and for whom?* Which further acknowledges the importance of context and diversity between, and within, rural sites.

Questions to be asked and answered during the *influence* component of the CDCT include:

1. How does this outcome data correlate with the qualitative data collected in the *inform* and *influence* stages of the CDCT?
2. Do the behavioural changes created by the implementation of the intervention seem sustainable? What key institutional investment indices can help sustain these changes?

3. Acknowledging the context of the implementation, how did organizational, sociological, or cultural structures influence the outcome data?

These example questions are meant to be guiding in nature, with other questions relative to the *interpret* process applied in a pragmatic capacity. The central aspect being addressed by the *interpret* component of the CDCT through the questions above is how this intervention can sustain by avoiding suboptimization. Further, framing outcome data in the context of the community (it's history, it's demographics, etc.) may reveal other consequences of the implementation through non-linear evaluation.

Raw outcome data is hard to integrate meaningfully into an implementation effort because it says little about the cause and effect of an intervention. It is a gross oversimplification to say that an intervention changes behaviour of it's intended population – rather, it provides individuals with resources and choice, which if sustained leads to a reflection and change by the individual. Any outcome which seeks to simply measure the change in behavior as a singular metric will occlude the true mediators of behavioral change, and risks incentivizing or disincentivizing the incorrect components of an intervention.

#### 6.3.1.4 Iterate

Lastly, the organization must have the capacity to iterate their process of informing, influencing, and interpreting their interventions, with antifragile principles in mind. A full list of guiding questions which should be asked by implementation teams during this stage of the CDCT can be found in Appendix G. The ability to iterate requires keeping initial interventions small in scale, allowing room for flexibility and project agility, and awareness of unintended consequences of implementation. To better iterate, reflection and the matrix of scale are important tools to have available to an implementation support team. Reflection is important in

the iteration process because it mandates a pause to the high-pressure nature of implementation, allowing for discussion about what has worked and what hasn't. Often, organizations are fixed in a permanent state of 'putting out fires.' This colloquialism refers to the fact that there is always another thing wrong with an intervention, service, or institution that requires the attention of its most burdened agents. Reflection helps the organization as a whole understand *why* these fires seem insatiable and highlights potential organizational strategies borne out of sense-making to combat them.

Questions to be asked and answered during the *iterate* component of the CDCT include:

1. What are the core components of the intervention? What are the peripheral ones? From the data collected in the *influence* component, how can we promote the important components of our intervention?
2. Are there agents within the system who we enroll as champions? Are there policy mandates we can align our project with? Is there a logical way to introduce choice to our intervention? Have we sufficiently integrated bottom-up information? Does our evaluative approaches survey other parts of the system? etc.
3. Does our project risk path dependence?

These example questions are meant to be guiding in nature, with other questions relative to the *iterate* process applied in a pragmatic capacity. The questions are conditional to the trajectory of the project as determined by its place on the matrix of scale, discussed shortly. Ultimately, the data collected in the three previous steps of the CDCT should form the priority questions of implementation teams at the *iterate* stage of the CDCT.

Reflection should occur both individually and organizationally before implementation iteration. Ideally, it occurs at both a macro and micro level, and allows an implementation team

to candidly take stock of their acute situational needs, future challenges, and past operations to create a tangible approach to future implementation efforts. To that end, the matrix of scale (expanded on below) is useful following an implementation iteration in understanding the state of a project's antifragility and the extent of institutional investment afforded to it. By using the matrix before an implementation team begins further iterations of the composite design cycle, they can identify whether their assumptions regarding the inform, influence, and iterate stages of the cycle were correct, and how to adjust them moving forward. By using the matrix and composite design cycle concurrently, the probability an intervention succeeds increases.

By understanding an organization's ability to follow and utilize the composite design cycle, reasonable conclusions can be drawn regarding the capacity of the given organization to implement an antifragile intervention. From following the composite design cycle, organizations should be able to deploy antifragile electronic health initiatives, which have a greater probability of sustaining and scaling to other contexts. Applying the six identified methodologies, and their outputs, throughout an implementation process will yield an antifragile program which incorporates optionality for it's end users (both patients and providers), feature non-linear evaluation, avoid sub-optimization, involve a hybrid model of leadership, and account for self-organization, emergence, and irreducible complexity. Such an intervention can then thrive in further rural contexts, sustain within these settings, and provide benefits to patients who experience inequity in healthcare access.

#### 6.3.1.5 Position in a policymakers tool box

The organizational readiness toolset is a sometimes-crowded space for policymakers. Comprehensively assessing organizational potential is equal parts an art and science, which requires sensitivity not only to practical characteristics of hard work and capability, but also

intangible concepts such as creativeness, invention, and vision. With reams of research, and an enhanced sense of importance placed on understanding where to allocate limited grant dollars, policymakers seeking effective organizational readiness tools can be paralyzed by choice. What sets the CDCT apart from similar tools is the inherent acknowledgement of the impact complexity has on decision-making. This complexity is inherent to the cycle, with care taken at each turn that organizations adequately account for it in their decision-making. Indeed, the ultimate end-goal of the CDCT is to produce initiatives which can thrive from the uncertainty, instability, and complexity which is inherent to implementation in health systems.

Additionally, the appreciation of policy context differentiates the CDCT from other tools. Policymakers are sometimes approached by organizations or private corporations with the lead 'this is a solution you need'. Divorced from the proof of concept or quality improvement report presented as evidence for said solution is an evaluation of policy context for it. The political tension for results, regardless of comprehensive due diligence, is enough to force policy-makers hand before an appropriate evaluation of context can be completed. The CDCT introduces some responsibility into procurement of eHealth interventions by prioritizing an evaluation of context – which includes a discovery of the history of an intervention and its accompanying setting. By forcing decision-makers to look before they leap, it minimizes the exposure to risk, and increases the potential an intervention is not only appropriate for its context but also that it could scale to other settings.

Further, policymakers are often confronted with the cynical realization that what may be good for the system over time does not align with shorter term political goals. Savvy policymakers often must compromise with shorter term goals when attempting to reform or construct policy which address system shortcomings over the long term. Democratic nations,

such as Canada, must craft policy with the spectre of politics constantly intervening in decisions and directions. Operating under these conditions only reinforces the need for a tool which can account for the technical facets of decision-making, and one where capturing and understanding public sentiment is a strength with regards to satisfying political demands. The qualitative methodologies of ethnography, narrative inquiry, and realist evaluation can promote the perspectives and views of the 'public' more thoroughly than purely quantitative approaches. This sentiment is referenced in political parameters already in policymaking, and instead of trying to control for that, the CDCT places it firmly in the readiness assessment, allowing for solutions which satisfy political demands while also benefiting the system over the long term.

Taken altogether, assessing organizational capacity to engage in antifragile design depends on their ability to follow the composite design cycle. Namely, the ability of an organization to *inform*, *influence*, *interpret*, and *iterate* throughout an implementation process corresponds with antifragile design. By using realism and complexity science to inform their implementation, implementation science and narrative inquiry to influence their intervention's mechanism, ethnography and realist evaluation to interpret the outcomes, and the matrix of sustainability and scale to iterate their implementation efforts, antifragile interventions can be derived. These '4 I's' of the CDCT combine outputs of six important methodologies, without adhering or restricting the process to one. While the methods seem numerous, implementation teams can be selective in the components of the methods they use and adjust them as the implementation process progresses. As already mentioned, no implementation process is the same, and hence the methods and strategies used will be different as well. By playing to a methods strengths and using separate methods at the different stages of implementation, a project can deal with the inherent complexity in healthcare, from its design to its evaluation.

To further illustrate the effectiveness in producing antifragile eHealth projects derived from the cycle, consider the following example of eHealth implementation during COVID-19. Small rural community hospitals became centres for information, treatment, and service during the first wave of the COVID-19 pandemic. These centres subconsciously used complexity science and realism to inform themselves and others on the salient aspects of eHealth implementation during the initial lockdowns (27). Recall, complexity science is useful as an informative tool, as it can tell us a bit about most facets of a system but lacks the depth to provide definitive information about a particular subsystem. Complexity science is descriptive in nature and excels in framing problems specific to a particular intervention. It works in tandem with realism, because realism recognizes that cause and effect in social systems will always be mediated by variables which may or may not be apparent to researchers. By using both these methods, and playing to their strengths, implementation teams can explore the nuance of their unique situation and begin to design their project accordingly. This initial design phase should be undertaken with antifragility as a priority (where possible).

In this example, complexity science would point to the importance of monitoring for unforeseen consequences in an implementation. Rural health centres guarded against this by monitoring their changes through established communication channels with both patients and providers. Patients could provide feedback to changes in standard practice through social media, which was monitored more closely with the change to eHealth initiatives seen throughout rural communities. Further, many rural community health centres began shifting a majority of their resources to online intake and support. This meant more time spent answering phones and interacting with patients through online portals (if one was available). Allied health and providers were acutely aware of shifts within the system and were guarding against problems

which they may otherwise not have noticed or considered. Rural health systems influenced the mechanism of their care through understanding and prioritizing the lived experience of there patients.

Rural health systems are still in the process of interpreting their outcome data and iterating their implementation processes as the COVID-19 pandemic persists. Organizations which followed components of the CDCT (informing, influencing, interpreting, and iterating) will likely see the eHealth programs deployed to mitigate health access challenges during COVID-19 sustain within their contexts. Whether followed consciously or not, the CDCT recommends powerful qualitative methodology, and the compilation of the outputs of these methodologies will provide rich descriptions of antifragile operators and their presence within the implementation. Implementation teams can then incorporate the data from the CDCT in subsequent iterations of implementation, with guidance from the matrix of scale.

### 6.3.2 Component 2: The Matrix of scale

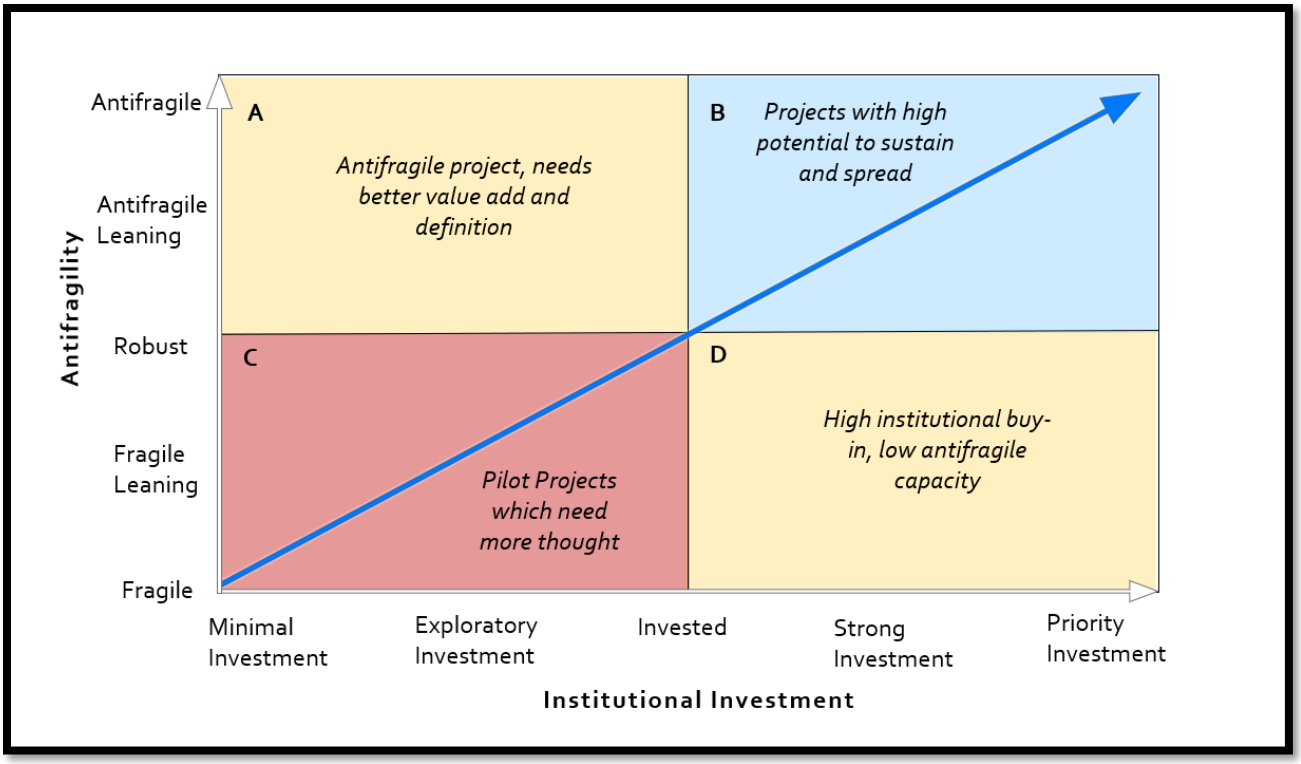
The MS **(Figure 10)** maps pilot project outcomes at the iteration stage of the CDCT into four quadrants, each with different recommendations in how to proceed in the next iteration of the implementation process. It is a tool meant for implementation teams as well as policymakers to understand where an eHealth initiative is strong, where it requires more thought, and potential challenges or barriers which could appear as the implementation progresses. The MS was developed through an NVivo © analysis of relevant literature to create the overall matrix, as described in Chapter 4. The outputs of this analysis were seen in Chapter 5. In particular, **figure 19** was influential in synthesizing the Matrix of Scale.

The matrix is designed with simple *x* and *y* axes. Along the *y* axis is *antifragility*, which is measured on qualitative a scale of fragile, fragile-leaning, robust, antifragile-leaning, to

antifragile. The score is assessed using keyword analysis of project proposals and published literature, and prospectively can be evaluated through embedment within the implementation teams. The antifragile operator coding protocol (appendix B) served as reference for evaluating antifragile content within a program's documentation. The $x$ axis represents *institutional investment* and was largely be defined as the organizations resource allocation, belief in success, and interest of a given project. Like the antifragility axis, institutional investment indices coding protocol (appendix B) was referenced to guide evaluation of institutional investment content.

The four quadrants of the matrix correspond to the general trajectory of an eHealth initiative at a given stage of implementation. Quadrant **A** represents projects which have a high antifragile score, but low institutional investment. Generally, this corresponds to the project doing a poor job of signalling it's importance in addressing gaps in practice and service. Projects in this quadrant should focus on their evidence for value added to a given system. Quadrant **B**

**Figure 23: The matrix of scale. Quadrants A, B, C and D represent different trajectories of eHealth initiatives.**



represents the strongest projects, which have both high antifragile scores and ample institutional investment. These projects should be prioritized by policymakers as they have the strongest potential to scale and sustain. Quadrant **C** represents projects which have high institutional buy-in, but poor antifragility. This is not necessarily negative, as resources can sometimes overcome fragile project design. However, it is the most precarious quadrant, as projects here could potentially fail despite massive resource utilization on behalf of institutions. Path dependence becomes intractable in this quadrant and should be guarded against. Quadrant **D** represents initiatives which are in their early days of design and should be strengthened in order to be seriously considered in other contexts.

The **blue line** intersecting represents balanced projects, where significant deviation from the line signals strength or weakness in one axis or another. Initiatives which fall above the equilibrium are stronger antifragile projects, and once which fall below have better institutional backing. Through the use of the MS, an understanding the shortcomings of a given initiative can be visualized to better approach the iterative nature of implementation, eventually moving a project closer to the line of equilibrium.

