**SOCIO-TECHNICAL SYSTEM DESIGN METHODOLOGY: DESKTOP REVIEW CASE**

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**A Seminar Paper Submitted to the Department of Computing Sciences, School of Information Science and Technology in Partial Fulfillment of the Requirements of the Degree of Doctor of Philosophy in Information Systems**

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**June, 2021.**

**Abstract**

It is commonly accredited that employing a socio-technical perspective to system development encourages systems that are aptly acceptable to end users. Consequently the approach delivers better value to organization stakeholders. Despite this effort, these software development approaches are not extensively exploited in the development process. This study therefore, reviews the reasons for this, explaining a variety of these issues with the most known socio-technical system design approaches available. This review proposes a replacement realistic model for socio-technical systems design which develops on the study of groups examining, information systems, work design, computer-supported cooperative work, and cognitive systems design. The gap between institutional change and system building is filled by two main different activities. These activities include awareness and sensitization as well as constructive development. From the architecture, we note the initial set of interdisciplinary research issues that address the problem. The application of socio-technical approaches during an economical way, and therefore it facilitates the integration of STSE with existing systems and software engineering approaches.

**Keywords:** System Design, Socio-Technical, Software Engineering,

1. **Background to the Study**

Socio-technical systems design (STSD) methods are an approach to system development. This is style that considers human, social and organizational factors. Technical factors within the design process of organizational systems are also taken into account. They require an extensive history and are intended to ascertain that the organizational and technical aspects of a system are considered concurrently. The impactiof applying these methods may be a better understanding of how human, social and organizational factors affect the ways in which work is accomplished and technical systems are utilized. This understanding can contribute to the planning of organizational structures, technical systems and business processes involved. Albeit many managers come to terms that socio-technical issues are paramount, socio-technical design methods are rarely used. We anticipate that the explanations for his or her lack of use are, essentially, difficulties in using the methods and as such a disconnection between these methods and both technical engineering issues and problems with individual interaction with technical systems. The underlying premise of socio-technical thinking is that systems design ought to be a process that considers both technical and social factors that influence the functionality and usage of computer-based management systems. The motivation for adopting socio-technical approaches to systems design is that failure to try to do so can increase the risks that systems would not make their expected contribution to the goals of the organization/company. Systems however, meet their technical ‘requirements’ but are considered to be a ‘failure’ because they are not delivering the expected support to add value to the organization. The source of the matter is that techno-centric approaches to systems design don't properly consider the complex relationships between the organization, the people enacting business processes and therefore, the system that facilitates all these processes (Norman, 1993; Goguen, 1999).  
  
The study claims here that there is a requirement for a practical approach to the engineering of socio-technical systems supported the gradual introduction of socio-technical considerations into existing software procurement and development processes. The study plans to deal with problems of usability and therefore the incompatibility of socio-technical and technical systems development methods. The long term research goal is to develop the sector of socio-technical systems engineering (STSE). It is believed that it is not ample to readily analyze a situation from a socio-technical perspective then explain this analysis to system engineers. Researchers argue that socio-technical analyses are often employed constructively when developing and evolving systems in organizations. A mammoth of institutions have invested heavily in software design methods and tools. Therefore, socio-technical approaches will only achieve success if they preserve and are compatible with these methods. We ought to avoid terminology that is alien to engineers, develop an approach that they will apply, and generate values that are proportionate to the time invested.

**1.2 Statement of the Problem**

Software development methods are geared towards developing an answer to ‘the problem’ and if that ‘problem’ is not vividly conceptualized using these design methods, then they are likely to generate inappropriate solutions. The nature of the identified problem, however, is never simple because every group of stakeholders has its own perspective on what it really is, rather than there being the single problem, there is usually a group of overlapping problems with antagonizing characteristics. Well, a number of these ‘problems’ could also be no such thing like some stakeholders could also be perfectly proud of the established order and their ‘problem’ is that a replacement system is being imposed on them as a result to the needs of other stakeholders. STSD approaches have noted that inferring ‘the problem’ that the system is meant to solve is one of the keys to system development success, and for that reason several STSD methods are oriented towards analyzing and problems understanding. Using STSD approach will assist the stakeholders to specialize in the character of the issues and are available to some agreement on what these really are. It will also help systems builders to know the most crucial problems rather than what they believe as being the actual ‘problem’ their system is meant to unravel.

**1.3 Objective of the Study**

This review sought to assess the challenges that deter socio-technical system design approach from being utilized by the software development community with a view of proposing on the way forward.

