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Thomas Roe Solberg for the degree of Master of Science in Industrial Engineering presented on March 9, 2017.

Title: A Proposed Framework for Increasing the Accessibility of Systems Thinking Intervention Approaches for Non-Systems Thinking Practitioners

Abstract approved: _____

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Abstract:

Meta-methodologies have been created to assist systems thinking practitioners in selecting applicable intervention approaches for different system states; however, current meta-methodologies do not address the lack of accessibility for non-systems thinking practitioners. To address this problem, the key system states that contribute the most to reduce the variety gap between interventionists and intervention approaches need to be identified and operationalized. Key system states are defined by Burrell and Morgan's (1979) sociological paradigms, which will act as the theoretical foundation of this research, similar to current meta-methodologies. This theoretical foundation led to the creation of sociological dimensions and sociological

categories designed to be accessible to non-systems thinking practitioners. The framework proposed in this research incorporates the basic premises of Bradley Moore, Javier Calvo-Amodio and Joseph Junker's work (2016). A data collection and treatment methodology was created for coding the system state of case studies of intervention approaches, complete with a codebook. The location of three intervention approaches (Viable Systems Model, Soft Systems Methodology and System Dynamics) were mapped within the proposed framework. Locations were found to be consistent with theory. The findings from this research support the notion that key system states can be identified and operationalized. Additionally, the proposed framework contributes to reducing the variety gap between interventionist and intervention approach by simplifying the process of selecting appropriate intervention approaches for the system state.

A Proposed Framework for Increasing the Accessibility of Systems Thinking Intervention Approaches for Non-Systems Thinking Practitioners

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Thomas Roe Solberg, Author

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Chapter 1

Introduction

1.1 Background

Organizations often encounter barriers during the course of employing intervention approaches for the problem situations they face, leading to poor implementation results. Jackson (2003) points out that managers often receive simple, quick-fix solutions to problems situations according to the latest management fad, however discover that they rarely work in face of increasing complexity, change, and diversity. Inversely, for more complex intervention approaches, the approach can become too theoretical and does not provide much guidance for interventionists as to how to utilize it properly (Jackson, 2003).

The barriers mentioned above can be explained using Ashby's law of requisite variety (Ashby, 1956), which states "only variety can destroy variety". In system terms, variety means "the number of possible states of a system" (Beer, 1993). This means that a system with multiple states can only be fully controlled if the would-be controller commands an equal number of states as the system (Jackson, 2003). For the purpose of this thesis, a controller will be referred to as an "interventionist".

While this statement brings attention to the overall "variety gap" between an interventionist and a system (see Figure 1), there are two "variety gaps" being addressed during the process of control:

(1) Between the system and the intervention approach, and;

(2) Between the intervention approach and the interventionist.

This is an important distinction, as the first scenario (quick-fix solutions) describes a variety gap between a high-variety system and a low-variety intervention approach, while the second scenario (complex solutions) describes a variety gap between a high-variety intervention approach and a low-variety interventionist. Figure 2 gives a graphical representation of these variety gaps.

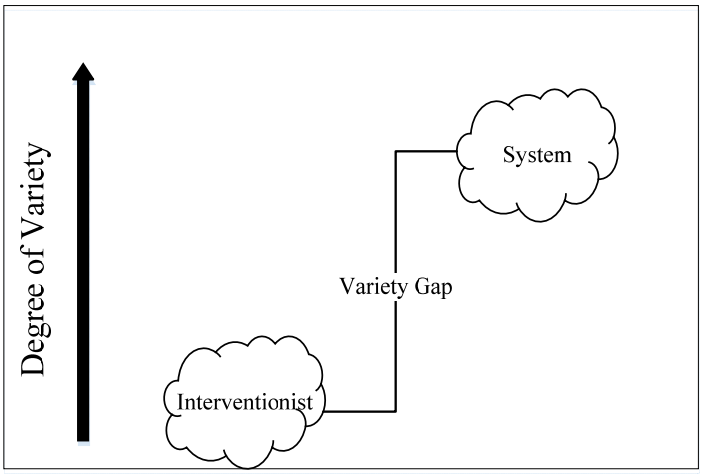

Figure 1. Degree of Variety between Interventionist and System

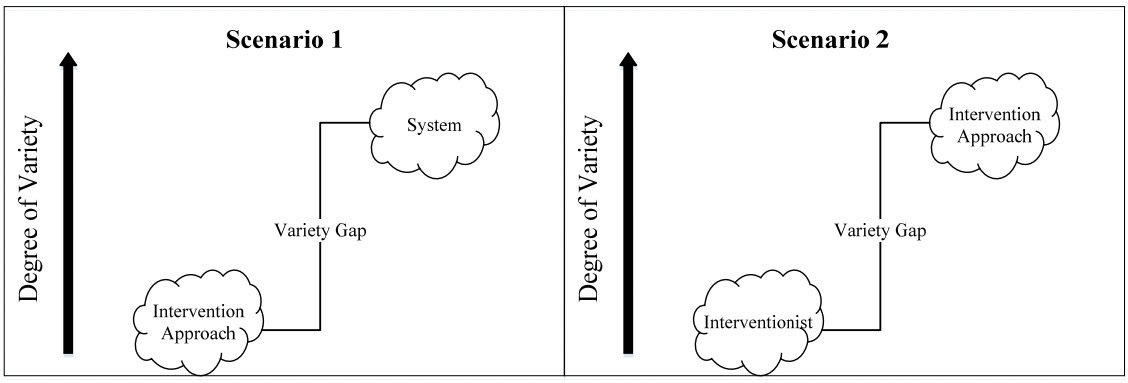

Figure 2. Degree of Variety between Interventionist, Intervention Approach, and System

Systems thinking has been tackling the variety gap between the system and the intervention approach since the 1970's. It was acknowledged that systems, particularly human-activity systems, can exhibit multiple states, and as a result systems thinking branched out from its positivist and functionalist philosophies, into multiple diverse philosophies (i.e. structuralism, interpretivism, radicalism, and postmodernism). In addition to thinking of systems in new ways, intervention approaches were developed to address system states. Due to the added complexity of determining the system state and its resulting intervention approach, meta-methodologies have been created, critiqued, and revisited since the 1990's (Jackson, 2001).

While these meta-methodologies have decreased the variety gap between intervention approach and system, there is still an underlying assumption that interventionists are proficient in the systems thinking language. In an attempt to match the variety of an intervention approach to the variety of the system, meta-methodologies demand a lot from the interventionist (Ormerud, 1997, as cited in Jackson, 2003, p. 373), and do not give sufficient attention to the interventionist (Taket and White, 2000, as cited in Jackson, 2003, p. 373). It is accepted that more thought needs to be put into the process of using an intervention approach (Jackson, 2000).

1.2 Problem Statement

There is no clear path to reducing the variety gap between the interventionist and the intervention approach without increasing the variety gap between the intervention approach and the system. Total Systems Intervention (TSI), the first meta-methodology,

initially appeared to solve this problem by following the philosophy of Critical Systems Thinking, focusing on identifying and distinguishing the different system states and their resulting intervention approaches. However, critique raised concerns of the structure being too rigid (Mingers & Brocklesby, 1997; Taket & White, 2000; Tsoukas, 1993). In other words, TSI's attempt to simplify the intervention approach ended up increasing the variety gap between the intervention approach and the system. Meta-methodologies have since acknowledged and incorporated postmodern philosophy to more accurately describe the system state by creating tailored intervention approaches, rather than choosing pre-existing intervention approaches (e.g. Local Systems Intervention (Flood, 2001)) and Critical Systems Practice (Jackson, 2001)). Postmodern critique has increased the variety of meta-methodologies to match the variety of the system; Yet, current meta-methodologies do not have a solution for decreasing the variety gap between the interventionist and the intervention approach, while also maintaining the variety gap between the intervention approach and the system (Shown in Figure 3).

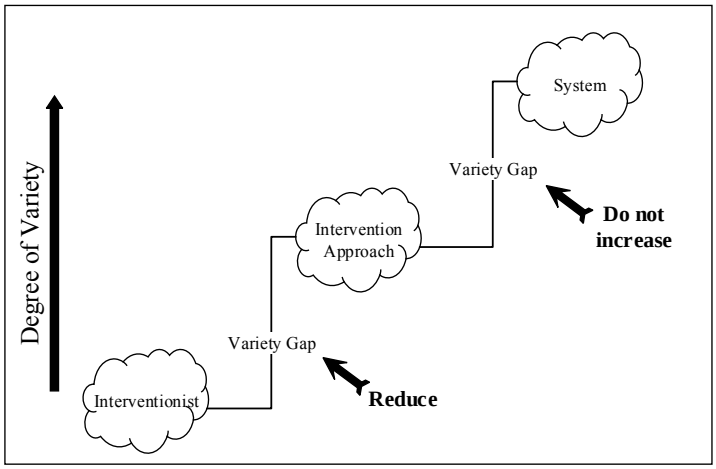

Figure 3. Variety Gap Problem Statement

1.3 Research Questions

In order to address this problem, the following questions need to be answered.

1.3.1 First Sub-Question

What key system states contribute the most to reduce the variety gap between low-variety interventionist and high-variety intervention approach?

1.3.2 Second Sub-Question

How can the key system states be operationalized to reduce the variety gap between low-variety interventionist and high-variety intervention approach?

1.4 Research Hypothesis

In order to address these questions, the following hypothesis need to be addressed.

1.4.1 First Hypothesis

There are a set of limited system states that can be used to reduce the variety gap between low-variety interventionist and high-variety intervention approach.

1.4.2 Second Hypothesis

Key system states can be operationalized to reduce the variety gap between low-variety interventionist and high-variety intervention approach.

1.5 Research purpose

The purpose of this research is to develop a framework for current meta-methodologies that is accessible to low-variety interventionists, while remaining grounded in high-variety systems.

1.6 Research Objective

The objectives of this research are

(1) Investigate and identify the nature of high-variety system states;

(2) To develop a meta-methodology framework that addresses high-variety systems, yet is approachable by low-variety interventionist.

1.7 Delimitations

1.7.1 Limitations

1. Intervention approach coding is based on the evaluation of intervention approaches from case studies.
2. Chosen intervention approach case studies must be accessible online to be considered for coding.
3. Identification of key systems states is based on acknowledged system states, meaning that the operationalization of system states will need to be updated as new system states are discovered and identified.

1.7.2 Assumptions

1. It is assumed that the intervention approach case studies analyzed are representative of the intervention approaches as a whole.
2. Case studies that did not implement their chosen intervention approach are assumed representative if they conclude the intervention approach to be useful.

1.8 Relevance of this Study

1.8.1 Need for this Research

There is a need to make meta-methodologies more accessible for non-systems thinking practitioners, without sacrificing the ability to view multiple states of the system.

1.8.1.1 Theoretical Research Needs

Understanding how to more accurately characterize system states, when compared to current meta-methodologies, by the set of assumptions they are based on, allowing for higher degree of granularity when describing system states, while remaining accessible to non-systems thinking practitioner.

1.8.1.2 Practical Research Needs

A framework that increases the accessibility of meta-methodologies to non-systems thinking practitioners, and in turn encourages the practice of systems thinking.

1.8.2 Benefits of this Research

Initiates a conversation of making systems thinking meta-methodologies more accessible to non-systems thinking practitioner.

1.9 Research Outputs and Outcomes

The output of this research is the creation of a framework that categorizes system states and intervention approaches based on the set of assumptions that constitute sociological paradigms. This contributes to the systems thinking body of knowledge by further enhancing the accessibility of meta-methodologies by developing a framework that will guide interventionists without requiring initial systems thinking knowledge.

Chapter 2

Background

2.1 Introduction

This section provides background knowledge on the foundations of this research. It details Systems Thinking philosophy and history, the philosophy and application of Critical Systems Thinking (CST) and the meta-methodology Total Systems Intervention (TSI), critiques and changes made to CST and TSI, and three systems thinking intervention approaches: Viable Systems Model, Soft Systems Methodology and System Dynamics. For a glossary of terms, readers are referred to Appendix A: Glossary of Terms.

2.2 Systems Thinking

Jackson (2003) views systems thinking as an approach focused on holism and creativity that assists its user in becoming better equipped to cope with complexity, change and diversity. Cabrera, Colosi and Lobdell (2008) view systems thinking as a unique perspective that influences the approach taken to evaluate any program, policy or initiative. Lane and Jackson (1995) point to systems thinking as a broad and diverse field, with interpretations spanning across multiple disciplines. For the purpose of this thesis a concise definition of systems thinking will be: Systems thinking is an interdisciplinary, holistic approach to understanding systems (Solberg, Calvo-Amodio, Ng, & Reintjes, 2016).

2.2.1 What is a System?

Calvo-Amodio et al. (2014) define a system as "a perceived whole whose elements are "interconnected" and have a purpose in a given context". This definition can be broken down into two components: The perceived purpose and the whole composed of interconnected elements.

With the terms "perceived" and "purpose in a given context", Calvo-Amodio et al. (2014) are stating that a system identity is highly dependent on what the analyst believes it to be. If analysts from different backgrounds and with different perspectives were set to identify the same system, their identity definitions would likely be different. For instance, if a group of random individuals listed the purpose of their car, answers could be:

1. To transport goods and materials from A to B.
2. To ensure I get to work every day.
3. To get me to my destination quickly.
4. To store all my loose cash and old receipts.

None of these answers are necessarily wrong, it simply depends on who you ask and their context. Additionally, the same person might give different answers during different stage of their life, as a young bachelor owning a sports car would define the purpose of their car differently than a middle-aged parent owning a minivan. This is why it is important to understand and record the context of the system identification, as the system may not change over time, but the analyst who assigns its identity likely will.

A system is also a "whole whose elements are interconnected". This is holistic viewpoint, contrary to a reductionist viewpoint (who identifies a system in terms of its elements). A holistic viewpoint identifies a system in terms of the emerging characteristics resulting from the interconnectedness of its elements (Jackson, 2003). Dr. Ackoff (1994) would often use a car as an example to explain how a system is not a sum of its parts; rather it is a product of the interactions of the parts. No single element of a car provides the emerging property of "get me to my destination quickly". Additionally, if any elements within a system were to improve their own capability, a holistic viewpoint would ask whether the improvement would likewise improve the system as a whole. Altering a car engine to accelerate faster might sound beneficial, but if the alteration leads to lower gas mileage or increased pollutants, an environmentally conscious driver would not desire said car.

2.2.2 Early History of Systems Thinking

Jackson (2001, 2003) explains that traditional systems thinking emerged as a transdiscipline (a term used for research conducted by investigators from different disciplines) in the 1940's and 1950's, as a holistic response to the failure of reductive scientific methods to handle the complexity found in biological and sociological domains. Applied systems thinking intervention approaches began during and immediately after World War II, with the creation of Operational Research (OR), Systems Analysis (SA), and Systems Engineering (SE). Prior to the 1970's, traditional systems thinking were largely dominated by functionalism and positivism; However, during the 1970's

traditional systems thinking went through a crisis, as the current way of thinking was poorly-equipped to face complex problem situations, in particular to human and social aspects of problems (Jackson, 2001, 2003).

In response to the criticism, system thinkers began exploring new philosophies (i.e. structuralism, interpretivism, radicalism, and postmodernism) and designed intervention approaches better suited to fill in what they saw as a gap in traditional systems thinking (Jackson, 2003). As these new intervention approaches competed amongst themselves as to which one would further the systems thinking discipline, it became apparent in the 1980's that all of the intervention approaches became relevant when viewed in their own systems state. This meant that the intervention approaches should be viewed as complementary rather than conflicting. This revelation also meant that there was a need for a philosophy and assisting meta-methodology that could guide interventionists as to which intervention approach best suited a given system state, which led to the philosophy of Critical System Thinking (CST) and its accompanied meta-methodology Total Systems Intervention (TSI) (Jackson, 2001, 2003). CST and TSI, and further developments will be discussed in chapter 2.3, 2.4, and 2.5.

2.2.3 Application of Systems Thinking

Jackson (2003) and Cabrera et al (2008) both point to the increasing popularity of systems thinking with those in need of holistic way to approach problem situations. Cabrera (2006) found that systems thinking appears in the fields of both social sciences, arts and humanities literature, as well as business, administration, finance, economics,

engineering, computer science, mathematics, physics, astronomy and planetary science. Lane and Jackson (1995) noted that the term systems thinking had become popular in the USA, although it was misconceived as purely associated with system dynamics, rather than an umbrella term for a large range of intervention approaches. They also express concern for the perception that systems thinking can be taught through the usage of one systems thinking intervention approach, or through the eyes of one system thinking expert (Lane & Jackson, 1995). As was discovered in the 1980's, system thinking covers a range of complimentary philosophies and intervention approaches, all which must be understood in order to accentuate holistic and creative thinking.

In order to fully understand systems thinking, its users must acknowledge that system thinking is first a thinking exercise. It focuses on being able to see multiple perspectives or system states, and is largely based on contextual patterns of organization rather than specific content (Cabrera et al., 2008). Learning systems thinking can compared to learning a new language:

1. First, basic grammar needs must be met (i.e. grammar structure, basic words etc.).
2. Learning how to communicate with native speakers.
3. Acquiring a taste of its different dialects and accents (who can say that one dialect is superior of another).
4. Learning how different cultures use the language in different ways.
5. Being able to understand the meaning behind songs and poems in the language.

Ironically, in order to learn the holistic nature of systems thinking, holistic learning is required. As systems thinking transcends multiple disciplines (Cabrera et al., 2008), and has previously fallen prey to being mislabeled (Lane & Jackson, 1995), the term systems thinking must be clearly explained and understood if its users are to enjoy its benefits during application. Additionally, novice systems thinkers need to understand that just like learning a new language, systems thinking requires time and dedication in order to become fully mastered. Viewpoints or opinions that were once clear from one perspective, may become subjective as new perspectives are explored, and although it might initially cause confusion and chaos within the system, the end application will be more likely to exhibit the same level of variety as the system.

2.3 Critical Systems Thinking

Jackson (2001) introduces Critical Systems Thinking (CST) as having being inspired by two sources: (1) Social theory, for creating a framework that grants an overview of analyzing and intervening in systems, and (2) systems thinking, for providing powerful systems concepts and intervention approaches. The previous chapters have delved on the details of systems thinking and paradigms (see section 2.3 and 2.4); this chapter will go into details of how they were to be used in unison.

CST arose during the 1980's, as a range of new systems thinking intervention approaches had been created to tackle various system contexts. Lane and Jackson (1995) argued for the need of a critical approach in order to produce and verify social systems science, and later (1987) argued for the position of the "pluralist strategy" (accepting that theoretical and practical developments are mutually informing, and recognizing that

different approaches address different aspects of the management task). Jackson (2001) described the goal of CST as to unify systems thinking by showing that the various system intervention approaches are complementary, and build on strong theoretical support.

2.3.1 Early theory of CST

When presented by Jackson and Flood (1991), the underlying philosophy of CST could be summarized as being based on five commitments:

1. Critical Awareness
2. Social Awareness
3. Pluralism at the methodological level
4. Pluralism at the theoretical level
5. Emancipation

(1) Critical Awareness and (2) Social awareness were grounded in an acknowledgment of social context and being critical in the application of methodologies. (3) Pluralism at the methodological level and (4) Pluralism at the theoretical level are a result of the "pluralist strategy" argued by Jackson (1987), as it was considered advantageous to consider all theoretical and methodological options within systems thinking during systemic intervention. (5) Emancipation arose from a need to create an intervention approach that dealt with coercive situations, and partly due to the eventual discovery of Ulrich's Critical Systems heuristics, CST was able to avoid reducing its scope to purely emancipatory approaches (Jackson, 2000).

In addition to these five commitments, CST largely based its philosophy on that of the German philosopher Jürgen Habermas, and his theory of the three domains of human interests that generate knowledge: technical, practical, and emancipatory (Jackson, 2000, p. 363). Technical interests revolve around material well-being (related to functionalism), practical interests focus on the social interactions between individuals or groups (interpretative), and emancipatory interests believe in protecting the previous two from any power that prevents the free discussion required to progress (Solberg et al., 2016).

In order to validate its philosophy, CST called for the creation of a "meta-methodology" capable of adhering to the same commitments and philosophy of CST.

2.4 Total Systems Intervention

Total Systems Intervention (TSI) was the meta-methodology created to put into practice the philosophy of CST. Developed by Flood and Jackson (1991), its purpose is to guide interventionists through the process of identifying the system state, determining which methodology is best suited for the system state, and implementing it.

2.4.1 Early theory of TSI

TSI follows the five commitments of CST, albeit in the form of three positions (Flood & Jackson, 1991):

1. Sociological Awareness (based on critical awareness and social awareness)
2. Human well-being and emancipation (based on emancipation)

3. Complementarism (based on pluralism at methodological and theoretical level)

Flood and Jackson (1991, p. 50) also embed seven principles on which TSI stands:

1. Organizations are too complicated to understand using one management "model" and their problems too complex to tackle with the "quick fix".
2. Organizations, their strategies and the difficulties they face should be investigated using a range of systems metaphors.
3. Systems metaphors, which seem appropriate for highlighting organizational strategies and problems, can be linked to appropriate systems methodologies to guide intervention.
4. Different systems metaphors and methodologies can be used in a complementary way to address different aspects of organizations and the difficulties they confront.
5. It is possible to appreciate the strengths and weaknesses of different systems methodologies and to relate each to organizational and business concerns.
6. Total Systems Intervention sets out a systemic cycle of enquiry with iteration back and forth between the three phases.
7. Facilitators, clients and others are engaged at all stages of the Total Systems Intervention process.

2.4.2 Application of TSI

The process of TSI revolves around three phases: creativity, choice, and implementation. The purpose of the creativity phase is to locate the problems within a system context.