#### 6.3.2.1 Quadrant A: Strategy Includes Demonstrating value-add to the Institution and Decision-Makers.

In this quadrant, projects have sufficient antifragile indication, but lack institutional investment. Institutional investment is attracted through the institutional investment indices explored in (Table 1:The institutional investment indices. The presence of Champions, Policy-alignment, funding, follow-up and support, and utilization indicate the investment of an organization or institution has for a given eHealth project in a rural community.) Even if the intervention has secured investment through funding and support for initial pilot project

implementation, there must be continued efforts to display how an intervention has affected the outcome of interest, and further how this effect has resulted in better value for the organization where it is implemented. This is usually accomplished via mix-methods approaches, wherein quantitative data regarding intervention utilization and subsequent system effect are combined with qualitative data such as interviews explaining how the intervention has brought about meaningful change.

If an implementation team has conducted their analysis through the deployment of coding protocol to their documentation and found their project in quadrant A within the matrix of scale, they should seek to better signal their value of the intervention to their institution. Where possible, the value should be shown without sacrificing what makes the intervention antifragile, however acceptable trade-offs can be made in this quadrant to secure sufficient funding and investment. It is irrelevant how antifragile a project is if there is no concrete pathway for its implementation due to a lack of funding. Pursuant to the need for trade-offs between antifragile operators and investment, funding is the ultimate dictator of a project's direction. Securing institutional investment is the primary priority for implementation teams, and it they must account for a larger top-down approach in implementation then they would necessarily like in order to secure said funding, that is a necessary step. In this quadrant, next steps for implementation teams include: providing a mixed methods assessment of value add for the institution, aligning their intervention with institutional priorities, articulating the place of their intervention in system reform or adjustment of standard practice, and/or enrolling a champion to endorse and promote their intervention.

#### 6.3.2.2 Quadrant B: Stay the Course: But be Cognizant of the Imposter of Success

When Rudyard Kipling wrote in his poem *If* – *"If you can meet with triumph and disaster, and treat those two imposters just the same*" – it was unlikely he was referring to eHealth implementation in rural communities. Nevertheless, that sentiment rings true for implementation teams who find their project in quadrant B. Here, projects have high levels of institutional investment, while also displaying remarkable levels of antifragility. In theory, these projects will have a higher *likelihood* of scaling and sustaining, but nothing is guaranteed. Just as Kipling noted – success can sometimes be an imposter, and it is important for implementation teams to maintain the course while allowing for sudden uncertainty or instability to influence an otherwise stable implementation. There is no empirically validated way to do this, besides being pragmatic and respond to adversity piecemeal and as it arises. Projects with high levels of antifragility as well as high levels of institutional investment will be situated in a better position to handle the unforeseen challenges of implementation which commonly becomes apparent as an implementation progresses.

Ultimately, if a project is aligned with quadrant B within the MS, it is important for implementation teams to not rest on their laurels. Referring to the CDCT, the cyclical nature of its application ensures that teams are constantly monitoring and reassessing the implementation process and the intervention they are applying the CDCT to. Even if during the *iterate* stage of the CDCT an analysis is conducted wherein their project lands in quadrant B, through the next cycle of the implementation something may change which is then reflected in the position of the project on the MS. Policy priorities may have shifted, or a key patient or provider champion may have departed from the intervention. Indeed, the list of possible fluctuations which can affect an implementation approach infinity. Implementation teams engaging with the antifragile design

portfolio would be wise to recognize the speed in which things can change and resist the urge to remain static in their approaches.

In quadrant B, next steps for implementation teams include further monitoring of interventional impact (through a mixed-methods approach), scanning event horizons for macro events (change in leadership, change in policy) which could have secondary effects on an implementation, and adhering to strategies which have shown success in their implementation to the point of their initial evaluation. Teams in this quadrant should also be open to the idea of adjusting their approaches – just because strategies or techniques have worked in the past are no guarantee they will continue to work into the future.

#### 6.3.2.3 Quadrant C: Back to the Drawing Board: But Don't Give Up

Projects in the quadrant C have low antifragile markers, as well as low institutional investment. Projects in this quadrant are likely a few strategy meetings away from being realized in any tangible fashion. The question for teams who find their projects in this quadrant is which axis they should prioritize: antifragility or institutional investment? Referring to the discussion regarding projects in quadrant A (high antifragility, low institutional investment) investment is rather more important than a projects antifragility. Without sufficient buy-in from an organization, or commitments from an institution, no amount of antifragility can overcome minimal or negligible investment.

Regardless, projects in quadrant C have low displays of both antifragility and institutional investment. This means that the program or electronic health intervention in question has not proven its fidelity in altering outcomes, or the projected need for the intervention is not as strong (or the case for it should be strengthened) by the implementation team. Implementation teams in this quadrant have relative freedom in how they can approach the design of their electronic

health program moving forward. Teams can prioritize a programs validity (both internal and external) while also choosing where antifragile operators can be leveraged. It is rare for programs to move from quadrant C to quadrant B in one iteration of implementation. Tinkering and adjusting after each implementation will likely be required in order for a program to display both high levels of antifragility and institutional investment. Implementation teams whose projects land in quadrant C therefore should first see how they can maximize their eHealth projects value on one axis or another, not both concurrently. Allowing for multiple iterations to shift an eHealth project from one quadrant to another allowed for diligence and nuance in eHealth project component adjustments.

Tangibly, implementation teams can shift their project from quadrant C by improving their eHealth interventions fidelity, displaying high levels of internal and external validity, ensuring antifragile operators are part of the design by including necessary language in program documentation, and exploring ways to align their project with policy mandates.

#### 6.3.2.4 Quadrant D: Implementation Teams Beware! Project Death has Rewarded Many a Careless Traveler Following Path Dependence

Implementation teams who conduct their analysis at the iterate stage of the CDCT and find their project within quadrant D should be concerned with the trajectory of their intervention. Programs which land in quadrant D have high levels of institutional investment, but low displays of antifragility. When initiatives are in quadrant D, the problems of path dependence become chief concern in further iterations of the implementation process. *Path dependence* is the continued implementation or installation of policy or programs, usually based on sunk cost or broader policy alignment, in contrast to the interventions or policy's impact on targeted outcomes. Path dependence is a danger to implementation teams, as programs which have high

amounts of investment usually have a vested interest to succeed by policymakers and decision-makers. If that program is fragile in nature however, the uncertainties and complexities common to implementation and documented throughout this dissertation, then investment may fall short of scaling and sustaining a project.

Teams who find their project in quadrant D should focus on incorporating antifragile operators into their subsequent implementation iterations. This could be done by introducing optionality in how the target population interacts with the intervention, embracing bottom-up perspectives on the intervention's implementation, and conducting a system mapping exercise to understand if the intervention is jeopardizing the efficiency of other parts of the system. By incorporating tangible facets of antifragile design, implementation teams can progress closer to the blue line of best fit, and move from quadrant D to quadrant B, wherein a project is invested, antifragile, and has potential to scale to other contexts.

## 6.4 Findings and Alignment with Research Questions

This section will explicitly link the findings of this dissertation to the research questions outlined in Chapter 2. The overall findings are multifaceted, with significant motivation for positive findings supplied in this dissertation, but also in published peer-reviewed papers, knowledge translation material (reports and infographics), and conference posters and presentations. These findings are primarily based on the thematic synthesis conducted to inform the evaluative MS framework, a scoping review on patient and provider attitudes toward eHealth integration and implementation, and ethnographic data regarding rural research and methodology to investigate organizational readiness (CDCT).

### 6.4.1 Can eHealth address the gaps in service provision experienced by rural communities?

eHealth has been heralded as a potential avenue to improve access to health services by rural communities. eHealth initiatives have been shown to alleviate the difficulties of receiving specialist treatment, lessens the loss to follow-up seen in treatment regimens, and eases regular wellness visits or check-ins with primary care providers. Rural populations do not see the same access to care available to urban centres. Much of this is systemic, intractable, and necessary to a 'spoke and wheel' model of care which has demonstrated efficiency and success. What this research advocates for is not the reform of the model itself, but better representation and support of eHealth in rural communities as access points. This shift will allow for better surveillance of disease, better compliance for treatments, and secondarily more data for research of rural influence on health and well-being. Regardless of the potential impacts eHealth initiatives may have in theory on rural health access, they must align with rural attitudes and beliefs in order to have successful implementations.

eHealth has been utilized by a wide range of health service areas to increase accessibility, including for specializations such as dermatology, neurology, and cardiology, as well as primary care and diagnostic testing. The variety of use, as well as the increased levels of use, signifies a recognition by researchers and providers of the potential eHealth has. Understanding values and attitudes of eHealth is separate from the established interest in eHealth however and was also considered within this review.

### 6.4.2 Can antifragility provide insight regarding implementations in organizations and allow for initiatives to scale and sustain in other contexts?

Broadly speaking, this dissertation provides further evidence that antifragility, when used in tandem with other methodologies, can provide tangible positive results regarding implementation in rural contexts (15,27,28). Conceptualizing rural health systems as complex adaptive systems

means implementation within these systems requires vision and principles which can mitigate some of the characteristics of CAS. In *paper two*, antifragility was established as an effective design method which has the vision and principles to allow for an eHealth intervention to gain strength from uncertainty. Antifragility has been applied in other domains of health sciences, and my doctoral research has contributed to understanding how antifragile operators can improve rural eHealth implementation.

### 6.4.3 Can the link of theory and practice in the form of an organizational readiness tool and evaluative framework help organizations and policymakers establish a baseline for iterative implementations?

The antifragile design portfolio is the link between the theory and practice questions regarding antifragile design being a viable implementation principle, and eHealth addressing health equity gaps in rural systems. The CDCT and MS, when deployed in tandem, support rural implementation teams in measuring the presence of antifragile operators within an intervention and providing direction for iterative implementations. The antifragile design portfolio is the first rurally derived and tailored framework, to my knowledge, for rural eHealth implementation. This is an important note, as the recommendations of the antifragile design portfolio can help reflect the difference in rural health policy and engaging in a strengths-based approach will bolster confidence and buy-in from rural stakeholders. The antifragile design portfolio effectively combines two proven factors which can help address health access inequity gaps, leading to better health outcomes of rural communities.

## 6.5 Conclusion

The findings of this dissertation can be delineated into three parts. The first is that eHealth integration into rural health systems can address health access equity gaps between rural

and urban communities. The second is that antifragility is a viable design principle which can improve implementation process and increase the chance an eHealth intervention sustains and scales in a rural community. The third is operationalizing the first two findings, in the form of the antifragile design portfolio for rural eHealth implementation. Comprised of two components, the composite design cycle theory of organizational readiness for antifragile deployment (CDCT) and the matrix of scale (MS), the antifragile design portfolio is distinctly rural in its creation and target.

The CDCT is a 4 part, iterative process where an organizations ability to deploy an antifragile eHealth intervention is assessed through it's ability to *inform, influence, interpret* and *iterate* throughout an implementation process. The MS, utilized at the *iterate* stage of the CDCT, provides implementation teams direction in iterative deployment. The MS positions eHealth initiative trajectory as a function of antifragility and institutional investment. It is based on content analysis adhering to *a priori* coding protocols (appendix B) derived from ethnographic observation, case studies, components of a realist evaluation and influential implementation science frameworks. Taken altogether, the findings of my doctoral research address access and equity problems highlighted by Canadian federal policymakers, rural stakeholders, and healthcare providers which will ultimately improve healthcare access in rural communities, and better outcomes of rural populations.

# Chapter 7: Discussion

## 7.1 Antifragile Design and Organizational Change

Part of implementation is necessary change to accommodate a new model of care, new technology, or new protocols. This requires acceptance of change, and proactive organizations will perform due diligence before an implementation to understand the acceptance of this change. Organizational change has been a subject of research interest in business, and recently these principles have been applied to healthcare (192). The antifragile design portfolio can help manage organizational change.

It is here then antifragile design's strength can be reasonably articulated. If the logic of organizational change and innovation requiring an environment resembling the edge of chaos is to be followed (as discussed in Chapter 2), then there needs to be a rules-based system which allows for a suitable amount of disorder. The nature of the rules being derived from implementation in healthcare means that the disorder incurred by this rule set will be tolerable for healthcare organizations in Canada and other universal systems. It helps create the edge of chaos which has been documented to encourage innovation, and further diffuse innovative techniques to broader levels of organization.

Better still, antifragile design has tangible outputs and markers aligned with methodologies such as narrative inquiry, realist evaluation, ethnography, and realism. The CDCT stage of *interpret* encourages implementation teams to evaluate these outputs as pursuant to their implementation – introducing the often invoked 'context is king' insight regarding implementation process (132). Information from these outputs will establish organizational parameters, signal the appropriate amount of disorder which can be endured by the system the

eHealth intervention is being implemented into, and provide directions for the next round of implementation process – *iteration*.

As Ray Pawson, one of the fathers of realist evaluation, has noted – *"the simple antidote to complexity is for inquiry to be iterative*"(132). This is further accounted for in the CDCT. Each implementation is traditionally seen as a one-off effort, to be taken back to some policy lab to be analysed, autopsied, and in some cases interred for an indeterminable period. The CDCT takes Pawson's quip to heart – implementation efforts are cyclical. Understanding the presence of complexity *and* sufficiently planning for it's influence in one attempt at implementation is akin to blindfolding a sailor in the middle of a gale and telling him to hit a 20 square foot island 10KM away in a small skiff. Teasing out the nuance and richness present in rural eHealth implementation requires sufficient understanding of a contexts history – *inform* in the CDCT – and room to *iterate* implementation efforts building on an understanding of that history as well lessons learned from an implementation process.

To properly engage with antifragile design, and to get the most value out of its range, the eHealth project to which this principled approach is applied must satisfy several requirements. The first is that the project in question is proven in its ability to affect outcome or has had success in other controlled environments. Antifragile design is inappropriate for a brand-new model of care, or in trying to understand which components of an eHealth intervention correlate to change in outcome. Antifragile design assumes that the eHealth project being implemented has displayed inherent value, both to the system and to patients interacting with it.

Secondly, antifragile design is most impactful when there are substantial sociological considerations accompanying the implementation of the eHealth initiative. Projects which have a more clinical axes of control, such as telerobotic surgery, are not as respondent to antifragile

operators because of the high levels of importance on the technological aspects of such an intervention and implementation. No amount of optionality will influence the correct way to operate a robotic arm in tele-surgical environments.

Thirdly, the alignment between antifragile portfolio outputs and interventional components should be as clear as possible. If stakeholders cannot understand the impact of applying antifragile indicators, their effects should be distilled in such a way which makes them pragmatic in nature. Research teams employing antifragile approaches should spend time formally developing integrated knowledge translation channels and strategies so that the tacit knowledge articulated by antifragile design is appropriately disseminated and understood.

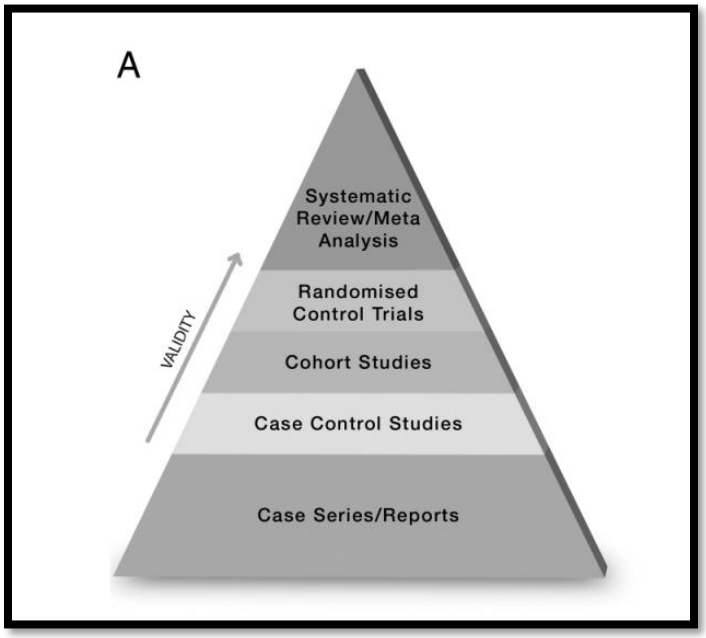
If these three parameters are met, then it is appropriate to deploy the antifragile design portfolio. The portfolio can help incur organizational change by providing a tolerable amount of 'chaos' into a healthcare system, while maintaining a strict set of rules regarding this chaos (presence and incorporation of antifragile operators). It is in this state where organizations move from stasis to fluidity, and innovative practices can freely diffuse. The antifragile design portfolio is uniquely poised to facilitate innovation, improve implementation, and ease organizational change.

