A CATEGORIZATION OF SOCIO-TECHNICAL SYSTEMS APPROACHES BASED ON CONTEXT AND PURPOSE

Rime Elatlassi, elatlasr@oregonstate.edu.
Chinmay Narwankar,
Javier Calvo-Amodio, Ph.D, Javier.calvo@oregonstate.edu.
204, Rogers Hall, Oregon State University, Corvallis, Oregon, 97330

ABSTRACT

Socio- technical systems are systems where humans interact with technology (hardware or software) towards the achievement of a goal. Because of the presence of the human behavior and the constant change and evolution of technology, such systems are constantly changing and are difficult to define. Various approaches exist to analyze and understand socio-technical systems' behaviors, however many of these approaches analyze socio-technical systems from a certain discipline's weltanschauung, problem context, and purpose of the system. Therefore, the proposed approaches only provide partial definitions that are difficult to generalize. The objective of this research is to provide a categorization of socio-technical systems based on their context and purpose, within an interpretive system paradigm(s). The resulting categorization will serve as a foundation for a socio-technical systems framework to assist analysis select and/or design the right socio-technical intervention approach based on context and purpose.

Keywords: Socio-Technical systems, Critical Systems Thinking, Problem Context, Methodological Purpose, Systems Thinking

INTRODUCTION

The term socio-technical system was originally used by Emery and Trist (1960) to describe systems that involve a complex interaction between humans, machines, and their surrounding environment. Those interactions exist in most organizations today. Therefore, in any organization, people, machines and context need to be considered (Gordon, Sommerville, 2011) given the multiple challenges facing organizations such as unexpected failures in meeting the budget and time constraints. Those issues are mainly due to the ill understanding of what socio-technical systems are. In fact, throughout literature, there is no clear consensus on the definition of socio technical systems. This research outlines the main problems facing the socio-technical systems and proposes a model as an attempt to solve all outlined issues.

BACKGROUND

Socio technical systems originated from the Haighmoor innovation where a group of workers in a coal mine were interacting with relatively new machines, at that time, organized themselves autonomous semi-independent groups regulating themselves with minimal supervision (Trist, 1981). This new atmosphere and work organizational design that involved man as well as machinery is considered the first form of a socio-technical system (Emery, 1978). This new organizational design had many new characteristics that were never observed in any work place before, however, one of the most interesting

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concepts is that humans were viewed as complementing the machine work, not just an extension of a machine (Jordan, 1963). As the Haighmoor case evolved and became more common, it became clear that it is no more feasible neither efficient to approach the social and technical sides of a socio-technical system as two totally separate sub-systems (Trist, 1981). The new definition of a socio-technical system became "work organizations exist to do work- which involves people using technological artifacts" (Trist, 1981). With this new definition, new conceptual frameworks (Trist, 1950). Ackoff and Emery, (1972) defined socio technical systems as systems where the social and technical sides are dependent on each other as well as co-producers of a desired future state.

Identified Characteristics

Since the apparition of the Haighmoor case, scholars have identified several attributes within socio-technical organizations. Following are most characteristics observed (Badham et al., 2000):
Contain independent parts
System able to adapt to external environment so as to pursue a certain goal
System contains internal interdependent social and technical parts
Equifinal (objectives can be attained through various routes), therefore, choices have to be made during design and development stages
System success relies on the success of both the technical and the social subsystems.
Lack of equilibrium between those two will result in the failure of the whole system.

Identified Levels of Socio-Technical Systems

Various levels of socio-technical systems, from micro to macro, were identified since the early appearance of socio-technical systems. The evolution of socio-technical systems throughout the following three categories introduced change in work roles expectations as well as level of reliability on technology.
Primary work systems: subsystems that perform a set of activities while having clear and hard boundaries within an organization (Miller, 1959).
Whole organization systems: such as workstations, plants that interact with the environment they exist within to keep a steady state production (Trist, 1981).
Macrosocial systems: Organizations operating at the whole society level, also called 'domains' (Trist, 1976a).