The purpose of the choice phase is to choose appropriate intervention approaches to handle the problems surfaced in the creativity phase. The purpose of the implementation phase is to implement the derived intervention approach from the choice phase. A summarized account of each phase can be found in Figure 4.

CREATIVITY	
Task	To highlight aims, concerns and problems
Tools	Systems Metaphors
Outcome	"Dominant" and "dependent" metaphors highlighting the major issues

CHOICE	
Task	To choose and appropriate systems-based intervention methodology (methodologies)
Tools	The "System of System Methodologies"; the relationship between metaphors and methodologies
Outcome	"Dominant" and "dependent" methodologies chosen for use

IMPLEMENTATION	
Task	To arrive at and implement specific change proposals
Tools	System Methodologies employed according to the logic of Total Systems Intervention
Outcome	Highly relevant and coordinated intervention

Figure 4. The Three Phases of TSI (Adapted from Flood & Jackson, 1991, p. 54)

Three important features of TSI need to be highlighted. First, the most probable outcome of the creative and choice phases are "dominant" and "dependent" metaphors and intervention approaches. This acknowledges that different metaphors and intervention approaches can be used; however, they may not be used at the same time. Second, Jackson (2003) stresses that TSI follows a systemic and interactive process. In other

words, as the perspectives of interventionists change, problem situation will be viewed in a different way, which will lead to changes in the chosen intervention approach. Jackson determines that the only way to address this change is to continually cycle around creativity, choice and implementation in order to change the methodologies that are dominant and dependent (Jackson, 2003). Third, as can be seen from the seven principles and the three phases, TSI relies heavily on the usage of Morgan's (1986) metaphors to investigate the system state, as well as tie specific intervention approaches to specific system states through SOSM.

2.5 CST and TSI since inception

The work of Flood and Jackson (1991) on CST and TSI has had an influential impact on the systems thinking community since their inception. Midgley (1998) comments that the works are so clearly written that he worried Flood and Jackson's viewpoint of CST could be regarded as definitive, threatening the continued development of CST. Regardless, there has been a range of critiques and subsequent research which will be explored in this chapter.

2.5.1 Critiques of Total Systems Intervention

The following critiques are identified by Jackson (2003) concerning TSI:

- Mingers and Brockelsby (1997) note the requirement of using "whole" metaphors, meaning that once a methodology has been selected it must be performed in the exact manner specified by the methodology.

- Tsoukas (1993) critiques Total Systems Intervention for not having a critical conversation around its choice of basing its pluralism on Habermas' theory of human interest.
- Taket and White (2000) do not believe sufficient attention is given to the role or style of the facilitator (As cited in Jackson, 2000, p. 373).
- Ormerud (1996) finds Total Systems Intervention to be demanding a lot from the interventionist, but not detailing where the proficiency is to be obtained (As cited in Jackson, 2000, p. 373)).
- From a post-modern perspective, Taket and White (2000) interpret that Total Systems Intervention is trying to "tame" pluralism rather than embrace it, and ignore the feelings and emotions of participants (As cited in Jackson, 2000, p. 373).

Additionally, Cummings (1994) notes that he believes that TSI would benefit from shifting its focus from Critical Theory to Postmodern Theory, and highlights what he finds to be the four biggest problems of TSI:

- Priorities regarding the five commitments (Should an interventionist remain dedicated to emancipation if social awareness leads to a more pragmatic approach?)
- Complementarism in practice (Interventionist will have inherent biases when choosing between the multitude of intervention approaches)
- The inconsistent nature of the dominant metaphor (How can CST be dedicated to complementarism and utilize dominance? How can a group of people come to consensus of what the "best" metaphor is to describe the situation? No ranking system for metaphors and subsequent intervention approaches)

- The inconsistency of recommendations stemming from a focus on dominant and dependent metaphors (dominant and dependent metaphors may end up contradicting each other, leading to conflicting conclusions.

A large portion of the critique directed towards TSI focuses on how rigid the structure is, and how the rigidity can lead to inner contradiction. In response, system thinkers have largely focused on the issue of rigidity, and have attempted to place a more "fluid" philosophy to TSI while maintaining the philosophy of CST.

2.5.2 Multi-methodology

Mingers and Brocklesby (1997) write that the amount and variety of intervention approaches stemming from various paradigms had vastly increased. They argue that systems thinkers need to begin utilizing multi-methodology, mixing methodologies rather than implementing one methodology at a time. Arguments against paradigm incommensurability include that it constrains theories within four polarized paradigms (Willmott, 1993) and although incommensurability is a feature of the model it does not derive from the model itself, rather from the content of the organization theories (N. Jackson & Carter, 1993). Four arguments in favor of (multi-paradigm) multimethodology are derived (Mingers & Brocklesby, 1997, p. 492):

1. Real-world problem situations are inevitably highly complex and multi-dimensional, requiring more than four paradigms to handle the richness.

2. An intervention is not a single, discrete event but a process that typically goes through a multitude of phases. Phases have different problems for the interventionist; therefore, it becomes more useful to combine methodologies.
3. Many people are already combining methodologies in practice.
4. Arguments from a postmodern perspective also support pluralism in methodology.

Mingers and Brocklesby (1997) conclude with the position that multimethodology research belongs to a new pluralist paradigm, and that the relationship between multimethodology and CST needs to be revisited, as multimethodology does not have the same inherent commitment to critique and emancipation as CST. Jackson (2003) includes these points in later intervention approach development, however warns that there must be an explicit recognition of the paradigms that the methodologies stem from, else there might be a relapse from pluralism into unreflective imperialism or pragmatism. Finally, Midgley (2016) concludes that the argument for methodological pluralism has "basically been won", although there are still discontent researchers.

2.5.3 Discordant Pluralism

Discordant Pluralism is a term created by Gregory (1996) intended to reconstruct the idea of complementarism suggested by Flood and Jackson (1991). Gregory (1996) argues that the stance offered by complementarism does not accommodate radically different strands perspectives, as it is inherently consensus based. Two metaphors are used to demonstrate the advantage of discordant pluralism: the force field metaphor and the constellation

metaphor. The force field metaphor highlights TSI's drive for consensus, comparing different perspectives as magnetic points, where the less magnetic perspectives can easily be subsumed by the stronger ones. This means that the most "desirable" perspectives can overwhelm the less "desirable" perspectives, regardless of which methodology is most appropriate. The constellation metaphor, on the other hand, allows for high levels of diversity and treats all perspectives with the same level of care and scrutiny. Perspectives are treated as planets and stars in the sky, where different locations and times make different perspectives clearer than others are. It is a more dynamic metaphor, and makes the case that time must be spent on researching perspectives as a small snapshot will rarely give the full picture. Discordant pluralism has the advantage when engaging conversations in coercive situations, as perspectives are understood as *incompatible* (given equal consideration) rather than *incomparable* (one is superior over another) (Gregory, 1996).

2.5.4 Local Systemic Intervention

Flood (2001; 1994) absorbed much of the postmodern critique of TSI, and incorporated it into the complementarist approach: Local Systemic Intervention (LSI). Flood (2001; 1994) explains the goal of LSI as to put in place a system of thought for action, focused on three types of discourse (How?-discourse, What?-discourse, and Why?-discourse) in order to encourage learning and assist interventionists in recognizing what response is needed for addressing problematic situations. Four new principles are developed:

1. Being systemic (recognizing hierarchies within systems, and realizing that both sub-systems and supra-systems need to be taken into account).
2. Meaningful participation (Involve the perceptions of all stakeholders in order to get the full picture).
3. Reflection (reflect upon relationships between different organizational interests, as well as the dominance of favored intervention approaches).
4. Enhancing human freedom (Nurture emancipatory practice for effectiveness and fairness).

In addition, Flood (2001; 1994) takes a higher-level perspective of the three phases of TSI (Creativity, Choice, and Implementation), and includes three modes of operation: Critical Review Mode, Problem Solving Mode, and Critical Reflection Mode. Critical Review Mode focuses on the need for interventionists to prepare themselves prior to intervening, reviewing an adequate base of models and methodologies before entering the next mode. Problem Solving Mode is essentially a reiteration of TSI, with the exception of allowing for a combination of intervention approaches rather than having dominant and dependent intervention approaches. Critical Reflection Mode focuses on critiquing the outcome of the previous two modes, asking the interventionist to be critical of both their creation and the overall process. The three modes of LSI are detailed in Figure 5.

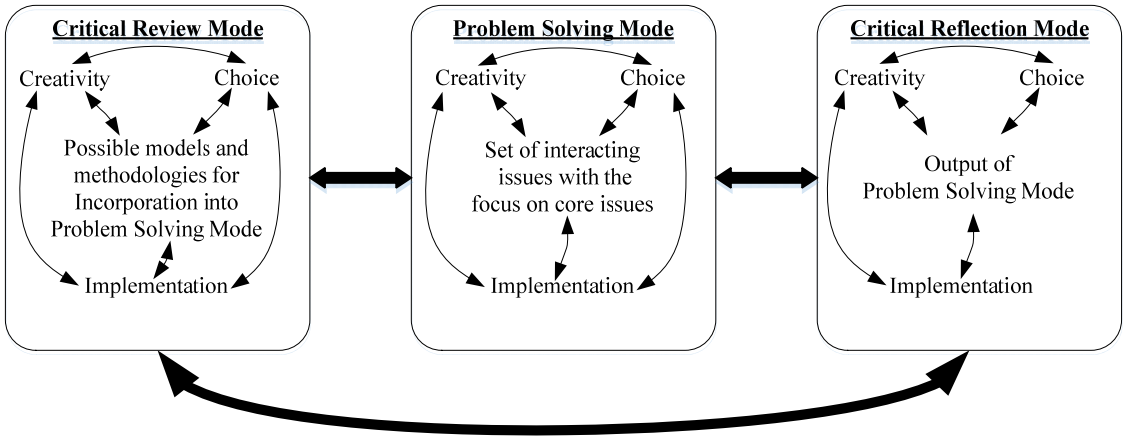

Figure 5. Local Systemic Intervention (Adapted from Flood & Romm, 1996, p. 113)

2.5.5 Critical Systems Practice

While Flood (1994) responded to critique by creating LSI, Jackson's (2003) response involved the creation of Critical Systems Practice (CSP). Jackson (2003) agrees with the direction of Flood (1994), and states that as a metamethodology, CSP no longer aspires to metaparadigmatic status. Its job has been shifted to protecting paradigm diversity, while encouraging critique between the paradigms. There is also an emphasis of pursuing 'creativity' in the form of pursuing different perspectives, and reflecting on the assumptions that underlie different paradigms (Jackson, 2003, p. 306). Mixing intervention approaches is considered necessary, however Jackson (2001) argues that there must be a form of structure to document why a combination of intervention approaches was successful. Additionally, the link between methodology and paradigm must remain strong in order to assure a theoretical rationale (Jackson, 2001). To further emphasize this point, Jackson (2003) adds a fourth phase to CSP called 'Reflection'. Figure 13 details the Reflection phase.

Reflection	
Task	To produce learning about the problem situation, the metamethodology itself, the generic systems methodologies and the methods, etc. used
Tools	Clear understanding of the current state of knowledge about these
Outcome	Research Findings that, for example, feed back into improving earlier stages of the metamethodology

Figure 6. Reflection Phase (Adapted from Jackson, 2003, p. 312)

Jackson (2003) reiterates that while CSP can provide the interventionist with holistic awareness and guidance, the interventionist are ultimately responsible for their choices. Additionally, he addresses what he believes to be the next two problems (Jackson, 2000):

1. The need for additional methods and methodologies during the choice phase of CSP.
2. Further refinement of the process of using CSP by interventionists.

2.6 Systems Thinking Intervention Approaches

The following chapters give a brief overview of the systems thinking intervention approaches selected for this research.

2.6.1 Viable System Model

The Viable System Model was created by Stafford Beer in 1972 (Beer, 1972). The intervention approach focuses on making systems "viable", which is to say capable of independent existence (Beer, 1984). Viable Systems Model does this by looking at management in terms of control and communication within systems (Moore et al., 2016).

Beer (1984) explains through Viable System Model that any viable system is composed of five sub-systems (Systems 1 to 5), that must work together to ensure viability of the overall system. The subsystems are referred to as (1) implementation, (2) co-ordination, (3) operational control, (4) development, and (5) policy, and are arranged as shown in Figure **7**.

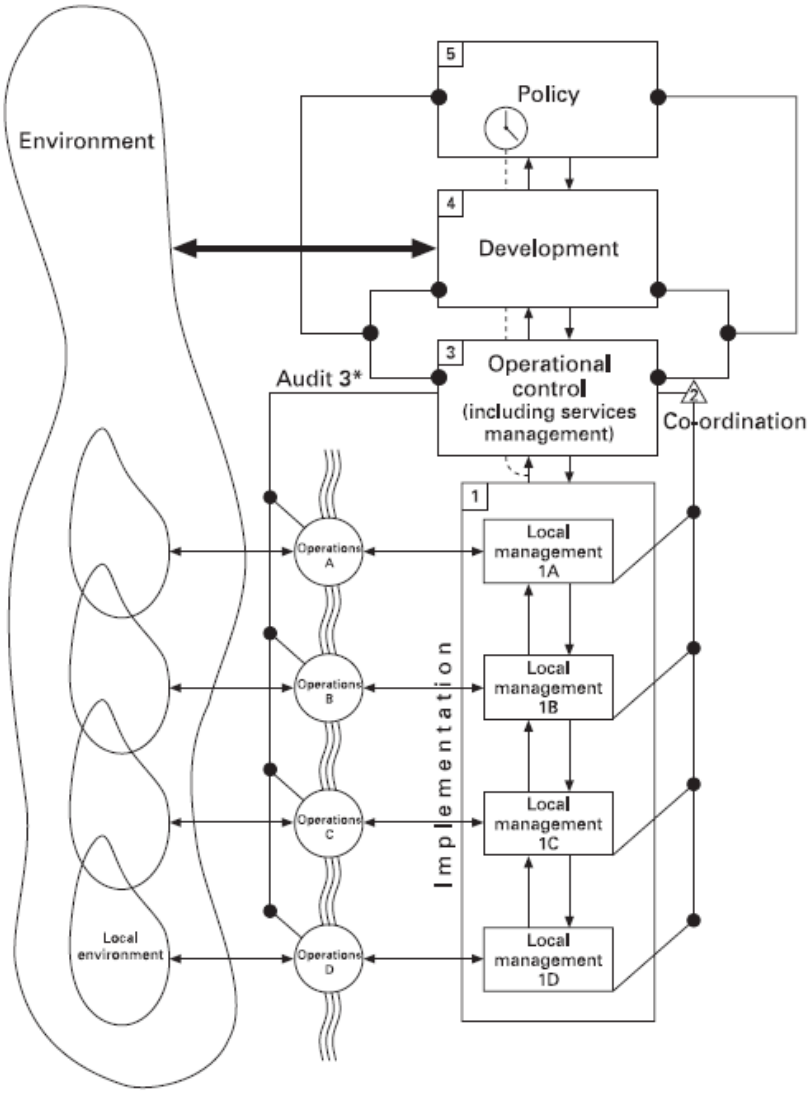

Figure 7. Viable System Model (Jackson, 2003, p. 92)

Jackson (2003) critiques Viable System Model in terms of not providing guidance for how individuals are to be motivated to perform or democracy to be arranged. As a result, Viable System Model can become a tool for the powerful to control and consolidate their own positions.

2.6.2 Soft Systems Methodology

Soft Systems Methodology was created by Peter Checkland in 1981 (Checkland, 1981). The intervention approach focuses on the nature of inquiry and learning, rather than optimization (Checkland, 1983). By working with diverse stakeholders, different perceptions of reality are uncovered and examined, and purposeful actions can be pursued (Jackson, 2003). Jackson (2003) explains that Soft Systems Methodology bases itself on a seven-stage cyclic, learning system, which begins in the "real world", moves into "systems thinking about the real world", and ends back in the 'real world" (Figure 8).

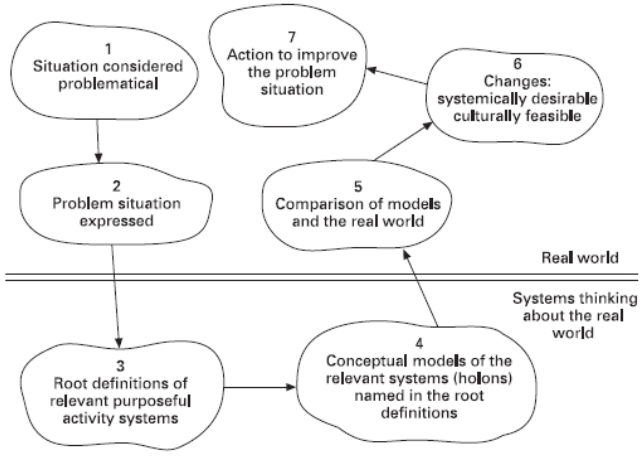

Figure 8. Soft Systems Methodology seven stage learning system (Jackson, 2003, p. 187)

Summarized, throughout the stages of the intervention approach an interventionist would analyze the problem situation at hand, create root definitions and conceptual models of the situation, compare models with the real world, determine which changes are feasible and act upon them. Well-known methods from this intervention approach include (Jackson, 2003):

1. "Rich Picture", a method where the user freely draws how they perceive the problem situation in terms of symbols, drawings and other representations.
2. CATWOE (Clients, Actors, Transformation, Weltanschauung, Owners, Environmental constraints), a method that focuses on clearly defining the problem situation in terms of stakeholders and viewpoints.

Jackson (2003) critiques Soft Systems Methodology in terms of its failure to recognize that it is applicable to a limited domain, as well as not establishing ground rules for what counts as "genuine" participation.

2.6.3 Systems Dynamics

System Dynamics was created by Jay Forrester in 1958, and popularized by Peter Senge in 1990 (Jackson, 2003). The intervention approach focuses largely on system behaviors, assisting its users in understanding and influencing key factors within a system (Forrester, 1991). Forrester (1994) describes the system dynamics process as consisting of six steps (Figure 9).

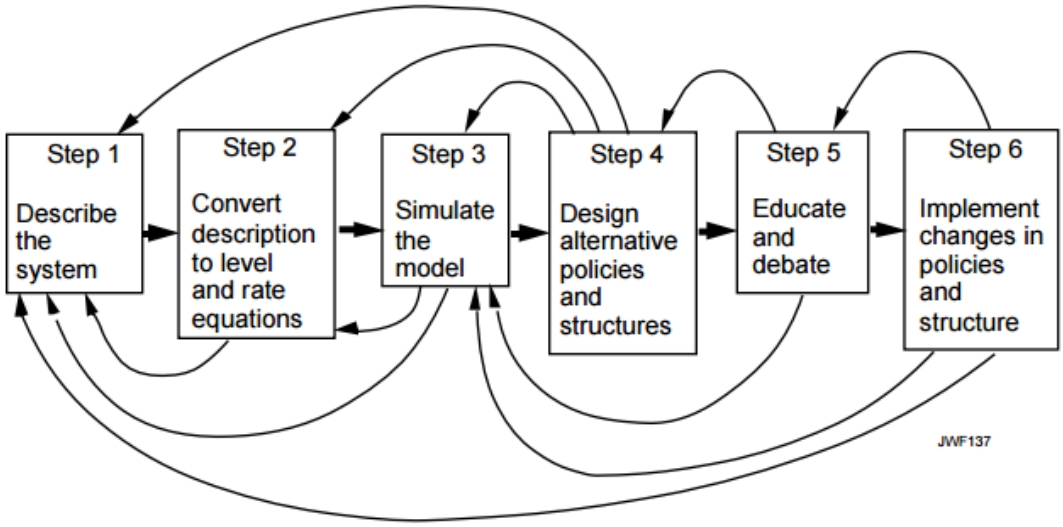

Figure 9. System Dynamics Process (Forrester, 1994, p. 4)

Summarized, an interventionist would have to describe the system, convert the description to representative equations and simulate a model, design policies based on the model output, debate the policies and finally implement. As can be seen in Figure 9, this is not strictly a linear process. The core methods from this intervention approach lie in (Forrester, 1991):

1. Causal loop diagrams, which show how variables interact in either balancing loops or reinforcing loops.
2. Stock and Flow diagrams, which measure behavior rates as interconnected variables change throughout the system in terms of stocks and flows.

Jackson (2003) critiques System Dynamics in terms of believing key management problems can be addressed with a limited number of system archetypes, often not being suitable for social situations, and assuming that all stakeholders within a system are in agreement.

Chapter 3

Literature Review

3.1 Introduction

This literature review provides the basis for answering the research questions in section 1.3. It details the Law of Requisite Variety, Sociological Paradigms, and a framework developed for complementarist intervention approaches.

3.2 Ashby's (1958) Law of Requisite Variety

Ashby (1958) defines variety as the number of elements that can be distinguished in a given set. He explains that in the set **[**bcaaCaBa**],** we can distinguish a variety of three letters, as well as a variety of five shapes. In terms of control, variety of disturbances needs to be regulated through a variety of responses. If V_D is the variety of D (disturbances), V_R is the variety of R (responses), and V_O is the variety of the outcome, V_O can be expressed as:

Equation 1. Law of Requisite Variety

$$Minimum\ V_O = V_D - V_R$$

This is Ashby's Law of Requisite Variety, simply stating that "Only variety in R can force down the variety due to D; Only variety can destroy variety" (Ashby, 1956, p. 207). This statement can also be stated as: "only variety can absorb variety" (Rosenkranz &

Holten, 2007). In essence, it means that only variety can overcome variety, only by increasing our variety can we overcome the variety of a situation.

For the use of Cybernetics, Heylighen and Joslyn (2001, p. 1) interpret variety as "a measure of the number of possible states or actions", and Stafford Beer (1993, p. 10) uses the term variety to describe "the number of possible states of a system". For the purpose of this thesis, variety will be defined as "The number of possible states or actions a system can experience".

