REFLECTIONS ON CATWOE, A SOFT SYSTEMS METHODOLOGY TECHNIQUE FOR SYSTEMS DESIGN

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ABSTRACT: This paper examines the SSM technique CATWOE, which focus on defining necessary elements that together constitute a human activity system from a certain perspective. Despite its recognition within the literature and its numerous use there are few studies on how the technique can be improved. This research reflects on each of the elements both from a theoretical and a practical perspective. Findings point to the fact that some of the terms have a meaning in everyday language that differs from its definition within CATWOE, other concepts are not well defined. This is unfortunate and may both lead to misunderstandings and limit analysis. The paper points at a number of ways in which the use of CATWOE can be developed in order to further support the process of eliciting novel ideas for future actions. Hence, the overall conclusion is that the elements need to be rethought and some of them renamed.

KEYWORDS: Soft Systems Methodology (SSM), CATWOE, Modelling, Interpretivism

1. INTRODUCTION

Soft Systems Methodology (SSM) is often used as a methodology for information systems development (Avison and Fitzgerald 1995; Checkland and Holwell 1997; Fitzgerald et al. 2002; Stowell 1995; Wood-Harper et al. 1985). SSM's strength lies in its tools for explicating different perspectives, their underlying assumptions and logical consequences. One of the most well know techniques for this is CATWOE. (Checkland and Scholes 1999; Smyth and Checkland 1976). This mnemonic word stands for: Customer, Actor, Transformation, Weltanschauung, Owner and Environmental constraints. However, in spite of its real-world validity and success, there are problems with CATWOE. Mingers (1992) criticises CATWOE on account of having no theory behind it. This lack of theoretical basis is of more than academic interest, and emerges as problems in practice. Little guidance is forthcoming apart from the admonition to follow the example of the experts.

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In addition to this general problem, our experience has shown that each of the elements can be criticized for being too vaguely defined and described, this is especially true for the central elements, W (Weltanschauung) and T (transformation process). Much of the problem lies in understanding precisely what is meant and what is helpful. In the following we will examine the CATWOE elements and put forward the problems we perceive. We start with a historical account of what CATWOE stands for and how it has developed. The paper ends with a discussion of some of the problems we have put forward and gives suggestions on how these might be handled in practice.

2. AN EXAMINATION OF CATWOE

CATWOE has changed little in its form since the early 1980s. Because of the wide usage of SSM in real world analysis and intervention, this is a surprising longevity, and suggests that there has been little need to change it because it is 'about right'. It is still being used and reported on (Ferrari et al. 2002; Mathiassen and Nielsen 2000; Pidd 2001).

Customer stands for the would-be beneficiaries or victims of the system.

Actor refers to the person or persons who would perform the transformation process.

Transformation processes some input to output.

Weltanschauung describes the world-view, which makes the transformation meaningful.

Owner stands for the person who can stop the transformation.

Environment represents constraints that are taken as given.

CATWOE came about as a combination of intuition, real world experience and also a desire to take into account the wisdom gleaned at that time in formal systems thinking (Smyth and Checkland, 1976), and Checkland reported (1981) that whenever one of the elements were omitted the analysis suffered. A hypothesis was set up that the six elements of CATWOE, would be traceable in a well-formulated root definition and tested by examining a range of root definitions and relating them to the happenings to find out whether any of the elements was missing and, if so, whether the absence had mattered. The elements were also compared with the 'formal system' model to establish a logical connection (Checkland 1981).

In the following we reflect on our experience of using CATWOE analysis. The observations and criticisms we make are made from the perspective of what we have found to be useful for analysis. We start with the core of CATWOE, i.e., T followed by W, and then proceed with the remaining elements.

2.1 TRANSFORMATION

T represents the purposeful activity to be modeled expressed as a transformation process. Traditionally, T has been formulated as transformation of some input to some output:

Input ---T---> Output

This is a highly versatile formulation because it can be used both when we know there is a problem (input given) but are not sure what to do, and also when there is something we wish to achieve (output given) but are not sure how. Focusing on the input can help us discuss what set of things is to be transformed in order to achieve output. Further, this formulation grounds the output by encouraging the analyst to make links between the current situation (input) and the imagined future situation (output). Setting the current and imagined situations side by side helps to make explicit whether the transformation is likely to be minor, radical or impossible. All these encourage the participants to play with different problem situations and future situations.