## 7.2 Assessing Evidence for Rural Communities and Health Systems: Expanding Evidence Based Medicine

Evidence-based medicine (EBM) has been the dominant paradigm of health policy formulation since the Canadian healthcare system has been in its infancy (193,194). Although not formally described until 1979 (195), EBM had dictated the treatment of patients centuries before. Intuitively, it makes logical sense to adhere to practices which have the best outcomes. Collating those practices and disseminating them is the foundation for the now widely accepted

EBM policies put in place not only in Canada, but also globally. EBM relies on an agreed upon pyramid of evidence (194) (**Figure 12**) which places systematic reviews at the top of the pyramid, and expert opinion on the bottom. When trying to discern best practice, it is integral that systematic reviews and randomized control trials are given the most consideration, while expert opinion is referenced sparingly.

**Figure 24: The pyramid of evidence validity.**
**Adapted from Murad et al.**




EBM is necessarily a diligent and slow process. Systematic reviews and meta-analysis take time to complete as they require a comprehensive review of extant literature. Case series and reports however, at the bottom of the pyramid, are faster and less laborious to complete. Although the evidence they contribute to policy iterations may be relatively anecdotal, when it is the only evidence available, it is still useful in framing policy gaps and problems which need to be addressed. The COVID-19 pandemic required an agile response, and policymakers needed to provide direction with little precedent available. This corresponds with the low-rules

environment perspective discussed by the Falk report regarding eHealth implementation and utilization during the third wave of the pandemic. Rural communities are poorly served by the current model of health policy (50,76,196), as statistical limitations such as population size, poor granularity in existing data, and limited resources mean that the highest levels of evidence are hard to produce for rural communities (76). The result is the application of policy derived from other contexts and evidence, ignoring the diversity of rural environments, and leading to poorer outcomes (197).

It warrants discussion regarding reforming the EBM pyramid to reflect the realities of implementation during COVID-19, as well as address challenges of healthcare research within rural settings. EBM and its influence on policy should be adjusted to account for rich qualitative work and case studies, such as narrative inquiries and realist evaluations. These qualitative analyses yield important information regarding rural mechanism of action for non clinical interventions. Recall, realist evaluations seek to understand the context, mechanism, and outcome of certain interventions (32,133). These evaluations attempt to account for the complex social layers which are present in any social programme, including healthcare interventions (198). Narrative inquiry has a focus on the lived experience of participants, and places them at the centre of any research attained from said experiences (199). Possessing qualitative rigor in their approach and outputs (200,201), they should occupy their own level within the pyramid, and be valid references for policymakers. Especially in times where tension for change is overwhelming, and evidence to guide it is sparse.

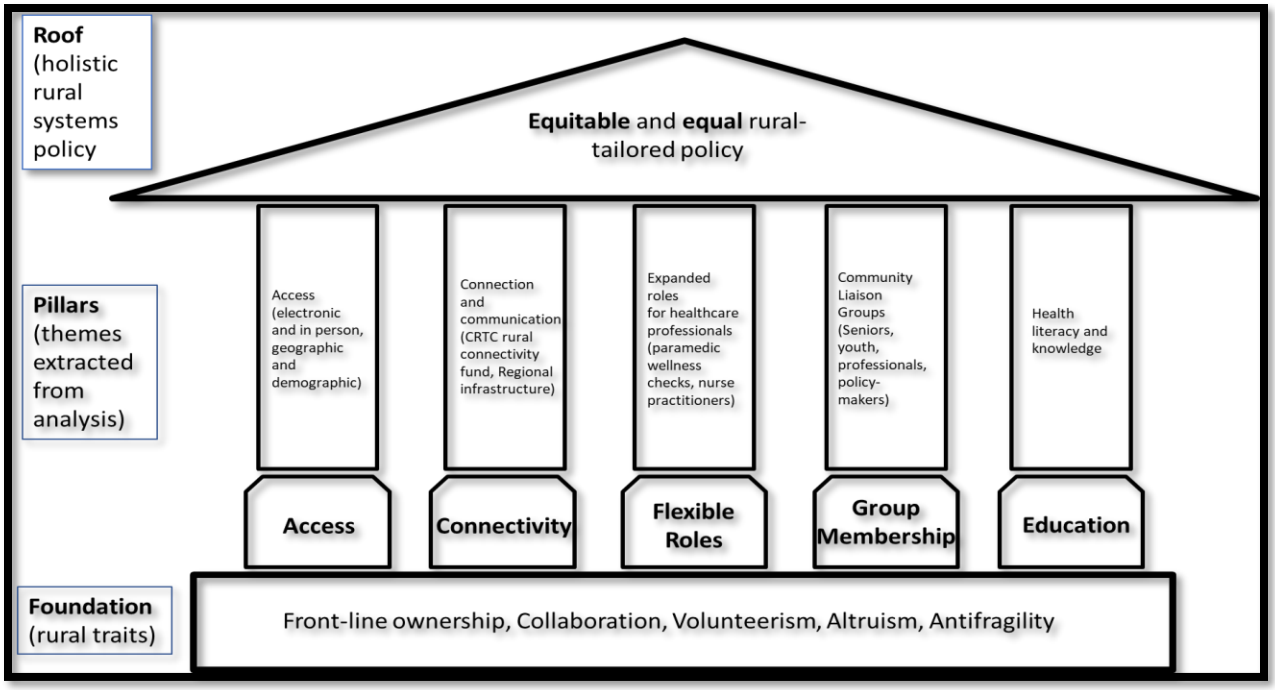
Incorporating different facets of evidence into the EBM model will allow for stronger overall body of health system policy, and will help bridge the gap in equity and equality of healthcare access for every Canadian; regardless of urban or rural resident status. The Canadian

Medical Association (CMA) has highlighted the need for place-based health policy to address the equality and equity of care in Canada (54). Without appropriate research paradigms which meaningfully address the difference in rural contexts, impactful policy will be hard to craft. Reflecting the difference of healthcare in rural settings is important in creating policy which serves rural communities better, instead of urban derived protocol associated with urban studies and methodology. My doctoral research uses results from narrative inquiry and ethnography regarding rural innovation during the COVID-19 pandemic (27) as evidence for the potential of qualitative methods, and argues for a reform to EBM in rural health systems to inform more cohesive statutes of rural health policies. The antifragile design portfolio operates on a strengths-based approach of rural research, prioritizing lived experience and qualitative data to better implement rural eHealth initiatives.

### 7.3 Towards Place-Based Health: Impacts of Findings on Creating a Place-Based Health System

**Figure 13** is a representation of what equitable and equal rural health-tailored policy could become with reasonable reform derived from the strengths of rural settings. It was derived from the focus group consultation with rural residents in Golden Lake, Canada (5.3), as part of the Free Range knowledge exchange program. This diagram showcases the difference in rural contexts and reframes which are traditionally seen as disadvantages. This is the larger rural place-based health system reform which could arise from the adoption of eHealth and antifragile project design within these communities. Rigorously exploring the multifaceted pillars supporting reformed rural health policy is outside the scope of my doctoral research but provide intriguing future directions and targets for other research building on antifragile eHealth project design and the antifragile design portfolio.

**Figure 25: A theoretical health system based on reform. Rural traits serve as the foundation, wherein themes gathered from focus group consultation in Golden Lake, Canada are built. The roof is a holistic rural health system policy.**




This place-based health approach is of note for a few reasons. The first is the implicit role eHealth would play in fostering, sustaining, and shaping a place-based health environment. Appropriate surveillance and treatment would be more readily available through the utilization and implementation of eHealth initiatives. These eHealth interventions would decrease the lag time in patients seeking care from providers, allow providers to appreciate the specific contexts of patients, and tailor their care meet these unique needs. Care which is appropriate culturally at an individual level will contribute to better outcomes at a population level. The incorporation of eHealth into health service provision can inform policy in other settings, with an emphasis on the personalization of medicine and medical treatment. Problems which are particularly pronounced in rural contexts (loss to follow-up, compliance to treatment, tyranny of distance) are mitigated by the implementation of eHealth.

Like many decisions, implementing eHealth to better account for the effect of place requires trade-offs and compromise. Pre-COVID-19, rural residents harboured reservations towards online services. As seen in 5.2.4, sometimes the innovative implementation of electronic initiatives in rural places is seen as harmful, such as the transition of banking services from in person to online in Robertstown, Australia. While basic tasks and questions could be addressed through this online medium, more nuanced and complex issues were harder to tackle. The movement of service into online structures wasn't met with the enthusiasm of convenience that policymakers wrongly assumed would lead to the services adoption. Following an antifragile approach, rural residents should be provided with *options* in how they manage a diagnosis. This *optionality* can have expanded parameters with the incorporation of eHealth into standard practice in rural communities.

Implementing eHealth needs to be done in a fashion which respects the place of its implementation, and the intervention should build on existing infrastructure (where possible). While COVID-19 has done much to dispel the resentment regarding online or electronic service, there still exists a vocal minority who want to repeal the online strategies adopted through the pandemic. Where eHealth was implemented hastily, it should be adjusted to account for the distinctive considerations of its context, not completely rescinded in favour of pre-pandemic practices.

eHealth is usually billed as a method of health systems extending their reach to populations which have traditional barrier to access. Through eHealth interaction, there is better management of existing conditions, monitoring for change in patient well-being, and better workflow for clinicians and allied health. The COVID-19 pandemic introduced worries of unintended consequences of hospital restrictions such as cancelled elective surgeries and reduced

out-patient services. Worsening outcomes for patients with heart failure and cancer were raised by specialists in these areas of medicine. Interestingly, preliminary research regarding the increased diagnosis of cancers and adverse events for heart failure patients have yet to materialize (202).

### 7.3.1 eHealth, Through Complexity Insights and Antifragile Design, Can Contribute to a Place-Based, Collectivist Health System

The Canadian health system was an international model of excellence for a universal payer scheme wherein all Canadians, regardless of sociodemographic status, had equal and equitable access to quality healthcare when they needed it. In the past two decades, the Canadian health system has fallen behind its G8 peers in this regard (44), and the COVID-19 pandemic has made it explicit that the system is in need of widespread reform to continue achieving its goals (203). Mortality increases in Canada are likely an artifact of a global pandemic, but longer life expectancies mean that more Canadians are living with multiple comorbidities longer – which require significant intervention and treatment. In order to meet the ever-growing demands of the healthcare system, wholesale policy reform is required, as the pandemic has shown the health system in Canada has been pushed to the brink.

Multiple comorbidities, spiralling costs, and out-of-date policy yields a health system, in its current form, which is borderline untenable to maintain moving forward. The COVID-19 pandemic has made it clear that provincial health systems, and the federal oversight they are subject to, have largely failed in providing equal and equitable care to all Canadians, a priority under the Canada Health Act (204). Further, this assertion of system failure is supported by unprecedented levels of provider burnout, record wait times in emergency departments across Canada, breakdowns in ambulance availability in our largest cities, record proportions of

Canadians without primary care, and a soaring budget which threatens to gobble up almost 15% of Canada's GDP with no discernible impact on outcome or performance (205). Conducting an autopsy on the Canadian health system as it stands may be premature, however COVID-19 variants continue to emerge, and reform is conspicuously absent. Regardless, discussing how antifragile design could influence a new approach to healthcare in Canada, and to a lesser extent globally, as well as diagnosing the symptoms which led to system failure in the wake of COVID-19 warrants thought.

Recall that the CDCT and MS are unique in the saturated readiness tool landscape for their 'priced-in' perspective on complexity. Until recently, complexity within implementation and evaluation literature has been seen as a confounding variable. One which had to be controlled for, mitigated, or outright excluded in order to establish causal relationships between forces and interactions within an implementation. The CDCT and MS are unique in that they consider complexity *inherent* to any implementation and have carefully selected methodology and indicators to account for this complexity in small places. As health policy within Canada shifts from a blanket, one-size-fits all dogma to a contextualized, personalized, and tailored approach of place-based health (55), understanding nuance and subtlety within the countless contexts of Canada becomes paramount. Complexity insights, such as *non-linearity*, *emergence*, *self-organization*, and *sense-making* all contribute to difference in experience and interaction with interventions or arms of a health system. Antifragile design provides operationalized principles which can help decision makers establish what works where and for whom, providing the foundation for a place-based health system.

As an example, consider the complex adaptive system property of *emergence*. Recall emergence is <u>the generation of novel structure, interaction, or phenomenon from the contact of</u>

existing entities, agents, or organizations. Emergence can lead to innovative facilitators of interventional adoption, or steadfast resistance to change through influence on attitudes and beliefs. Emergence is hard to predict, difficult to measure, and crucial to understand for any successful intervention. Antifragile operators such as *optionality* and *hybrid leadership* approximate the presence of emergence with an implementation and provide direction for implementation teams regarding how to capture it for the benefit of the eHealth intervention in question. *Optionality* is the ability to make choices. This effectively addresses emergence within an implementation by providing both users of the intervention and research teams agility in their response to critical implementation components.

Consider the virtual health room (VHR) implementation in rural Sweden. The technology implemented for use in the context of the VHR project could also be used for educational and secure meetings by clients and patients. Suddenly, instead of having to make trips to larger population centres, clients could use the VHR infrastructure for other meetings, even if they were not comfortable using it for managing their health. Eventually, attitudes changed, and patients began using the room for its original purpose – while retaining the option to use it for others. This optionality accounted for the emergence of other needs and was a reason for it's sustained use within the community of interest.

These micro-level complexity insights transcend individual contexts or anecdotes. Emergence does not only occur in individual communities, but also in larger health organizations, hospitals, and policy-making bodies. To account for this, antifragile operators can also make their presence felt here – aiding a transition from top-down, urban derived health policy to place-based holistic protocols. Optionality and hybrid leadership can materialize by incorporating patient partners into decision-making processes, professional bodies, and unions of

allied health groups (nurses, radiology technicians, pharmacy, etc.) and increasingly technological partners (industry focus groups) to provide input throughout the policy pipeline. This would allow for policymakers to theorize regarding potential places for emergence to arise and incorporate a diversity of perspectives on a given interventions consequences. It will also provide them with options in how to implement and advocate certain interventions, perhaps with insight previously unavailable through increased reliance on other parts of the system. The trade-off will be in separating the signal from the noise – as while knowledge is power, too much information can obscure the important data which should be prioritized.

Another hallmark of complex adaptive systems is *non-linearity*. Interventional size rarely scales 1:1 to patient outcomes (206). Resource abundant interventions can have middling effects on patient or provider behaviour, while comparably small changes to process or structure can have drastic system wide consequence. This non-linearity is a consequence of the 'system of systems' structure of complex adaptive systems, meaning that the whole of the system is greater than the sum of its parts. An intervention targeting behavioural change in one part of the system can lead to unexpected consequence in another – be this good or bad. As an example, consider again the implementation of a rural virtual health room. Although the initial uptake of such an initiative may be limited in scope, it effectively shows rural residents that virtual care is possible in a high-quality manner. This shifts their attitudes towards rural eHealth usage, and so the next project which is implemented stands a better chance of scaling and sustaining in each context. This would not have been possible without earlier implementation efforts, and while the original intervention may have failed in its goals and objectives, it succeeded in altering attitudes, making subsequent efforts more appealing. For this reason alone, continuing to engage communities and

patients after failed implementations is important, and becoming antifragile essential to mitigating the risk of implementation absorbed by rural communities.