3.2.1 The significance of the Law of Requisite Variety

Beer (1993) has proclaimed that the Law of Requisite Variety is as important to managers as Einstein's law of relativity to physicists. Jackson (2003) translates the statement "Only variety can overcome variety" for managers as:

"Systems can only be controlled if the would-be controller can command the same degree of variety as the system" (Jackson, 2003, p. 9).

This signifies that a controller can only control a system if they are able to exhibit as many states as the system they are attempting to manage (See Figure 10).

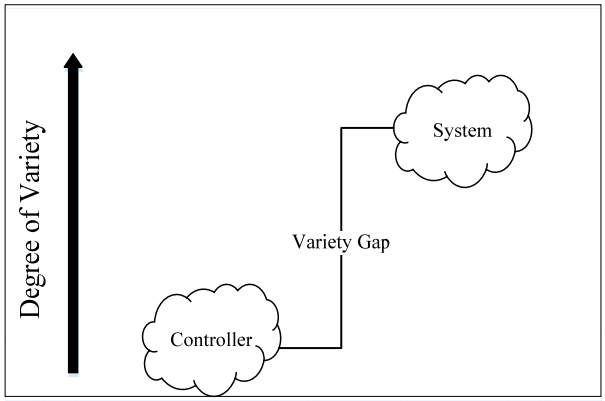

Figure 10. Variety between Controller and System

For further illustration, in order for a manager to gain control of a system, two situations can occur: (1) either the system being managed decreases the number of states it exhibits (becomes simplified), or (2) the manager increases the number of states he/she exhibits. The first situation can be exemplified by our actions towards the outside environment; in order to ensure that we do not experience uncomfortable weather, we have built sturdy houses to shelter against the elements. We have reduced the variety of the surrounding environment (system state) by creating an environment that we control. The second situation can be exemplified by viewing a human's dietary needs; in order to ensure that we receive all vitamins and nutrients required to survive or in order to avoid certain food allergies, we need to increase our knowledge (controller variety) of our body's dietary needs and consume accordingly. In both situations, the "variety gap" between controller and system is decreased, and chances of successful control interventions in increased (Figure 11).

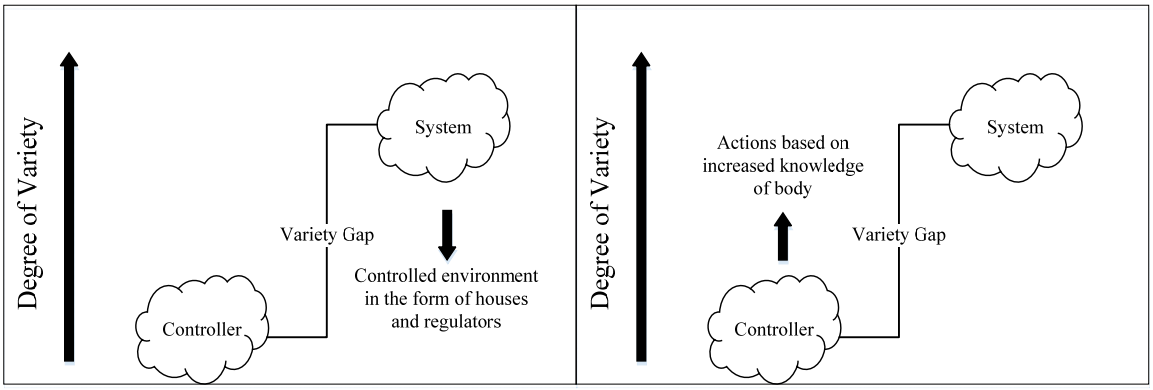

Figure 11. Decreasing the Variety Gap

This gives a basic understanding of the Law of Requisites and its implications on why some systems are better managed than others; either the variety gap between controller and system has been successfully reduced, or the variety gap remains large enough to generate unstable results.

It is important to note that the emphasis is on reducing the variety gap, and not eliminating it. A controller that exhibits as much variety as the system will have the ability to command full control of the system. This paints a scene of a controller simply learning all the states of the system acting accordingly. The underlying issue with this statement is that it gives the impression that it is possible for a controller to exhibit as many states of the system. If we acknowledge that the human body of knowledge has not yet reached its peak, we must acknowledge that it is impossible for a controller to learn all states of a system. However, the degree of system intervention success is proportional to the interventionist's knowledge of the system, and the actions taken based on that

knowledge. Therefore, the more knowledge a controller gains of a system, the more the variety gap will be reduced.

3.2.2 Law of Requisite Variety for System Intervention

For the purposes of this thesis, a controller or manager will be referred to as an interventionist, and the act of controlling the system will be referred to as an intervention approach. Intervention approaches are the tools created to intervene in systems, and as such, we can consider the process of intervention to have three main elements:

1. A system in need of intervention.
2. An intervention approach.
3. An interventionist utilizing the intervention approach.

It is common to consider an interventionist and an intervention approach as the same element, as one cannot exist without the other (Figure 12). After all, what use is a hammer if there is no one to utilize it?

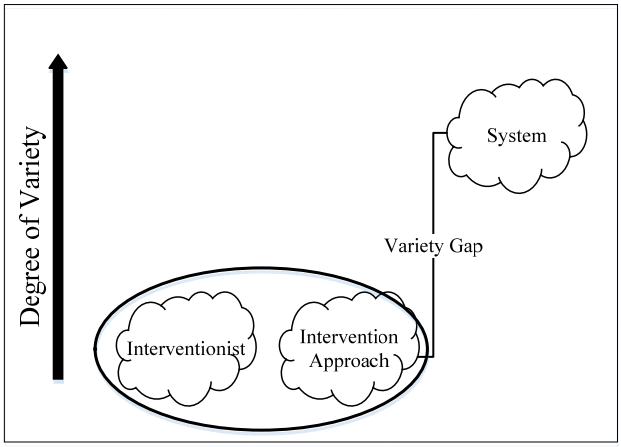

Figure 12. Interventionist and Intervention Approach

This mentality assumes that the variety gap between an interventionist and a given intervention approach is small enough to be negligible. This assumption cannot hold in highly complex systems. Midgley, Munlo, and Brown (1998) discuss a case where a systems thinking intervention approach created a communication barrier between the researchers and management, resulting in an impromptu thirty-minute presentation in "plain English". Jackson (2003) points out that intervention approaches can become too theoretical and do not provide much guidance for interventionists as to how to utilize it properly. High-variety intervention approaches created for a high-variety system need to address the potential variety gap between interventionist and intervention approach, particularly if the intervention approach exhibits a higher degree of variety than the intended interventionist does (Figure 13).

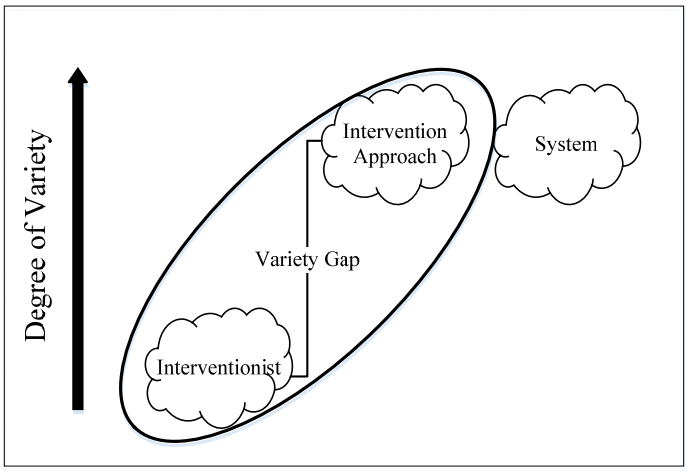

Figure 13. Interventionist and Intervention Approach Variety gap

Intervention approaches are created to assist interventionists in intervening with a system. If a high-variety intervention approach is to be created that can be utilized by low-variety

interventionists, the intervention approach must be designed in a manner that addresses the variety gap between interventionist and intervention approach, without sacrificing the variety gap between intervention approach and system.

3.3 System Paradigms

This section focuses on system paradigms, which for the purpose of this thesis are synonymous with the term "system state". The following sections will discuss what a paradigm is, discuss the impact of paradigms on social theory and systems thinking, and detail the paradigms that are recognized by systems thinkers.

3.3.1 What is a paradigm?

When a system becomes too complicated or difficult to understand, the number of possible courses of action available to the interventionist increases (Ackoff 1962, as cited in Lane & Jackson, 1995, p. 474). Given this dilemma, it becomes important to define a system in a way that can easily be understood. There have been different attempts to describe the nature of a system's state, and the most current attempts rest with utilizing sociological paradigms. Table 1 displays various definition of the term "paradigm".

Table 1. Paradigm Definitions

Author	Title	Definition
Burrell and Morgan (1979)	Sociological Paradigms and Organizational Analysis (p. 23)	"We regard our four paradigms as being defined by very basic meta-theoretical assumptions which underwrite the frame of reference, mode of theorizing and *modus operandi* of the social theorists who operate within them. It is a term which is intended to emphasize the commonality of perspective which binds the work of a group of theorists together in such a way that they can be usefully regarded as

Table 1. Paradigm Definitions

Author	Title	Definition
		approaching social theory within the bounds of the same problematic"
Morgan (1979)	Paradigms, Metaphors, and Puzzle Solving	"The term "paradigm" is therefore used here in its metatheoretical or philosophical sense to denote an implicit or explicit view of reality"
Mingers and Brocklesby (1997)	Multimethodology: Towards a Framework for Mixing Methodologies (p. 2)	"A paradigm is a very general set of philosophical assumptions that define the nature of possible research and intervention. There can only be a relatively small number of paradigms extant at one time although the actual number, and their characterization in terms of underlying dimensions, differs."
Calvo-Amodio (2002)	Systems Thinking and the Internet (p. 9)	"Therefore, an accepted problem-solution procedure or paradigm will share some defined notions, the same point of view, very similar terminology and a scope that will limit the lines of research that can be explored until replaced by a new one."
Mike Jackson (2003)	Systems Thinking Creative Holism for Managers (p. 37)	"The word paradigm is now commonly used to refer to something like world view or way of seeing things. Originally, however, it had a technical meaning, provided by Kuhn (1970), and referred to the tradition of research regarded as authoritative by a particular scientific community. It was the set of ideas, assumptions and beliefs that shaped and guided their scientific activity".
Todd Bowers (2014)	Developments in Critical Systems Theory: On Paradigms and incommensurability (p. 2)	"Within a paradigm, points of view about the world's constitution and its structure are compatible, ontologically; its values, concerns, conventions and assumptions, "truths" and traditions of working in the world, too, are generally shared – epistemologically."
Midgley (2016)	Dealing with challenges to methodological pluralism: The paradigm problem, psychological resistance and cultural barriers (p. 1)	"Paradigmatic Research communities makes different philosophical, theoretical and methodological assumptions, which flow into their views on what kinds of methods they consider valid or legitimate."

As can be seen in Table 1, there is no agreed-upon definition upon the exact nature of a paradigm. For the purpose of this thesis, the above definitions will be summarized as follows: A paradigm constitutes a set of assumptions regarding the nature of a system.

3.3.2 Usage of Paradigms in Social Theory and Systems Thinking

The first attempt to categorize worldviews occurred within social theory by Morgan and Burrell (1979). What had initially began as a concern of academic sectarianism, led to the uncovering of certain underlying assumptions on which theorists base their perspective on, in other words different "ways of seeing". The framework presented had the goal of enlightening theorists of all paradigms, claiming that a theorist had to become familiar with paradigms that are not his/her own in order to fully appreciate alternative points of view. They concluded that the social world could be conceived in terms of four paradigms: Functionalist, Interpretive, Radical Humanist and Radical Structuralist, and two key dimensions: Subjective-Objective dimension and Regulation-Radical Change dimension (Burrell & Morgan, 1979). This relationship can be seen in Figure 14.

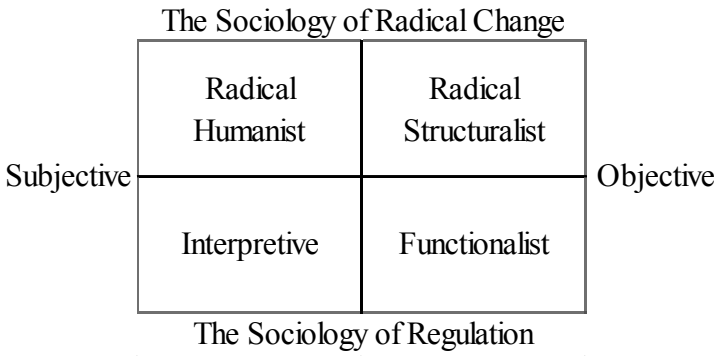

Figure 14. Sociological paradigms and key dimensions (Adapted from Burrell & Morgan, 1979, p. 22)

Morgan (1979) found that within paradigms there are different ways of approaching a shared reality or worldview, known as metaphors. The term metaphors were further

explored by Morgan (1986), finding metaphors to be a useful tool in understanding situations, implying a "way of thinking" and a "way of seeing" that assists the user in simplifying and thus understanding the world around them.

Separately from social theory, the systems thinking realm had undergone a "crisis" in viewing complex and social aspects of system states since the early 1970's, leading to the development of alternative philosophies and intervention approaches from traditional systems thinking (Jackson, 2001). Jackson and Keys (1995) examined the interrelationships between systems-based intervention approaches and problem contexts, and expressed a need for a coordinated research program to deepen understanding of different problem contexts. The purpose of viewing systems in terms of problem contexts would be to identify the type of intervention approach appropriate for the situation. Flood and Jackson (1991) utilized the tool "System of Systems Methodologies" (SOSM) in order to group problem contexts by two dimensions: (1) Systems, and (2) Participants. The systems dimension refers to the complexity of the system, classified from "simple systems" to "complex systems". The participants dimension refers to the relationship between participants of a system intervention, classified from "unitary", to "pluralist", to "coercive". Problem contexts were related to Morgan's (1986) metaphors, which in turn could be related to intervention approaches (Figure 15, Figure 16, and Figure 17).

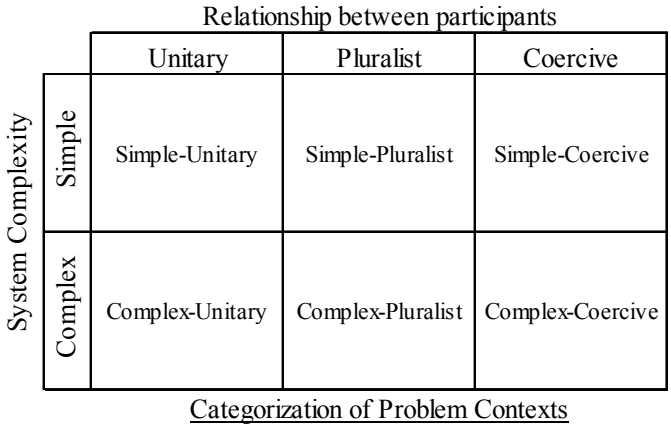

Figure 15. Categorization of problem contexts (Adapted from Flood & Jackson, 1991, p. 35)

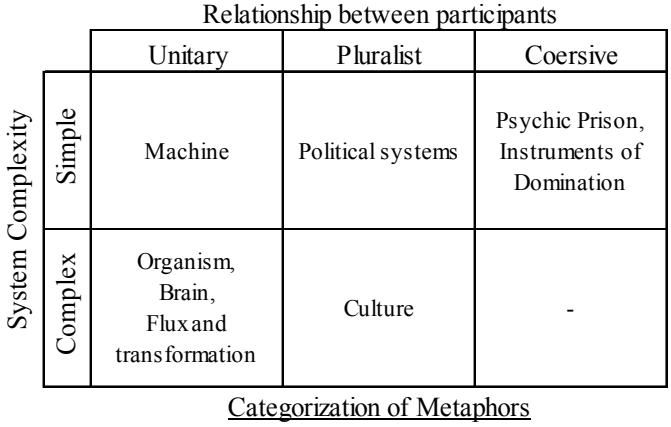

Figure 16. Categorization of metaphors (Adapted from Flood & Jackson, 1991, p. 42)

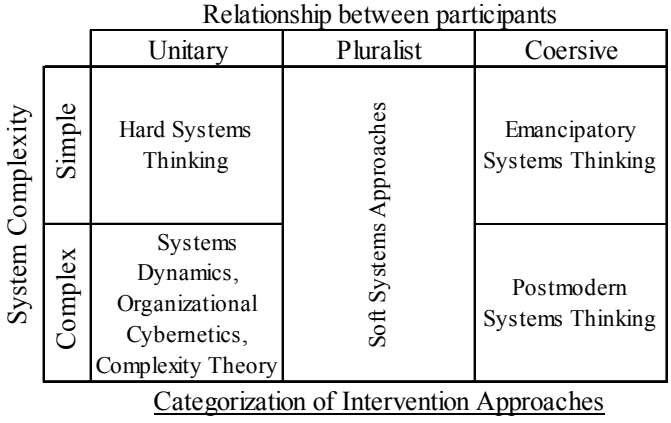

Figure 17. Categorization of intervention approaches (Adapted from Flood & Jackson, 1991, p. 42)

Jackson (2003) incorporated sociological paradigms to SOSM, claiming that the best way to encourage creativity when identifying the nature of a social system is through paradigms. Identifying system states through metaphors does not demand that radically different perspectives are considered. Paradigms, on the other hand, are each based on assumptions that are dissenting to other paradigms, demanding that radically different perspectives be considered during the identification of a system state (Jackson, 2003). Figure 18 illustrates this connection.

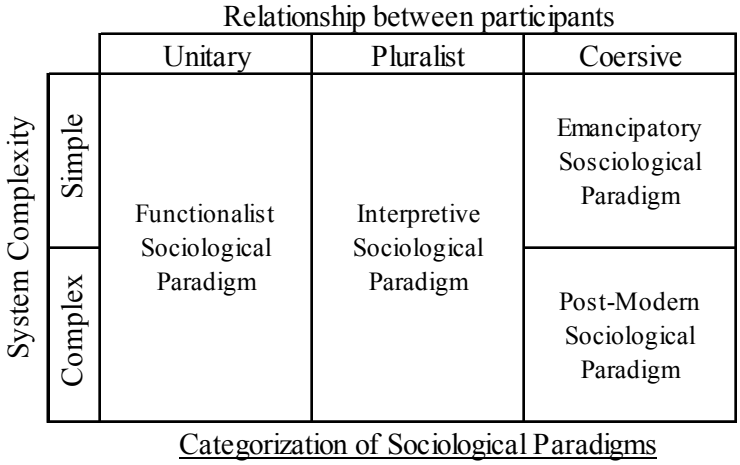

Figure 18. System of System Methodologies Categorization (Adapted from Flood & Jackson, 1991)

Jackson (2000) identifies four types of system approaches, and adjusts the paradigms originally conceived by Morgan and Burrell (1979) to bridge the connection between sociological theory and systems thinking. Two changes were made: (1) The Radical Humanist and Radical Structuralist paradigms are combined into an "Emancipatory" paradigm, and (2) the inclusion of the "Postmodern" paradigm.

3.3.3 Types of paradigms

The following sub-sections will go into detail of the most commonly recognized paradigms within systems thinking: Functionalist paradigm, interpretive paradigm, emancipatory paradigm, and postmodern paradigm. In an effort to best describe the "core" of each paradigm, multiple author definitions are included, as well how both Morgan and Burrell (1979) and Jackson (2000) categorize each paradigm.

3.3.3.1 Functionalist Paradigm

According to Morgan and Burrell's (1979) framework of paradigms, the functionalist paradigm follows an objective, regulatory way of thinking. According to Jackson's (2003) SOSM, the functionalist paradigm handles systems where participant relationships are unitary (have similar values, beliefs and interests), and system approaches belonging to this paradigm focus on improving goal seeking and viability. Definitions of the term functionalist paradigm can be found in Table 2.

Table 2. Functionalist Paradigm Definitions

Literature	Definition
(Jackson, 2003, p. 38)	"The functionalist paradigm takes its name from the fact that it wants to ensure that everything in the system is functioning well so as to promote efficiency, adaptation and survival. It is optimistic that an understanding can be gained of how systems work by using scientific methods and techniques to probe the nature of the parts of the system, the interrelationships between them and the relationship between the system and its environment. "
(Jackson, 2000, p. 107)	"When this perspective is adopted, systems appear as objective aspects of a reality independent of us as observers. Using the methods of the natural sciences, they are examined in order to discover the laws that govern the relationships between their parts or sub-systems. If knowledge about the behavior of a system can be gained in this way, the knowledge can be used by experts to improve the technical efficiency or efficacy of the system and/or its long-term ability to adapt and survive. The tenor of the functionalist approach is modernist."
(Burrell & Morgan, 1979, p. 26)	"Functionalist theorists have been at the forefront of the order-conflict debate, and the concepts which we have used to categorize the sociology of regulation apply

Table 2. Functionalist Paradigm Definitions

Literature	Definition
	in varying degrees to all schools of thought within the paradigm. It is characterized by a concern for providing explanation of the status quo, social order, consensus, social integration, solidarity, need satisfaction and actuality. It approaches these general sociological concerns from a standpoint which tends to be realist, positivist, determinist and nomothetic."
(Bowers, 2014, p. 2)	"The positivist/structural-functionalist systems paradigm (often referred to by any of its three words) is the world of modern science and social science: the world of certainty; of logical proofs and deductions, reproducibly verifiable facts and hypotheses, exact measurements, objective observation, of unbiased and universal truths".