But following the input-output formulation according to its formal rules has proved difficult in practical analysis. For example, Checkland (Checkland and Scholes 1999) observed, "the most common error is to confuse the input which gets transformed into the output with the resources needed to carry out the transformation process." To overcome such difficulties the formulation

"Need for X ---T--> Need met"

became popular - and today might well be the most commonly occurring statement of T amongst users of CATWOE as a whole. Such a statement may be a safe option and a useful starting point, and Checkland (Checkland and Scholes 1999) remarks, "when people realize that there is a formula (an abstract one) which will always produce a formulation which is at least technically correct, namely 'need for X' transformed into 'need for X met', they seize on this with glee."

However, even this form did not solve the problem. "Unfortunately," Checkland continues (Checkland and Scholes 1999), "they then often slip into writing down such transformations as 'need for food' transformed into 'food'. What a fortune you could make in the catering industry if you knew how to bring off that remarkable transformation! It is evidently not easy to remember that in a transformation what comes out is the same as what went in, but in a changed (transformed) state." This is a problem, not with the 'need for X' form as such, nor even with the input-output form, but with understanding T aright, whatever syntactic form is adopted.

Besides the fact that the statement 'need for X' does not solve such problems, it also creates problems of its own. In this form, the input and output statements contain almost identical information (X is, in fact, a statement of output) so the T statement becomes almost a tautology. Also, the 'need for' form effectively neutralizes most of the possible benefits inherent in the input-output form. It restricts CATWOE analysis to situations in which the output, X, is known, thus hindering its use where an awareness of problem situation is the starting point for the analysis. No longer is the analyst encouraged to ground X in the current situation, and no longer can the analysis use input to indicate what things are to be transformed in order to achieve output. Yet, one positive aspect with this formulation of T is that it emphasizes the human element, since it is human beings that have and define needs.

However, the input-output form has problems that cannot be solved by 'need for X'. It presupposes that we can conceptualize the input and output, which is not always possible in an organizational setting, nor in a design situation, nor any other situation where one learns one's way as the work proceeds. In some situations the input and output elements are constantly changing over time, and often depend on people involved.

Another problem, that has been more important to us, relates to the lack of richness in T statements. We are exhorted, in CATWOE analysis, to try to find a simple T, but this tends to generate narrow T statements that do not embrace the richness of the real transformation that is required. Striving towards a simple T generatets a tendency towards interpreting T from only one aspect, the technical, social, economic, etc. while every T in fact involves several aspects, all of which should be in harmony.

Finally, Mathiassen and Nielsen (2000) argue the way T itself has been handled poses problems. Change processes are not always suitable to be cast in the form of a transformation, sometimes it is preferable to view them as interactions. To illustrate this they use a study of a municipal hospital reorganisation where six independent surgical departments with their own nursing supervisor were turned into six subordinate sections of one centralized unit to be jointly managed by a unit manager and the six nursing supervisors. The relevant system they choose to exemplify the stated difficulty with T in the form of input – output is "unmanaged resources - manage - managed resourses". The authors continue to say "It is, however, somewhat redundant that the output of such a 'manage' transformation is 'managed', and it is rather confusing and sometimes even wrong to characterize the input as 'unmanaged'. A would-be problem-solver might not be able to find tangible evidence of 'unmanaged' resources. A more likely situation would be to find managed resources - some poorly managed, some exellently managed - but nevertheless managed. This conception, as a consequence, does not contain any more information than a transformation of resources into resources" (p.247f.) According to the authors the main idea of management processes like the above is not primarily related to a transformation. "It is rather maintenance of some structural properties of resources" (p.248). For those situations the authors propose the term "interaction system" rather than "transformation system".

In this section we have shown several ways of interpreting and using T of CATWOE. We have also pointed at some of the strength and weaknesses in each of them. While some of the weaknesses might eventually be resolved by finding the correct forms, other cannot, but must instead be handled by conscious choice.

2.2 WELTANSCHAUUNG

Weltanschauung, W, is what makes T meaningful and we find it indispensible in analyses and design, because it is closely related to participants' perspectives. But W can be confusing, leading to a number of problems. Already in 1982 Fairtlough pointed out that the concept was used in many different senses during

the development of SSM. In order to clarify the use of the term Weltanschauung within the methodology Checkland and Davies (1986) introduces three different levels of Weltanschauung: W1, W2 and W3. W1 represents the W in CATWOE and is said to be a given-as-taken set of assumptions which makes a particular statement about a system meaningful and its purpose is only to help in model building, rather than capturing the whole of reality. W2 is related to a version of the problem situation, and serves to make W1 relevant. W3 is linked to our beliefs and assumptions about reality and makes us understand social situations. But we find that even these distinctions can be confusing in practice and therefore do not always solve the problem.