Models of participation and power sharing between stakeholders in socio-technical systems

Interest group democracy: where labor and management are considered two distinct groups of stakeholders. Labor in this kind of setting negotiates for independence from management (Trist, 1981).
Representative democracy: In this setting, the lower labor has high influence over upper management decisions (Trist, 1981).
Owner democracy: In this setting, labor has the privilege to participate in equity (Trist, 1981).
Work-linked democracy: Labor groups make decisions about how work is organized at their own level (Trist, 1981).

A Categorization of Socio-Technical Systems Approaches

STS Approaches Identified Throughout Literature
Throughout literature, various approaches have been recognized to best deal with socio-technical systems. All identified methods have been refined and adapted to particular work conditions and cultures. It was noted however that none of those approaches, that are specifically designed to deal with socio-technical systems was in common use because of many reasons such as the lack of awareness of the existence of such methods (Eason, 2001). Below is summary of all identified approaches:
Socio-technical system design: User participation at all stages of design is the main concept of this approach. User is not only to be included to ensure technical deliverables, but to also ensure social success of the system (Gordon, Sommerville, 2011)
Soft Systems Methodology (SSM): This method is mainly influenced by action research and is known for its emphasis on understanding the problem. Understanding the problem within SSM involves understanding the role and weltanschauung of every stakeholder involved in the system (Checkland, 1981)
Cognitive Work Analysis (CWA): is an approach that predicts the amount of work that can performed by socio-technical systems. This is therefore the only existing method that is neither normative nor descriptive, but instead predictive (Vicente, 1999).
The Socio-technical Method for designing work systems: This method analyzes the amount and difficulty level of tasks allocated to machines and humans (Waterson et al., 2002). This method also analyzes tasks that have been allocated to teams and serve as a function allocation methodology.
Ethnographic Approach: This method benefits from ethnographic studies to design socio-technical systems (Martin and Sommerville, 2004)
Contextual Design: Focuses on end users and how those will be using the end product. The socio-technical system design in this case is a mirror of the end product and its user (Beyer and Holtzblatt, 1999)
Cognitive Systems engineering: this approach observes and analyses organizational culture to identify issues and repeated patterns of failure at the place so as to offer a practical support for socio-technical system design (Woods and Hollnagel, 2006).
Human-centered Design: This approach considers the social and environmental context so as to understand how humans will be coping with their daily tasks.

PROBLEM IDENTIFICATION

Even with the existence of all previous Socio-technical system approaches that have the potential to address complex issues in large socio-technical systems, these methods had no significant impact on problem-solving within socio-technical systems (Mumford,2000; Mathews,1997). There are various reasons contributing to the poor understanding of socio-technical settings by analysts and other stakeholders, following are some of the major identified problems:

Inconsistent terminology: One of the main issues that facing socio-technical system's analysts is the high variability in socio-technical systems terminology. The confusion starts by the large variation of literature defining the term 'socio-technical systems'. The fact that there is no agreement on the definition of socio-technical settings resulted on

various classifications and understandings of socio-technical systems. Also, this large variation id terminologies and understandings resulted in the development of various approaches and methodologies each dealing with a specific context and environment. Such methods cannot be generalized; therefore, other socio-technical systems cannot benefit from such methodologies.

Varying System Boundaries: A main issue faced when dealing with socio-technical systems is the fact that stakeholders describe the same systems differently. This is because various stakeholders draw distinct boundaries of the system depending on their role within that system. Since socio-technical systems contain social and technical components, it is very frequent that stakeholders are describing the system either from its technical or social angle depending on the side they are most exposed to within the system. It is very rare to encounter stakeholders that perceive both social and technical aspects simultaneously.

Conflicting Values: Within socio-technical systems, there are two different philosophies that determine the nature of socio-technical systems and how they are managed: humanistic philosophy versus the managerial philosophy (Land, 2000). The humanistic philosophy involves around the improvement of the working environment and argues that improvement in production and quality will follow. On the other hand, the managerial philosophy focuses more on production and the organization's objectives. Within socio-technical systems, one of those two philosophies has to be dominant while the other is marginal. Therefore, there will be a constant conflict between both philosophies (Land, 2000).