3.3.3.2 Interpretive Paradigm

According to Morgan and Burrell's (1979) framework of paradigms, the interpretive paradigm follows a subjective, regulatory way of thinking. According to Jackson's (2003) SOSM, the interpretive paradigm handles systems where participant relationships are pluralist (have compatible interests, but do not share similar values and beliefs), and system approaches belonging to this paradigm focus on improving goal exploring purposes. Definitions of the term interpretive paradigm can be found in Table 3.

Table 3. Interpretive Paradigm Definitions

Literature	Definition
(Jackson, 2003, pp. 38-39)	"The interpretive paradigm takes its name from the fact that it believes social systems, such as organizations, result from the purposes people have and that these, in turn, stem from the interpretations they make of the situations in which they find themselves. Organizations happen, and people act and interact in organizations, as a result of their interpretations. This paradigm wants to understand the different meanings people bring to collaborative activity and to discover where these meanings overlap, and so give birth to shared, purposeful activity."
(Jackson, 2000, p. 211)	"The interpretive systems approach is frequently referred to as "soft systems thinking" because it gives pride of place to people rather than to technology, structure or organization. In contrast to the functionalist approach, its primary area of concern is perceptions, values, beliefs and interests. It accepts that multiple perceptions of reality exists, and sometimes come into conflict, and wants to help managers and consultants to work successfully in a "pluralistic" environment of this kind."

Table 3. Interpretive Paradigm Definitions

Literature	Definition
(Burrell & Morgan, 1979, p. 28)	"The interpretive paradigm is informed by a concern to understand the world as it is, to understand the fundamental nature of the social world at the level of subjective experience. It seeks explanation within the realm of individual consciousness and subjectivity, within the frame of reference of the participant as opposed to the observer of action. In its approach to social science it tends to be nominalist, anti-positivist, voluntarist and ideographic."
(Bowers, 2014, p. 2)	"The interpretivist systems paradigm takes care to point out that each of us sees the world differently, subjectively, and each of us knows or understands it in their own way. This paradigm is concerned with and cares about reconciling issues of individuality and personal differences in a social world. It accepts that we disagree and are unpredictable".

3.3.3.3 Emancipatory Paradigm

While the functionalist and interpretive paradigm are equally shared between sociological paradigms and systems thinking paradigms, the emancipatory paradigm is slightly different. Jackson (2000) comments that the concept of "emancipation" is highly contested, with arguments spanning multiple areas, such as:

- Whether we should seek human, individual or non-human (i.e. the environment) emancipation;
- Whether we should take a modern or postmodern approach;
- Whether we should take a subjective or objective approach, or;
- Whether we should focus on local or universal emancipation.

In attempts to handle this diversity, "radical humanist" and "radical structuralist" paradigms are combined into an "emancipatory" paradigm. This shifts the focus on what all approaches to emancipation have in common, which is to be suspicious of the current social order and seek to radically reform it (Jackson, 2000). According to Jackson's (2003) SOSM, the emancipatory paradigm handles systems where participant relationships are coercive (few interests in common, and hold conflicting values and

beliefs, leading to decisions being based on who has most power), and system approaches belonging to this paradigm focus on improving ensuring fairness. Various definitions of the emancipatory paradigm can be found in Table 4.

Table 4. Emancipatory Paradigm Definitions

Literature	Definition
(Jackson, 2003, p. 39)	The emancipatory paradigm takes its name from the fact that it is concerned to 'emancipate' oppressed individuals and groups in organizations and society. It is suspicious of authority and tries to reveal forms of power and domination that it sees as being illegitimately employed. It criticizes the status quo and wants to encourage a radical reformation of, or revolution in, the current social order. It pays attention to all forms of discrimination, whether resting on class, status, sex, race, disability, sexual orientation, age, etc.
(Jackson, 2000, p. 291)	"All emancipatory systems approaches are suspicious of the current social order and seek to radically reform it. They see society, as presently constituted, as benefitting some groups at the expense of other groups which are suffering domination or discrimination. The divides in society which lead to inequality may be along class, race, gender, sexual orientation, age, capabilities or other lines. Whichever of these are chosen as the main foci of attention, the aim is to emancipate those who are suffering as a result of current social arrangements."
(Burrell & Morgan, 1979, pp. 32-34)	On Radical Humanist Paradigm: "One of the most basic notions underlying the whole of this paradigm is that the consciousness of man is dominated by the ideological superstructures with which he interacts, and that these drive a cognitive wedge between himself and his true consciousness. This wedge is the wedge of 'alienation' or 'false consciousness, which inhibits or prevents true human fulfillment" On Radical Structuralist Paradigm: "Whereas the radical humanists forge their perspective by focusing upon 'consciousness' as the basis for a radical critique of society, the radical structuralist concentrate upon structural relationships within a realist social world. They emphasize the fact that radical change is built into the very nature and structure of contemporary society, and they seek to provide explanations of the basic interrelationships within the context of total social formations. On Radical Change: "Its basic concern is to find explanations for the radical change, deep-seated structural conflict, modes of domination and structural contradiction which its theorists see as characterizing modern society. It is a sociology which is essentially concerned with man's emancipation from the structures which limit and stunt his potential for development.
(Dahrendorf, 1959, p. 162)	On Coercion theory of society versus integration theory of society: "What I have called the coercion theory of society can also be reduced to a small number of basic tenets, although here again these assumptions oversimplify and overstate the case: (1) Every society is at every point subject to processes of change; social change is ubiquitous

Table 4. Emancipatory Paradigm Definitions

Literature	Definition
	(2) Every society displays at every point dissensus and conflict; social conflict is ubiquitous. (3) Every element in a society renders a contribution to its disintegration and change. (4) Every society is based on the coercion of some of its members by others."

3.3.3.4 Postmodern Paradigm

There is a slight irony to creating a postmodern paradigm, as postmodernists abhor the idea of being labeled within a categorization scheme. Hatch (1997) explains that the postmodern value for diversity contradicts the idea of unifying ideas and understandings into a single, all-encompassing explanation. Postmodernism believe that knowledge is fundamentally fractured in so many pieces that there can be no reasonable expectation to put it together, and therefore challenge the modernistic desire for unifying views (Hatch, 1997). Additionally, postmodernism encompasses two concepts:

1. "Discourse", a term that removes the human agent as the center of control, and analyzes social life in terms of uncertainty and instability (Cooper & Burrell, 1988).
2. "Deconstruction", a method that reverses the process of construction, intended to show that the structures of the social world we take for granted are artificial (Cooper & Burrell, 1988).

Jackson (2000) explains that Burrell and Morgan's framework is "modernist" in nature, and postmodernism can therefore only be related in an oppositional manner. Nonetheless, according to Jackson's (2003) SOSM, the postmodern paradigm is categorized where participant relationships are coercive (few interests in common, and

hold conflicting values and beliefs, leading to decisions being based on who has most power), and system approaches belonging to this paradigm focus on promoting fairness. Definitions of the term postmodern paradigm can be found in Table 5.

Table 5. Postmodern Paradigm Definitions

Literature	Definition
(Jackson, 2003, p. 39)	"The postmodern paradigm takes its name from the fact that it opposes the 'modernist' rationality that it sees as present in all the other three paradigms. It challenges and ridicules what it regards as their 'totalizing' attempts to provide comprehensive explanations of how organizations function. From the postmodern perspective organizations are far too complex to understand using any of the other paradigms. It takes a less serious view of organizations and emphasizes having fun. It also insists that we can learn much by bringing conflict to the surface, claiming a space for disregarded opinions and thus encouraging variety and diversity."
(Jackson, 2000, p. 333)	"The basic thrust of post-structuralist and postmodern thinking (referred to here simply as postmodernism) is aimed at the totalizing and normalizing tendencies of the discourse that dominate in modernism. All "grand narratives", whether referring to maximizing the efficiency and effectiveness of "systems" or to the possibility of universal emancipation, are subject to debunking… …The postmodern approach seeks, through methods such as deconstruction and genealogy, to reclaim conflict and to ensure that marginalized voices are recognized and heard."
(Cooper & Burrell, 1988, p. 98)	"Postmodern discourse begins with the idea that systems have lives of their own which make them fundamentally independent of human control… …Since the world is basically self-referential, it is neither pro-human nor anti-human; it just is. Postmodernism therefore decenters the human agent from its self-elevated position of narcissistic 'rationality' and shows it to be essentially an observer-community which constructs interpretation of the world, these interpretations having no absolute or universal status… …The key to understanding the discourse of postmodernism is the concept of difference: a form of self-reference in which terms contain their own opposites and thus refuse any singular grasp of their meanings, e.g., the paradox of the 'global village' in which the enlargement of the world through modern communication techniques actually makes it smaller".

Although postmodernism can be seen as only being interested in highly complex situations with high degree of coercion (hence its position within SOSM), postmodernism is not only intended to comment on "difficult situations". Postmodernism is above all else a critique of the ethnocentric rationalism advocated by modernism, making it

applicable to any "modernist" situation (Cooper & Burrell, 1988). In this sense, postmodernism falls into the same context as Critical Systems Thinking philosophy, as a lens to view paradigms rather than a paradigm unto itself. For the purpose of this thesis, postmodernism will therefore not be viewed as a paradigm, similarly to Burrell and Morgan's framework (1979).

3.4 Moore, Calvo-Amodio and Junker's (2016) Framework

Moore, Calvo-Amodio and Junker (2016) observed that system thinking meta-methodologies still require an interventionist to be a system thinking practitioner in order to be accessible. The objective of Moore et al.'s (Midgley et al., 2016) research was to create a framework for defining both intervention approaches and problem contexts that could be used as a tool for non-systems thinking practitioners when selecting intervention approaches. To define intervention approaches, four categories were designed to define intervention approaches based on observations from literature applications. Each category ranged between two extremes. Categories and extremes can be found in Table 6.

Table 6. Moore et al.'s Categories and Extremes (2016, pp. 14-15)

Category	Category definition	Extreme
Scope	Is the problem context an issue of generating work products (i.e., operations), or is it a consequence of organizational structure (i.e., design)?	Organizational operations vs Organizational design
Inspiration	Is the problem context primarily concerning organizational resources, or does it involve the external environment (i.e., context)?	Resources (internally) driven vs Context (environmentally) driven
Solution	In the problem context, is it necessary to seek a specific goal (i.e., optimize) with one correct solution, or can it be satisfied with an adequate solution? (An adequate solution implies that there are multiple correct answers or that the goal is not well defined.)	Optimal amount of resources vs Adequate amount of resources

Table 6. Moore et al.'s Categories and Extremes (2016, pp. 14-15)

Category	Category definition	Extreme
Ideal	Will the problem context be most affected by shifts in organizational culture, or modifications in organizational control?	Organizational culture vs Organizational control

Each category was given a two-directional scale ranging from 0 to 5 to add a quantitative, measureable approach. Additionally, the two-directional scale received a shaded box to represent the area of value for the scale. A user would be able to move the shaded box between the two extremes in order to demonstrate their preference (an example is provided for the scope category in Figure 19).

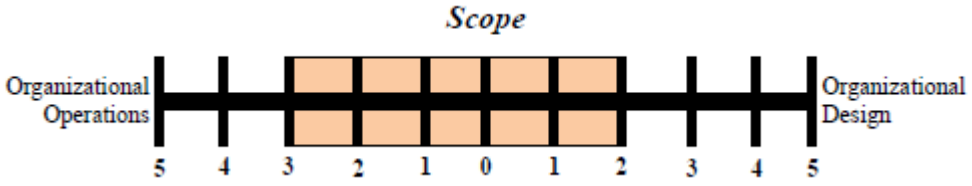

Figure 19. Moore, Calvo-Amodio and Junker's scope category (2016, p. 16)

Each category was placed in a framework in order to graphically represent intervention approaches and problem contexts. Moore et al. (2016) then selected three intervention approaches (Viable Systems Model, Knowledge Management, and Toyota Production System) and used expert opinion to map them according to the four categories. The resulting framework, complete with the intervention approaches can be seen in Figure 20.

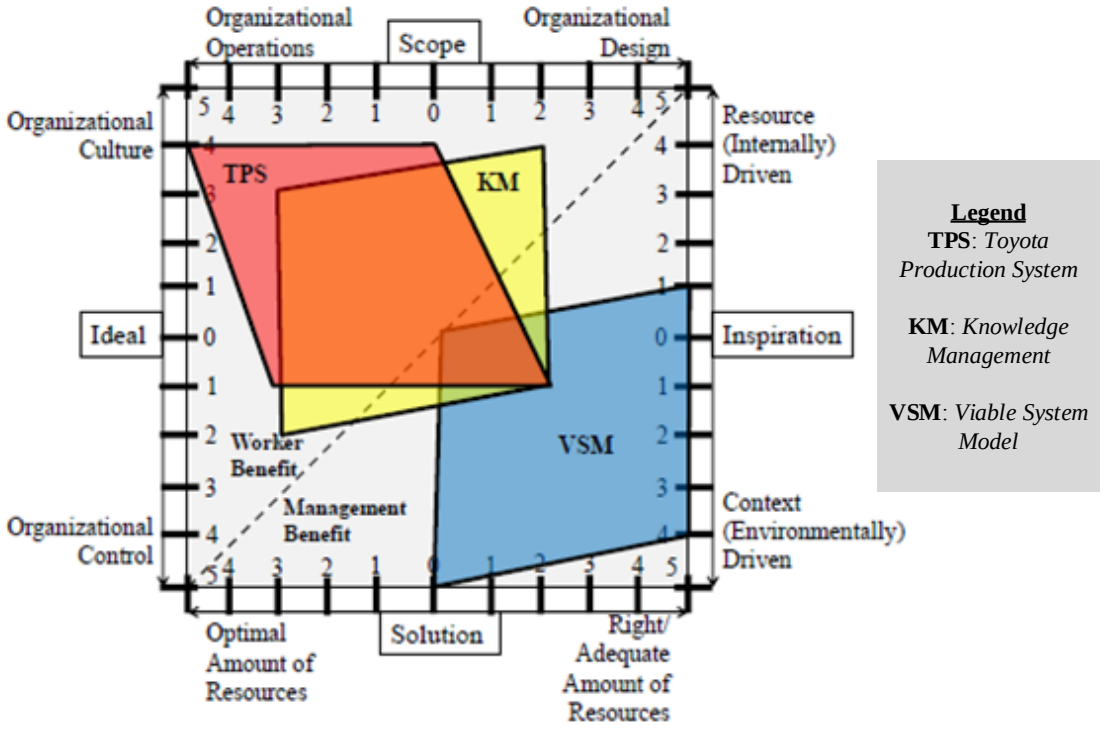

Figure 20. Moore et al.'s framework, complete with three intervention approaches (2016, p. 23)

With three intervention approaches mapped, an interventionist would be able to map their own problem context according to the same categories, and as a result would be able to see which intervention approach(es) best suited their problem context.

There is a range of limitations acknowledged by Moore et al. (2016) for this framework:

1. Currently intervention approaches are forced to fit into polygons with equal length sides.

2. Framework needs further definition in selecting values on the valuation questionnaire.
3. Definitions of problem contexts and intervention approaches are based on expert opinion.
4. Definition of intervention approaches in the framework should be established.
5. It is unclear how a dominant approach can be determined beyond expert opinion.

3.5 Gap in Literature

While current meta-methodologies have incorporated postmodern critique to reduce the variety gap between intervention approach and system, there is still a need for addressing the variety gap between an interventionist and an intervention approach. There are three distinguishable explanations for the variety gap between an interventionist and an intervention approach:

1. What key system states contribute the most to reduce the variety gap between interventionist and intervention approach?
2. How to operationalize the key system states to reduce the variety gap between interventionist and intervention approach?
3. How to implement the intervention approach?

Current meta-methodologies are not designed to address this variety gap, acknowledging that more work is needed to become accessible to non-systems thinking practitioners. This need has increased further with the postmodern incorporation of mixing intervention approaches. The framework created by Moore et al. (2016) addresses the first two

assumptions by categorizing system states and intervention approaches by non-systems thinking language, with a range of limitations. The framework requires further definition for its categories and category extremes, and currently only bases its categorization of problem contexts and intervention approaches on expert opinion.

3.6 Conceptual Model

Figure 21 displays the conceptual model for this research.

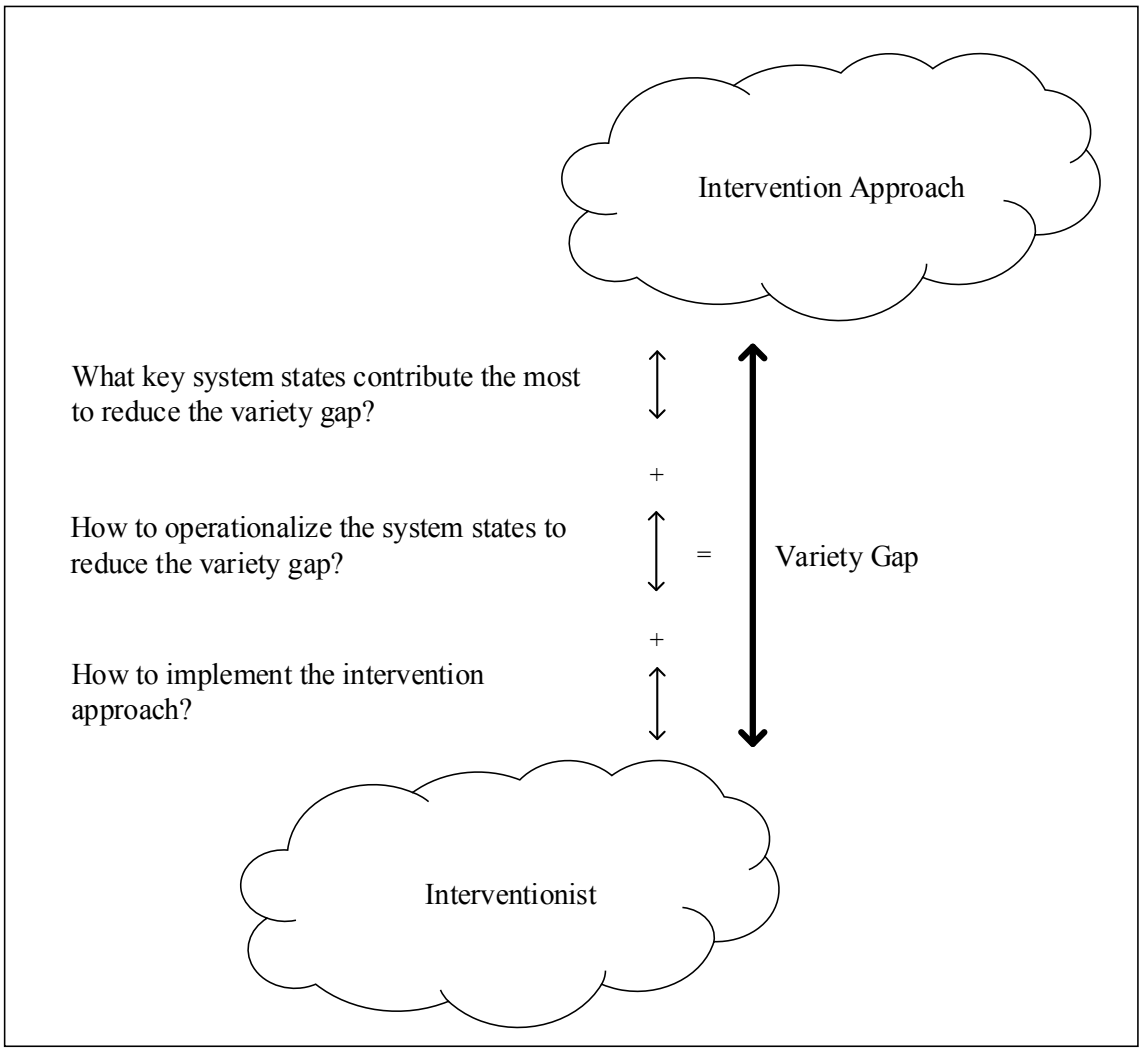

Figure 21. Conceptual Model

Chapter 4

Methodology

4.1 Introduction

The purpose of this chapter is to describe the experimental design used in this research.

4.2 Research Design

4.2.1 Incorporating and refining Moore, Calvo-Amodio and Junker's (2016) work

The proposed framework for this research incorporates the framework created by Moore et al. (2016) and also strives to address the limitations described by Moore et al. (2016). The purpose remains to create a framework that can act as a tool to assist interventionists in selecting appropriate intervention approaches without the need of system thinking proficiency. In order to fully define the categories and category extremes, the categories are now based in the theoretical rationale of sociological paradigms created by Burrell and Morgan (1979), resulting in alterations to the original categories create by Moore et al. (2016). This is not a drastic departure from the basic premise proposed by Moore et al. (2016), as it was found to exhibit the same characteristics as the sociological paradigms. Figure 22 displays how Moore et al. (2016) framework can be translated into the sociological paradigms.