**1.4 Literature Review**

This study explored the various challenges that hinder socio-technical system design approach from being employed by the software development community.

**1.4.1 Socio-Technical Systems Design**

The concept of socio-technical systems was initially coined by Emery and Trist (1960) to explain lucidly on systems that involve a superior interaction between machines, humans and the environmental aspects of the work system. Nowadays, this communication is true of most enterprise systems. The consequence of this definition is that, each one of those factors like machines, people and context demand to be considered when developing such systems by using STSD approaches. Nevertheless, these methods resemble philosophies than the types of design methods that are normally related to systems engineering (Mumford, 2006). STSD methods in most cases provide pieces advice for sympathetic system designers instead of a detailed notation and a process that is expected to be followed to the letter. The term socio-technical system is currently widely applied to describe many intricated systems, but there are five key features of open socio-technical systems (Badham *et al*., 2000): Systems ought to have interrelated components. Systems are expected to adapt to and pursue the inner external environments; Systems have indoors like environment consisting of separate and interconnected technical and social subsystems components. Besides, Systems have an equifinality. This means that systems objectives are often realized by quite one approach. This suggests that there are choices in design to be considered during system development, System performance solely relies on the combined optimization of the social and technical subsystems. That focus on one among these systems to the exclusion of the contradictory is most likely going to guide to a degraded system utility and performance. STSD approached were developed to aid the planning of such systems in an organization. The study has restricted the span here to the present class of systems and do not consider deeply the embedded systems, for example, where there is normally lack of social subsystem involved.

**1.4.2 Socio-Technical Systems Design Perspectives**

The Socio-technical systems design however, has been manifested widely during the selection of various approaches. “Diverse traditions developed in many countries at different times have led to distinct approaches”, as claimed by (Mumford, 2006) for a reasonably comprehensive empirical review. Although Individual methods, to some level, show dissimilar national beliefs and approaches to figure and work organization. The repercussions have usually been that every method is ready-made to specific market niche, which partially explains why there have not been any momentous or successful trials to integrate approaches to come up with a more general, standardized method of socio-technical system design for the development purposes.

There has been a limited transferability of the available methods. Generally, those who realized the approach have had most success in applying it. Mumford’s ETHICS (1983, 1995), for instance, was preferably utilized in the USA, that is when Mumford worked directly with institutions based there like DEC, because the nature of the different markets has distorted, the methods have not always kept pace. In some cases, the methods are reactively refined ETHICS, for instance has lately been using agile method of software development (Hickey *et al*., 2006). In most cases, however, there has not been any reconsideration of the role of the sooner fundamental concept of STSD. Whether this is often because STSD is not deemed relevant to the novel ways of working or because there is simply no idea of those approaches is an open question for discussion in computing arena. STSD remains an interesting field of research and practice, although in many instances it is the ideas, instead of the first approaches, that are being applied.  
  
One area where system user participation has been taken critically is in software development using agile method such as Dynamic Systems Development Method (DSDM), extreme programming (XP), and Scrum (Abrahamsson *et al*., 2002) for a review and analysis of those methods. These methods includes a minimum of some face to- face user involvement although, in practice who actively plays the user roles can often depend on who is out there to communicate with the developers and use short repetitive development cycles to develop evolutionary prototype solutions in a manner that takes account of local contingencies ( Boehm & Turner, 2004). However, agile methods are commonly concerned with end-user needs, and make the simplistic hypothesis that: (a) competent users avail themselves to interact with the event team and (b) the user needs are marching with broader institutional requirements. While there are definitely interesting ideas evolving from agile methods, their specialty in interaction with individual users does not address the necessity for broader socio-technical awareness in systems engineering. Additionally to the approaches covered by Mumford (2006) broad review done also revealed several other approaches that include socio-technical concepts. We believe that these other methods can also help inform the event of socio-technical systems.

Soft Systems Methodology (SSM; Checkland, 1981; Checkland & Scholes, 1999), which develops on a number of concepts from action research, has its roots in systems engineering community in place of the social sciences. SSM takes into account purposeful action as a system: logically associated activities are linked together as holistic and therefore the evolving property of the whole is its purposefulness. SSM key features are in its specialty in developing an understanding of the subject (However, SSM employs a more generic term problematic situation). This implication takes under consideration the responsibilities, roles and concerns of the stakeholders that are relevant to the actual problem. The understanding of the subject provides the idea for the solutions, which in return takes under consideration stakeholders’ differing verdicts. SSM vividly acknowledges that the eventual solution is predicated on attempting to accommodate the thoughts and needs of different stakeholders. We believe that problem understanding is one of the SSM’s principal strengths; however it also can be worth to develop information models on the more technical aspects of a system. It has been great to assess existing information systems too (Checkland & Poulter, 2006).