Further, in our analyses we have frequently encountered trivial Ws, illustrated by the following statement linked to the transformation of improving the health of a population:

> "Organized provision of health care is feasible and desirable; it can be planned and organized." (Bergvall-Kåreborn 2002)

Such W statements arise in many analyses, but actually provide little meaning. They neither help us discuss and explicate differences in perspective, nor pinpoint what makes T meaningful. There are two parts: (1) that X is feasible and (2) that it is desirable. To say “X is feasible”, i.e. it is achievable and can be planned, adds almost no meaning to T and what little meaning “X is desirable” has is very weak. To go further we must seek to enunciate why organized provision of health care is believed to improve the health of a population as well as why improved health is desirable. These questions relate to the roles fulfilled by people in the situation and to their W2 and W3 (Bergvall-Kåreborn 2002). So, when the purpose of our analysis is to explicate different perspectives, we need to actively seek to elicit and express different Ws as well as their sources.

2.3 CUSTOMER

C, Customer, is defined as the beneficiary or victim of the system's activity. The term 'customer', however, has an unfortunate connotation that narrows its meaning and use in practice, namely of a recipient or purchaser of goods or services. This point can be illustrated by an example given by Checkland (1979) in relation to mistakes in defining C. “For example, customers in the marketplace are frequently named as representing CATWOE’s ‘C’ in Root Definition’s of production planning systems. For such a system the correct ‘C’ (the system’s direct beneficiaries or victims) are the people responsible for carrying out the production process” (p. 48).

However, Checkland uses this example in order to illustrate the tendency to define C too widely. He argues that “[w]ithin CATWOE the most common mistake is to define as C, the system’s beneficiaries or victims, some persons who are affected by the system but at several removes” (p. 48). Hence, he sees the use of defining C as the customers in the marketplace as a C at several

removes while we mean that this is an effect due to confusing the term Customer in CATWOE with the everyday word customer.

Besides this it could also be argued that it is a mistake to try to define C too narrowly because it is often the indirect impacts that determine the real success or failure of a system, and analysis should uncover all of them and provides means for discussing them. As illustrated in Mitev's (1996) discussion of the SNCF railway ticketing system, in which many kinds of people and groups were affected - passengers, ticket office staff, trades unions, the traveling public, etc. - the impacts of a system can be widespread and unpredictable and occur by indirect means.

Finally, in using the term customer we have found a tendency to focus on positive benefits of T and neglect to analyze the possible negative impacts that T might have. For these reasons we tend not to use the term during our analyses, but rather terms like 'beneficiary', 'victim', etc. Hence, what is needed is a view of Customer that helps the analyst to uncover both all those affected by T, at different levels of abstraction, and whether the impact is negative or positive.

2.4 OWNER

O, Owner of the system, is defined as those who could stop the T. This is a quite wide definition that can include owners ranging from CEO’s to terrorists. However, in most of the studies reported on the owner is represented by a person or group with formal power to stop the transformation (Checkland and Scholes 1990) and in Checkland’s 30-year retrospective he clarifies the concept by stating that O is part of the system on the next higher level. “In SSM this higher level is the level at which a decision to stop the system operating would be taken: it is the level of the system ‘owner’, i.e. the O of CATWOE” (Checkland and Scholes 1999).

As with the term Customer, Owner also has an unfortunate connotation that narrows its meaning and use in practice. Firstly, it seems awkward to try to identify an owner at all when the system is for example a university, or some other publicly owned organization. In theory the owner of these systems consist of the whole of society, but in practice this is not so. Instead it is a much smaller group of people that has any real potential to stop transformation processes related to education, health, welfare, etc, if the system does not meet their aspirations.

Secondly, owner is also often thought of as a strong influential beneficiary of the system, especially within private companies. If too close connection is made between owner and beneficiary, which, might be the case when focusing on the aspirations of the owner, the terms owner and customer might become blurred.

Thirdly, limiting O to formal power excludes other interesting and important power relations and informal power structures that can be just as important to analyze and model. For example, in a high quality restaurant its proper functioning could be stopped either by the legal owner, or by the chef.