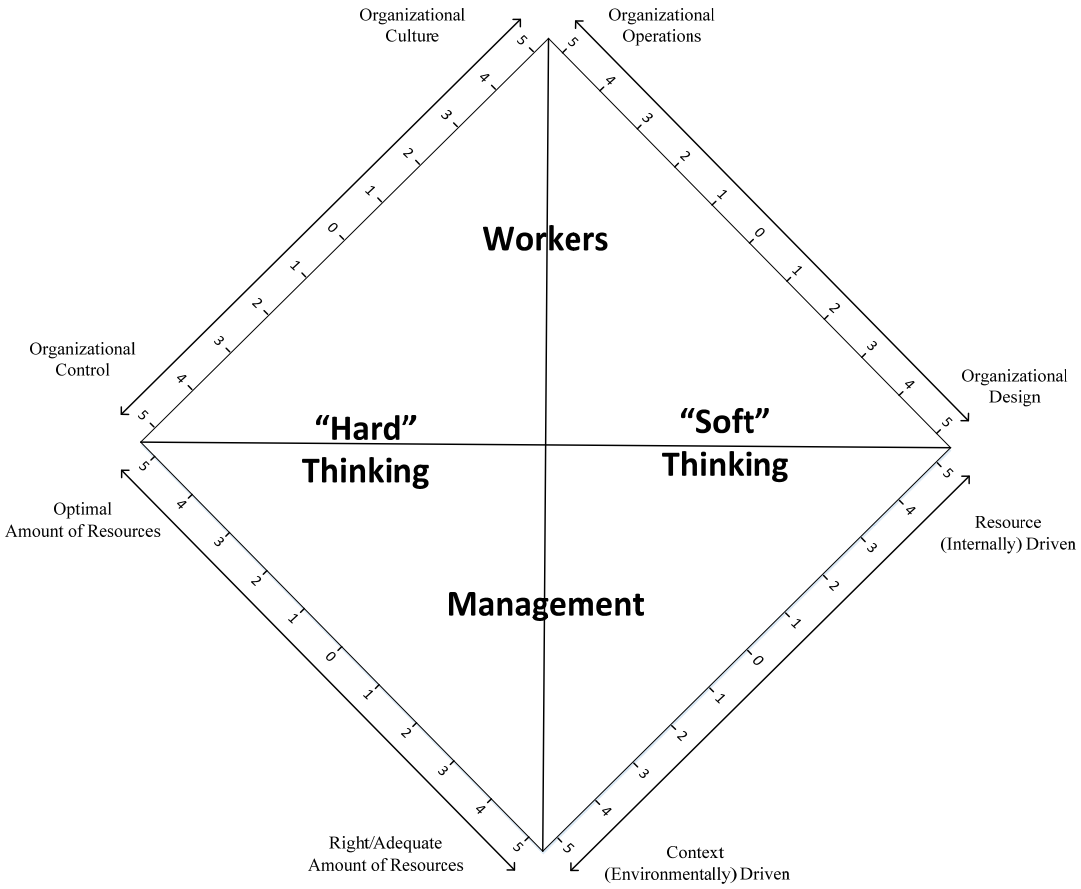

Figure 22. Moore et al.'s framework transition to sociological paradigms

As can be seen in Figure 22, Moore et al.'s framework exhibits the same foci as Burrell and Morgan's (1979) framework, with the horizontal axis similar to the objective-subjective dimension, and the vertical axis similar to the radical change-regulation dimension (see Figure 14, page 39).

Rather than having four categories in each edge, the new framework is built on two axis composed of three categories in each (adding up to six categories). The location of intervention approaches are determined through coding sample case studies for each intervention approach, rather than expert opinion. The shape of the framework is no

longer based on a two-directional scale with forced sides of five units. Instead, the location of an intervention approach is located within a five-by-five matrix.

4.2.2 Qualitative design of proposed framework

Jackson (2003) matches SOSM (See section 2.4.2 in Chapter 2) to Burrell and Morgan's (1979) sociological paradigms, and describes each paradigm in terms of their aim, attached metaphors and emphasis. The proposed framework imitates the subjective-objective dimension and regulation-radical change dimension from Burrell and Morgan (1979), however the axis are renamed to "Complexity" (degree of difficulty in identifying process) and "Complicatedness" (degree of difficulty in implementing process). The relationship can be seen in Table 7.

Table 7. Jackson's (2003) Definitions of Paradigms and Resulting Paradigm Dimensions

Paradigm	Aim	Metaphors	Emphasis	Paradigm Dimensions
Functionalist	Improving goal seeking and viability	Machine, Organism, Brain, Flux and Transformation	Efficiency (degree of accomplishing goal for less effort)	**Complexity** *"Degree of difficulty in identifying process"*
			Efficacy (degree of accomplishing the correct goal)	
Interpretive	Exploring purposes	Cultures, Political systems	Effectiveness (degree of accomplishing goal successfully)	
			Elegance (degree of accomplishing goal in a pleasing manner)	
Emancipatory	Ensuring fairness	Psychic prisons, Instruments of domination	Emancipation (degree of which all relevant stakeholders have a voice)	**Complicatedness** *"Degree of difficulty in implementing process"*
			Empowerment (degree of which all relevant stakeholders have a say)	
Post-modern	Promoting diversity	Carnivals	Exceptions (Degree in which the minority is accommodated)	

Table 7. Jackson's (2003) Definitions of Paradigms and Resulting Paradigm Dimensions

Paradigm	Aim	Metaphors	Emphasis	Paradigm Dimensions
			Engagement/Emotion (degree of which all relevant stakeholders are actively involved)	

For this research, postmodern paradigm is excluded due to the rationale of "postmodernism" being a lens of which to view paradigms. Further justification details can be found in chapter 3.3.3.4.

Complexity and Complicatedness are composed of six sociological categories C_m, which are in turn composed of two binary category extremes E_{mn}. Table 8 details the dimensions, sociological categories, category extremes, and definitions.

Table 8. Paradigm Dimensions, Sociological Categories and Category extremes

Paradigm Dimensions	Sociological Categories C_m	Category Extremes E_{mn}
Complexity "Degree of difficulty in identifying process"	**Consensus**: The degree of which the stakeholders of a system share similar viewpoints (m=1)	**Disagreement**: Views on goals and solutions vary among stakeholders (n=1) **Agreement**: Views on goals and solutions are shared among stakeholders (n=2)
	Infrastructure: The degree of which the system focuses on quantitative or qualitative information (m=2)	**Qualitative**: System focuses on qualitative processes/information (n=1) **Quantitative**: System focuses on quantitative processes/information (n=2)
	Scope: The degree of how conclusively the desired state of a system is being viewed (m=3)	**Approximation**: Stakeholders believe that a known solution can be approached (n=1) **Optimization**: Stakeholders believe a known solution can be reached (n=2)
Complicatedness "Degree of difficulty in implementing process"	**Harmony**: The degree of which change is encouraged in the system (m=4)	**Radical Change**: There is strong desire to restructure the current system (n=1) **Regulation**: There is little desire to restructure to the current system (n=2)
	Participation: The degree of which the system is influenced by different stakeholders (m=5)	**Disintegration**: There are few stakeholders participating in influencing the system (n=1) **Co-ordination**: There are many stakeholders participating in influencing the system (n=2)
	Control: The degree of which the system is driven by prescribed processes (m=6)	**Bottom Up Driven**: Stakeholders actions are governed by their own decisions (n=1) **Top Down Driven**: Stakeholder actions are governed by prescribed processes (n=2)

Figure 23 displays the proposed framework in terms of the paradigm dimensions Complexity and Complicatedness, as well as the location of sociological categories and category extremes within Complexity and Complicatedness.

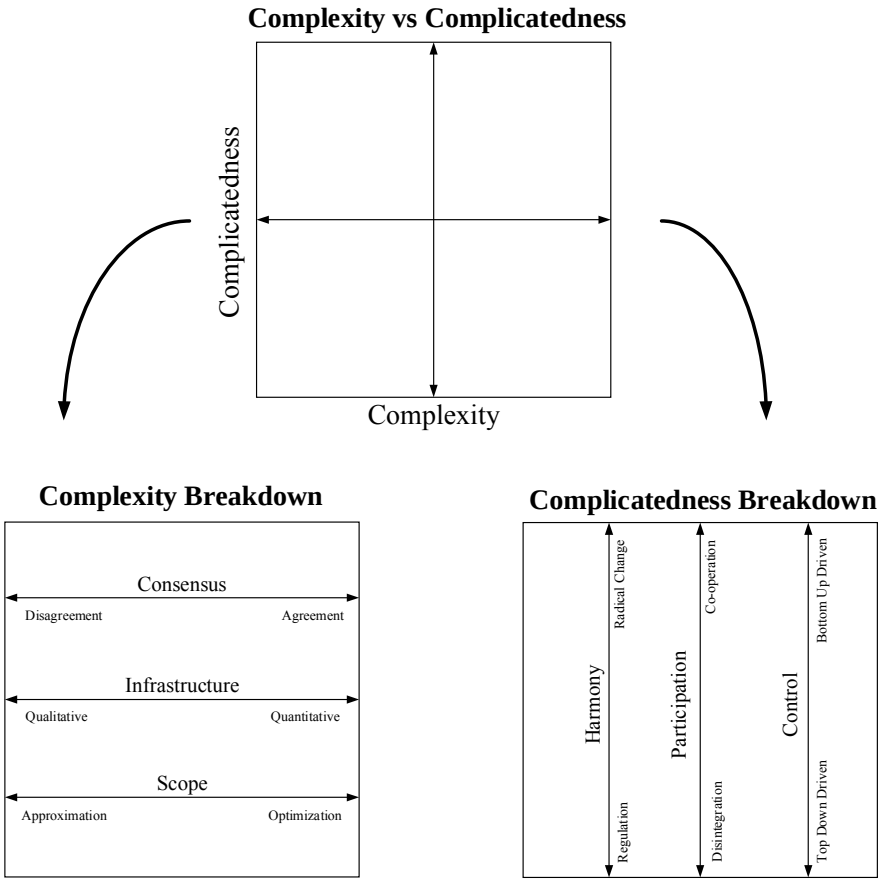

Figure 23. Proposed Framework "Complexity vs Complicatedness"

The proposed framework exhibits the same structure as Burrell and Morgan's (1979) framework, as the category extremes located on the horizontal axis of the framework (Complexity) mimics the subjective-objective dimension, and category extremes located on the vertical axis of the framework (Complicatedness) mimics the regulation-radical

change dimension. The sociological paradigms can therefore be mapped in a similar way, as can be seen in Figure 24.

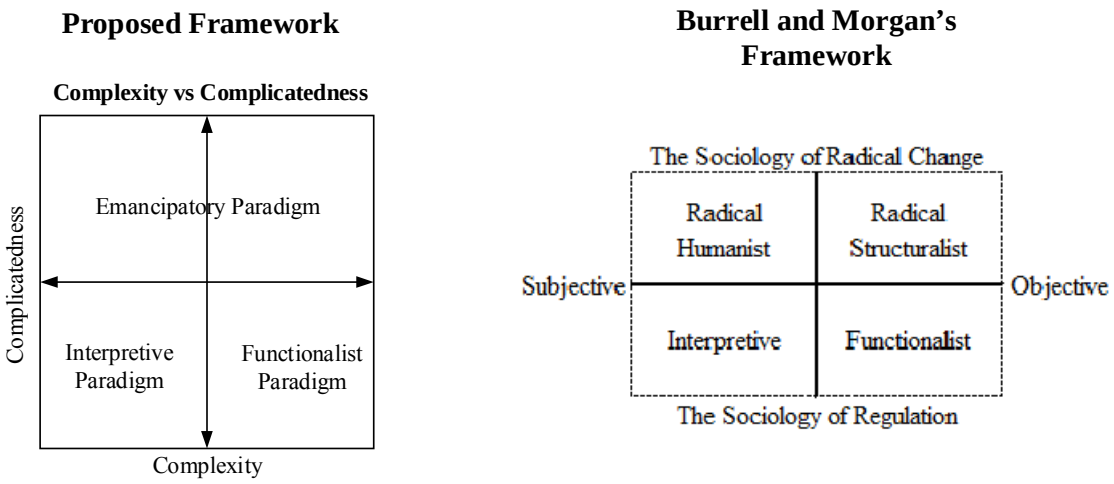

Figure 24. Proposed framework compared to Burrell and Morgan's (1979, p. 22) framework

4.2.3 Type of Research

The qualitative nature of this research is founded in inductive reasoning. Inductive reasoning uses specific instances or occurrences to draw conclusions about entire populations (Leedy & Ormrod, 2016). For this research, a sample of case studies are coded for three different intervention approaches, and the emerging patterns are used to draw conclusions of the behavior of the intervention approaches. Leedy and Ormrod (2016) have ten general strategies for organizing and analyzing qualitative data, all which were addressed during the course of this research (See Table 9)

Table 9. Addressing of qualitative data strategies

Qualitative data analysis strategies (Leedy and Ormrud, 2016)	Addressed in this research
Convert the data into one or more forms that will be easy to organize and analyze	All case study articles were collected in .pdf format for ease of readability.
Organize the data in a preliminary, superficial way that will enable you to locate them as you proceed	Data was sorted by author, year, title, and number of citations in Microsoft Excel.
Identify preliminary categories that are likely to be helpful in coding the data	Six sociological categories with two extremes each were created based on sociological paradigms.
Divide the data into meaningful units that will be individually coded.	Individual case studies, where the current state of the case study is coded.
Apply the initial coding scheme to a subset of the data	Codes were tested on two case studies for each intervention approach and were deemed adequate for capturing the required information.
Construct a final list of codes and sub-codes, and define each code and sub-code as specifically and concretely as possible	Codebook was created for each code, complete with definitions, inclusion/exclusion criteria and examples (Appendix B).
Consider using two or more raters to code the data independently	Additional coders were considered, but deemed unnecessary for the codes utilized due to fidelity of codes. Codebook and guidelines are included in appendix as validation tools.
Identify noteworthy patterns and relationships among the codes.	Patterns were identified among each intervention approach, and resulted in a location in the proposed framework for this research. Details on how to acquire this location can be found in Chapter 4.
Be alert of outliers, exceptions, and contradictions within the data set	The patterns found from analyzing the codes are consistent with theory.
Interpret the data in light of your research problem	The research problem asked what system states are needed, and how should the system states should be operationalized to create a framework that reduces the variety gap between interventionist and intervention approach. The data collected and analyzed allows for the creation of a framework that requires minimal system thinking proficiency from the interventionist.

4.2.4 Research Focus

The focus of this research is to provide the foundations for categorizing intervention approaches on sociological paradigms. The area of interest is the state of the system implementing the intervention approach. In order to code the state of a system using an intervention approach, case studies were collected, coded, and the results were analyzed and located within a proposed framework.

4.2.5 Research Hypotheses Revisited

First Hypothesis: There are a set of limited system states that can be used to reduce the variety gap between low-variety interventionist and high-variety intervention approach.

Second Hypothesis: Key system states can be operationalized to reduce the variety gap between low-variety interventionist and high-variety intervention approach.

4.3 Collection and Treatment of Data

4.3.1 Data Collection

Case studies were chosen as the most appropriate medium to collect information on the state of systems using intervention approaches. Sample case studies were collected for three intervention approaches: Viable Systems Model, Soft Systems Methodology, and Systems Dynamics. Case studies were selected because they are well known within the systems thinking community, having been created (respectively) in 1972, 1981, and 1958. Viable System Model and System Dynamics are traditionally considered functionalist intervention approaches, and Soft Systems Methodology is considered an interpretative intervention approach. Further details on each intervention approach can be found in chapters 2.6.1, 2.6.2, and 2.6.3. Case study articles were collected using keywords in online databases, including Oregon State University library database. Databases and Keywords used are shown in Table 10 and Table 11.

Table 10. Data Collection Databases

Online Databases	
Web Of Knowledge	http://apps.webofknowledge.com/
EBSCO	http://web.b.ebscohost.com/
IEEE Explore	http://ieeexplore.ieee.org/Xplore/home.jsp
Science Direct	http://www.sciencedirect.com/
JStor	https://www.jstor.org/
OSU Library 1Search	http://osulibrary.oregonstate.edu/
Google Scholar	https://scholar.google.com/
Google	https://www.google.com/

Table 11. Data Collection Keywords

Keywords
Soft System Methodology, SSM
System Dynamics, SD
Viable Systems Model
case study, application, implementation, in action

Searching within a database ceased once no more articles related to keywords were appearing and all keywords had been exhausted. Any article that appeared related to keywords was collected, and evaluated for applicability by following the criteria detailed in chapter 4.3.2. Table 12 displays the number of case studies found during data collection, and the number of case studies that were considered applicable after treating the data.

Table 12. Number of Case Studies

Intervention approach	Case studies found during data collection	Case studies remaining after data treatment
Viable Systems Model	23	13
Soft Systems Methodology	25	17
Systems Dynamics	42	21
Total	90	51

4.3.2 Treatment of Data

Case studies were selected based on the following criteria:

1. Case study must be a peer-reviewed journal, conference paper or book.
2. Case study must refer to one case study, or if referring to multiple case studies in one article, provide sufficient information to tie case studies to an overall system.
3. Case study must provide sufficient information on the system state of the case study for coding.
4. Case study must conclude that the intervention approach was well suited for the system state. **Note**: Coding would include case studies that were not implemented if the intervention approach was concluded as well suited by the authors.

All case studies fulfilling the criteria were ranked by number of citations. Each intervention approach needed to have an equal amount of case studies to code to ensure equal representativeness. Top ten case studies were selected for coding for each intervention approach, and sorted by number of citations. Figure 25 shows the number of citations for each intervention approach case study.

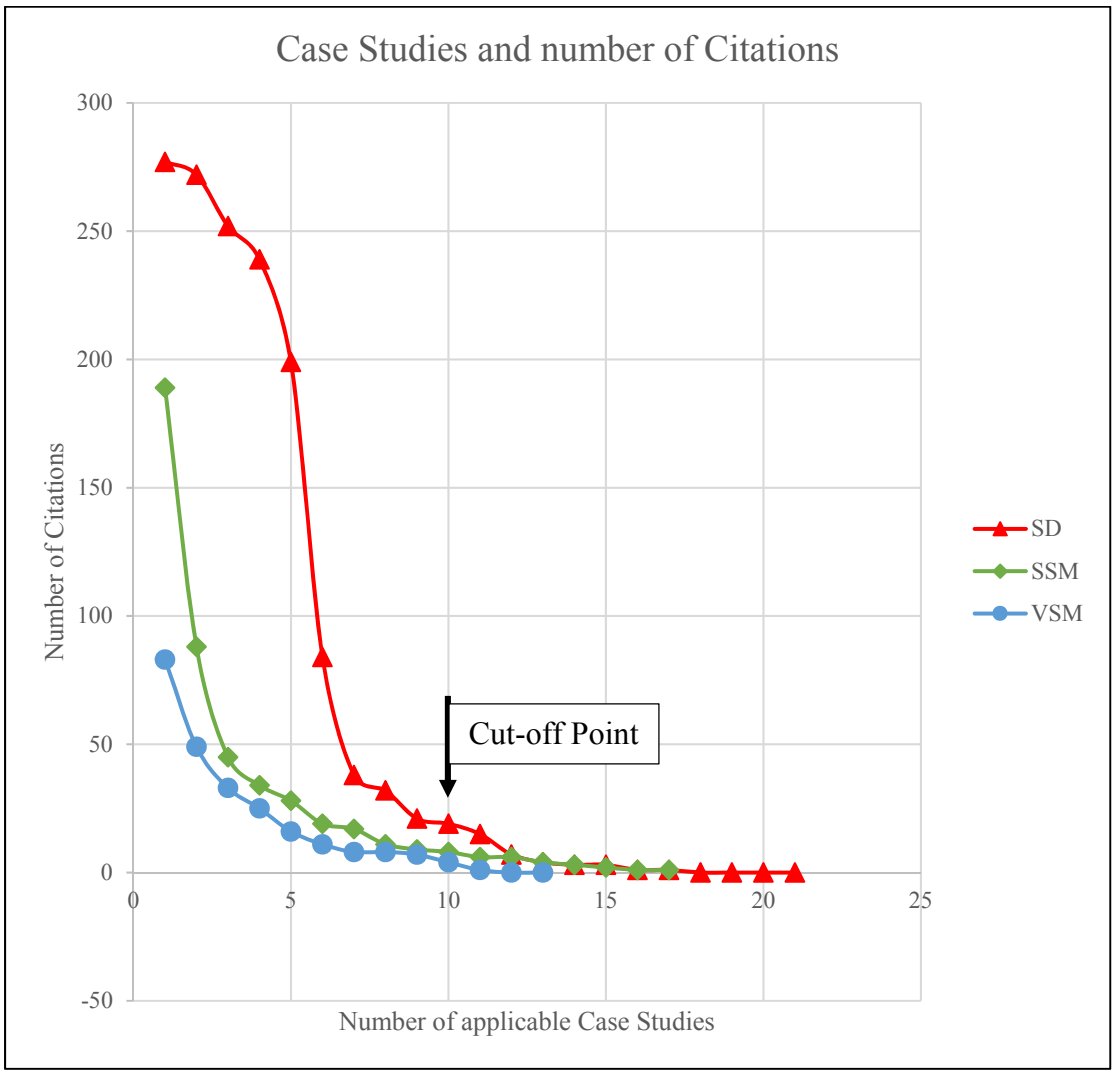

Figure 25. Case Studies and number of citations

Self-citations were recorded for each case study to determine whether it would skew the order of citations, and were found to not have any impact. Top ten case studies for each intervention approach as well as number of citations and self-citations can be found in Appendix B: List of Case Studies.

Each case study were coded in each of the six sociological categories by one of the two extremes (meaning exactly six of twelve extremes were coded, one in each sociological

category). As the level of fidelity required was low, no additional coders were required. A codebook was created to give a descriptions, inclusion/exclusion criteria, and examples of each code (Appendix C: Codebook). Results from coding can be found in Chapter 5.

4.4 Methodological Issues

The following sub-sections describe the potential issues of the chosen methodology.

4.4.1 Reliability

Reliability of research methodology is as accurate within the boundaries set by the codebook and case studies.

4.4.2 Validity

Validation of case studies is based on having been published by a journal or written in a book. Validity of coding categories is based on established theory of sociological paradigms. Validity of coding results are based on similarity to established approaches to applying of systems thinking intervention approaches to paradigms.

4.4.3 Replicability

Any researcher that attempts to replicate the work presented in this research will be provided with the definitions for each coding category, the logic from which the sociological category was created, and a guideline for how to apply codes to case studies and analyze the results.

4.4.4 Bias

Bias in this research was minimized by selecting case studies and coding of case studies. In order to address these biases, data collection guidelines were established and followed, and specific definitions were given for the codes in the form of a codebook.

