MEETING SUSTAINABILITY CHALLENGES: SOFT SYSTEMS THINKING AS AN ENABLER FOR CHANGE

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Abstract

There are three dimensions of sustainability: environmental, economic, and social. One important task is to integrate them so as to identify how more sustainable paths can be identified, assessed, and decided upon. Previous research has identified systems thinking as a key to achieving this. The purpose of the paper is to build on these ideas and to propose an initial framework that demonstrates the potential of incorporating soft systems methodology and a theory of modalities, introducing aspects in addition to environmental, economic, and social ones. Moreover, theoretical exploration shows that understanding different predispositions, or worldviews, are vital to creating shared and purposeful actions. This paper expresses the intentions of a pre-study, and the ideas are far from mature; however, the importance of collaboration in shared and more sustainable actions is the basis for an industry-wide initiative called the Construction Climate Challenge (CCC).

Keywords: Complexity, Sustainability, Research methodologies and methods, Soft systems methodology, systems thinking

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1 INTRODUCTION

The oft-cited Brundtland (1987) report concluded that the environment (i.e., where we all live) and development (i.e., what we all do to improve our part of the environment) are inseparable. We should have a long-term horizon that includes not only us but also generations to come. The three dimensions of sustainability—namely, environmental, economic, and social—stem from the 1987 report, and it might be reasonable to argue that the division of those dimensions has its roots in interpretations of the report. These dimensions have been commonly illustrated as pillars (Adams, 2006; see Figure 1, left) or as highlighting sustainable development represented by the middle section of overlapping circles (see Figure 1, middle). Such illustrations describe the possibility of interpreting the dimensions as separate entities, in turn indicating that sustainable development can be achieved by managing the aspects one at a time, or, in the worst case, by addressing only one of them. The pillars and the overlap illustration suggest that trade-offs can be made, but this is not the case in real life (Adams, 2006). Therefore, an integrated view of sustainable development illustrated by concentric circles (see Figure 1, right) has been introduced to replace the others. The illustration of the three dimensions as parts of a holistic entity in which all sublevels (social and economic) clearly affect both each other and the whole (environment) calls for new approaches to dealing with the challenges.

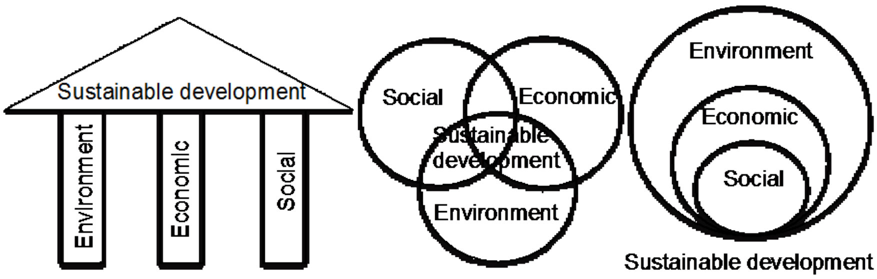

Figure 1. Illustrating a changed mind-set.

The concentric integrated view has also given rise to thoughts about collaboration among several different stakeholders. The concept of a supply chain that creates shared value (Porter & Kramer, 2011) allows for the presence of several stakeholders, though it does not necessarily demonstrate each stakeholder's perspective or specific contribution to the common goal. The common goal is, unsurprisingly, perceived from each stakeholder's particular point of view. From this argumentation, it can be said that complexity in sustainable development arises because (1) diverse, interconnected stakeholders (2) that all have different views (3) all apply different expertise to address sustainability. Porter and Kramer (2011) argue that an important issue related to sustainable development has gained only limited interest—namely, the area between economic efficiency and social progress. They conclude that companies are trapped in an old-fashioned approach to value creation in which they fail to address societal needs and ignore long-term successes at the expense of optimal short-term financial performance.