While the owner of the restaurant has the formal power, the chef in this scenario, being highly qualified and with widespread reputation, has extensive informal power. She/he can destroy the business of the restaurant by suddenly deciding to leave if her/his aspirations are not met.

Fourthly, suggesting that O is a part of the system one level up in the hierarchy O becomes, in effect, part of E, the environment. Since E imposes constraints the question arises whether O is to be seen as the owner or an environmental constraint, and what differentiates these two. We might now need to distinguish between constraints that O imposes on the system and those that E imposes on O. This suggests yet another layer of hierarchy that would be necessary, another complication to remember.

Finally, suggesting that O is a part of the system one level up in the hierarchy, particularly in combination with the interpretation that this implies someone with formal powers, narrows our view of who could be seen as the owner and on what grounds the transformation can be stopped. We experience this as a weakness since it limits our ability to create diverse models. Besides this it also creates uncertainty in relation to the other CATWOE elements, especially C and E.

2.5 ACTOR

A, Actor, is defined as 'those who would do T'. It may give fewer problems than C and O, but there are still problems in defining who exactly is to be included in this group. That some Actors are also Customers in that they are 'victims or beneficiaries of T', can be difficult for the SSM apprentice to grasp.

However, we have found that the concept of Actor, A, does not often play any important part in reported SSM studies. We find that it is more common to model different T, C, W or O, while A seem to be more “stable”. One reason for this can be that the traditional view within systems design methodologies has focused on how models and methodologies influence the output of the change while to a large extent ignored the impact of the analyst. Emphasizing the Actor’s role and impact on the system brings forth issues like how differences between occupational groups, professions, and educational backgrounds affect how T might be carried out. This also brings to light the important question of what knowledge or competence is needed in order to accomplish the modeled T.

2.6 ENVIRONMENT

Finally, E, Environmental constraints, refers to “elements outside the system which it takes as given” (Checkland and Scholes 1990). Constraints are important elements in all design actions (Löwgren and Stolterman 1998; Stolterman 1991) since they in many ways frame the problem situation. But there is a tendency to make E merely a description of the current situation, and to focus on quite general constraints like time and resources. Glancing through SSM studies (Checkland and Scholes 1990) common Es prove to be:

- existing structure
- ethos, norms
- modern technology
- company resources
- corporate objectives
- project definition

It takes little thought to list common constraints that always appears such as the above and by doing so supposedly satisfying the method's requirement for E. However, this way of thinking can stifle creative search for those constraints that are germane to the situation being analyzed. It can also lead to an over-constrained analysis where it becomes difficult to provide new insights, which is the purpose of most analyses. To overcome this the notion of E needs to be enriched and made clearer in meaning in order to draw out its full benefit in practical situations. By this the SSM apprentices can more quickly learn how to gain maximum benefit from including the concept in their analysis.

In our practical experience we have found it useful to distinguish between two different types of constraints that are taken as given and that affect the design situation. We term these determinative and normative constraints. Determinative constraints constitute elements that are given by nature and can be exemplified by phenomena such as the law of gravity, the structure of wood, and biological human characteristics. Because of the nature of these we need to adjust, or find ways to get around them. Normative constraints, on the other hand, are socially constructed which means that they are amendable to change. They can be exemplified by subjects such as, ethical norms, organizational structures and human interpretation.

3. DISCUSSION

In the following we will discuss some issues that we have come to the fore in the previous section. Following the development of SSM we have noticed a trend, among the developers of SSM, towards focusing on methodology rather than method. This can be seen in the writings of Checkland (1999) where he moves from the seven stage model through the process model that includes the cultural and logical streams, ending up in the basic shape model. On a more detailed level it is noticeable in his way of casting root definitions where he more and more frequently uses the form of PQR rather than the classical form of CATWOE. It is also visible in the way the constitutive rules are defined and in his dismissal of the formal systems model.

While this trend can be understood as Checkland's way of moving more and more into mode 2 thinking as the methodology becomes internalized. This is an unfortunate development for newcomers wanting to learn the methodology since it is well known that mode 1 is the usual entry to the methodology and for this use more precise and detailed steps and direction are needed. Conserning CATWOE, which is the focus of this paper, when replacing it with PQR the

human dimension, represented in customer, actor, owner, is downplayed. As mentioned above early experience of SSM found that whenever one of these CATWOE elements was missing the analysis suffered. If this still holds it is reasonable to assume that extensive use of PQR can harm the analysis.