## 7.4 Mitigating Rural Risk for eHealth Implementation using the Antifragile Design Portfolio

Implementation efforts in rural settings carry with them dormant risk to both the community and research team. Research teams are broadly more cognizant of these risks than communities, and sometimes there is a lack of communication or transparency between these two groups. Ensuring all assumptions and beliefs are explicit is an important step in establishing the context an eHealth intervention is entering, and one which is highlighted during the *inform* stage of the CDCT. This *inform* stage is more than simply making an implementation team aware of the salient cultural or organizational bounds an intervention is acting upon, but is also key to informing communities, and to a lesser extent researchers, on the risk they are exposing themselves to by undergoing an implementation. Having these risks documented and discussed mitigates their potential impact if implementation processes fail and helps maintain an environment of trust in the face of such a situation.

Risks to research teams include reputational, personal, academic, and monetary. Failure of an implementation of an eHealth initiative in a rural setting could lead to a breakdown of relationships between rural stakeholders and researchers. Further, academic centres (universities, institutions) may also re-evaluate research teams' ability to achieve results in rural implementation, which may lead to decreased funding or greater administrative oversight on grant applications. This decrease in monetary resources could impact future implementation plans or projects. Personal relationships may also suffer, as the stress which accompanies an intervention implementation predictably leads to conflict. If that conflict is not managed in a

proactive way, it can fester and lead to bitterness and resentment between team members, rural stakeholders, and other relevant groups. Lastly, reputational risks could include a decrease in prestige or respect within a field, and the feeling of a need to deflect a failure onto other factors of the implementation. Indeed, implementation processes fail for a myriad of reasons, and there could be a particular issue which led to the demise of a project. Its important research teams are candid about why an implementation faced challenges however – as being disingenuous exposes communities to costly hazards for future project implementation.

While risks to a research team and its members are mostly contained to the micro level with regards to the broader health system, community risks span both the meso and macro level. As has been established, rural health systems are greater than the sum of their parts. eHealth interventions in rural communities attempt to address the gap in access between urban and rural residents. To do so, they often target a specific part of the system (consultation for specialists, for example). However, failure of an intervention is not limited to the section of the system it targets. The exposure to risk communities take on scales much steeper than individual research teams, and these risks are not necessarily explicit or articulated. Reputational, functional, innovative, and existential risk all accompany an implementation process for rural communities. Conceptualizing these risks, as well as effectively communicating them with rural populations, is the focus of this section. Discussing regression to the tail (207), health system management, and antifragile design as risk mitigation strategy further highlight the importance of antifragile approaches to rural eHealth project implementation.

Part of effective health system management is ensuring there is sufficient surge capacity for the extreme type events which ostensibly happen once in a lifetime (208). These events, such as a pandemic, war, earthquakes, etc. are major system stressors which affect the entirety of a

system. These events could either be predictable – such as a hurricane predicted through modelling of low-pressure systems in the Caribbean, or unpredictable, such as 'black swan (209)' events like the September 11th terrorist attacks or the emergence and dominance of the internet. The distinction between a predictable and unpredictable event lands largely on the surveillance, models, and attention events are paid. The COVID-19 pandemic, in many ways, was entirely predictable – which makes the response to it an even greater failure (210). Besides a handful of harbingers in the compartmentalized structure of the CIA, the September 11th attacks came as a complete surprise. In the scope of this project, these extreme events are of interest because they exemplify the need for antifragile entities and display why eHealth in rural communities – if established in an antifragile manner – can help mitigate the effects of these events, whether predictable or not.

Building surge capacity requires a careful conceptualization of risk. If urban emergency department triages are considered, volume levels can fluctuate greatly over a given period of time. These fluctuations could vary from as low as 160 triages over a 24-hour period, to 240 at as the upper bound. As a decision-maker then, how can you plan your resources so that when the extreme events occur – the 240-triage day – the department is prepared to handle the increased demand for capacity? Firstly, it must be acknowledged that outcomes do not scale linearly with system stress. As triage numbers climb, more patients are present within the department. These patients require resources: blood tests, diagnostic imaging, consultations with a wide array of medical services, wound care, and nursing attentiveness. Further, this care should ideally be occurring within a room with instruments and material specifically designed to manage adverse outcomes or deterioration of the patient in the unfortunate event this occurs. As diagnoses are made, which requires communication between several different healthcare professionals, patients

are ultimately either admitted to the appropriate service for further treatment or released with sufficient care being provided or follow-up instructions.

When triage numbers (i.e. system stress) increase, the pool of resources afforded to patients becomes stretched thin. Consultations and treatment do not occur in efficiently designed rooms in a controlled environment – but rather in hallways, ambulance bays, and waiting rooms. Wait times for care increase, as patients triaged in lower priorities linger in uncertainty and distress for up to twelve hours (211). The dangers for patient outcomes this could introduce are self-evident. Additionally, stress builds within providers, as disgruntled patients exacerbate tensions latent within an emergency department between consulting services, physicians and nursing staff, and allied health professionals such as paramedics, pharmacists, and social workers. The result? Essentially what has happened during the fourth wave of the pandemic: a mass exodus of nurses, cancellation of surgeries, substance abuse and mental illness rampant among health workers, and triaging at the highest level of hospitalization: intensive care units (212). Planning for the average day, and underestimating the impact an extreme event can have, has drastic consequences. A case can be made that traditional approach to managing system stress has fallen short of accounting for the increased challenges of a pandemic. Risk needs to be revisited and reframed and planning for such risk needs to be adjusted accordingly.

The idea of surge capacity and non-linear risk is also common to rural communities and their health systems. An intriguing hypothesis for risk which is worth referencing is the idea of regression to the tail (213). If a standardized Poisson distribution is considered, then for a given event, there exists a higher likelihood of that event happening clustered around certain frequencies. In other words, in the case of a rural eHealth initiative, there is a higher probability that usage of the intervention follows a pattern similar to a Poisson distribution, where at any

given time, there will be a moderate number of users, with lower or increased volume decaying in probability respectively. Regression to the mean is the idea that if usage is busy for a sustained period (or the opposite – if usage is low for a sustained period), then eventually the usage will return to 'average' levels, according to the Poisson distribution. Regression to the mean has become a commonly cited statistical phenomenon, and its presence has been confirmed in disciplines as diverse as biology to baseball (214). Recently however, there has been an exploration of a related but functionally drastically different statistical sensation – regression to the tail (207,213). Understanding regression to the tail in the context of health systems planning and risk management can help ensure that we are better prepared for the next pandemic, and the lessons of COVID-19 are not forgotten.

Regression to the tail occurs when the population mean is poorly defined or not defined at all. When the population mean is not easily determined, such as in a pandemic, earthquake, or rural eHealth initiative, regression to the mean more closely resembles regression to the unknown – or regression to infinity. These populations have 'fat-tailed' probability distributions, where extreme events are not one-off happenstance or coincidence, but systemic to the processes in question. Risk in this case must assume that extreme events are inherent to their broader categorical origins and planning to mitigate this risk cannot treat the extreme events as low-probability bad luck, but *certain* fat tailed consequence. Regression to the tail dictates that there will *always* be an event more extreme than the most extreme to date. Technical mathematic modelling has proven this to be true in the case of the COVID-19 pandemic (215), and a separate analysis of IT projects and even Olympic games bids has also provided evidence for this occurrence. Regression to the tail is important for rural communities to bear in mind when planning for a rural eHealth project because of its presence in implementation, and the outcomes

it can influence. Antifragile program design mitigates this risk (cuts the tail) to an extent, and so is an important principle in rural health service design.

Rural communities expose themselves to significant risk when they agree to implement a rural eHealth initiative, however that risk is not always made explicit. Indeed, articulating the extent to which an implementation failure can impact a community may very well cause such hesitation among rural stakeholders, eHealth would be effectively avoided altogether. The risk lies in their labeling by researchers, clinicians, policymakers, and even their own residents as a 'problem-site' or 'difficult case'. Project failure, often through no inherent fault of the community in question, has far ranging effects which can impact future research projects, inclusion in policy consultation, and future implementation. This initial exclusion of certain communities because of their reputation as a tough environment to work and research becomes a vicious feedback loop, wherein an initial poor implementation process creates bitterness or ill-will between research teams and communities, lowering willingness to work together in the future. Other communities which have more positive outcomes eventually become sites of further research and dedication of resources. This fosters further resentment and distrust, and the cycle repeats.

Further, neither party is particularly incentivized to confront the initial implementation or work through the issues which arose and became such a harmful feedback loop. Research teams are incentivized by grant money, publications, and dissemination of their findings. Unless otherwise motivated, working with a problem site - from a research perspective - does not yield any reward. Similarly, communities do not have an obligation to reach out – although many do. Depending on the turnover rates of agents in power within these communities, the initial trust which was broken in these implementations is hard to reproduce and cultivate. The result is a

continued exacerbation of tensions between affected communities and implementation teams. In the most extreme cases, the lack of research about rural contexts contribute to the overall decline of the community, manifested by high migration rates, decay of traditional industry, and redistribution of services to better reflect surrounding population levels.

These challenges satisfy the regression to the tail parameters and are representative of the massive unforeseen and underreported risk taken on by rural communities when they agree to be a site for an eHealth implementation. Extreme events throughout an implementation, such as departure of key agents, changing of funding priorities, or a shift in broader policy goals are commonplace in rural research. Traditionally designed projects, that is, projects without antifragile indicators, are subject to these extreme events on a routine basis. These issues are *systemic* to rural eHealth implementation, and further facilitate the 'nation of pilot projects' issue within Canada. As stated, the impact of these regression to the tail events carries significant risk for the involved rural communities, and at its most dire stages can pose an existential threat to the community itself. This risk needs to be effectively communicated to all stakeholders, along with a strategy to confront it.

Antifragile design can cut the tail of these extreme events by providing options to implementation teams in how to adjust or transition their interventions, perspectives from across the spectrum of a healthcare system through hybrid leadership, highlighting leverage points to target via non-linear evaluation, and agility in resource allocation by starting small. Combined, these operators improve the potential of a given eHealth project thriving in its context, and further can conceptualize and articulate the challenges an intervention faced throughout its implementation. Providing concrete and clear barriers or behaviours which influenced a rural eHealth implementation lessens the risk a community becomes a 'non-case' in future research, as

there exists future direction for both communities and researchers to focus on for future implementations. Creating a place-based health system first requires an acknowledgement of the difference between rural and urban risks, and a complexity informed rural toolkit to avoid these risks. The CDCT and MS are a good start towards that end.

### 7.5 Assumptions, Delimitations, and Limitations

Much of the research done during my doctoral studies is theoretical in nature. The components of implementation are highly reliant on contextual factors such as attitudes, beliefs, values, and politics (216). Evaluating these aspects of intervention are hard to quantify, and reliable methodological toolkits for doing so are still being researched and tested themselves. Further, an agreed upon trait of complex adaptive systems is their inability to be examined by reductionistic means. The whole of the system is greater than the sum of its parts, meaning diagnosing and prescribing effective frameworks for implementing eHealth interventions (as an example) is in part subject to educated guesswork. The mechanism of interventional change can exist independent of our knowledge of it. Sometimes, that mechanism cannot be articulated or effectively measured, and the reality of an interventions impact on system function can only be approximated. Therefore, any results regarding system change as a function of antifragile design or complexity informed indicators must be evaluated with some reservation, as sociological phenomena often are.

Empirical validation of the theory of antifragile program design therefore is difficult under pervading methodological paradigms. Much of my doctoral research then focuses on the organizational readiness of institutions to embrace and effectively deploy complexity informed approached to implementation of interventions, specifically eHealth interventions. Assessing organizational readiness should be a strong priority and coupled with tangible frameworks to

guide eHealth implementation. Organizational readiness can be seen as a proxy to how well institutions can facilitate autonomous change, sustain initiatives, and ultimately effectively implement a given intervention.

Implementation in a complex adaptive system such as a rural health organization then can meet many different barriers. Complexity science can help overcome these barriers, but it is not a silver bullet with regards to guaranteeing a successful implementation. A limitation of this work then is in its definitive capacity to effectively move the needle in implementation. Sustainment and scaling of innovative practices, and their integration into standard operation, will continue to be an issue within healthcare, especially with the importance of evidence-based medicine in policy creation. Although there is tremendous pressure for a uniform approach to implementation of eHealth, or a collation of best practices on a global scale, the complexity of implementation limits our approaches as researchers as approximations as to what works where, and for whom, based on the sometimes incomplete information at hand.

Complexity science has also been termed as descriptive, but not necessarily proscriptive. An effective way to frame an issue or problem, but not necessarily the best way to solve it. While healthcare is a result driven discipline, especially with the highly politicized nature of it, the most important part of approaching a problem is formulating it. Complexity science can open the nuance of problems which before seemed resistant to traditional methodology or thought surrounding it. Utilizing complexity informed approaches and leveraging some of the facets of complex adaptive systems provides a solution space for researchers and decision-makers which previously was not codified.

eHealth implementation is routinely used as interchangeable with innovation, innovative practices, or similar terms. While it could be argued that using these two terms as synonyms for

one another is conflating their true meaning in an implementation sense, eHealth uptake is a nuanced way to evaluate innovation. eHealth implementation requires changes in attitudes, service structures, and organizational roles. These changes and adaptations require a significant break from traditional practices and approaches. For example, locating responsibility for an eHealth initiative in a rural hospital requires support from a diverse range of stakeholders, and shifts the power dynamic of regular brick-and-mortar hospital-based care. Patients are increasingly seen as partners in their care, and should be treated as equal decision-makers in their care when appropriate.

While discussing the particulars of indigenous research, especially health research, is outside the scope of this dissertation, it would be disingenuous not to recognize the significant overlap between rural communities and indigenous populations. Indigenous peoples are disproportionally represented in rural and remote communities within Canada and require culturally appropriate methods in order to better understand the challenges they face in receiving effective care. The work of my doctorate does not consider indigenous communities, and therefore the findings within could be ineffective when aiding implementation of eHealth in these same communities.

It is worth reiterating that making an intervention antifragile still does not guarantee its success. Many things in life are immune to prediction (111), and the fates of e-health initiatives are no different. Ultimately it is about maximizing the probability a project will succeed while minimizing the probability the project will fail. Even so, drastic changes (loss of funding, loss of key agents, paradigm shifts) all serve to ensure that no one can be perfect in their predictions or their designs. An antifragile project is not necessarily a foolproof one; but rather one which is better served in the long run compared to its fragile (or even resilient) produced counterparts.

Antifragile projects could have a better chance than their counterparts at scaling up and spreading to broader levels of organization, but until a prospective study is undertaken nothing definitive regarding antifragility can be said.

That is partly why the CDCT is made up of no less than 6 distinct methodologies, with the allowance for the incorporation and utilization of more methodologies if the situation demands it. If you can address a problemed implementation with six methodologies, or more if needed, then what is the point in having a framework to begin with? Frameworks should seek to collate, converge, and narrow how an implementation team approaches an intervention, not widen, and diverge. Working in a complex adaptive system however requires agility in how you approach problem, and the ideology wars between complexity science, realist evaluation, implementation science etc. obscure the point that there can't be *one* dominant paradigm for approaching the implementation of an intervention. With the knowledge that each implementation is unique, the methodology which is used in the face of this novelty should reflect that. Allowing agility and freedom to use a particular method, and its outputs, reflects the strengths that each of these methods bring to the table at difference stages of implementation.