4.4.5 Representativeness

Intervention approach case studies targeted by this research are from different years, targeting different systems, different authors, different degrees of implementation, different journals. Due to this variety, results from the combined intervention approach case studies are considered representative of each intervention approach.

4.5 Research Constraints

Due to a lack of intervention approach case studies that have been fully implemented, case studies that undergo an intervention approach and conclude its usefulness were included regardless of real implementation. Additionally, only case studies that could be located were used in this research.

Chapter 5

Results

5.1 Introduction

The purpose of this chapter is to present the results of the coding, describe the analysis performed, and explain how the framework can be used by interventionists.

5.2 Result from Study

The three intervention approaches Viable Systems Model, Soft Systems Methodology, and System Dynamics were represented by thirty case studies, split up by ten case studies each. Each case study was evaluated according to six sociological categories C_m. In each sociological category, the cases were coded into one of two category extremes E_{mn}. Table 13, Table 14 and Table 15 displays the resulting count for each category extremes code (CoE_{mn}) within the case studies for Viable Systems Model, Soft Systems Model, and System Dynamics respectively.

Table 13. Viable System Model Coding Results

Intervention Approach	**Viable System Model (10 cases)**	
Sociological Category C_m	**Category Extremes E_{mn}**	**count of cases (CoE_{mn})**
Consensus (m=1)	Disagreement (n=1)	6
	Agreement (n=2)	4
Infrastructure (m=2)	Qualitative (n=1)	5
	Quantitative (n=2)	5
Scope (m=3)	Approximation (n=1)	4
	Optimization (n=2)	6
Harmony (m=4)	Radical Change (n=1)	4
	Regulation (n=2)	6
Participation (m=5)	Co-operation (n=1)	5
	Disintegration (n=2)	5

Table 13. Viable System Model Coding Results

Intervention Approach	Viable System Model (10 cases)	
Sociological Category C_m	**Category Extremes E_{mn}**	**count of cases (CoE_{mn})**
Control (m=6)	Bottom Up Driven (n=1)	4
	Top Down Driven (n=2)	6

Table 14. Soft Systems Methodology Coding Results

Intervention Approach	System Dynamics (10 cases)	
Sociological Category C_m	**Category Extremes E_{mn}**	**count of cases (CoE_{mn})**
Consensus (m=1)	Disagreement (n=1)	8
	Agreement (n=2)	2
Infrastructure (m=2)	Qualitative (n=1)	4
	Quantitative (n=2)	6
Scope (m=3)	Approximation (n=1)	7
	Optimization (n=2)	3
Harmony (m=4)	Radical Change (n=1)	3
	Regulation (n=2)	7
Participation (m=5)	Co-operation (n=1)	4
	Disintegration (n=2)	6
Control (m=6)	Bottom Up Driven (n=1)	8
	Top Down Driven (n=2)	2

Table 15. System Dynamics Coding Results

Intervention Approach	System Dynamics (10 cases)	
Sociological Category C_m	**Category Extremes E_{mn}**	**count of cases (CoE_{mn})**
Consensus (m=1)	Disagreement (n=1)	4
	Agreement (n=2)	6
Infrastructure (m=2)	Qualitative (n=1)	3
	Quantitative (n=2)	7
Scope (m=3)	Approximation (n=1)	6
	Optimization (n=2)	4
Harmony (m=4)	Radical Change (n=1)	7
	Regulation (n=2)	3
Participation (m=5)	Co-operation (n=1)	5
	Disintegration (n=2)	5
Control (m=6)	Bottom Up Driven (n=1)	9
	Top Down Driven (n=2)	1

5.3 Data Analysis

The following sections detail (1) the quantitative design of the proposed framework, (2) how to determine the locations of intervention approaches based on coding results, (3) how to locate the system state within the proposed framework, (4) how to calculate the distance between system state and surrounding intervention approaches, (5) how to determine the level of fit between the system state and surrounding intervention approaches, and (6) provide an example of the proposed framework in action.

5.3.1 Quantitative Design of Proposed Framework

Figure 26 displays the sociological categories in relationship to the proposed framework.

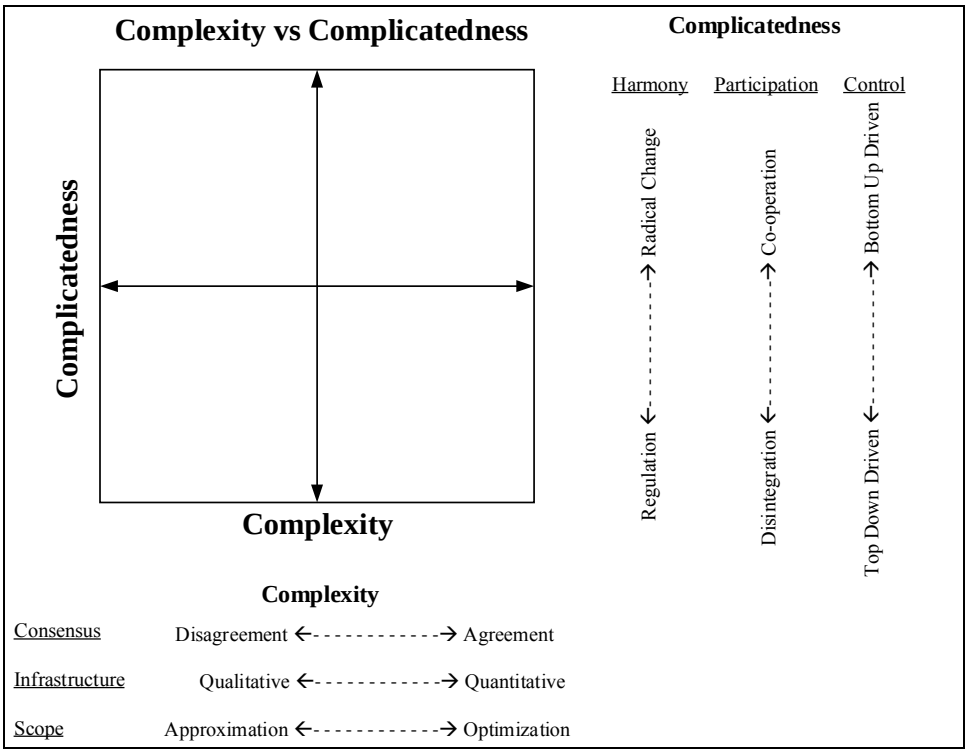

Figure 26. Categories in relationship to the Proposed Framework

Each paradigm dimension (Complexity and Complicatedness) is composed of three sociological categories. Each sociological category C_m has two category extremes, E_{m1} and E_{m2} (see chapter 4.2.2 – Table 8 for details). To assign the coding results for the category extremes (CoE_{mn}) to the proposed framework, an appropriate scaling system needs is designed through 5 steps.

Step 1 is to acquire the sociological category ratios, which are calculated for each sociological category based on the ratio between category extremes coded for its 10 case studies. Sociological category ratios are found by:

Equation 2. Sociological Category Ratio

$$Sociological\ Category\ C_m\ Ratio = \frac{CoE_{m1}}{CoE_{m1} + CoE_{m2}}, \qquad for\ m = 1,2,..,6$$

As an example, applying the coding results to Equation 2, the sociological category ratio for the consensus category within Viable Systems Model Infrastructure (Table 13) gives the category extremes for agreement and disagreement as 4 and 6 respectively. Thus, by replacing the category extreme values into Equation 2, we have:

$$Sociological\ Category\ m\ Ratio = \frac{E_{mn1}}{E_{mn1} + E_{mn2}}$$

$$= \frac{Count\ of\ Disagreement}{Count\ of\ Disagreement + Count\ for\ Agreement} = \frac{6}{6+4} = 0.6$$

Step 2 is to transform the sociological category ratios into three bins: 1) Leaning towards one extreme (Extreme 1), 2) leaning towards the other extreme (Extreme 2), or 3)

remaining between the two extremes (Between Extremes). Creating bins is justified, based on the following assumptions:

- Sociological categories are assumed to lean within an intervention approach.
- The process of determining system state for the interventionist is assumed to become simpler (It is easier for an interventionist to describe their system state in terms of extremes rather than a ratio between 0 and 1).
- Bin are assumed to reduce ambiguity if intervention approaches are added to the framework by a different method than coding 10 case studies.

Step 3 is to translate the sociological category ratio bins into quantitative values, ratios were designated to the bin they leaned towards. Any ratio less than 0.4 is designated to Extreme 1 bin, and any ratio greater than 0.6 is designated to Extreme 2 bin. Ratios between 0.4 and 0.6 were determined to belong to the "Between extremes" bin. Once a ratio is placed in a bin, it assigned the average value of the bin range. The sociological category ratios and respective values assigned for each bin can be found in Table 16.

Table 16. Ratios and values assigned

Bins	Ratio found	Ratio Range	Bin Value
Extreme 1	< 0.4	0 - 0.399	0.2
Between extremes	0.4 - 0.6	0.4 - 0.6	0.5
Extreme 2	> 0.6	0.601 - 1	0.8

Step 4 is to determine the range of average values that can be assigned to a paradigm dimension. All sociological categories are assumed to be of equal value, therefore the location of an intervention approach or system state on a paradigm dimension can be found by averaging the values assigned to each sociological category belonging to that

paradigm dimension. As each sociological category can only be assigned three possible values (0.2, 05 or 0.8), there is a limited number of average values that can be assigned to a paradigm dimension. Table 17 displays the possible sociological category value combinations and possible average values, sorted by average values.

Table 17. Possible sociological category value combinations

Sociological category combination	Average Value
[0.2, 0.2, 0.2]	0.2
[0.2, 0.2, 0.5]	0.3
[0.2, 0.2, 0.8]	0.4
[0.2, 0.5, 0.5]	0.4
[0.2, 0.5, 0.8]	0.5
[0.5, 0.5, 0.5]	0.5
[0.5, 0.5, 0.8]	0.6
[0.8, 0.5, 0.5]	0.6
[0.8, 0.8, 0.2]	0.7
[0.8, 0.8, 0.8]	0.8

Step 5 is to create a scale based on the range of values gained from step 4. When sorted, the frequency of the possible average values can be uniformly distributed on a scale between one and five (See Table 18).

Table 18. Possible outcomes to scale value

Average Value	Possible Outcomes		Frequency	Scale
0.2		[0.2, 0.2, 0.2]	1	1
0.3		[0.2, 0.2, 0.5]	1	
0.4	[0.2, 0.2, 0.8]	[0.5, 0.5, 0.2]	2	2
0.5	[0.2, 0.5, 0.8]	[0.5, 0.5, 0.5]	2	3
0.6	[0.5, 0.5, 0.8]	[0.8, 0.8, 0.2]	2	4
0.7		[0.8, 0.8, 0.5]	1	5
0.8		[0.8, 0.8, 0.8]	1	

The scale of 1-5 can be placed within the proposed framework for both Complexity and Complicatedness (See Figure 27).

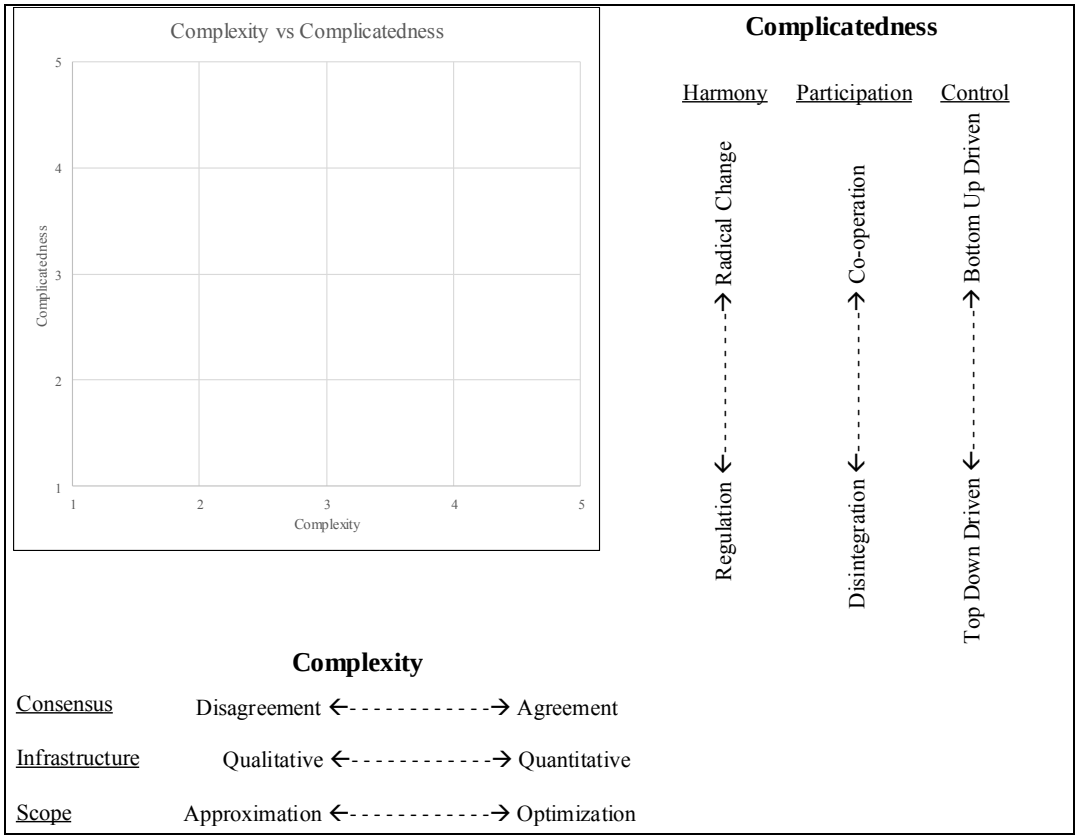

Figure 27. Proposed Framework Design

5.3.2 Locating intervention approaches within proposed framework

Each intervention approaches can be given a location from 1-5 on the complexity axis and the complicatedness axis based on the sociological category ratio calculated from the case study results. This is determined through three steps:

1. Step 1: The appropriate bin value must be calculated for each sociological category based on the sociological category ratio (Table 16).
2. Step 2: The average value within an axis must be calculated based on the average of its corresponding sociological categories (Table 17).

3. Step 3: The average value gained must be converted to a location within the scale of 1-5 (Table 18).

Following these steps, Table 19 displays the location of the intervention approaches.

Table 19. Location of Intervention Approaches

				(Step 1)	(Step 2)	(Step 3)
Intervention Approach	**Category Extreme**	**Values**	**Ratio**	**Bin**	**Average value**	**Location**
Viable System Model	Agreement	4	0.4	0.5	0.5	3
	Disagreement	6				
	Quantitative	5	0.5	0.5		
	Qualitative	5				
	Optimization	6	0.6	0.5		
	Approximation	4				
	Regulation	4	0.6	0.5	0.5	3
	Radical Change	6				
	Disintegration	5	0.5	0.5		
	Co-ordination	5				
	Top Down Driven	4	0.6	0.5		
	Bottom Up Driven	6				
Soft Systems Methodology	Agreement	2	0.2	0.2	0.3	1
	Disagreement	8				
	Quantitative	6	0.6	0.5		
	Qualitative	4				
	Optimization	3	0.3	0.2		
	Approximation	7				
	Regulation	3	0.7	0.8	0.5	3
	Radical Change	7				
	Disintegration	4	0.6	0.5		
	Co-ordination	6				
	Top Down Driven	8	0.2	0.2		
	Bottom Up Driven	2				
System Dynamics	Agreement	6	0.6	0.5	0.6	4
	Disagreement	4				
	Quantitative	7	0.7	0.8		
	Qualitative	3				
	Optimization	6	0.6	0.5		
	Approximation	4				
	Regulation	7	0.3	0.2	0.3	1
	Radical Change	3				
	Disintegration	5	0.5	0.5		
	Co-ordination	5				
	Top Down Driven	9	0.1	0.2		

Table 19. Location of Intervention Approaches

				(Step 1)	(Step 2)	(Step 3)
Intervention Approach	**Category Extreme**	**Values**	**Ratio**	**Bin**	**Average value**	**Location**
	Bottom Up Driven	1				

The locations of each intervention approach within the proposed framework is shown in Figure 28.

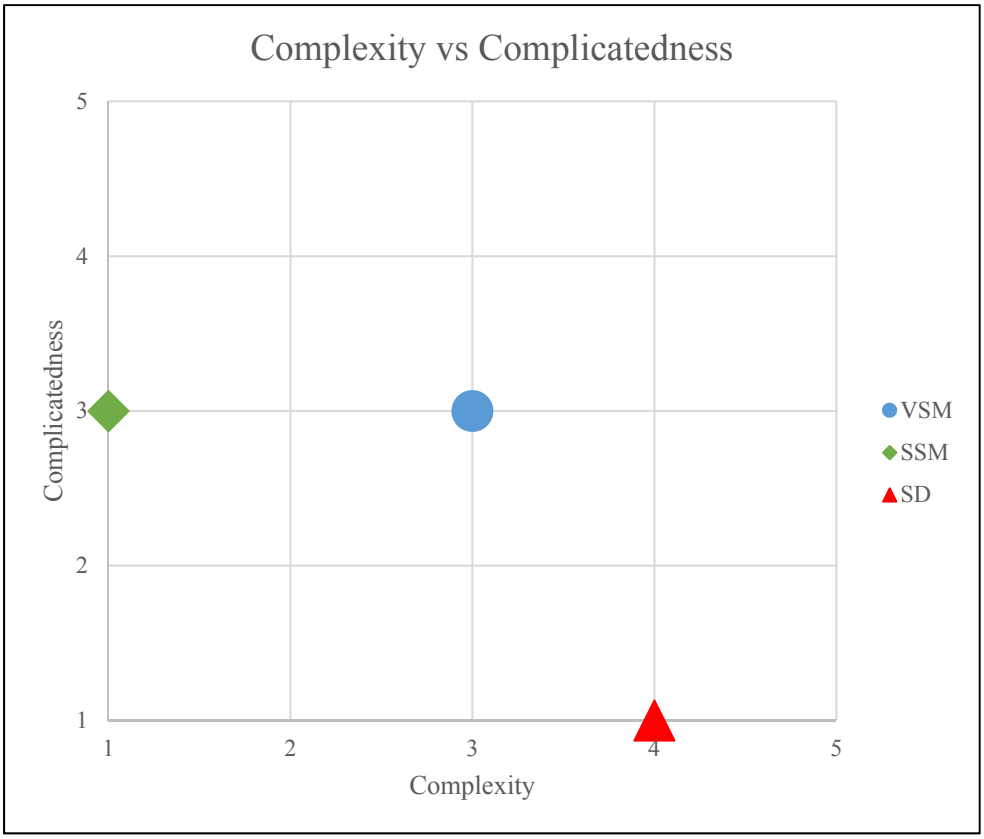

Figure 28. Intervention approaches locations in proposed framework

Viable Systems Model and Systems Dynamics are commonly considered to belong to the functionalist paradigm, while Soft Systems Dynamics is commonly considered to belong to the interpretive paradigm (Flood & Jackson, 1991). The locations determined within in this framework support this notion. Further details on the intervention approaches can be found in chapter 2.6.

5.3.3 Locating the system state within proposed framework

To determine the location of the system state, the interventionist will have to identify their system state in terms of the six sociological categories. For each sociological category, the interventionist must determine which extreme the system state most resembles. If the interventionist determines that the system state does not lean towards either extreme, they may choose "middle" as somewhere in between extremes. Table 20 displays the possible system state user inputs.

Table 20. System State Categories

Paradigm Dimension	Sociological Category	Category Extreme	Definition
Complexity	Consensus	Agreement	Views on goals and solutions are shared among stakeholders
		Middle	Both occur close to equally
		Disagreement	Views on goals and solutions vary among stakeholders
	Infrastructure	Quantitative	System focuses on quantitative processes/information
		Middle	Both occur close to equally
		Qualitative	System focuses on qualitative processes/information
	Scope	Optimization	Stakeholders believe a known solution can be reached
		Middle	Both occur close to equally
		Approximation	Stakeholders believe that a known solution can be approached
Complicatedness	Harmony	Regulation	There is little desire to restructure to the current system
		Middle	Both occur close to equally

Table 20. System State Categories

Paradigm Dimension	Sociological Category	Category Extreme	Definition
		Radical Change	There is strong desire to restructure the current system
	Participation	Disintegration	There are few stakeholders participating in influencing the system
		Middle	Both occur close to equally
		Co-ordination	There are many stakeholders participating in influencing the system
	Control	Top Down Driven	Stakeholder actions are governed by prescribed processes
		Middle	Both occur close to equally
		Bottom Up Driven	Stakeholders actions are governed by their own decisions

Once the interventionist has determined the appropriate category extreme, the user input is quantified by being translated to the appropriate bin. Table 21 displays this translation.

Table 21. System State Categories Translated to Bins

Paradigm Dimension	Sociological Category	Category Extreme	Designated Bin Value
Complexity	Consensus	Agreement	0.8
		Middle	0.5
		Disagreement	0.2
	Infrastructure	Quantitative	0.8
		Middle	0.5
		Qualitative	0.2
	Scope	Optimization	0.8
		Middle	0.5
		Approximation	0.2
Complicatedness	Harmony	Regulation	0.8
		Middle	0.5
		Radical Change	0.2
	Participation	Disintegration	0.8
		Middle	0.5
		Co-ordination	0.2
	Control	Top Down Driven	0.8
		Middle	0.5
		Bottom Up Driven	0.2

Once user input has been translated to designated bins for each sociological category, the location of the system state is calculated in the same way that the location of intervention approaches is calculated in step 2 and 3 (see chapter 5.3.2).