Cognitive Work Analysis (CWA; Vicente, 1999; Rasmussen *et al*., 1994b) was designed to scrutinize the work that would be undertaken by complex socio-technical systems. It is therefore a formative approach which is supported by predicting what a system could do, in contrast to many approaches which may be normative (how work should be done) or descriptive (how work is).  
The socio-technical approach for designing work systems (Waterson *et al*., 2002) concentrates on system development. It is important to identify operations that demand to be allocated to machines (and implemented using Information Technology) and also takes into account those tasks that require to be performed by human beings (for both individually and as teams). This approach is meant for all-purpose use in function allocation and socio-technical task systems.

Contextual design methodology (Beyer & Holtzblatt, 1999) is aimed towards designing products straightforwardly from the designer’s understanding of how the system user actually performs responsibilities. It is founded on the idea that any system inherently embodies a specific way of operation, which largely influences how the systems are going to be used and the way it will be planned. Contextual design increases the activities that are focused on the front of design, and, especially, on customers and their work.

Cognitive system engineering (Hollnagel & Woods, 2005; Woods & Hollnagel, 2006) dwells on the analysis of institutional issues, and offers some practical assistance for systems design. CSE employs observation as a tool for analyzing the context, and uses abstraction on the findings to spot trends within the observations that happen across work settings and situations, consequently escalating the understanding of sources of failure and experience.

Human-centric design (International Standards Organization, 2010), which follows principles like basing the planning on a specific understanding of users, what their tasks are, and therefore the environments within which those operations are administered . Besides, it includes the four main design activities that call for understanding and specification of the context during which the systems are going to be employed, and clearly refers to considerations of social and cultural factors, including working practices and therefore the structure of the organization.

**1.5 Challenges with Existing Perspectives to Socio-Technical Systems Design**

The development of STSD approaches has acknowledged and attempted to handle real problems in understanding and developing more complex organizational systems which, nowadays, inevitably believe that large-scale application-intensive systems. In spite of the positive experiences in demonstrator projects, however, these approaches have not had any significant effect on industrial application production practice. The explanations for this letdown to adopt and sustain the utilization of STSD methods are examined in several places, and from several perspectives (Mathews, 1997; Mumford, 2000, 2006). We review the problems identified by these scholars below, and also describe other issues that have been noted in our own use of STSD approaches.

**1.5.1 Inconsistent Terminology**

There is a considerable difference in what users mean by the concept of socio-technical system and this is frequently inevitably perplexing to potential adopters of those methods. The concept has its original extraction in organizational and psychotherapy, in task administered by the Tavistock Institute between 1950s and 1960s. Although, it is also closely connected with the industry of management science in UK, the ETHICS approach (Mumford 1983, 1995) was developed at the Manchester graduate school. Currently, various fields have adopted the term, often using their own understanding. Sometimes that specializes in the social system, sometimes on the technical, but scarcely on both altogether. This might assist to explain the somehow dissimilar nature of the literature (Griffiths and Dougherty, 2001). It is imperative that folks involved during a particular system development venture have an approved understanding of what is intended by the concept of socio-technical system. This specifically applies to the event team, so as to structure sure that they specialize in the agreed social and technical elements of the system and the style these are interrelated and communicate. The point in time is that there ought to be an agreement on the social and technical aspects of the system that needs to be jointly optimized.

**1.5.2 Levels of Abstraction**

Congruent to the concerns of terminology are problems in influencing the most agreeable levels of abstraction to employ when scrutinizing and explaining the socio-technical systems. As an alternative of using various terms to describe a similar thing, though, here we are talking about people and explaining an equivalent system but utilizing a different level of abstraction. Often supported by the very fact that they infer the system limitations in several places. There is a twist by some to breakdown the system into different social and technical systems. The depth of the study for every of the subsystems is then given a unique emphasis. The main target often falling totally upon the technical aspects of the main system (Eason, 2001). Finding the satisfactory level of abstraction is essential, but often difficult. Hollnagel (1998), for instance, criticizes the work upon socio-technical systems for over-emphasizing the circumstance, which infuses the organizational aspects, at the cost of neglecting the individual. He claims that modern methods cannot acceptably explain why system users perform erroneous actions and, hence, cannot be used in human consistency analysis. When this viewpoint is considered to the acute, undesirable actions are simplistically noted because the findings of organizational failings, which stack the likelihood against the users, who is then portrayed since the blameless victim of those failings. On the other hand, it overlooks the very reality that the context involves individuals, often operating as a part of a team, who throughout their own volition could still theoretically perform the right action.