One of the problems with CATWOE, pointed at in the above, is the use of the concepts customer and owner. Due to their common use in everyday language as concepts originating from economics and jurisprudence, their meaning in CATWOE modeling are easily misinterpreted. This can be seen in a number of case studies where the concept has been wrongly used as synonymously with recipient or purchaser of goods or services instead of its true meaning, i.e. beneficiary and victim of the system's transformation. Because of this the authors choose to refer to terms like beneficiary and victim, or stakeholders in order to avoid misunderstandings that limit the scope of analysis.

Concerning owner in its relationship to jurisprudence the authors argue that if this is the way to understand the term in SSM modeling the term could be clarified by relating it to concepts like formal power, authority and, above all, responsibility. This clarification would also make the term more meaningful in relation to public organizations where the there is no 'proper' owner. In these organizations the term could then, more easily, be linked to people in management functions. Such a clarification can make it necessary to rename the term to something more fitting to the diversity of organizational types existing in today's society. However, limiting the term to jurisprudence narrows its meaning and does not open up thinking about others, with informal power, who also could stop the transformation.

A third term that might benefit from renaming is transformation. We have in the above discussed various uses of the term and their strength and weaknesses. From the discussion we now conclude that it might be beneficiary to leave the engineering term transformation in favor of the broader term "change". Besides this, it is also possible to combine the formula input $\rightarrow$ output with the "need for X"-statement by the phrase "Change I into O in order to achieve the need for X. This combination statement not only includes the benefits of both its including formulas but also introduces an additional level of recursion which might further clarify W (to be discussed next). However, this suggestion cannot be verified at the moment but needs to be left for further research.

As illustrated in the section discussing W, statements meant to explicate the underlying rational behind a given transformation has a tendency to become trivial in practice. The authors argue that one way to overcome this is to expand the notion of W to include statements related to the problem situation (W2) as well as to the wider social situation of which the version of the problem is a part (W3). To use the suggested combination statement for T is one way to operationalise this. An additional way is to define W in relation to different aspects of reality such as the social, economic, ethical, historical and logical. Doing this can highlight different views on what qualifies a system and relate

these different views to differences in professional roles, responsibilities and interests. However, further research on this topic is needed.

The final CATWOE-element to be discussed is Environment. In SSM case studies we have noticed that the environmental constraints defined tend to be of a quite general form and therefore the same constraints are frequently returning regardless of case. Using the element in this way does not sufficiently enrich our understanding of the relevant system. To avoid that this element is seen as routine the authors define and categorize the constraints as determinative or normative (Mirijamdotter 1998). Our experience of doing this is that this opens up the thinking and focuses attention to situation specific constraints. It forces the analyst to stop and think about what is really determinative and normative in this specific situation, and by this reduces the chances that the element is listed by pure routine. Often this kind of analysis makes us aware of the fact that many things that we assume to be determinative might not be so. They may rather be related to our social roles and norms and may therefore be possible to influence.

Besides this we want to draw attention to the common definition of environment in systems thinking (Churchman 1984; Schoderbek et al. 1990) which limits our view on what we need to consider in our design. According to these definitions the environment is that which affect the system but which the system has no, or little, possibility to influence. This leaves out all those stakeholders that are affected by the system but who has no power to influence the system. Ulrich (1998) has pointed to this problem and introduced the concept "context of application" as a counter-concept to environment. However, we prefer to think of the concept as a compliment to environment, rather than as a counter-concept. How, this line of thinking can be included in CATWOE-analysis we leave for further research.

4. CONCLUSION

In this paper we examine the CATWOE-analysis used in SSM and point at its strengths and weaknesses in present use. We notice that while SSM has developed during its more than 30-years of use the CATWOE-elements have not. The definitions are instead related to the 1970s version of SSM, which at that time still had a quite strong relation to methods of Systems Engineering and Systems Analysis. Hence, according to the authors CATWOE would also benefit from a development, more precisely there is a need for rethinking, and in some cases renaming, the CATWOE elements. However, CATWOE-analysis is both well known and well used, it is an indispensable technique in SSM and has many benefits to offer systems design in general. Because of this the authors argue that a development of CATWOE is an important step in the overall development of the methodology and worthy further research.

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