Instead of methodological looseness, accounting for varying perspectives of implementation, and providing a means to examine relevant implementation phenomena, should be seen as implementation teams widening their error bands in the inevitability that something goes wrong. Instead of being mandated to follow the guidelines of complexity science, or implementation science, when other methodologies can provide more nuance with regards to appropriate action, implementation teams should have freedom in using these methods – as long as they can provide meaningful and tangible feedback for the implementation at hand. The nature of studying implementation of interventions into complex adaptive systems is different from

studying closed systems in a laboratory setting. In the former example, countless forces and principles intervene across the lifespan of an intervention, requiring scientists and implementation teams to perform educated guesses regarding which ones are protective of a successful intervention and which are actively harming it.

The antifragile design portfolio is a mid-level theory for the implementation of eHealth initiatives in rural communities. It is not a silver bullet for implementation, nor is it a unifying theory for the largely sociological nature of implementation. It requires projects to have displayed fidelity, be unique in their rural focus, and have well articulated objectives to address rural health access. When the conditions are met, despite it's limitations, the antifragile design portfolio represents a rural tailored framework which can reform rural health systems to exhibit place-based health policy benefits, improving health access equity and ultimately rural population health outcomes.

## 7.6 Conclusion

The discussion section of this dissertation explored how antifragile design can facilitate organizational change, why rural health system reform requires a reassessment of the EBM pyramid, how rural health systems would benefit from a changing health system perspective to reflect place-based health benefits, and how the antifragile design portfolio can mitigate rural risk for eHealth implementation. Lastly, assumptions, limitations, and delimitations were discussed, including the fact that the antifragile design portfolio is not a silver bullet in implementation, and that not all projects will satisfy the conditions for its application.

Antifragile design facilitates organizational change by introducing a tolerable amount of chaos into health system structure, while maintaining a rule set (antifragile operators) to adhere

to. This allows for the diffusion of innovative practices while stifling behaviour which may be harmful to the health system as a whole. Rural health policy is poorly informed in part because of the reliance on rigorous statistical evidence to create broad policy, such as systematic reviews and randomized control trials. These research designs are more difficult to undertake in rural communities because of small sample sizes and lack of diversity within those sample sizes. Introducing powerful qualitative methodologies into the EBM pyramid can improve rural research richness and better reflect the considerations for rural communities – structuring rural health systems as different, not disadvantaged.

Place based health advocates for the realities of the socio-cultural, geographic, and socio-economic place of a patient to be manifested in the care they receive. This requires building equitable access to care in rural communities, the objective of the antifragile design portfolio. Finally, the antifragile design portfolio can trim the tail of risk taken on by rural communities in eHealth implementation. Because of the poorly defined population means for rural eHealth interventions, regression to the mean is regression to the extreme. Antifragile design can mitigate these extreme events, allowing more eHealth interventions to scale and sustain within their contexts, and provide healthcare access options to rural populations.

# Chapter 8: Conclusion

A key theme throughout my doctoral research is the importance of framing a problem. That is clear from the assertion of using a strengths-based approach to rural implementation and shifting the perspective of rural communities from disadvantaged to different. Further, conceptualizing rural health systems as complex adaptive systems, and interventions as interactions between a context, mechanism, and outcome provides solid foundation to analyse rural eHealth implementation. How we think about a problem is much more important than the solution. The findings of this dissertation seek to arm implementation teams in rural communities with sensitive, complexity aware tools which will help them reason through implementation processes which are subject to challenges and barriers which persist in complex adaptive systems. Instead of applying implementation frameworks derived from inappropriate settings, or deploying protocol mandated from an urban decision-making centre divorced from the context it governs, the antifragile design portfolio is formulated *by* rural implementation and is distinctly tailored *for* rural implementation.

This representation in rural research is important and contributes to the growing call for place-based health system reform. Place-based reform will prioritize equitable care where every individual has equal opportunity to be healthy. Good health is something often taken for granted, and only missed in its absence. Without good health, work becomes more difficult, relationships become strained, and personal circumstances can deteriorate. To date, rural Canadians, and rural populations internationally, have not had the same opportunity to be healthy as their urban counterparts. Through poorer healthcare access, poorer health outcomes follow. The antifragile

design portfolio is uniquely placed to address that gap through better implementation of eHealth interventions and will help afford every rural Canadian a chance at good health, and a better life.

Ultimately, this dissertation has shown that eHealth can be integrated into health systems to address health access inequities, antifragility is a viable design principle for eHealth interventional design, and the antifragile design portfolio can help rural organizations deploy eHealth initiatives in an antifragile fashion. Through the tandem employment of the CDCT and MS, rural implementation teams can feel comfortable and confident in engaging with an implementation process. This confidence and comfort is hard to overstate, as the importance of confidence in approach, confidence in outcome, and confidence in ability to recover from mistakes all contribute to better implementation process. Prospectively validating the antifragile design portfolio through post-doctoral projects, and disseminating it within rural research working groups, serve as logical next steps to growing the body of work surrounding rural implementation strategy and technique.

## 8.1 Future Directions

Two potential projects have emerged as ways to deploy the antifragile design portfolio in nascent eHealth initiatives in rural communities. The first is scaling a digital therapeutic for managing heart failure from an acute, urban setting in Toronto, Canada to rural Ontario health teams. This project would be funded through a CIHR health system impact fellowship, with partnerships at the University Health Network and University of Toronto. Applying the antifragile design portfolio to scaling this digital therapeutic would serve as the basis for implementation process throughout the post-doc and provide data regarding it's effectiveness.

The second project is a MITACS post-doctoral fellowship with the Carbonear Institute for Rural Reach by the Sea (CIRRIS). Through a partnership with CIRRIS and Memorial

University of Newfoundland, operationalizing local thinking and promoting grass roots rural health initiatives would be the focus. This too would provide an opportunity to prospectively validate the antifragile design portfolio and understand it's application as an embedded scientist in real-time implementations.

I would like to close my dissertation with hope that the lessons learned from the COVID-19 pandemic do not go ignored. Health system reform, particularly rural health system reform, has been a long time coming. There is an old saying in politics: "*never let a good crisis go to waste*". Integrating eHealth into rural health systems through a principled approach with vision in the form of the antifragile design portfolio helps ensure the tragedy of the COVID-19 pandemic sees genuine response. Rural Canadians deserve a healthy life and improving their access to health services is a good way to start.

# Appendices

## Appendix A

### List of Original, Peer Reviewed Publications

*Paper One:* **Petrie, S.** Peters, P. Untangling complexity as a health determinant: Wicked problems in healthcare. Health Sci Inq. 2020 Aug 10;11(1):131–5. https://doi.org/10.29173/hsi299

*Paper Two:* **Petrie, S**. Peters, P. Carson, D. Antifragile by Design: Using Antifragility as a Guiding Principle in Future Rural eHealth Implementation and Evaluation. *Health Science Inquiry,* 49-52. August 2019. ISSN: 2562-7791

*Paper Three:* **Petrie, S.** Carson, D. Peters, P. Hurtig, A-K. LeBlanc, M. Simpson, H. Barnabe, J. Young, M. Ostafichuk, M. Hodge, H. Gladman, J. Smale, M. and Gonzalez Garcia, M. (2021) What a Pandemic Has Taught Us About the Potential for Innovation in Rural Health: Commencing an Ethnography in Canada, the United States, Sweden, and Australia. *Frontiers of Public Health* 9:768624. doi: 10.3389/fpubh.2021.768624

*Paper Four:* LeBlanc M, **Petrie S**, Paskaran S, Carson DB, Peters PA. Patient and provider perspectives on eHealth interventions in Canada and Australia: a scoping review. Rural and Remote Health 2020; 20: 5754. https://doi.org/10.22605/RRH5754

*Paper Five:* McDougall, E. Webber, K. and **Petrie, S.** (2021) Addressing the need for more nuanced approaches towards transit-induced gentrification: A case for a complex systems thinking framework. *Urban Geography*. In review

## Appendix B

## *A priori* Coding Protocols of the Thematic Synthesis

### B.1 Antifragile Operators Coding Protocol

1. *An Antifragile Program will generally:*
    a. **Embrace and harness emergence through optionality** (content pertaining to options which account for the spontaneous structure that arises through the interaction of people, policies, and societal and community influence.)
        i. Emergent structures (such as the clustering of certain clients, or the protocol they follow when interacting with the system) should be observed, codified, and formalized by program implementors, as these behaviours reflect the inherent methods used by clients to accomplish goals within the system.
    b. **Start small** (code content regarding the implementor(s) tinkering and iterating with relatively low investment of resources)
    c. **Incorporate feedback from multiple stakeholders** (code content of feedback coming from clients, providers, leadership, community, patients, etc.)
    d. **Engage in non-linear evaluation** (code content regarding attempts to capture the unforeseen consequences that an initiative will have on other parts of the system, a holistic evaluation approach must be utilized to minimize potential negative impacts of program implementation)
        i. Avoiding **sub-optimization** (optimizing one part of the system at the expense of the system as a whole) should be a priority of program directors and implementors.
        ii. One method of non-linear evaluation is forgoing labeling an initiative a success or a failure, and instead looking at the strengths and weaknesses of a program as it progresses through its implementation scheme.
    e. **Capitalize on optimization, avoid suboptimization** (all programs, wherever possible, should focus on providing their clients with as many tangible options as it aligns with program goals. Options allow clients of the program to engage with it as it suits their specific needs and allows for the sustainability and scalability of the program in the long run. It also allows for the partial solution of wicked problems[7] common to sociological settings. Code content where implementation teams made concentrated efforts to avoid jeopardizing other parts of the system)
2. *As a result, antifragile programs will:*
    a. **Thrive in the face of volatility** (thriving projects would be characterized as being enthusiastically supported by practitioners, used by a diversity of stakeholders, with frequent and positive engagement by patients or clients, movement from a 'pilot' to

[7] Wicked problems are problems with seemingly no solution

part of routine health services (or other) framework, a secure funding source(s) identified, and the potential to 'scale-up' services and expand to other locations.

b. **Be agile** (project agility is crucial to the survivability of initiatives. Implementors should highlight this face with senior leadership in their organizations, and prioritize creating dynamic programs which can sufficiently match the complexity of many societal (health, justice, etc.) problems in the modern day.
    i. Agile projects also have the added bonus of being easier to scale to other contexts (organizations, communities, hospitals, etc.)

c. **Allow implementors flexibility in their approaches** (one of the main benefits of point b) in section 1. (starting small) is the allowance of implementation teams to probe what works best for whom without risking an entire budget. Implementors should not be limited in their thinking, and should recognize the importance of creativity when engaging with potential solutions.

## B.2 Institutional Investment Indices Coding Protocol

1. *An institutionally invested program will generally:*
    a. **Embrace and enroll champions** (code content wherein agents with either formal or informal status within an organization which can be opinion or clinical leaders to facilitate adoption of an intervention)
        i. Explicit reference to champions and their impact on implementation should be codified, including, but not limited to, administrative, clinical, patient, or policymaking influences. The presence of champions is indicative of institutional investment.
    b. **Align with broader policy** (code content wherein implementation teams focus on aligning their intervention with organizational, municipal, provincial, or federal policy priorities to gather institutional investment)
    c. **Have demonstrated and explicit follow-up and support structures** (content regarding support infrastructure, dedicated agents to monitor an intervention and its context, and other follow-up mechanisms shows institutional investment.)
    d. **Have secure, identified, and accessible funding schemes** (content regarding the source, length, and amount of funding from recognized research bodies)
    e. **Experience utilization and uptake from the target population** (implementation contends with the rates of uptake of an intervention, not necessarily the rate change in disease or symptom status. Content regarding rates of use, raw volume of usage, number of sites adopting the initiative, etc. shows better institutional investment to sustain and spread an initiative.)
2. *As a result, institutionally invested programs will:*
    a. **Maintain their fidelity** (institutionally invested projects will retain their interventional fidelity with the presence of the institutional invest index content from section 1.)
    b. **Provide structure and stability within a system (**institutionally invested projects will remain relatively stable in a complex adaptive system such as a rural health system. This stability is important as agents within the system gradually accept the intervention as standard practice, and displaying the institutional investment of a project will improve their confidence in the interventions effectiveness)
        **i.** Institutionally invested projects can positively change informal opinions and attitudes regarding a novel intervention or organizational change.
    c. **Allow implementors flexibility in their approaches** (like antifragile projects, institutionally invested projects allow implementors more room for error, more time to iterate, and pathways for understanding how an intervention functions in a given context. By displaying one or more of the indices in part 1, institutionally invested projects have more margin for error than projects with less institutional investment.

Lessons learned from implementation iterations need to effectively be incorporated into future design processes.)

**Appendix C**

**List of Abbreviations:**

**ADP:** Antifragile Design Portfolio

**AO:** Antifragile Operator

**CAS:** Complex Adaptive System

**CDCT:** Composite Design Cycle Theory (for antifragile deployment of eHealth initiatives)

**CHI:** Canada Health Infoway

**CIHR:** Canadian Institutes of Health Research

**CFIR:** Consolidated Framework for Implementation Research

**CVTAC:** County Virtual Triage Activity Centre

**DIDO:** Drive In, Drive Out

**EBM:** Evidence Based Medicine

**FIFO:** Fly In, Fly Out

**II:** Institutional Investment

**MS:** Matrix of Scale

**NASSS:** Non-Adoption, Abandonment, Scale-up, Spread, Sustainment

**OTN:** Ontario Telehealth Network

**RE-AIM:** Reach, Effectiveness, Adoption, Implementation, Maintenance

**QI:** Quality Improvement

**Appendix D**

Unique coding references per paper in thematic synthesis. See next page.