**1.5.3 Conflicting Value Systems**

In an effort to form sense of the literature, Land (2000) suggested that it is often divided into two main categories. Each category is speculated on a group of values that underpins most of the judgment around socio-technical systems. The major set of values can be a fundamental effort to humanistic principles. On the other hand, the planner is getting to progress the standard of working life and job satiation of the system users. It is claimed that the increases in efficiency will subsequently follow, which will produce added value for the business. Early methods to STSD were specifically concerned with ensuring that humanistic principles were considered at the planning and employment of the latest systems.  
  
The second set is normally described as administrative values. During this view, socio-technical ethics are taken into account for helping to realize the corporate goals (specifically economic ones). Humanistic targets are thought of as having inadequate inherent values, however if their accomplishment findings in better employee performance and hence the corporate benefits as a result, then all is well and alive. Methods such as contextual design are principally geared to the employment of STSD as an approach to building systems and subsystems that provide simplistic organizational support.   
  
Ethnographic analyzes are frequently considered as a transitional category. Most people add this part as adopted in an ethno-methodological method where, it is argued, the analysis of the work is not influenced by any specific theoretical model or intended performance. The degree to which such analysis is actually value-free is, of course, arguable.  
Problems emanate when these unique sets of values inherit inconsistency. The dichotomy in this case between the primary two categories aids to explain why, in some instances, managers and employees can both be somehow doubtful of socio-technical thoughts, with the previous using managerial values, and thereof the latter, humanistic values.

**1.5.4 Multidisciplinality**

Some of the failures of STSD are repeatedly attributed to the multidisciplinary environment of system developments. The requirements for various disciplines to be included is widely accepted, but the boundaries between the disciplines are basically maintained, in spite of the efforts at creating interdisciplinary teams by including field specialists within the development process. The complexity is particularly right down to the failures in understanding and interaction, where one discipline does not fully comprehend what the opposite disciplines can achieve (Bader & Nyce, 1998), and hence does not question them to deliver something that supports the system building processes. Dekker *et al*. (2003), for instance, have recommended that practitioners of ethnography and contextual design never succeed to deliver products which are employed by other disciplines. Their dispute is that a number of the work administered by ethnographers and people drawn in a contextual inquiry does not go far enough, since it critically stops after collecting data, instead of analyzing the information to uncover patterns, trends and insights to be more readily employed by others. This was explained during a report on cooperation between application engineers and sociologists, where it had been realized that differences in both language and culture were major obstacles to multidisciplinary work (Sommerville *et al*., 1992).  
  
In general, the upkeep of limitations between the varied disciplines could also be results of the way that systems development has usually been perceived and administered. Specialised folks or teams were typically allocated roles for a specific stage of development process, like interface design, requirements analysis were rarely involved by other developers. Instead of including other specialists what is required is that a private feature that working knowledge and acceptance of what the contradictory disciplines require to offer, and may communicate effectively with them.

**1.5.5 Analysis without Synthesis**

Socio-technical design approaches have frequents been known to analyze existing systems, but these approaches are scarce within the “support that they supply for the more constructive synthesis where the results of the analyses are systematically utilized in the software design process”. Nevertheless, it is worth to criticize the existing systems that have failed, however without always recommending how the challenges might be solved by appropriately re-engineering of the system (Kawka & Kirchsteiger, 1999). There are a few recorded samples of the successful use of those concepts during a prospective manner, specifically for the main instance of a substitution sort of a system. This might flow from the envisioned world challenge (Woods & Dekker, 2000) which occurs due to the problem of speculating the relationship between the technology, people and context during a realm that does not yet exist.  
  
There are a number of techniques which requires to be exploited within the development of the latest systems starting from the overall perception of learning from the past experience, to using existing subsystems. Petroski (1986, 1994, 2006), for instance, has acknowledged how engineering has gradually grown as a discipline over the centuries by learning from its past failures.

**1.5.6 Fieldwork Issues**

Although STSD approaches like user involvement design prescribe the participatory of users, it is comparatively silent on issues like which users to pick , what level of expertise in design they have then on (Damodoran, 1996; Scacchi, 2004). More commonly for fieldworks, there are problems with the identification of the users system within the first place, before making the decision which groups of users ought to be involved. The traditional methods involving an infused ethnographer are costly and prolonged; although opinions like ‘quick and dirty’ ethnography address this to some level (Crabtree, 2003).   
  