Another often-cited quote comes from P. G. Gyllenhammar, Volvo Group in Sweden stated that "companies are part of the problem, but also part of the solution", thus simultaneously arguing that companies have an obligation to care for the environment. The Volvo Group has long incorporated environmental care as a core company value, and it has been—and remains—dedicated to reducing harmful emissions from both its products and its facilities. In 2012 Volvo joined the WWF Climate Savers programme. Recently, Volvo Construction Equipment, part of the Volvo Group, launched and hosted an initiative to address the climate challenge in the construction industry, dubbed the Construction Climate Challenge (CCC, 2014). At the heart of the initiative is the idea that grand challenges cannot be met by solitary efforts but can only be addressed through collaboration all along the supply chain. Martin Weissburg, CEO of Volvo Construction Equipment, has said, "As a construction equipment manufacturer we recognize that we can only do so much by focusing on the areas where we have direct impact. Approximately 90% of the climate impact comes from the use of our equipment, and our machines are used in nearly all steps of the construction industry lifecycle." Thus, yet another standpoint indicates that the climate challenge is not only related to technical issues but also is far more relationally complex than one might first think.

The success of confronting grand global societal problems depends on rethinking how the business is operated; instead of taking a business-as-usual approach, one must facilitate a sustainable mind-set that supports decision making at every level and across companies. The creation of shared values, inside and outside the company, seems an important aspect of sustainability. The shared values need to in some way align with the goals of all stakeholders. Straightforwardly, a common goal can be achieved or agreed upon if all specific goals are connected to it, thus motivating different stakeholders to drive the change. One core question is how to understand stakeholders' different perspectives and goals in a collaborative challenge.

This paper describes theory from the systems science area and explores a plausible framework that builds on diverse aspects of sustainable development. This is done in order to contribute to the early stages of a sustainable product-development process, with the particular aim of building shared goals and creating an awareness of multiple stakeholders' perspectives.

1.1 Background, study approach, and delimitations

This paper builds on a literature investigation in which the selection of theories was inspired by systems thinking as a means of addressing real industrial challenges. Systems thinking became interesting for company managers when Peter Senge's book *The Fifth Discipline* was launched in the 1990s; the ideas have been expanded to address sustainability challenges (Senge et al. 2008). Systems thinking has been combined with sustainability science under the concept of resilience (see, e.g., Stockholm Resilience Centre). The research community of systems thinking originates from cybernetics, but the concept is widely applied in information systems design and knowledge management. Peter Checkland (1999) is one of the pioneers who successfully introduced soft systems methodology (SSM) in the design and development of the Concorde airplane, a project that typically involves many different stakeholders. The seven principles for building resilience in social-ecological systems (Simonsen et al. 2014) involve visualizing ways to apply systems thinking to address global challenges. One of the principles (no. 4), "foster complex adaptive systems thinking" clearly states, "we need to understand the complex interactions and dynamics … " (p. 10), between actors and systems. Another principle (no. 5) is to encourage continuous learning and experimentation (p. 12). The climate challenge is a global one, and global change is needed. Since today we suffer from serious ecological problems, we need to put much effort into preventing catastrophes and crises, or, in the worst cases, to find quick solutions to ease the consequences. Therefore, many efforts focus to prevent tipping points from arising on say, a network or a governance level. An important issue in the global challenge is that none of the networks has the mandate or ability to directly tackle climate change (see, e.g., Galaz, Österblom, Bodin & Crona, 2014). This encourages research on lower levels, too. The motivation for this paper stems from global high-level work, but it attempts to bring systems thinking to the engineering level of R&D and to innovation projects in companies—that is, to the very early stages of product development.

The problem and the application areas in this paper are based on empirical data from the construction industry. Empirical data is not specifically accounted for in the paper, since it is not included in the aim, which is to describe theoretical domains related to the multi-stakeholder view. In relation to this, it should be mentioned that there is a research area and community addressing stakeholder management and that tools exist—for example, tools to identify who has influence over a project (MindTools, 2014). Seen from a novice's perspective, stakeholder management seems to rely on a dependency between power and interest in order to manage the relationships. This paper presents an initial attempt to explore interests and presumptions among stakeholders. In this effort, stakeholder management might be fruitful for future studies, but that would be too advanced at this stage.