| | Antifragile Code | B : Avoiding Suboptimization | C : Hybrid Leadership | D : Non-linear evaluation | E : Optionality | F : Starting Small | Institutional Investment Code | H : Champions | I : Follow-up and support | J : Funding | K : Policy Alignment | L : Utilization |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 : Alami2017 | 24 | 3 | 8 | 4 | 6 | 3 | 24 | 4 | 5 | 4 | 4 | 7 |
| 2 : Al-Kadi2009 | 4 | 1 | 0 | 1 | 2 | 0 | 3 | 1 | 1 | 0 | 0 | 1 |
| 3 : Anvari2007 | 4 | 3 | 0 | 0 | 1 | 0 | 8 | 0 | 4 | 2 | 2 | 0 |
| 4 : Baker2004 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 5 : Barrett2009 | 5 | 3 | 1 | 1 | 0 | 0 | 12 | 2 | 3 | 2 | 2 | 3 |
| 6 : Bello2017 | 4 | 1 | 0 | 1 | 2 | 0 | 4 | 0 | 1 | 0 | 2 | 1 |
| 7 : Bhandari2011 | 11 | 2 | 6 | 1 | 2 | 0 | 17 | 6 | 6 | 1 | 2 | 2 |
| 8 : Bidargaddi2017 | 1 | 1 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0 | 1 | 2 |
| 9 : Boman2014 | 5 | 1 | 1 | 0 | 3 | 0 | 2 | 0 | 1 | 0 | 1 | 0 |
| 10 : Boots2012 | 2 | 1 | 0 | 0 | 1 | 0 | 2 | 0 | 1 | 0 | 0 | 1 |
| 11 : Bradford2015 | 11 | 1 | 4 | 1 | 4 | 1 | 5 | 0 | 3 | 0 | 2 | 0 |
| 12 : Bridgens2008 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 13 : Buckley2012 | 4 | 1 | 0 | 0 | 3 | 0 | 4 | 0 | 0 | 1 | 2 | 1 |
| 14 : Byrom2016 | 4 | 1 | 0 | 0 | 3 | 0 | 5 | 0 | 2 | 0 | 1 | 2 |
| 15 : Cadilhac2014 | 7 | 1 | 2 | 2 | 1 | 1 | 8 | 0 | 3 | 3 | 0 | 2 |
| 16 : Carlson2012 | 9 | 1 | 0 | 4 | 3 | 1 | 8 | 2 | 2 | 0 | 0 | 4 |
| 17 : Cloutier2008 | 4 | 1 | 0 | 1 | 2 | 0 | 7 | 1 | 2 | 1 | 1 | 2 |
| 18 : Conn2013 | 5 | 0 | 1 | 1 | 2 | 1 | 11 | 1 | 4 | 2 | 2 | 2 |
| 19 : Cowain2001 | 2 | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 20 : Elliott2012 | 7 | 1 | 1 | 0 | 4 | 1 | 8 | 0 | 3 | 0 | 1 | 4 |
| 21 : Faulkner2002 | 4 | 0 | 0 | 2 | 1 | 1 | 7 | 0 | 3 | 2 | 2 | 0 |
| 22 : Fennell2017 | 7 | 0 | 2 | 3 | 2 | 0 | 4 | 1 | 1 | 1 | 0 | 1 |
| 23 : Gagnon2009 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 : Gardner2016 | 3 | 0 | 0 | 1 | 2 | 0 | 3 | 0 | 2 | 0 | 1 | 0 |
| 25 : Gibson2011a | 8 | 0 | 5 | 1 | 2 | 0 | 7 | 2 | 0 | 1 | 3 | 1 |
| 26 : Gordon2012 | 2 | 2 | 0 | 0 | 0 | 0 | 7 | 0 | 2 | 1 | 2 | 2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 : Greenberg2006 | 3 | 0 | 2 | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 0 |
| 28 : Greenwood2004 | 3 | 1 | 0 | 0 | 2 | 0 | 4 | 0 | 2 | 0 | 1 | 1 |
| 29 : Hoffmann2008 | 4 | 1 | 0 | 1 | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 30 : Host2018 | 3 | 0 | 0 | 2 | 1 | 0 | 2 | 0 | 1 | 1 | 0 | 0 |
| 31 : Humer2017 | 7 | 2 | 1 | 3 | 1 | 0 | 9 | 0 | 3 | 0 | 3 | 3 |
| 32 : Jennett2005 | 3 | 0 | 1 | 2 | 0 | 0 | 4 | 2 | 0 | 1 | 1 | 0 |
| 33 : Jewett2017 | 2 | 0 | 0 | 2 | 0 | 0 | 3 | 0 | 0 | 0 | 2 | 1 |
| 34 : Jhaveri2016 | 5 | 1 | 1 | 0 | 3 | 0 | 8 | 1 | 4 | 0 | 2 | 1 |
| 35 : Johansson2014a | 5 | 1 | 0 | 1 | 3 | 0 | 6 | 0 | 4 | 0 | 0 | 2 |
| 36 : Johnson2015 | 2 | 0 | 0 | 1 | 1 | 0 | 4 | 0 | 1 | 0 | 1 | 2 |
| 37 : Jong2004 | 2 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| 38 : Jong2004a | 3 | 0 | 0 | 0 | 2 | 1 | 3 | 0 | 0 | 1 | 1 | 1 |
| 39 : Khalil2014 | 4 | 0 | 2 | 0 | 1 | 1 | 9 | 3 | 3 | 2 | 1 | 0 |
| 40 : Krum2013 | 4 | 0 | 1 | 1 | 1 | 1 | 7 | 0 | 1 | 2 | 2 | 2 |
| 41 : Kumar2006 | 6 | 1 | 0 | 0 | 3 | 2 | 3 | 0 | 1 | 1 | 1 | 0 |
| 42 : LaBelle2018 | 6 | 1 | 1 | 2 | 2 | 0 | 7 | 0 | 1 | 1 | 3 | 2 |
| 43 : Liddy2017 | 4 | 0 | 0 | 1 | 3 | 0 | 8 | 0 | 1 | 3 | 3 | 1 |
| 44 : Loh2005 | 2 | 0 | 1 | 0 | 0 | 1 | 3 | 0 | 1 | 0 | 2 | 0 |
| 45 : Loi2014 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 46 : Long2015 | 2 | 0 | 1 | 1 | 0 | 0 | 6 | 0 | 1 | 1 | 4 | 0 |
| 47 : Margolis2008 | 5 | 2 | 0 | 0 | 2 | 1 | 7 | 1 | 1 | 2 | 1 | 2 |
| 48 : Mathews2008 | 7 | 3 | 2 | 1 | 1 | 0 | 4 | 0 | 2 | 0 | 1 | 1 |
| 49 : McGregor2007 | 6 | 1 | 0 | 0 | 5 | 0 | 11 | 0 | 5 | 0 | 4 | 2 |
| 50 : McWilliams2016 | 12 | 3 | 3 | 0 | 5 | 1 | 7 | 0 | 1 | 3 | 1 | 2 |
| 51 : Moffatt2011 | 6 | 0 | 0 | 4 | 2 | 0 | 6 | 0 | 2 | 4 | 0 | 0 |
| 52 : Mooi2012 | 4 | 0 | 1 | 2 | 1 | 0 | 6 | 1 | 4 | 0 | 1 | 0 |
| 53 : Muttitt2004 | 3 | 1 | 2 | 0 | 0 | 0 | 13 | 3 | 3 | 1 | 4 | 2 |
| 54 : Nagao2012 | 2 | 1 | 0 | 0 | 1 | 0 | 9 | 0 | 4 | 0 | 1 | 4 |
| 55 : Nathoo2010 | 2 | 1 | 0 | 0 | 1 | 0 | 8 | 1 | 4 | 0 | 1 | 2 |
| 56 : Naverlo2016 | 5 | 0 | 1 | 3 | 1 | 0 | 4 | 0 | 2 | 0 | 2 | 0 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 57 : Newman2013 | 13 | 2 | 1 | 4 | 5 | 1 | 12 | 2 | 2 | 2 | 4 | 2 |
| 58 : Nilsson2009 | 4 | 1 | 0 | 1 | 2 | 0 | 3 | 0 | 1 | 1 | 0 | 1 |
| 59 : O'Day2016 | 1 | 0 | 1 | 0 | 0 | 0 | 9 | 0 | 2 | 1 | 3 | 3 |
| 60 : Pidgeon2017 | 2 | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 0 | 0 |
| 61 : Poulsen2015 | 5 | 0 | 0 | 1 | 4 | 0 | 4 | 0 | 1 | 0 | 1 | 2 |
| 62 : Reddy2000 | 4 | 1 | 0 | 0 | 2 | 1 | 4 | 1 | 2 | 1 | 0 | 0 |
| 63 : Richardson2015 | 9 | 3 | 1 | 3 | 2 | 0 | 5 | 0 | 2 | 0 | 0 | 3 |
| 64 : Rimal2017 | 4 | 0 | 2 | 0 | 2 | 0 | 10 | 0 | 3 | 1 | 1 | 5 |
| 65 : Roberts2015 | 6 | 1 | 0 | 2 | 1 | 2 | 4 | 0 | 2 | 0 | 1 | 1 |
| 66 : Rowell2014 | 5 | 0 | 1 | 1 | 3 | 0 | 9 | 1 | 1 | 2 | 2 | 3 |
| 67 : Sabesan2014 | 5 | 0 | 1 | 1 | 2 | 1 | 8 | 1 | 4 | 1 | 1 | 1 |
| 68 : Sabesan2012h | 5 | 1 | 1 | 0 | 2 | 1 | 1 | 0 | 1 | 0 | 0 | 0 |
| 69 : Sabesan2010 | 4 | 1 | 2 | 0 | 1 | 0 | 4 | 0 | 1 | 1 | 2 | 0 |
| 70 : Sabesan2015 | 3 | 0 | 2 | 0 | 1 | 0 | 4 | 0 | 0 | 0 | 3 | 1 |
| 71 : Saqui2007 | 11 | 2 | 2 | 3 | 3 | 1 | 10 | 0 | 1 | 2 | 3 | 4 |
| 72 : Saurman2011 | 8 | 1 | 0 | 5 | 2 | 0 | 11 | 0 | 3 | 0 | 3 | 5 |
| 73 : Serhal2017 | 6 | 2 | 0 | 4 | 0 | 0 | 7 | 0 | 1 | 1 | 4 | 1 |
| 74 : Sevean2009 | 9 | 3 | 1 | 2 | 2 | 1 | 5 | 1 | 2 | 0 | 2 | 0 |
| 75 : Shuaib2010 | 3 | 1 | 0 | 0 | 1 | 1 | 8 | 0 | 5 | 0 | 1 | 2 |
| 76 : Simpson et. al 2014t | 10 | 4 | 2 | 2 | 1 | 1 | 11 | 2 | 6 | 0 | 3 | 0 |
| 77 : Simpson2014 | 4 | 0 | 1 | 1 | 2 | 0 | 6 | 1 | 1 | 0 | 4 | 0 |
| 78 : Smith&Bensink2005 | 5 | 1 | 0 | 1 | 3 | 0 | 11 | 2 | 3 | 1 | 1 | 4 |
| 79 : Smith2004 | 4 | 1 | 1 | 0 | 2 | 0 | 8 | 0 | 2 | 1 | 2 | 3 |
| 80 : Stenlund | 5 | 2 | 1 | 0 | 2 | 0 | 5 | 1 | 1 | 1 | 2 | 0 |
| 81 : Tam2017 | 6 | 3 | 0 | 2 | 0 | 1 | 3 | 0 | 1 | 0 | 1 | 1 |
| 82 : Tanguay2015 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0 | 3 | 0 | 1 | 0 |
| 83 : Taylor2012 | 13 | 2 | 3 | 4 | 4 | 0 | 5 | 2 | 2 | 1 | 0 | 0 |
| 84 : Tetu2014 | 11 | 2 | 3 | 3 | 3 | 0 | 13 | 1 | 2 | 3 | 4 | 3 |
| 85 : Tynan2017 | 6 | 0 | 1 | 3 | 2 | 0 | 4 | 0 | 2 | 0 | 2 | 0 |
| 86 : VanAst2007 | 4 | 1 | 0 | 0 | 3 | 0 | 10 | 2 | 4 | 1 | 1 | 2 |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87 : Volpe | 9 | 0 | 3 | 2 | 3 | 1 | 11 | 3 | 3 | 0 | 4 | 1 |
| 88 : Warmington | 15 | 4 | 2 | 3 | 4 | 2 | 5 | 0 | 2 | 1 | 1 | 1 |
| 89 : Wilkes2004 | 10 | 2 | 2 | 2 | 2 | 2 | 7 | 0 | 1 | 0 | 3 | 3 |
| 90 : Wood2012 | 11 | 3 | 3 | 1 | 4 | 0 | 21 | 2 | 6 | 1 | 6 | 6 |
| 91 : Zilliacus2010 | 4 | 3 | 0 | 1 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 3 |

## Appendix E

Percentage of paper coded for each code in thematic synthesis.