5.3.4 Calculating distance between system state and intervention approaches

Once the system state location *p* has been determined within the proposed framework, the interventionist must determine which of the intervention approaches *i* best fit their system state. This decision is based on the distance C_i from the location of the system state *p* (*a*, *b*) to the location of each neighboring intervention approach q_i (a_i, b_i), assuming rectilinear distances. The variable *a* is the location of the system state on the complexity axis, and the variable *b* is the location of the system state on the complicatedness axis. The variable a_i is the location of intervention approach *n* on the complexity axis, and the variable b_i is the location of intervention approach *n* on the complicatedness axis. As the proposed framework is divided into quadrants, containing 90° angles, it is possible to use the Pythagorean Theorem to calculate all possible rectilinear distances (Equation 3).

Equation 3. Pythagorean Theorem

$$C_i = \sqrt{{A_i}^2 + {B_i}^2} \qquad for\ A_i\ and\ B_i > 0, \qquad i = 1,2,3 \quad and$$

$$C_i = A_i, or\ C_i = B_i \quad for\ A_i\ or\ B_i\ = 0, \qquad i = 1,2,3$$

Where

$$A_i = |a - a_i|\ and\ B_i = |b - b_i|$$

$$System\ State\ Location = p(a, b)$$

$$Intervention\ Approach\ i\ Location = \ q_i(a_i, b_i), \quad for\ i = 1,2,3$$

Figure 29 displays this relationship graphically.

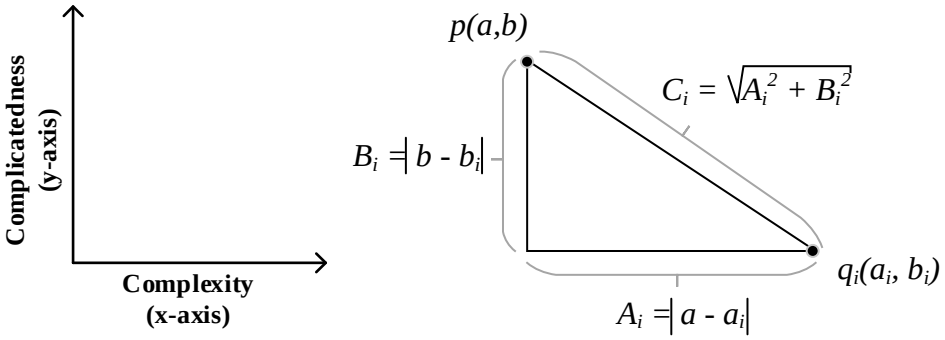

Figure 29. Distance *C* from location *p* to location *q*

Figure 30 displays an example with the system state *p* located at a=3 and b=2.

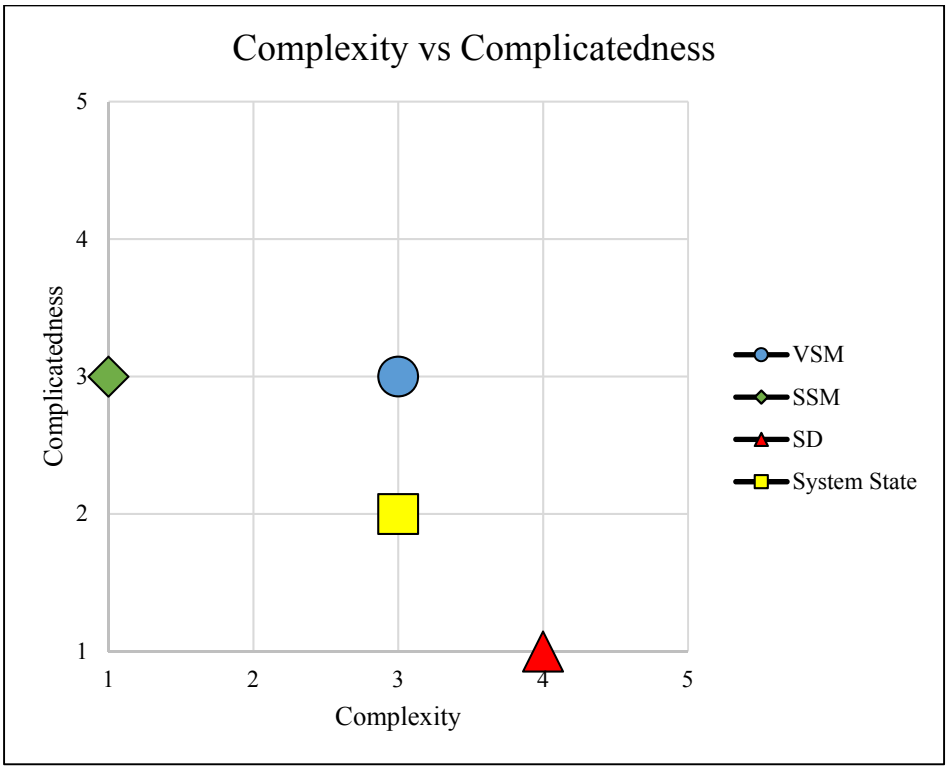

Figure 30. Proposed Framework with System State (3,2)

The distance from the p to the Viable Systems Model (q_1), Soft Systems Methodology (q_2) and System Dynamics (q_3) is shown in Figure 31, and calculated in Table 22.

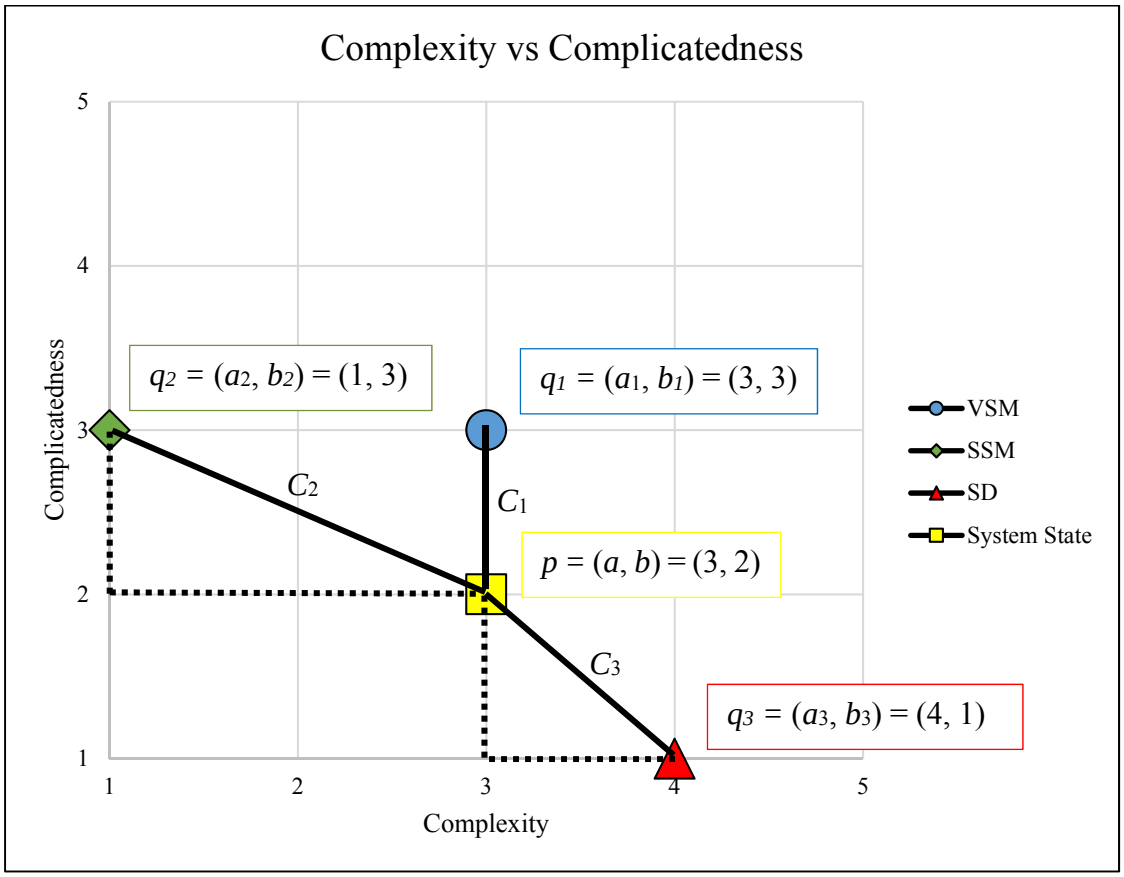

Figure 31. Calculating distance in Proposed Framework with System State (3,2)

Table 22. Distances with System State (3,2)

Intervention approach	Distance
Viable System Model (i=1)	$C_1 = b - b_1 = 1.00$
Soft Systems Methodology (i=2)	$C_2 = \sqrt{(a-a_2)^2 + (b-b_2)^2} = \sqrt{(3-1)^2 + (2-3)^2} = 2.21$
Systems Dynamics (i=3)	$C_3 = \sqrt{(a-a_3)^2 + (b-b_3)^2} = \sqrt{(3-4)^2 + (2-1)^2} = 1.41$

5.3.5 Level of fit between system state and intervention approaches

The proposed framework is designed to determine the level of "fit" between the system state and surrounding intervention approaches. To assign levels of "fits" based on distance, all possible distances C_i must be evaluated. To get the full range of distances, the system state p is placed on (1, 1) in the proposed framework, and the distance C_i is calculated from system state p to intervention approach q using Equation 3. Table 23 shows the resulting rectilinear distances, based on the different locations of intervention approach q (a_i, b_i). For instance, the distance C_i from the system state p (1, 1) to intervention approach (2, 3) is equal to 3.61.

Table 23. Possible distances C_i

		Location q (b_i)				
		1	**2**	**3**	**4**	**5**
Location q (a_i)	**1**	0	1.00	2.00	3.00	4.00
	2	1.00	1.41	2.24	3.16	4.12
	3	2.00	2.24	2.83	3.61	4.47
	4	3.00	3.16	3.61	4.24	5.00
	5	4.00	4.12	4.47	5.00	5.66

Based on the distance between locations, a scale of "fits" was created to assist interventionists in determining which intervention approach(es) best suit their intervention approach. Table 24 shows the proposed fits based on distance, and Table 25 summarizes the resulting fits by distance.

Table 24. Fit based on locations distance

		Complexity axis location				
		1	**2**	**3**	**4**	**5**
Complicatedness axis location	**1**	Great Fit	Great Fit	Fair Fit	Poor Fit	No Fit
	2	Great Fit	Good Fit	Fair Fit	No Fit	No Fit
	3	Fair Fit	Fair Fit	Poor Fit	No Fit	No Fit
	4	Poor Fit	No Fit	No Fit	No Fit	No Fit
	5	No Fit	No Fit	No Fit	No Fit	No Fit

Table 25. Intervention Approach Fits

Distance	Level of fit
1.00 or less	Great Fit
1.001 – 1.50	Good Fit
1.501 – 2.25	Fair Fit
2.251 – 3.00	Poor Fit
3.01 or more	No Fit

By granting a scale of "fits", interventionists will be able to compare which intervention approaches best suit their system state, as well as determine to what degree they should incorporate their chosen intervention approaches.

5.3.6 Proposed framework in action

This chapter provides an example of the proposed framework in action. The proposed framework assists interventionists in deciding which intervention approaches best matches the state of the system they are improving. The interventionist must undergo the following steps:

1. Locate the system state and surrounding intervention approaches within the proposed framework

2. Calculate the distance between the system state and the surrounding intervention approaches within the proposed framework
3. Determine the degree of fit between the system state and the surrounding intervention approaches

An interventionist is expected to determine which category extreme (if any) best represents the system state. Table 26 displays the input an interventionist might select.

Table 26. System State User Input

Paradigm Dimension	Sociological Category	Category Extreme	Definition	User Input
Complexity	Consensus	Agreement	Views on goals and solutions are shared among stakeholders	*Disagreement*
		Middle	Both occur close to equally	
		Disagreement	Views on goals and solutions vary among stakeholders	
	Infrastructure	Quantitative	System focuses on quantitative processes/information	*Qualitative*
		Middle	Both occur close to equally	
		Qualitative	System focuses on qualitative processes/information	
	Scope	Optimization	Stakeholders believe a known solution can be reached	*Optimization*
		Middle	Both occur close to equally	
		Approximation	Stakeholders believe that a known solution can be approached	
Complicatedness	Harmony	Regulation	There is little desire to restructure to the current system	*Regulation*
		Middle	Both occur close to equally	
		Radical Change	There is strong desire to restructure the current system	
	Participation	Disintegration	There are few stakeholders participating in influencing the system	*Disintegration*
		Middle	Both occur close to equally	
		Co-ordination	There are many stakeholders participating in influencing the system	
	Control	Top Down Driven	Stakeholder actions are governed by prescribed processes	*Bottom Up Driven*
		Middle	Both occur close to equally	

Table 26. System State User Input

Paradigm Dimension	Sociological Category	Category Extreme	Definition	User Input
		Bottom Up Driven	Stakeholders actions are governed by their own decisions	

By following the steps detailed in chapter 5.3.1 and 5.3.3, the input from the interventionist is translated into a location in the proposed framework. This translation can be seen in Table 27.

Table 27. Translating input to locations

Paradigm Dimension	User input	Bin	Average Value	Location
Complexity	Disagreement	0.2	0.4	2
	Qualitative	0.2		
	Optimization	0.8		
Complicatedness	Regulation	0.2	0.4	2
	Disintegration	0.2		
	Bottom Up Driven	0.8		

The system state location is mapped on the proposed framework, and distances are compared from the system state to each surrounding intervention approach. Figure 32 shows the location of the system state and the intervention approaches Viable System Model, Soft Systems Methodology and System Dynamics within the framework.

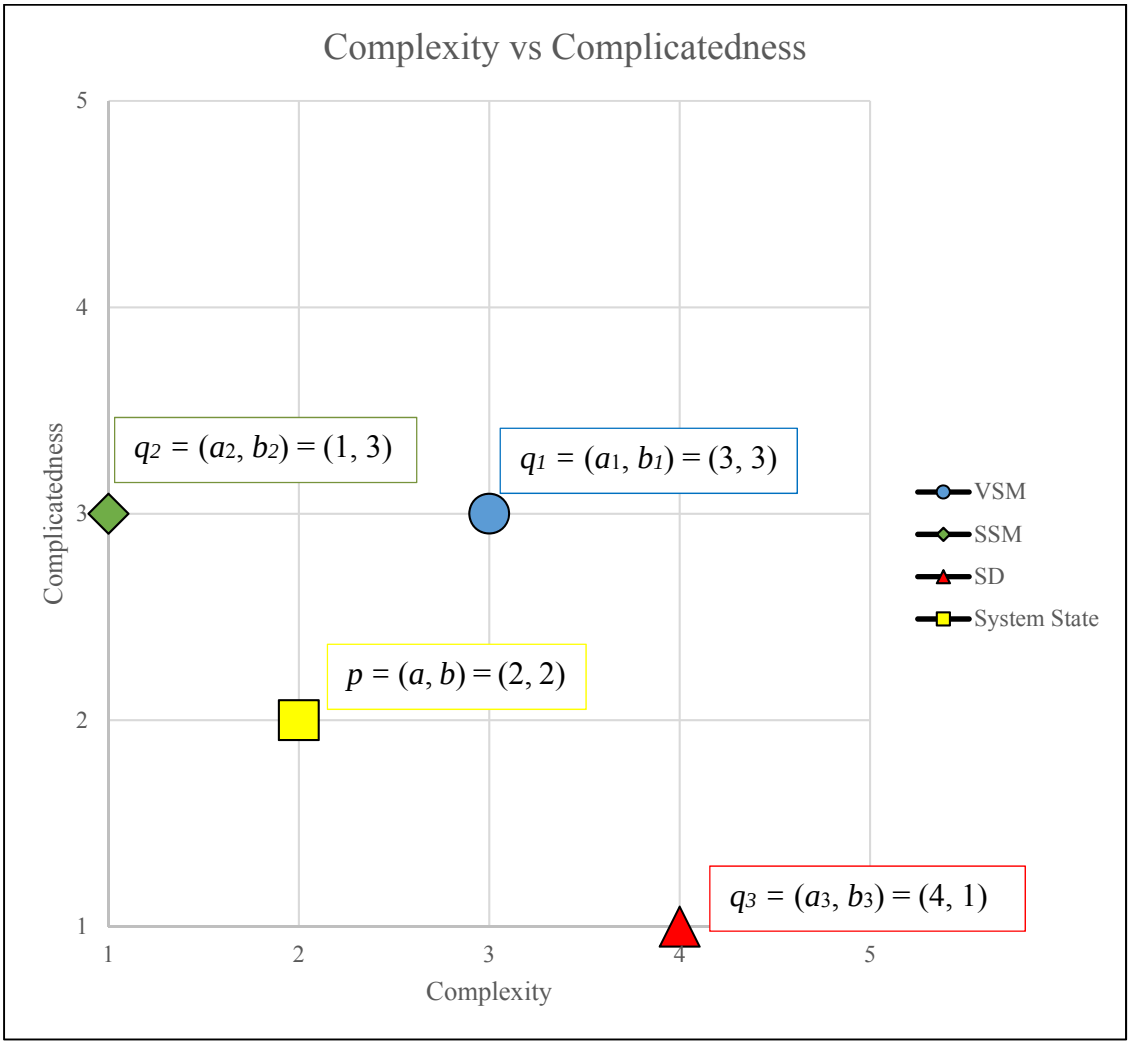

Figure 32. Proposed Framework in Action

The degree of fit for each intervention approach is determined from the Pythagorean Theorem as detailed in chapter 5.3.4. Table 28 displays output from the framework in terms of the distance from the system state to each intervention approach, and the degree of fit.

Table 28. Proposed Framework Output

Intervention approach	Distance	Conclusion
Viable System Model	$C_1 = \sqrt{(a-a_1)^2 + (b-b_1)^2} = \sqrt{(2-3)^2 + (2-3)^2} = 1.41$	Good Fit
Soft Systems Methodology	$C_2 = \sqrt{(a-a_2)^2 + (b-b_2)^2} = \sqrt{(2-1)^2 + (2-3)^2} = 1.41$	Good Fit
Systems Dynamics	$C_3 = \sqrt{(a-a_3)^2 + (b-b_3)^2} = \sqrt{(2-4)^2 + (2-1)^2} = 2.23$	Fair Fit

Based on the user input of the categories, it is found that Viable System Model and Soft Systems Methodology are both good fits, and elements of System Dynamics could be considered as well. It is important to note that the proposed framework cannot give exact ratios of which intervention approaches to use or combine, rather it gives estimates on how well a given intervention approach fits the system state based on past real-life interventions.

The interventionist is encouraged to combine multiple intervention approaches in order to incorporate the perspectives granted by different intervention approaches. For instance, an interventionist could utilize the CATWOE and "Rich Picture" methods from Soft Systems methodology to aid in the construction of a Viable Systems Model of the system. A summary of the different intervention approach can be found in chapter XXX, however determining which methods to use from the different intervention approaches is outside the scope of the proposed framework, and is addressed in future work (Chapter 6).

Chapter 6

Conclusion

6.1 Features of this Research

The purpose of this research was to develop a meta-methodology framework accessible to low-variety interventionists, while remaining grounded in high-variety systems. Table 29 presents a summary of the rationale of the steps taken to achieve this purpose.

Table 29. Rationale of Steps Taken

Steps taken	Rationale
Identified a gap in literature	It was determined that there is a gap in variety between interventionists and systems thinking intervention approaches that is not being addressed by current meta-methodologies. Three distinguishable gaps exist: 1. Interventionist must understand their system state in terms of potential intervention approaches; 2. Interventionist must understand all potential intervention approaches to distinguish which approach, or mix of approaches, is most applicable to their system state, and; 3. Interventionist must understand selected intervention approaches to implement their procedures effectively. The first two assumptions can be addressed by developing an accessible meta-methodology framework. The third assumption is outside the scope of this research.
Determined how to address the gap	There is a need for a meta-methodology framework that is accessible to interventionists while remaining grounded in systems thinking. In order to develop this framework, the key system states that contribute the most to reduce the variety gap between interventionist and intervention approach needed to be identified and operationalized.
Created framework	Similarly to previous meta-methodologies (TSI, LSI, CSP), the theoretical foundation of the system states is based on Burrell and Morgan's (1979) sociological paradigms. Two sociological dimensions and six sociological categories were created based off the sociological paradigms, allowing an interventionist to quickly assess the state of a system as well as complementary intervention approaches. The design of the proposed framework incorporates the basic premises of the work of Moore, Calvo-Amodio, and Junker (2016).
Created and employed methodology for collecting and analyzing data	Three system thinking intervention approaches were "mapped" within the proposed framework through qualitative data analysis. Case studies representative of the three intervention approaches were located, treated for reliability, and the system states were coded with the six categories based on sociological paradigms.

Table 29. Rationale of Steps Taken

Steps taken	Rationale
Analyzed data	The location of the three system thinking intervention approaches were found by placing the distribution within a sociological category into one of three bins, getting the average value of categories within a sociological dimension, and assigning the intervention approach in the 5 by 5 matrix of the proposed framework. The distance between the system state and the surrounding intervention approaches is calculated based on Euclidean distance, and assists the interventionist in determining applicable intervention approaches.

6.2 Findings from this Research

The findings from this research support both of the hypotheses presented in this thesis:

1. There are a set of limited system states that can be used to reduce the variety gap between low-variety interventionist and high-variety intervention approach.
2. Key system states can be operationalized to reduce the variety gap between low-variety interventionist and high-variety intervention approach.

The sociological paradigms discovered by Burrell and Morgan (1979) address the first hypothesis, as they address all system states known to system thinking. The sociological paradigms have been consistently used throughout systems thinking literature when categorizing systems thinking approaches, and are summarized to focus on the functionalist, interpretive, and radical humanist and radical structuralist (which are combined as emancipatory) paradigms. Jackson (2003) includes a postmodern paradigm, however this thesis does not include it as postmodernism is considered as a critique to current paradigms rather than a paradigm itself.