Unclear Social Success Criteria: While there are clear performance criteria for all technical deliverables, it is very hard to evaluate social success within socio-technical systems. Even with the existence of some social criteria in some cases, there are no clear procedures to evaluate the success or failure of those social criteria Majchrzak and Borys' (2001).

Multidisciplinary: A great challenge facing socio-technical system is the fact that such systems exist in a wide range of disciplines. Therefore, it is difficult to develop a general understanding of those systems (Gordon, Sommerville,2011).

PROPOSED CONCEPTUAL MODEL

The proposed conceptual model in figure 1 suggests that socio-technical systems should be observed from a weltanschauung that equally considers the technical and the social aspects. This weltanschauung is coming to correct the current situation of socio-technical systems that have been faultily dealt with based on only its technical or social side. The proposed new weltanschauung is going to address all socio-technical problems previously discussed

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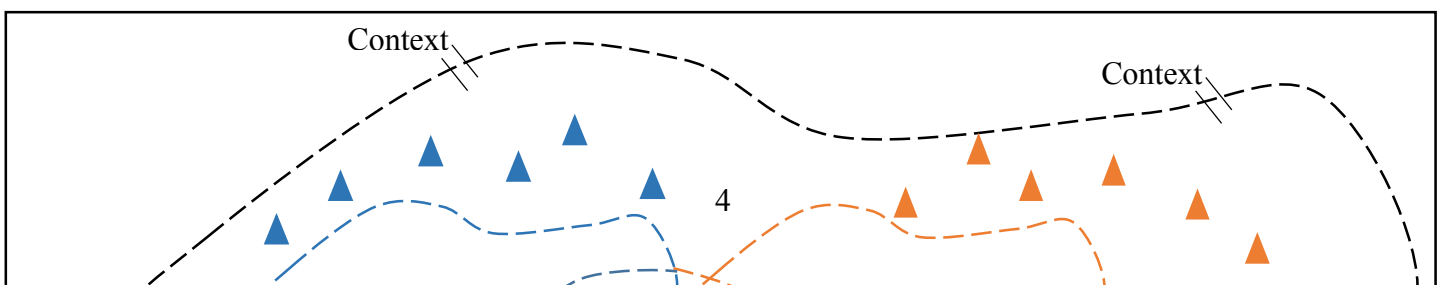
Unified Terminology: by using a terminology that is comprehensive and not specific to any discipline. This will help practitioners from various disciplines to share their knowledge and experiences with socio-technical systems.

Equally Considering the Social and Technical Aspect*:* The proposed weltanschauung is built upon the belief that socio-technical systems can healthily evolve only if the social and technical sides are well balanced and equally considered.

Developing Social Key Performance Indicators: this will allow organizations to evaluate their social performances in addition to measuring their technical ones. If an organizations fail to meet their social or technical goal, then required procedures should be followed to regain the balance of the system. In addition to that, it is necessary to develop correct procedures that will allow organizations to evaluate whether the social key performance indicators were met or not.

Context: Even if the proposed weltanschauung is using a comprehensive terminology, it should still be sensible to the context where it is being used. Considering the context is a matter that should be considered at the application phase where practitioners will be trying to apply the socio-technical system approaches to manage the specific socio-technical system to be considered.

CONCLUSION AND FUTURE WORK

Socio-technical systems are a fresh field that requires extensive future research. Despite the long history accompanying socio-technical systems, there are still many ambiguities surrounding the anthologies those systems as well as their corresponding methodologies and approaches. Future research should first comprehensively define socio-technical systems independently of their field of activity. Later, emphasis should be put on developing approaches that would guarantee the healthy balance between the technical and social aspects of socio-technical systems. This can be accomplished by developing suitable methods that would allow organizations measure their social performances and compare the obtained results with fixed social key performance indicators.

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