| | A : Antifragile Code | B : Avoiding Suboptimization | C : Hybrid Leadership | D : Non-linear evaluation | E : Optionality | F : Starting Small | G : Institutional Investment code | H : Champions | I : Follow-up and support | J : Funding | K : Policy Alignment | L : Utilization |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 : Alami2017 | 21.46% | 3.65% | 6.77% | 3.77% | 6.68% | 2.3% | 27.69% | 5.42% | 5.59% | 3.81% | 4.45% | 8.41% |
| 2 : Al-Kadi2009 | 21.29% | 8.7% | 0% | 3.35% | 12.58% | 0% | 27.04% | 6.96% | 15.66% | 0% | 0% | 4.42% |
| 3 : Anvari2007 | 17.65% | 12.07% | 0% | 0% | 5.58% | 0% | 30.3% | 0% | 13.69% | 8.7% | 12.01% | 0% |
| 4 : Baker2004 | 50% | 23.91% | 0% | 0% | 0% | 26.09% | 0% | 0% | 0% | 0% | 0% | 0% |
| 5 : Barrett2009 | 18.35% | 16.26% | 0.87% | 1.22% | 0% | 0% | 31.65% | 5.91% | 6% | 6.17% | 5.3% | 8.26% |
| 6 : Bello2017 | 28.78% | 7.27% | 0% | 6.08% | 15.44% | 0% | 21.22% | 0% | 8.27% | 0% | 7.87% | 5.08% |
| 7 : Bhandari2011 | 20.22% | 3.88% | 9.46% | 1.75% | 5.13% | 0% | 29.78% | 10.34% | 11.24% | 0.77% | 3.84% | 3.6% |
| 8 : Bidargaddi2017 | 12.82% | 12.82% | 0% | 0% | 0% | 0% | 37.18% | 0% | 0% | 0% | 14.1% | 23.08% |
| 9 : Boman2014 | 29.06% | 5.98% | 5.77% | 0% | 23.29% | 0% | 17.95% | 0% | 11.97% | 0% | 5.98% | 0% |
| 10 : Boots2012 | 21.83% | 9.17% | 0% | 0% | 12.66% | 0% | 28.17% | 0% | 16.16% | 0% | 0% | 12.01% |
| 11 : Bradford2015 | 33.66% | 3.75% | 10.97% | 4.21% | 10.62% | 4.1% | 16.34% | 0% | 9.3% | 0% | 7.04% | 0% |
| 12 : Bridgens2008 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| 13 : Buckley2012 | 24.3% | 6.6% | 0% | 0% | 17.7% | 0% | 25.7% | 0% | 0% | 10.6% | 9.9% | 5.2% |
| 14 : Byrom2016 | 21.59% | 6.91% | 0% | 0% | 14.68% | 0% | 24.53% | 0% | 13.82% | 0% | 7.77% | 10.71% |
| 15 : Cadilhac2014 | 27.44% | 4.12% | 10.35% | 4.88% | 3.54% | 4.55% | 22.56% | 0% | 9.18% | 8.84% | 0% | 4.55% |
| 16 : Carlson2012 | 25.14% | 3.14% | 0% | 10.86% | 9.13% | 2.02% | 24.86% | 5.71% | 4.7% | 0% | 0% | 14.45% |
| 17 : Cloutier2008 | 17.57% | 5.72% | 0% | 3.21% | 8.63% | 0% | 32.43% | 7.33% | 6.12% | 3.01% | 4.12% | 11.85% |
| 18 : Conn2013 | 14.53% | 0% | 1.86% | 3.31% | 6.78% | 2.58% | 33.74% | 2.5% | 12.59% | 6.86% | 6.3% | 8.96% |
| 19 : Cowain2001 | 40.23% | 18.42% | 0% | 0% | 21.8% | 0% | 9.77% | 0% | 9.77% | 0% | 0% | 0% |
| 20 : Elliott2012 | 24.54% | 3.91% | 3.68% | 0% | 14.95% | 1.99% | 25.46% | 0% | 11.89% | 0% | 1.61% | 11.96% |
| 21 : Faulkner2002 | 15.74% | 0% | 0% | 5.81% | 7.74% | 2.19% | 34.26% | 0% | 15.24% | 10.52% | 8.5% | 0% |
| 22 : Fennell2017 | 30.82% | 0% | 8.66% | 14.82% | 7.34% | 0% | 19.18% | 4.36% | 5.12% | 4.09% | 0% | 5.61% |
| 23 : Gagnon2009 | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24 : Gardner2016 | 18.36% | 0% | 0% | 7.72% | 10.65% | 0% | 31.64% | 0% | 20.37% | 0% | 11.27% | 0% |
| 25 : Gibson2011a | 30.78% | 0% | 18.2% | 3.98% | 8.59% | 0% | 19.22% | 5.39% | 0% | 1.72% | 9.69% | 2.42% |
| 26 : Gordon2012 | 12.54% | 12.54% | 0% | 0% | 0% | 0% | 37.46% | 0% | 9.16% | 5.52% | 11.39% | 11.39% |
| 27 : Greenberg2006 | 31.05% | 0% | 18.41% | 0% | 12.64% | 0% | 12.64% | 0% | 12.64% | 12.64% | 0% | 0% |
| 28 : Greenwood2004 | 21.36% | 9.79% | 0% | 0% | 11.57% | 0% | 28.64% | 0% | 17.95% | 0% | 4.6% | 6.08% |
| 29 : Hoffmann2008 | 46.48% | 12.5% | 0% | 22.27% | 11.72% | 0% | 3.52% | 0% | 3.52% | 0% | 0% | 0% |
| 30 : Host2018 | 23.31% | 0% | 0% | 15.54% | 7.77% | 0% | 26.69% | 0% | 12.55% | 14.14% | 0% | 0% |
| 31 : Humer2017 | 24.1% | 8.17% | 5.35% | 8.17% | 2.4% | 0% | 25.9% | 0% | 5.59% | 0% | 14.66% | 5.65% |
| 32 : Jennett2005 | 24.45% | 0% | 3.71% | 20.74% | 0% | 0% | 25.55% | 12.23% | 0% | 7.42% | 5.9% | 0% |
| 33 : Jewett2017 | 15.28% | 0% | 0% | 15.28% | 0% | 0% | 34.72% | 0% | 0% | 0% | 25.17% | 9.55% |
| 34 : Jhaveri2016 | 18.25% | 4.3% | 4.45% | 0% | 9.5% | 0% | 31.75% | 5.49% | 14.84% | 0% | 10.24% | 1.19% |
| 35 : Johansson2014a | 21.37% | 4.57% | 0% | 3.23% | 13.58% | 0% | 28.63% | 0% | 21.17% | 0% | 0% | 7.46% |
| 36 : Johnson2015 | 20.52% | 0% | 0% | 5.6% | 14.93% | 0% | 29.48% | 0% | 4.1% | 0% | 4.66% | 20.71% |
| 37 : Jong2004 | 29.53% | 0% | 0% | 11.4% | 0% | 18.14% | 20.47% | 0% | 0% | 20.47% | 0% | 0% |
| 38 : Jong2004a | 17.6% | 0% | 0% | 0% | 13.14% | 4.46% | 32.4% | 0% | 0% | 18.37% | 9.57% | 4.46% |
| 39 : Khalil2014 | 15.56% | 0% | 8.89% | 0% | 3.25% | 3.43% | 32.99% | 10.34% | 15.14% | 6.25% | 4.15% | 0% |
| 40 : Krum2013 | 12.49% | 0% | 5.03% | 3.14% | 4.31% | 3.14% | 35.94% | 0% | 4.04% | 9.07% | 11.32% | 11.5% |
| 41 : Kumar2006 | 32.72% | 3.94% | 0% | 0% | 25% | 3.78% | 17.28% | 0% | 4.98% | 4.5% | 7.8% | 0% |
| 42 : LaBelle2018 | 21.07% | 6.29% | 4.8% | 6.84% | 3.14% | 0% | 28.93% | 0% | 3.93% | 3.69% | 14.62% | 6.68% |
| 43 : Liddy2017 | 16.67% | 0% | 0% | 4.17% | 12.5% | 0% | 33.33% | 0% | 1.55% | 15.47% | 11.3% | 5.01% |
| 44 : Loh2005 | 23.61% | 0% | 12.02% | 0% | 0% | 11.59% | 26.39% | 0% | 9.66% | 0% | 16.74% | 0% |
| 45 : Loi2014 | 30.1% | 0% | 30.1% | 0% | 0% | 0% | 19.9% | 0% | 0% | 0% | 19.9% | 0% |
| 46 : Long2015 | 8.02% | 0% | 5% | 3.02% | 0% | 0% | 41.98% | 0% | 8.85% | 7.92% | 25.21% | 0% |
| 47 : Margolis2008 | 18.2% | 10.08% | 0% | 0% | 4.66% | 3.46% | 31.8% | 2.56% | 6.17% | 7.44% | 4.51% | 11.13% |
| 48 : Mathews2008 | 30.22% | 10.51% | 8.79% | 4.74% | 6.18% | 0% | 19.78% | 0% | 9.96% | 0% | 4.33% | 5.49% |
| 49 : McGregor2007 | 17.33% | 1.69% | 0% | 0% | 15.64% | 0% | 31.47% | 0% | 15.54% | 0% | 13.51% | 4.83% |
| 50 : McWilliams2016 | 29.57% | 8.53% | 6.41% | 0% | 12.31% | 2.32% | 20.43% | 0% | 2.42% | 7.67% | 2.47% | 7.87% |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51 : Moffatt2011 | 30.96% | 0% | 0% | 22.13% | 8.83% | 0% | 19.04% | 0% | 9.29% | 9.75% | 0% | 0% |
| 52 : Mooi2012 | 25.15% | 0% | 3.24% | 17.59% | 4.32% | 0% | 24.85% | 3.09% | 16.2% | 0% | 5.56% | 0% |
| 53 : Muttitt2004 | 10.05% | 2.59% | 7.46% | 0% | 0% | 0% | 39.95% | 7.58% | 9.21% | 1.99% | 15.34% | 5.84% |
| 54 : Nagao2012 | 7.06% | 2.6% | 0% | 0% | 4.46% | 0% | 42.94% | 0% | 18.18% | 0% | 2.13% | 22.64% |
| 55 : Nathoo2010 | 6.51% | 3.58% | 0% | 0% | 2.94% | 0% | 43.49% | 3.67% | 20.18% | 0% | 4.5% | 15.14% |
| 56 : Naverlo2016 | 28% | 0% | 7.53% | 16.94% | 3.53% | 0% | 22% | 0% | 9.65% | 0% | 12.35% | 0% |
| 57 : Newman2013 | 24.55% | 2.21% | 2.47% | 7.15% | 11.3% | 1.42% | 25.45% | 3.82% | 5.8% | 3.26% | 6.55% | 6.03% |
| 58 : Nilsson2009 | 26.74% | 8.07% | 0% | 7.28% | 11.39% | 0% | 23.26% | 0% | 6.01% | 5.7% | 0% | 11.55% |
| 59 : O'Day2016 | 2.73% | 0% | 2.73% | 0% | 0% | 0% | 47.27% | 0% | 8.83% | 2.99% | 18.18% | 17.27% |
| 60 : Pidgeon2017 | 21.13% | 0% | 0% | 0% | 21.13% | 0% | 28.87% | 0% | 28.87% | 0% | 0% | 0% |
| 61 : Poulsen2015 | 22.93% | 0% | 0% | 4.84% | 18.09% | 0% | 27.07% | 0% | 8.97% | 0% | 4.56% | 13.53% |
| 62 : Reddy2000 | 23.16% | 7.23% | 0% | 0% | 13.92% | 2.01% | 21.29% | 11.11% | 10.17% | 11.11% | 0% | 0% |
| 63 : Richardson2015 | 28.51% | 10.62% | 2.61% | 9.88% | 5.4% | 0% | 21.49% | 0% | 10.31% | 0% | 0% | 11.18% |
| 64 : Rimal2017 | 13.83% | 0% | 7.18% | 0% | 6.65% | 0% | 36.17% | 0% | 11.77% | 1.13% | 2.79% | 20.48% |
| 65 : Roberts2015 | 26.67% | 8.06% | 0% | 9.03% | 5.48% | 4.09% | 23.33% | 0% | 10.97% | 0% | 9.57% | 2.8% |
| 66 : Rowell2014 | 19.5% | 0% | 2.86% | 3.49% | 13.15% | 0% | 30.5% | 2.99% | 4.89% | 6.29% | 4.76% | 11.56% |
| 67 : Sabesan - timelyaccess 2014 | 19.82% | 0% | 3.9% | 5.31% | 6.8% | 3.81% | 25.7% | 4.48% | 15.34% | 4.48% | 5.89% | 4.48% |
| 68 : Sabesan- rural cancer care 2012h | 36.24% | 9.27% | 8.43% | 0% | 18.54% | 8.99% | 9.27% | 0% | 9.27% | 0% | 0% | 0% |
| 69 : Sabesan2010 | 29.31% | 9.77% | 13.56% | 0% | 5.98% | 0% | 20.69% | 0% | 6.32% | 3.33% | 11.03% | 0% |
| 70 : Sabesan2015 | 20.22% | 0% | 12.19% | 0% | 8.02% | 0% | 29.78% | 0% | 0% | 0% | 23.3% | 6.48% |
| 71 : Saqui2007 | 26.46% | 5.84% | 3.46% | 7.22% | 7.47% | 2.47% | 23.54% | 0% | 2.08% | 1.88% | 7.91% | 11.67% |
| 72 : Saurman2011 | 18.11% | 3.43% | 0% | 9.57% | 5.11% | 0% | 31.89% | 0% | 8% | 0% | 6.98% | 16.91% |
| 73 : Serhal2017 | 20.86% | 6.42% | 0% | 14.44% | 0% | 0% | 29.14% | 0% | 2.85% | 7.28% | 10.79% | 8.21% |
| 74 : Sevean2009 | 35.6% | 12.55% | 3.7% | 8.85% | 6.58% | 3.91% | 14.4% | 3.02% | 4.66% | 0% | 6.72% | 0% |
| 75 : Shuaib2010 | 10.87% | 4.97% | 0% | 0% | 3% | 2.9% | 39.13% | 0% | 26.92% | 0% | 5.38% | 6.83% |
| 76 : Simpson et. al 2014t | 23.18% | 8.24% | 6.11% | 4.61% | 2.01% | 2.21% | 26.82% | 3.83% | 15.17% | 0% | 7.82% | 0% |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77 : Simpson2014 | 22.48% | 0% | 4.38% | 6.95% | 11.14% | 0% | 27.52% | 4.38% | 4% | 0% | 19.14% | 0% |
| 78 : Smith&Bensink2005 | 13.89% | 1.98% | 0% | 1.59% | 10.32% | 0% | 36.11% | 3.9% | 10.32% | 3.9% | 4.83% | 13.17% |
| 79 : Smith2004 | 16.82% | 4.9% | 4.62% | 0% | 7.3% | 0% | 33.18% | 0% | 8.6% | 2.87% | 7.86% | 13.86% |
| 80 : Stenlund | 22.17% | 10.3% | 4.26% | 0% | 13.55% | 0% | 24.86% | 3.14% | 3.47% | 4.59% | 13.66% | 0% |
| 81 : Tam2017 | 28.86% | 12.15% | 0% | 7.34% | 0% | 9.37% | 21.14% | 0% | 4.81% | 0% | 6.96% | 9.37% |
| 82 : Tanguay2015 | 0% | 0% | 0% | 0% | 0% | 0% | 50% | 0% | 39.02% | 0% | 10.98% | 0% |
| 83 : Taylor2012 | 39.24% | 6.89% | 7.32% | 10.7% | 14.33% | 0% | 10.76% | 3.87% | 4.59% | 2.3% | 0% | 0% |
| 84 : Tetu2014 | 21.69% | 3.92% | 5.13% | 8.33% | 4.3% | 0% | 28.31% | 1.38% | 4.69% | 4.08% | 8.83% | 9.33% |
| 85 : Tynan2017 | 25.32% | 0% | 3.03% | 15.58% | 6.71% | 0% | 21.75% | 0% | 16.67% | 0% | 10.93% | 0% |
| 86 : VanAst2007 | 15.28% | 4.17% | 0% | 0% | 11.11% | 0% | 27.78% | 4.17% | 17.36% | 2.78% | 6.94% | 10.42% |
| 87 : Volpe | 28.2% | 0% | 9.8% | 6.25% | 12.15% | 8% | 15.33% | 5.17% | 6.01% | 0% | 7.22% | 1.86% |
| 88 : Warmington | 41.1% | 10.16% | 5.75% | 10.63% | 11.02% | 3.54% | 8.9% | 0% | 3.7% | 1.34% | 1.5% | 2.36% |
| 89 : Wilkes2004 | 27.9% | 4.22% | 4.73% | 8.06% | 7.17% | 6.97% | 18.87% | 0% | 2.3% | 0% | 10.88% | 8.89% |
| 90 : Wood2012 | 17.97% | 5.08% | 3.87% | 1.63% | 7.39% | 0% | 32.03% | 1.88% | 10.51% | 1.63% | 8.17% | 9.84% |
| 91 : Zilliacus2010 | 29.42% | 20.86% | 0% | 8.56% | 0% | 0% | 20.58% | 0% | 0% | 4.14% | 0% | 16.44% |

**Appendix F**

Pearson correlation coefficients for code cluster analysis by word similarity.

| Code A | Code B | Pearson Correlation Coefficient |
|---|---|---|
| Codes\\Antifragile Code\Optionality | Codes\\Antifragile Code | 0.934443 |
| Codes\\Institutional Investment code | Codes\\Institutional Investment code\Follow-up and support | 0.903884 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Institutional Investment code | 0.897251 |
| Codes\\Institutional Investment code | Codes\\Antifragile Code | 0.884424 |
| Codes\\Complex Adaptive System code | Codes\\Antifragile Code | 0.865221 |
| Codes\\Antifragile Code\Avoiding Suboptimization | Codes\\Antifragile Code | 0.86314 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Antifragile Code | 0.861972 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Complex Adaptive System code | 0.854046 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Complex Adaptive System code | 0.849588 |
| Codes\\Antifragile Code\Hybrid Leadership | Codes\\Antifragile Code | 0.847731 |
| Codes\\Complex Adaptive System code\Emergence | Codes\\Complex Adaptive System code | 0.837444 |

| | | |
|---|---|---|
| Codes\\Antifragile Code\Optionality | Codes\\Complex Adaptive System code | 0.832748 |
| Codes\\Institutional Investment code\Follow-up and support | Codes\\Antifragile Code | 0.8253 |
| Codes\\Antifragile Code\Optionality | Codes\\Institutional Investment code | 0.814756 |
| Codes\\Institutional Investment code | Codes\\Complex Adaptive System code | 0.814454 |
| Codes\\Institutional Investment code\Utilization | Codes\\Institutional Investment code | 0.794346 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Antifragile Code | 0.784215 |
| Codes\\Antifragile Code\Optionality | Codes\\Institutional Investment code\Follow-up and support | 0.779152 |
| Codes\\Institutional Investment code | Codes\\Antifragile Code\Hybrid Leadership | 0.777894 |
| Codes\\Antifragile Code\Optionality | Codes\\Antifragile Code\Avoiding Suboptimization | 0.775695 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Institutional Investment code\Follow-up and support | 0.768447 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Complex Adaptive System code | 0.761147 |
| Codes\\Institutional Investment code\Follow-up and support | Codes\\Complex Adaptive System code | 0.755513 |
| Codes\\Complex Adaptive System code | Codes\\Antifragile Code\Avoiding Suboptimization | 0.755107 |

| | | |
|---|---|---|
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Institutional Investment code | 0.752562 |
| Codes\\Institutional Investment code | Codes\\Institutional Investment code\Funding | 0.750428 |
| Codes\\Institutional Investment code | Codes\\Antifragile Code\Avoiding Suboptimization | 0.748491 |
| Codes\\Antifragile Code\Hybrid Leadership | Codes\\Institutional Investment code\Follow-up and support | 0.747197 |
| Codes\\Complex Adaptive System code\Emergence | Codes\\Antifragile Code | 0.742693 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Antifragile Code\Hybrid Leadership | 0.741123 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Antifragile Code | 0.73788 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Antifragile Code | 0.729365 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Complex Adaptive System code | 0.728437 |
| Codes\\Antifragile Code\Optionality | Codes\\Antifragile Code\Non-linear evaluation | 0.727401 |
| Codes\\Antifragile Code\Hybrid Leadership | Codes\\Complex Adaptive System code | 0.720976 |
| Codes\\Antifragile Code\Optionality | Codes\\Complex Adaptive System code\Emergence | 0.717136 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Antifragile Code\Optionality | 0.716909 |

| | | |
|---|---|---|
| Codes\\Antifragile Code\Optionality | Codes\\Antifragile Code\Hybrid Leadership | 0.715776 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Complex Adaptive System code | 0.714626 |
| Codes\\Institutional Investment code\Utilization | Codes\\Antifragile Code | 0.710448 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Antifragile Code\Optionality | 0.709808 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Institutional Investment code | 0.702534 |
| Codes\\Institutional Investment code\Follow-up and support | Codes\\Antifragile Code\Avoiding Suboptimization | 0.699883 |
| Codes\\Institutional Investment code | Codes\\Complex Adaptive System code\Emergence | 0.69893 |
| Codes\\Antifragile Code\Optionality | Codes\\Complex Adaptive System code\Non-linearity | 0.697666 |
| Codes\\Antifragile Code\Starting Small | Codes\\Antifragile Code | 0.682892 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Antifragile Code\Hybrid Leadership | 0.679659 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Institutional Investment code | 0.675919 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Antifragile Code\Avoiding Suboptimization | 0.672752 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Institutional Investment code\Follow-up and support | 0.672745 |