One limitation of the paper is that sustainability per se is not accounted for; here it is assumed that the climate challenges motivating the study are well known. Another delimitation is that established sustainable product development literature and theory are not specifically addressed. This is because we suggest a complementary, not yet mature approach to the existing situation; we apply a pre-study approach to elaborate on ideas rather than to account for final results. Nevertheless, the chosen theoretical domains acknowledge sustainability issues and sustainable development from a systems methodology perspective. Yet another limitation is that despite having stakeholders in focus, the study does not describe the actors in terms of, for instance, positions or roles in a value chain. At a construction site, actors like machine operators and material and equipment suppliers work within the same limited area, but the network of actors and stakeholders supporting the planning, coordination, and execution of the work is much wider. Here it is therefore assumed that the concept of value-chain collaboration is known when addressing methods to facilitate insights into the stakeholders' different views. Such an attempt is thought of as advancing sustainable development beyond isolated efforts.

2 RELATIONAL COMPLEXITY

The integrated view illustrated by the concentric circles (Figure 1, right) thus provides a view of a system and its parts—that is, of social systems and economic systems affecting the environmental system. The environmental system can be described as natural, the social as addressing humans and society, and the economic as manufactured and financial (Parkin, Sommer & Uren, 2003). Bluntly, designed systems such as businesses, products, services, and societies have effects on the natural system, the earth. Today, we know that stability (equilibrium) is at risk, which is the earth's ability to cope with increasing climate threats (e.g., ocean acidification, climate change, biodiversity losses, and chemical pollution) has reached its tipping point. The application of systems thinking has been implemented to some extent but could be broadened.

SSM, a methodology particularly developed for taking action, has been refined over the years, but the original version presented a seven-step methodology describing an iterative process. The first four iterative steps seek to understand the root definitions of relevant systems and from there, in steps five to seven, to take action to change or improve the situation (Checkland, 1999). A newer version of the overall framework for SSM consists of three basic phases, presented in simplified form in Figure 2. SSM considers the world to be complex and problematic, and the grand challenge is not problem solving but defining the problem itself (Checkland, 1999)—in other words, ensuring that the right problem is being addressed.

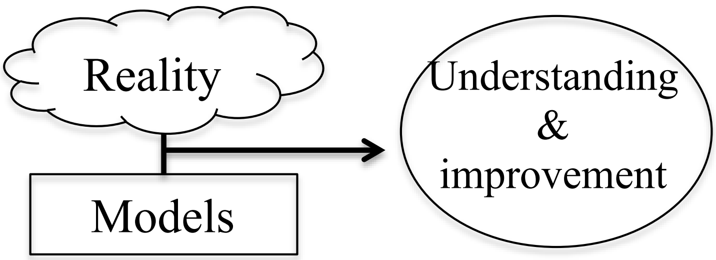

Figure 2.SSM framework (adapted from Checkland, 1999).

A problem in this context is seen as "a mismatch between intention or expectation, and outcome" (Checkland, 1972, p. 88). Several models have been created using systems concepts; this is done to yield an understanding of the problematic situation and to allow the design of a "new reality" rather than fixing the malfunctioning one (Mirijamdotter, 1998). These ideal models are compared to each other, and the differences between them become the basis for changes. The methodology originates from a criticism of applying systems engineering rationale to complex human and social problems—for example, using models as blueprints of reality (cf. the drawing of a technical artefact) instead of as tools for inquiry and exploration. A technical artefact depicts another type of complexity in terms of, say, assembly. Complexity in this case describes the intertwined dysfunctional or functional links between different standpoints, or worldviews. Differences in worldviews become barriers or enablers of collaborative actions. Clarifying the differences between worldviews reveals distinct objectives and rationales; those point towards what are perceived as meaningful actions for improvements and, in turn, support a shared strategy. There is a strong emphasis in SSM on learning, particularly learning about problem situations and about different perspectives (Mirijamdotter, 1998).