The key system states are operationalizing by categorizing the sociological paradigms into six categories (consensus, infrastructure, scope, harmony, participation, and control), and successfully applying them to representative case studies, thereby

addressing the second hypothesis. The locations of intervention approaches are consistent with theory, adding further validation to the structure of the framework.

By addressing the two hypothesis, the proposed framework contributes to decreasing the variety gap between interventionist and intervention approach by:

1. Assisting the interventionist by identifying system states in terms of intervention approaches, and;
2. Assisting the interventionist in determining which combination of intervention approaches best fit the system state, based on the distance between the intervention approaches and the system state in the proposed framework.

Figure 33 displays the conceptual model addressed for this research. By addressing the first two statements, the variety gap between interventionist and intervention approach has been reduced.

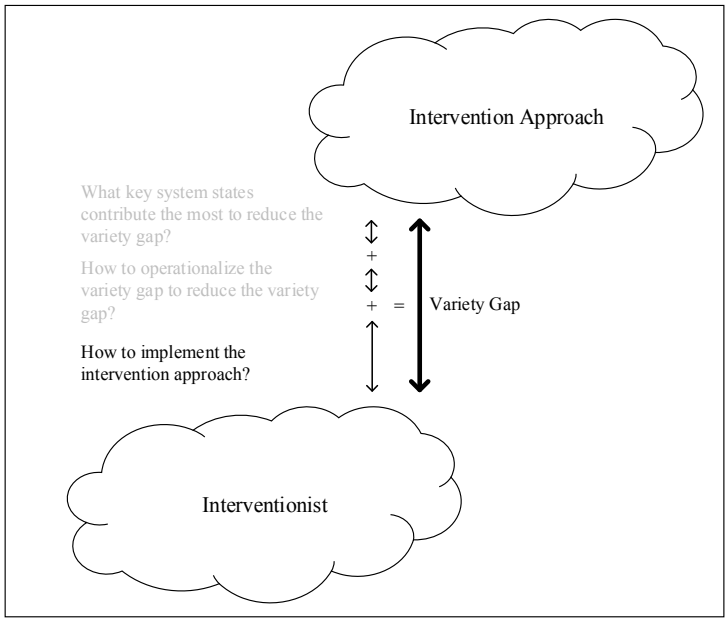

Figure 33. Conceptual Model Addressed

The proposed framework is capable of reducing the variety gap between interventionist and intervention approach; however, as can be seen in the conceptual model, it does not remove it. Interventionists are still held responsible in researching the suggested intervention approaches and determining in what manner they can be combined.

In addition to reducing the variety gap between interventionist and intervention approach, the proposed framework avoids increasing the variety gap between the intervention approach and the system by remaining grounded in systems thinking literature. This variety gap can be considered as having been reduced, as paradigms are now categorized in a more granular, measurable manner.

Finally, this research answers both calls from Jackson (2003), for additional methods or methodologies that can be used during the choice phase of CSP (In the form of sociological categories rather than metaphors), as well as further refining the process of using meta-methodologies for interventionists.

6.3 Future Research Needs

Due to the exploratory nature of this research, future investigation is required. Future research needs are summarized in Table 30.

Table 30. Future Research Needs

Future Research Needs	Description
Expansion of proposed framework in the form of additional intervention approaches, paradigm dimensions, or sociological categories	The proposed framework currently maps three intervention approaches: Viable Systems Model, Soft Systems Methodology, and System Dynamics. There is a need to further map out additional intervention approaches (i.e. Toyota Production System, Interactive Planning, and Critical Systems Heuristics or Team Syntegrity) in order to give interventionists a larger range of potential intervention approaches. Paradigm dimensions are currently based in the objective-subjective and regulation-radical change sociological dimensions by Burrell and Morgan. If additional paradigms are discovered to be useful for mapping system states, they should be added to the framework. The six sociological categories created for this framework are representative of the sociological paradigms; however, there are likely additional sociological categories that are equally valid. If additional sociological categories are created, they should be added to the framework. **Note:** The inclusion of additional categories or sociological paradigms will allow for further granularity of the framework. The proposed framework should be scaled accordingly.
Consider refining data collection methodology to include other methods than case study coding as ways to map intervention approaches	One drawback of using case studies for coding intervention approaches is the existence of representative case studies. This is not to say that intervention approaches are not being applied, rather that there is a lack of case studies detailing the implementation. The proposed framework would benefit from additional methods to locating intervention approaches within the sociological paradigms, as it will increase the "pool" of potential intervention approaches that can be coded into the proposed framework.
Develop a methodology to determine how intervention approaches can be combined	Currently the proposed framework informs the interventionists to what degree an intervention approaches fits their system state; however, it does not inform in what manner intervention approaches can be combined. Future work may include guidelines for determining how intervention approaches can be combined depending on the "fit".

Table 30. Future Research Needs

Future Research Needs	Description
Create guidelines to introduce the various intervention approaches to interventionists	Although the focus of this research is to reduce the variety gap between interventionist and intervention approach, it does not provide the interventionist with guidelines on how to implement intervention approaches. Currently interventionists need to research intervention approaches on their own, however guidelines should be created that can assist the interventionist. Assistance can come in the form of references to how other organizations have successfully implemented intervention approaches, or attempts to "translate" the systems thinking language.
Create testable hypothesis for future framework designers	The hypothesis presented in this research are untestable, however future designers can use this research as a springboard for future hypothesis. Examples of testable hypotheses include: Hypothesis 1: The usage of the proposed framework reduces the time spent selecting appropriate intervention approaches. Hypothesis 2: The usage of the proposed framework increases the likelihood of adopting system thinking intervention approaches. Hypothesis 3: The usage of the proposed framework leads to successful application of system thinking intervention approaches.

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Appendix A: Glossary of Terms

Table 31 provides the working definitions for this research.

Table 31. Working Definitions

Terminology	Working Definition
Complexity	The degree of difficulty in identifying process.
Complicatedness	The degree of difficulty in implementing process.
Subjective-objective dimension	The degree of subjective versus objective. For the purpose of this thesis, will be treated as "Complexity".
Regulation-Radical Change dimension	The degree conflict between regulation and radical change. For the purpose of this thesis, will be treated as "Complicatedness".
Ashby's Law of requisite variety	Only variety in R can force down the variety due to D; Only variety can destroy variety. See Chapter 3.2.
Pluralism	A condition in which two or more states coexist.
Discordant pluralism	A strategy that views perspectives as incompatible (given equal consideration) rather than incomparable (one is superior over another). See Chapter 2.5.3.
Systems Thinking	Systems thinking is an interdisciplinary, holistic approach to understanding systems. See Chapter 2.2 .
System	A system is a perceived whole whose elements are "interconnected" and have a purpose in a given context. See Chapter 2.2.1.
Imperialist	The imperialist strategy assumes that one strand of management science is fundamentally superior, but incorporates aspects of other strands if they seem useful.
Pragmatist	The pragmatist strategy is distrustful of theory, and brings strands of management science based on what works in practice.
Positivist	Philosophical theory states that every rationally assertion can be scientifically verified or is capable of logical or mathematical proof.
Method	The procedure for accomplishing or approaching a goal.
Methodology	For the purpose of this thesis, will be treated as "Intervention Approach".
Intervention approach	A set of methods guided by an overarching philosophy.
Philosophy	The study of the theoretical basis of a particular branch of knowledge or experience.
Meta-methodology	A procedure for choosing among methodologies.
System state	The present situation of a system.
Functionalist	A philosophy that assumes the social world is composed of concrete empirical artefacts and relationships which can be identified, studies and measured through approaches derived from the natural sciences. See Chapter 3.3.3.1.
Interpretive	A philosophy that assumes the social world is an emergent social process which is created by individuals. Social reality is seen as a network of assumptions and subjective meanings. See Chapter 3.3.3.2.
Emancipatory	A philosophy that is concerned with finding explanations for radical change, deep-seated structural conflict, modes of domination and structural contradiction which its theorists see as characterizing modern society. See Chapter 3.3.3.3.

Table 31. Working Definitions

Terminology	Working Definition
Postmodernism	Postmodernism is above all else a critique of the ethnocentric rationalism advocated by modernism. Postmodernism believe that knowledge is fundamentally fractured in so many pieces that there can be no reasonable expectation to put it together, and therefore challenge the modernistic desire for unifying views. See Chapter 3.3.3.4
Critical systems Thinking	A philosophy whose goal was to unify systems thinking by showing that the various system intervention approaches are complementary, and build on strong theoretical support. See Chapter 2.3
System State	For the purpose of this thesis, will be treated as "Paradigm".
Paradigm	A paradigm constitutes a set of assumptions regarding the nature of a system.
Interventionist	Person utilizing intervention approach to improve the state of the system.
Practitioner	For the purpose of this thesis, will be treated as "Interventionist".
User	For the purpose of this thesis, will be treated as "Interventionist".

Appendix B: List of Case Studies

Case studies for Viable Systems Model can be found in Table 32.

Table 32. List of Viable System Model Case Studies

Author	Year	Title	Total Citations	Self-citations
John Brocklesby Stephen Cummings	1996	Designing a Viable Organization Structure	83	5
Richard Vidgen	1998	Cybernetics and Business Processes: Using the viable System Model to Develop and Enterprise Process Architecture	49	0
P. Kawalek D.G. Wastell	1999	A Case Study Evaluation of the Use of the Viable System Model in Information Systems Development	33	0
Angela Espinosa J. Walker	2013	Complexity management in practice: A Viable System Model intervention in an Irish eco-community	25	5
Joseph W.K. Chan	2011	Enhancing organisational resilience: application of viable system model and MCDA in a small Hong Kong company	16	0
John Brocklesby	2012	Using the Viable Systems Model to examine multi-agency arrangements for combatting transnational organised crime	11	0
Rodina Ahmad Mohammed B. Yusoff	2006	A VIABLE SYSTEM APPROACH TO TACKLE COMPLEX ENTERPRISE SITUATION FOR SISP	8	0
Cheng Hua Chen	2005	Case Study Application of VSM to Transfer Pricing	8	0
Benjamin Gmur Andreas Bartelt Ramon Kissling	2010	Organization from a systemic perspective Application of the viable system model to the Swiss Youth Hostel Association	7	0
John Beckford	1992	Passing on a Family Business, or a Family Business Passing on? An Application of the Viable System Model	4	1

Case studies for Soft Systems Methodology can be found in Table 33.

Table 33. List of Soft Systems Methodology Case Studies

Author	Year	Title	Total Citations	Self-citations
Peter Checkland	1985	Achieving 'Desirable and Feasible' Change: An Application of SSM	189	5
Brian Lehaney Ray J. Paul	1996	The Use of Soft Systems Methodology in the Development of a Simulation of Out-patient Services at Watford General Hospital	88	4
Akira Tajino Robert James Kyoichi Kijima	2005	Beyond needs analysis: soft systems methodology for meaningful collaboration in EAP course design	45	2
John Brocklesby	1995	Using Soft Systems methodology to identify competence requirements in HRM	34	0
Robert Macadam	1989	A Case study in the use of soft systems methdology - Restructuring an academic organization to facilitate the education of systems agriculturalists	28	2
Wenbin B. Liu Wei Meng John Mingers Ning Tang Wei Want	2012	Developing a performance management system using soft systems methodology: A Chinese case study	19	2
Jon Warwick	2008	A Case Study using Soft Systems methodology in the Evolution of a Mathematics Module	17	0
Eva Sgourou Panagiota Katsakiori Ionna Papaioannou Stavros Goutsos Emmanouel Adamides	2012	Using Soft Systems Methodology as a systemic approach to safety performance evaluation	11	0
Alison Chilvers	2000	Critical issues in the use of Soft Systems Methodology - a case study in the long-term management of digital data objects	9	0
K Kotiadis AA Tako EAJA Rouwette C Vasilakis J Brennan	2013	Using a model of the performance measures in SSM to take action: a case study in health care	8	1

Case studies for System Dynamics can be found in Table 34.

Table 34. List of System Dynamics Case Studies

Author	Year	Title	Total Citations	Self-citations
DC Lane C Monefeldt JV Rosenhead	2000	Looking in the wrong place for healthcare improvements: A system dynamics study of an accident and emergency department	277	1
Krystyna A. Stave	2003	A system dynamics model to facilitate public understanding of water management options in Las Vegas, Nevada	272	0
James M. Lyneis Kenneth G. Cooper Sharon A. Els	2001	Strategic management of complex projects: a case study using system dynamics	252	0
H.C. Guo L. Liu G.H. Huang G.A. Fuller R. Zou	2001	A system dynamics approach for regional environmental planning and management: A study for the Lake Erhai Basin	239	13
Patroklos Georgiadis Dimitrios Vlachos Eleftherios Iakovou	2005	A system dynamics modeling framework for the strategic supply chain management of food chains	199	2
Wee-Kean Fong Hiroshi Matsumoto Yu-Fat Lun	2009	Application of System Dynamics model as decision making tool in urban planning process toward stabilizing carbon dioxide emissions from cities	84	0
Ross D. Collins Richard de Neufville Joao Claro Tiago Oiveira Abilio P Pacheco	2013	Forest fire management to avoid unintended consequences: A case study of Portugal using system dynamics	38	1
Agnes S. Rwashana Ddenbe W. Williams Stella Neema	2009	System Dynamics Approach to immunization healthcare issues in developing countries - a case study of Uganda	32	1
Hossein Haghshenas Manouchehr Vaziri Ashkan Gholamialam	2015	Evaluation of sustainable policy in urban transportation using system dynamics and world cities data: A case study in Isfahan	21	0
Hamed Vafa-Arani Salman Jahani Hossein Dashti Jafar Heydari Saeed Moazen	2014	A system dynamics modeling for urban air pollution: A case study of Tehran, Iran	19	0

Appendix C: Codebook

Note:

Codes are applied to how the system perceives itself. For example, if the system (including stakeholders) perceives itself as being in agreement, it will fall into "Agreement" code, regardless of coder perception of stakeholder's level of agreement.

Stakeholder Definition: Any person that is affected or involved with the system.

Codes:

Short description: [Agreement]

Detailed description: [Views on goals and solutions (or lack thereof) are shared among stakeholders]

Inclusion criteria: [Stakeholders are in agreement of shared goals, objectives, or perceived solutions]

Exclusion criteria: [Stakeholders do not share goals, objectives or perceived solutions]

Typical exemplars: [Actions affecting a system are confirmed/unopposed]

Atypical exemplars: [Stakeholders are working together, but not coming to conclusions]

Purpose of code: [Determine whether the stakeholders within a system are in agreement of actions taken towards goals and solutions]

Short description: [Disagreement]

Detailed description: [Views on goals and solutions vary among stakeholders]

Inclusion criteria: [Stakeholders are in disagreement of shared goals, objectives, or perceived solutions]

Exclusion criteria: [Stakeholders are unopposed in their actions]

Typical exemplars: [Stakeholders require convincing due to disagreement or confusion]

Atypical exemplars: [Stakeholders give an impression of disagreement, but act in agreement]

Purpose of code: [Determine whether the stakeholders within a system are in disagreement of actions taken towards goals and solutions]

Short description: [Quantitative]

Detailed description: [System focuses on quantitative information]

Inclusion criteria: [Decisions within system are determined with quantitative data]

Exclusion criteria: [Qualitative data is guides decision making]

Typical exemplars: [Decisions are based on money, time, emissions etc.]

Atypical exemplars: [Quantitative data is utilized, however is not the focus of the stakeholders]

Purpose of code: [Determine whether decisions within a system require quantitative data]

Short description: [Qualitative]

Detailed description: [System focuses on qualitative information]

Inclusion criteria: [Decisions within system are determined with qualitative data]

Exclusion criteria: [Qualitative data is guides decision making]

Typical exemplars: [Decisions are based on improving communications, coordination, planning, policy etc.]

Atypical exemplars: [Qualitative data is discussed, however making decisions require quantitative data]]

Purpose of code: [Determine whether decisions within a system require qualitative data]

Short description: [Optimization]

Detailed description: [Stakeholders believe a known solution can be reached]

Inclusion criteria: [The focus of the system is to minimize, maximize, meet expectations, be precise, hit benchmarks etc.]

Exclusion criteria: [Stakeholders express a need for acquiring benchmarks, defining their process, understanding, rather than hitting a definite goal]

Typical exemplars: [Desire to make a process as efficient or effective as possible]

Atypical exemplars: [Looking for a better solution, but not knowing necessarily what the solution will present itself as]

Purpose of code: [Determine whether decisions focus on reaching obtainable goals]

Short description: [Approximation]

Detailed description: [Stakeholders believe that a known solution can be approached]

Inclusion criteria: [The focus of the system is to assess, plan ahead, improve, learn]

Exclusion criteria: [Stakeholders want to reach definite goals, and/or believe that the system is well enough understood to maximize and minimize certain metrics]

Typical exemplars: [Desire to explore the system through assessment and learning]

Atypical exemplars: [Exploring the system with the desire of the most efficient or effective solution]

Purpose of code: [Determine whether decisions focus on approaching temporary goals]

Short description: [Regulation]

Detailed description: [There is little desire to restructure to the current system]

Inclusion criteria: [Stakeholders want to "tweak" system rather than re-design it, do not want to change the system at all, believe external forces are reason for problem]

Exclusion criteria: [There is a clear expressed need for to restructure system]

Typical exemplars: [Government regulations, power to change is minimized, high level of effort is required to make change, would rather model system rather than change it]

Atypical exemplars: [Stakeholders do not follow the system set in place, stakeholders are looking outside of their system for assistance, already incorporating large degrees of change]

Purpose of code: [Determine whether system wants to be adjusted]

Short description: [Radical Change]

Detailed description: [There is strong desire to restructure the current system]

Inclusion criteria: [Stakeholders are willing to re-design the system to make changes]

Exclusion criteria: [Change is desired, but only in form of non-invasive, surface-level adjustments]

Typical exemplars: [Implementations are being made, radical improvement, stakeholders are non-dismissive of suggestions,]

Atypical exemplars: [Author of paper expresses a need for change, however the stakeholders of the system do not act in a way that supports the expressed need. Large degree of monitoring]

Purpose of code: [Determine whether system wants to be structurally altered]

Short description: [Co-ordination]

Detailed description: [There are many stakeholders participating in influencing the system]

Inclusion criteria: [A large portion of total stakeholders can exhibit influence on the behavior of the system]

Exclusion criteria: [A small portion of total stakeholders can exhibit influence on the behavior of the system]

Typical exemplars: [Culture of cooperation, granting autonomy, groups working together]

Atypical exemplars: [Decision-making is granted to one group, few groups allowed to shape the change of the system]

Purpose of code: [Determine whether system is influenced by a large degree of stakeholders]

Short description: [Disintegration]

Detailed description: [There are few stakeholders participating in influencing the system]

Inclusion criteria: [A small portion of total stakeholders can exhibit influence on the behavior of the system]

Exclusion criteria: [A large portion of total stakeholders can exhibit influence on the behavior of the system]

Typical exemplars: [Managerial driven, few involved parties are part of making changes]

Atypical exemplars: [Decision makers need support from stakeholders, multiple organizations working together]

Purpose of code: [Determine whether system is influenced by a small degree of stakeholders]

Short description: [Top-down Driven]

Detailed description: [Stakeholder actions are governed by prescribed processes]

Inclusion criteria: [A process is created to guide the actions of the stakeholders]

Exclusion criteria: [Stakeholders do not have a prescribed process to dictate the direction of decisions]

Typical exemplars: [Decisions must be reported to higher management prior to implementation, restraints set in place make creative change difficult, models are followed]

Atypical exemplars: [Strategies are bypassed, desire for groups to work independently]

Purpose of code: [Determine whether actions are based on prescribed control]

Short description: [Bottom-up Driven]

Detailed description: [Stakeholders actions are governed by their own decisions]

Inclusion criteria: [Stakeholders do not follow guidelines, regulations, prescribed processes etc.]

Exclusion criteria: [Actions of stakeholders are guided by policies, guidelines, regulations etc.]

Typical exemplars: [Groups make own decisions, policies are not followed]

Atypical exemplars: [Procedures are scheduled, principles are followed, guidelines followed]

Purpose of code: [Determine whether actions are based on individual control]

Paradigm dimensions	Paradigm definition	Sociological Categories	Sociological Category definition	Category extremes	C. Extremes defined
Complexity	"Degree of difficulty in identifying process"	Consensus	The degree of which the stakeholders of a system share similar viewpoints	Agreement vs Disagreement	**Agreement:** Views on goals and solutions are shared among stakeholders **Disagreement:** Views on goals and solutions vary among stakeholders
		Infrastructure	The degree of which the system focuses on quantitative or qualitative information	Quantitative vs Qualitative	**Technology:** System focuses on quantitative information **Social:** System focuses on qualitative information
		Scope	The degree of how conclusively the desired state of a system is being viewed	Optimization vs Approximation	**Optimization:** Stakeholders believe a known solution can be reached **Approximation:** Stakeholders believe that a known solution can be approached
Complicatedness	"Degree of difficulty in implementi ng process"	Harmony	The degree of which change is encouraged in the system	Regulation vs Radical change	**Regulation:** There is little desire to restructure to the current system **Radical Change**: There is strong desire to restructure the current system
		Participation	The degree of which the system is influenced by different stakeholders	Disintegration vs Co-ordination	**Disintegration**: There are few stakeholders participating in influencing the system **Co-ordination**: There are many stakeholders participating in influencing the system
		Control	The degree of which the system is driven by prescribed processes	Top down driven vs Bottom up driven	**Top Down Driven**: Stakeholder actions are governed by prescribed processes **Bottom Up Driven**: Stakeholders actions are governed by their own decisions