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|---|---|---|
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Antifragile Code\Non-linear evaluation | 0.670046 |
| Codes\\Institutional Investment code\Utilization | Codes\\Antifragile Code\Optionality | 0.666596 |
| Codes\\Institutional Investment code\Utilization | Codes\\Antifragile Code\Starting Small | 0.66265 |
| Codes\\Antifragile Code\Hybrid Leadership | Codes\\Antifragile Code\Avoiding Suboptimization | 0.661904 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Antifragile Code\Avoiding Suboptimization | 0.659333 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Institutional Investment code\Funding | 0.656631 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Institutional Investment code\Follow-up and support | 0.65609 |
| Codes\\Institutional Investment code | Codes\\Institutional Investment code\Champions | 0.65186 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Antifragile Code\Avoiding Suboptimization | 0.650828 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Complex Adaptive System code\Non-linearity | 0.65013 |
| Codes\\Complex Adaptive System code\Emergence | Codes\\Antifragile Code\Avoiding Suboptimization | 0.649302 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Antifragile Code | 0.644819 |

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|---|---|---|
| Codes\\Antifragile Code\Starting Small | Codes\\Institutional Investment code | 0.641044 |
| Codes\\Institutional Investment code\Follow-up and support | Codes\\Complex Adaptive System code\Emergence | 0.638557 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Antifragile Code\Non-linear evaluation | 0.638447 |
| Codes\\Institutional Investment code\Utilization | Codes\\Complex Adaptive System code | 0.637273 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Complex Adaptive System code\Emergence | 0.63162 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Complex Adaptive System code\Emergence | 0.631301 |
| Codes\\Institutional Investment code\Utilization | Codes\\Antifragile Code\Non-linear evaluation | 0.624249 |
| Codes\\Antifragile Code\Hybrid Leadership | Codes\\Institutional Investment code\Champions | 0.624219 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Antifragile Code\Hybrid Leadership | 0.620491 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Antifragile Code\Optionality | 0.618575 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Complex Adaptive System code\Emergence | 0.618512 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Institutional Investment code\Follow-up and support | 0.618296 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Complex Adaptive System code\Emergence | 0.617836 |

| | | |
|---|---|---|
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Institutional Investment code\Funding | 0.616506 |
| Codes\\Institutional Investment code\Utilization | Codes\\Antifragile Code\Avoiding Suboptimization | 0.613407 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Institutional Investment code | 0.611883 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Antifragile Code\Avoiding Suboptimization | 0.611779 |
| Codes\\Antifragile Code\Hybrid Leadership | Codes\\Complex Adaptive System code\Emergence | 0.611725 |
| Codes\\Institutional Investment code\Funding | Codes\\Complex Adaptive System code | 0.610657 |
| Codes\\Institutional Investment code\Funding | Codes\\Antifragile Code | 0.607161 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Antifragile Code\Hybrid Leadership | 0.604913 |
| Codes\\Institutional Investment code\Utilization | Codes\\Institutional Investment code\Follow-up and support | 0.60427 |
| Codes\\Institutional Investment code\Funding | Codes\\Institutional Investment code\Follow-up and support | 0.602899 |
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Antifragile Code\Non-linear evaluation | 0.600583 |
| Codes\\Institutional Investment code\Follow-up and support | Codes\\Institutional Investment code\Champions | 0.599572 |

| | | |
|---|---|---|
| Codes\\Antifragile Code\Starting Small | Codes\\Antifragile Code\Optionality | 0.594617 |
| Codes\\Institutional Investment code\Champions | Codes\\Antifragile Code | 0.59148 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Institutional Investment code\Follow-up and support | 0.58591 |
| Codes\\Institutional Investment code\Utilization | Codes\\Institutional Investment code\Policy Alignment | 0.579875 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Complex Adaptive System code\Non-linearity | 0.579809 |
| Codes\\Antifragile Code\Starting Small | Codes\\Antifragile Code\Non-linear evaluation | 0.576603 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Complex Adaptive System code\Sense-making | 0.567683 |
| Codes\\Institutional Investment code\Utilization | Codes\\Complex Adaptive System code\Emergence | 0.56358 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Antifragile Code\Avoiding Suboptimization | 0.559568 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Complex Adaptive System code\Non-linearity | 0.558489 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Institutional Investment code\Policy Alignment | 0.558179 |
| Codes\\Antifragile Code\Starting Small | Codes\\Complex Adaptive System code | 0.551379 |

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|---|---|---|
| Codes\\Complex Adaptive System code | Codes\\Institutional Investment code\Champions | 0.550259 |
| Codes\\Antifragile Code\Optionality | Codes\\Institutional Investment code\Funding | 0.546576 |
| Codes\\Antifragile Code\Starting Small | Codes\\Institutional Investment code\Follow-up and support | 0.545677 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Antifragile Code\Non-linear evaluation | 0.543333 |
| Codes\\Antifragile Code\Hybrid Leadership | Codes\\Institutional Investment code\Funding | 0.53963 |
| Codes\\Institutional Investment code\Utilization | Codes\\Complex Adaptive System code\Sense-making | 0.537045 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Complex Adaptive System code\Emergence | 0.535073 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Institutional Investment code\Funding | 0.533097 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Antifragile Code\Hybrid Leadership | 0.531855 |
| Codes\\Antifragile Code\Starting Small | Codes\\Antifragile Code\Avoiding Suboptimization | 0.52948 |
| Codes\\Institutional Investment code\Utilization | Codes\\Complex Adaptive System code\Non-linearity | 0.52846 |
| Codes\\Institutional Investment code\Policy Alignment | Codes\\Institutional Investment code\Champions | 0.525404 |

| | | |
|---|---|---|
| Codes\\Institutional Investment code\Funding | Codes\\Antifragile Code\Avoiding Suboptimization | 0.518605 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Institutional Investment code\Policy Alignment | 0.511121 |
| Codes\\Institutional Investment code\Utilization | Codes\\Antifragile Code\Hybrid Leadership | 0.510162 |
| Codes\\Antifragile Code\Optionality | Codes\\Institutional Investment code\Champions | 0.508361 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Institutional Investment code\Champions | 0.507637 |
| Codes\\Antifragile Code\Non-linear evaluation | Codes\\Institutional Investment code\Champions | 0.503598 |
| Codes\\Antifragile Code\Starting Small | Codes\\Institutional Investment code\Policy Alignment | 0.498542 |
| Codes\\Antifragile Code\Starting Small | Codes\\Complex Adaptive System code\Emergence | 0.495746 |
| Codes\\Antifragile Code\Starting Small | Codes\\Antifragile Code\Hybrid Leadership | 0.495186 |
| Codes\\Institutional Investment code\Utilization | Codes\\Complex Adaptive System code\Unintended Consequences | 0.487778 |
| Codes\\Institutional Investment code\Funding | Codes\\Complex Adaptive System code\Emergence | 0.477205 |
| Codes\\Complex Adaptive System code\Sense-making | Codes\\Institutional Investment code\Funding | 0.471646 |

| | | |
|---|---|---|
| Codes\\Complex Adaptive System code\Emergence | Codes\\Institutional Investment code\Champions | 0.471416 |
| Codes\\Institutional Investment code\Utilization | Codes\\Institutional Investment code\Funding | 0.471013 |
| Codes\\Institutional Investment code\Champions | Codes\\Antifragile Code\Avoiding Suboptimization | 0.465155 |
| Codes\\Antifragile Code\Starting Small | Codes\\Complex Adaptive System code\Sense-making | 0.46066 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Institutional Investment code\Champions | 0.45402 |
| Codes\\Institutional Investment code\Funding | Codes\\Institutional Investment code\Champions | 0.448282 |
| Codes\\Antifragile Code\Starting Small | Codes\\Complex Adaptive System code\Non-linearity | 0.439952 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Antifragile Code\Starting Small | 0.437895 |
| Codes\\Complex Adaptive System code\Unintended Consequences | Codes\\Institutional Investment code\Funding | 0.431804 |
| Codes\\Antifragile Code\Starting Small | Codes\\Institutional Investment code\Funding | 0.423943 |
| Codes\\Antifragile Code\Starting Small | Codes\\Institutional Investment code\Champions | 0.403484 |
| Codes\\Institutional Investment code\Utilization | Codes\\Institutional Investment code\Champions | 0.402966 |

| | | |
|---|---|---|
| Codes\\Complex Adaptive System code\Non-linearity | Codes\\Institutional Investment code\Champions | 0.391126 |

**Appendix G**

An implementation team checklist to understand antifragile deployment organizational readiness

1. *Inform – questions should be answered in complexity science terms*
    a. **Has your community undertaken an electronic health initiative in the past?**
        i. **If YES:** What was the end state of that program? Who was involved? What were the programs origins? How was the program implemented? What has changed (organizationally, technologically) since then?
        ii. **If NO:** Has there been other electronic programs deployed here (not specifically health related?) What are the general attitudes and opinions on electronic programs?
        iii. **Applicable to BOTH:** What are the community's strengths? What are some challenges? Who are key agents within the community? What sort of collaboration between the community and researchers has happened in the past?
    b. **What are some assumptions made about the implementation from rural stakeholders and implementation team members?**
        i. **For RURAL STAKEHOLDERS:** Do they consider their community rural? Do they perceive a clinical or health access need for the intervention? Do they identify supports which can help sustain the intervention (volunteer groups, local expertise, etc.)?
        ii. **For IMPLEMENTATION TEAMS:** What are some preconceptions of rural communities which need to be challenged? What is the consensus opinion of the intervention? Who is the agreed upon stakeholder or group of stakeholder to consult regarding challenges or problems with the implementation?
    c. **What are pertinent logistical concerns which may impact an implementation?**
        i. **INFRASTRCTURE concerns:** Is there sufficient bandwidth for an intervention? Is there dedicated space to house interventional components? Is there identified channels of communication between support resources and intervention users?
        ii. **SOCIOLOGICAL concerns:** What existing social connections could impact an intervention? Is there capacity to provide follow-up and support in leveraging local resources? What socio-cultural or socio-economic facets of the community could impact the implementation? How can these facets be leveraged or mitigated?
2. *Influence – questions should be answered through narrative inquiry outputs*
    a. **Where can optionality be integrated into the interventions to facilitate better uptake?**
        i. **For PATIENTS:** How do patients interact with the intervention? Which components of the intervention are most relevant to its fidelity? How

would patient behaviour change with a change in patient-facing resources? How is patient feedback being integrated into the implementation?

ii. **For PROVIDERS:** How has the intervention tangibly influenced standard practice? How is provider feedback being integrated into the implementation? How would provider uptake change with the introduction of choice to the intervention? Which choices are most pertinent to the fidelity of the intervention?

b. **What can the lived experience of patients and providers tell us about the overall reception of the intervention?**

i. **For PATIENTS:** How has this intervention help manage your disease or condition better? What are the strengths of the interventions? What are some challenges? Who would you ask to change certain parts of the intervention (clinicians, technologists, etc.?)

ii. **For PROVIDERS:** How has the intervention improved you ability to manage your patients (better communication, better follow-up, etc.)? What are the strengths of the intervention? What are the challenges? Who would you ask to change certain parts of the intervention (administrators, technologists, patients, etc.?)

3. *Interpret – data should be framed through ethnographic accounts and realist evaluation*

a. **How can outcome data be better understood through different perspectives?**

i. **Through REALIST EVALUATION:** How does the program logic correlate with the data collected in the *inform* and *iterate* steps? How could complex adaptive system traits such as emergence, sense-making, and non-linearity obscure the data? What are the stakeholder assessments of the outcome data (patients and providers?)

ii. **Through ETHNOGRAPHIC ACCOUNTS:** How does the lived experience of the community correlate with outcome data? What are some unforeseen consequences of the implementation which should be mitigated or leveraged? How has the intervention been received by stakeholders of the community?

b. **How can the outcome data motivate further investment for sustainability of the intervention?**

i. **Securing FUNDING**: Is there a clinical or patient champion who can be enrolled? Are there funding calls which are appropriate for this intervention? Does the outcome data address significant policy concerns? Has the intervention demonstrated system savings?

ii. **Securing COMMUNITY BUY-IN**: Has follow-up and support structures been founded in local expertise? Have hybrid-leadership modalities been incorporated into the implementation? Have patient or provider accounts of interventional impact been sufficiently recorded (outside of quantitative outcome data?)

4. *Iterate – project should be understood as a function of investment and antifragility*

a. **How to integrate more institutional investment indices into your intervention?**

i. **CHAMPIONS:** Through data collected in *inform, influence,* and *interpret,* are there agents who could be enrolled as champions? Has a champion arisen organically through the first implementation iteration?
ii. **FUNDING:** Have funds been released which can help sustain the intervention? Have other funding sources emerged which can be used?
iii. **UTILIZATION:** Has the intervention improved the uptake or rate of use in the target population? Has the intervention decreased the use or mitigated volume of another service?
iv. **FOLLOW-UP AND SUPPORT:** Is there local expertise which can be leveraged? Can agents in the community be sufficiently trained to provide logistical, organizational, or technical support?
v. **POLICY ALIGNMENT:** Does the intervention adhere to mandates prioritized by institutes of relevance (hospitals, provincial policy, Federal policy, etc.?) Has new policy been signalled as a priority which the intervention can align with?

b. **How to integrate more antifragile operators into your intervention?**
i. **OPTIONALITY:** Referencing the data from the *influence* stage of the CDCT, how can further choice help facilitate uptake of the intervention? Which interventional components are must suited for the adoption of choice?
ii. **NON-LINEAR EVALUATION:** How has the intervention changed attitudes, values, or beliefs within the community? How have these changes been reflected in outcome data? How does the intervention positively or negatively impact other parts of the system?
iii. **HYBRID LEADERSHIP**: Are there dedicated channels to facilitate bi-directional flow of information within the implementation? How transparent is the implementation team with rural stakeholders? How has feedback from stakeholder relevant to the implementation been integrated?
iv. **STARTING SMALL:** In future iterations, is there a way to pilot certain changes? Have resources allocated to the project been reasonably distributed? Are there contingency plans to avoid overspending or over committing?
v. **AVOIDING SUBOPTIMIZATION:** Through data collected in the *interpret* stage, how have ethnographic accounts or realist evaluations framed the reception of the intervention? How might the intervention impact the wider system?

*These questions are meant to be guiding in nature and are subject to the pragmatic needs of the intervention's context.*

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