The word *systems* is not used the same way in SSM and in systems engineering. The main features of a system (i.e., input, transformation, output, feedback loop) are similar in both areas, but since systems engineering originates from a technical environment, there are key differences in constraints and boundaries. Soft systems are thought of as having, as the concept indicates, soft boundaries. That is, the perceived system can easily expand and be re-organized to include or exclude parts. A value chain, for example, can be seen from several levels. Looking at a firm level, the boundaries between companies are clear, but if they collaborate in cross-organizational projects, there are other boundaries; likewise, looking at the actors' roles in each project highlights additional, different boundaries. Thus,

the boundaries are not only soft but also invisible. In systems engineering the boundaries are hard, tangible, and settled by technical constraints—for example, a car can easily be seen as a separate entity; it is not the same system as the road or even as the brake or the wheel. Some properties of a system are visible only when combining the parts (Checkland, 1999), so the focus must be on the whole rather than on each part. A car (the whole) emerges from the properties of the ignition system, the steering system, the fuel system, and so forth (Mirijamdotter, 1998). This is why studies on higher levels of abstraction make sense in SSM: the properties of lower levels become meaningful when seen as a whole (cf. the integration of social, economic, and environmental aspects of sustainability).
Simply, the world is considered from a hard systems view to *be* a system—the world is systematic. But from a soft systems view, the world is multi-faceted and problematic; it can be *explored* by applying system concepts—here, our inquiries are systemic. The division into either a hard, technical system or a soft, human-activity system is useful to aid understanding but should not open a debate; rather, it is simply a way to make a clear distinction between rationales (Checkland, 1999). Basically, it is vital to understand that there are two different methodologies and that each is built upon a distinct logic that serves specific problem-solving purposes (Checkland, 1999). SSM is an attempt to turn the mechanistic view of life that has governed businesses since the Industrial Revolution into a more humane while still maintaining an orientation towards problem solving (Mirijamdotter, 1998).

3 A MULTI-STAKEHOLDER VIEW

The mnemonic CATWOE is a model developed within SSM, and it summarizes the criteria for a well-investigated and comprehensively described root definition: the contents of a perceived problem and why a change would be a purposeful action. The model has been adapted in a number of additional settings, including in the design of information systems, but is there presented as FATCOP: functionality, application domain, technology, conditions, object system, and philosophy (Rose, 2002). Yet such models are too artefact focused to bring about a change in mind-set. Instead, the CATWOE approach serves as a better model for including at least three different stakeholders—namely, clients, actors, and owners.

- Clients: those or the one who benefits from or suffers from the change
- Actors: those or the one who makes the change
- Transformation: the change that the input must undergo to become a desired output
- Worldview: the particular standpoint that makes the change meaningful
- Owners: those or the one who has the formal power to stop the change
- Environmental constraints: external limits that are taken for granted (adapted from Checkland, 1999)

The combination of the transformation, the change, and the worldviews creates insights, purposefulness, and motivation for the planned actions. The root definition could be formulated as follows (Checkland, 1999; Mirijamdotter, 1998):

> An O-owned and A-operated system, which, affecting C, transforms T to a new state of T according to some W, within the given constraints E.

Over the years, the form has been simplified, and elements can be omitted, but doing so should always be a conscious act (Checkland, 1999). One simple example of a root definition as presented above might be this:

> A landlord-owned and tenant-operated system that affects the environment negatively by producing household waste transforms that waste into material to be recycled by sorting it out from combustible waste, in accordance with the belief "my behaviour matters," within the given constraints that recycling bins are available and easy to use.

If the worldview, the belief in the example, does not match another stakeholder's view, there is a clash in the purpose of recycling, and in the end, good intentions might be in vain. On the level of high abstraction, this form of a root definition bears similarities to the form of a mission statement (e.g., Ulrich & Eppinger, 2012) used in product design. However, in SSM terms, mission statements are based on a mechanistic reasoning that aligns with its intentions, so one statement is directly agreed upon and formulated. The strength of a root definition is thus that it aligns with established procedures but provides insight into interactive challenges by developing contrasting statements.

Further, those statements should, if used in product design, precede the mission statement rather than be used to validate a wrong decision. The next phase in SSM includes the development of conceptual models, which visualize the minimum activities needed to make the change—in other words, to connect what the system is (root definition) and what the system does (conceptual model). There is also a developed set of criteria to assess whether the activities will work or will aid the change (Checkland & Scholes, 1990). Notably, these models should be used to create a sound dialogue between stakeholders and are not the actual plan. This phase is thus the learning stage about what exists in the real-world situation. The strength of the learning stages is that underlying norms, standards, and values are revealed, but these stages also shed light on the possibilities that those will actually be changed (Checkland, 1999). There are, of course, criticisms of SSM—for example, it does not include the ethical dimension and assumes that learning solves problems in which there are conflicting interests (see Mirijamdotter, 1998 for a thorough analysis).
SSM has been extended with a multi-stakeholder view sustaining several aspects, or modalities, of reality (Mirijamdotter, 1998). In particular, this extension has helped reveal diverse aspects of human experiences so those can be met in the designed solutions. The modalities of life originate from a philosophical framework—the Philosophy of the Cosmonomic Idea—dating to 1953, developed by Herman Dooyeweerd. Basically, the work relies on the insight that all questions (in science and life) are consciously or unconsciously answered from the perspective of specific beliefs about reality (Mirijamdotter, 1998). The modalities have been further analysed since 1953, and new ones have been added (e.g., de Raadt, 1989; Strijbos, 1995). Each modality has a nucleus and a kernel (see Figure 3: modalities on the left and kernels on the right).

Credal	– faith
Ethical	– love
Juridical	– justice
Aesthetic	– harmony
Economic	– viability
Operational	– production
Social	– social interaction
Informatory	– symbolic representation
Historical	– formative power
Logical	– distinction
Sensitive	– feeling
Biotic	– vitality
Physical	– energy
Kinematic	– motion
Spatial	– continuous extension
Numerical	– discrete quantity

Figure 3. Modalities and their kernels (adapted from Mirijamdotter, 1998; de Raadt, 1991).

In Dooyeweerd's notion, knowledge is present in each of the modalities. De Raadt (1991) added a modality called the epistemic, its kernel being knowledge, that has received criticism. That modality is omitted here because when applying modalities, in practice the basic idea is to put knowledge into action, and naming one specific aspect *knowledge* might misleadingly suggest that the other modalities do not represent knowledge. The order of the modalities has been settled according to the interrelationships between them. Beginning at the bottom in Figure 3, the *numerical* modality and its discrete quantity constitute a foundation that is prerequisite for the *spatial* modality, and the *spatial* is in turn a prerequisite for the *kinematic*, and so forth. The order makes it possible to express aspects of one modality by describing another of a higher level. Thus, one important feature of a modality is that it cannot be explained by its own concepts: for instance, the *economic* cannot be thought of as being economic but must be explained through an understanding of the *aesthetic* and of harmony. As a consequence, the kernel of economic viability concerns, for example, long-term sustainable revenues and prosperity rather than short-term profits. The modality *operational* and its kernel, production (or work), is related in SSM terminology to the elements of a continuously changing process (Mirijamdotter, 1998). The highest modality, *credal*, and its kernel, faith, is originally connected to religious faith, but can today be understood as representing ideology or certain strong belief. The modality *ethical* and its kernel, love, represent care for another, and *juridical* and justice are oriented towards the individual, the idea that everyone should be given equal conditions (Mirijamdotter, 1998).

The modalities are useful in preventing dualistic thinking, such as a strict socio-technical or socio-economic perspective, since they all sustain a more comprehensive view of life and business. There are two types of law governing the order of the modalities—namely, determinative and normative law (represented by the grey triangular shadow in Figure 3). Determinative modalities relate to facts and explicit knowledge, and normative ones relate to subjective measures and experienced knowledge; lower-level modalities are more determinative than the upper-level ones are. Simply, the modalities visualize that the higher the degree of normative law, the higher the dependency on an individual's worldviews that needs to be understood. Mirijamdotter's (1998) critical review of SSM concludes that its limitations will be fewer if it is combined with modalities; she further suggests using the combination of the approaches to gather information, support analysis, and take action to change problematical situations.

4 TOWARDS (ANOTHER) MODEL

Systems thinking, especially SSM, suggests learning and knowledge development as tools to address relational complexity. Knowledge is thus a vital concept—in this case it relates to, say, identifying a lack of knowledge by understanding problems, discovering gaps between domains, and gaining an understanding of stakeholders' different prerequisites (which are based on their worldviews). Taking decisions to improve sustainable development is described as including a different paradigm (e.g. Rossi et.al. 2013). Approaches, i.e. tools and methods, to apply such knowledge in design and development are lacking (Rossi et.al. 2013). In this paper, the contribution to progress a wider knowledge base than merely related to products and to the past choices (see for example Rossi et.al 2013) is in focus. Describing the theoretical foundation of a systems-thinking approach that integrates several modalities or aspects has in this paper been an effort to make a contribution. Based on this investigation, the future intention is to suggest a tool that brings together multiple stakeholders' perspectives in a more product-neutral approach. The purpose with the pre-study project, of which this paper is an initial part, is to address the early stages of a sustainable product development process—in particular, to support building shared goals and creating awareness of multiple stakeholders' worldviews. SSM delineates three different types of stakeholders: clients, actors, and owners. The methodology also provides systems thinking models that can be combined with modalities to provide a diverse set of perspectives about what constitutes a meaningful change, a transformation. The modalities point to questions that should be answered before decisions are made.

Decisions can be strategic, tactical, and operative. These characteristics are present regardless of the abstraction level (e.g., industry level, company level, project level). Strategic decisions are those that are overarching and long term (e.g., five-year plans) and concern direction and future. Strategic decisions are based on visions and expectations; the relevant decisions require broad information but almost no details. Tactical decisions, by contrast, have a shorter time horizon (e.g., one year) and concern resource allocation and goals. Here, broad information and a limited level of details are needed. Operational decisions include short-term decisions based on narrow, focused information that provides substantial depth of details—for example, about a certain machine or procedure. An initial framework in the format of a table is a first attempt to incorporate these levels into a model that can guide a multi-stakeholder analysis (Table 1). The distinct worldviews provide data for the analysis (i.e., contents of the cells). The worldviews can thus be readily compared. For example, from the economic modality a client might ask for a robust product, the actor wants a fast product and the owner might favour a cheap product, understanding this creates awareness for sustainable development.

Table 1. An initial framework.

	Strategic			**Tactical**			**Operational**		
Modality	*Client*	*Actor*	*Owner*	*Client*	*Actor*	*Owner*	*Client*	*Actor*	*Owner*
Credal…									
Economic									
Etc.									

The theoretical and methodological presentation in this paper provides background for possibilities of investigating, analyzing, and incorporating various stakeholders' perspectives into sustainable development. In conclusion, theoretical possibilities and practical implications can advance the modest result, the table format just presented. It can, under conditions in which worldviews can be captured in a simplified way, provide a basis for insights. Nevertheless, future work is needed to combine SSM and the modalities. This includes, among other things, the following tasks:

- Develop guiding questions to identify and categorize various stakeholders.
- Design a method for summarizing worldviews.
- Develop some measures/assessments against which to weigh perspectives. SSM assumes that each perspective is as valid as any other. Here, established tools for sustainable development will be analysed and adapted.
- Develop some standard for the analysis.

The approach should be seen as complementary and not as an attempt to replace established sustainability methods. It is, however, an effort to contribute to an integrated sustainable development process using systems thinking.

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