The identification of the main target users of the system, extent and level of details needed within the fieldwork. This is most frequently not just a drag for STSD. Within the arena of HCI, for instance , there have been discussions about pragmatism of using the available methods, which are noted as exceedingly time consuming. Discounted engineering (Nielsen, 1993) and light-weight approaches (Monk, 1998) offer possible solutions.

**1.6 Summary of the Impediments**

The problems that have been identified all have got to be solved if socio- technical methods are to be accepted and effectively utilized by the systems development community. None of them are overwhelming, although the solution to a number of the issues rose, like the inadequacy of the agreed success criterion will only emerge as users employ the framework. This study applied the issues to address to the wants for a particular discipline of socio-technical systems development, which are described next.

**1.7 Socio-Technical Systems Engineering**

In pondering on the history of socio-technical approaches, Mumford (2006) suggested that these methods still remain relevant, claiming that there is still a task for humanistic, socio-technical  
thoughts within the 21st century. Additionally to the humanistic disputes, we believe there is a robust and pragmatic instance for applying socio-technical methods to systems engineering. Simplistically put, the failure of huge complex systems to satisfy their time schedule, costs, and stakeholder expectations are not, by and enormous, failures of information technology. Rather, these projects are a failure because they do not recognize the social and organizational intrigues of the system environment during which the systems are implemented. The results of this are unbalanced user needs, pitiable systems design and user interfaces that are not user friendly. All of those produce change during construction, which leads to delays deliverables, and a system that does not reflect the ways in which different stakeholders operate.

We have seen that the system users inevitably have various concerns. The most concerns of the developers are typically whether the system fulfills the needs requirements.  
The primary doubt of the users is apparently whether the system will support them to carry out daily jobs, without negatively affecting other parts of their tasks. The most concern of managerial level is whether or not the system will produce the added value to the organization in a timely manner and whether it is submissive with policy requirements. Putting together all these different concerns is not an easy job. We claim that these worries are often considered, a minimum of partially, by evolving current socio technical approaches into a discipline of socio- technical systems engineering (STSE), during which a socio-technical method pervades the whole systems development life-cycle.

Besides, we have to require under considerations the obstacles to introducing any new method namely: New approaches require upfront investment for an indefinite later return on the investment, often, there is a high penetration cost in terms of equipment and training to use new approaches and therefore the issues of method usability and experience is required to augment method usability but if initial usability is not good, the methods will not be used.  
  
These constraints assume that, regardless of the academic achievements of latest techniques and methods in systems development, it is difficult to urge practitioners to implement them. If STSE is to become realistic in usage, we would like to admit these barriers and consequently develop approaches that will minimize the prices of introduction and thereof the associated risks.  
  
To realize our vision we would like to improve communications between system users about socio-technical issues, and give constructive support for employing information on socio-technical aspects in both technical systems design and organizational change processes. We therefore visualize two sorts of STSE activities:

**1.7.1 Sensitization and Awareness Activities**

These are concerned with sensitizing the users across the system to the worries of other stakeholders, and with convincing the stakeholders of the importance of a socio-technical method. for instance, the developers involved in designing the system backend application could be made aware of the very fact that complete data collection in some settings could also be practically unworkable.  
  
Necessitate for sensitization differs by counting on the people in an organization and therefore the organization itself. In agreement with the pragmatic pursuit of STSE, activities are selectively used as the situation may dictate. It is vivid from the extensive knowledge in ethnographic researches, however, that sensitization is critical if the later stages of systems engineering are to be successful. Failure at an infancy stage will mean that key system users will not comprehend the effect of socio-technical aspects on systems and why these systems design is not basically a technical process.  
A key issue here is that, of course, is the way to achieve sensitization in practical circumstances. The empirical literature is of little importance because, usually, existing socio-technical researches have already bridged this barrier and have convinced corporate and other organizations to get entangled in these studies.

**1.7.2 Constructive Engagement**

This activity of constructive engagement is concerned with incorporating STSD approaches into the most sensible systems development and change the management processes in an organization. Constructive engagement varies accounting on the event or change activities that are involved.

**1.8 Conclusions and Recommendations**

Systems design methods are increasing towards developing an answer to ‘the problem’, therefore if that ‘problem’ is not well comprehended, applying the methods will produce an inappropriate solution. The identified problem, however, is never simple since each group of stakeholders has its own opinion on what it really is, rather than there being a single problem, there are generally groups of overlapping problems with antagonizing characteristics.

Definitely, a number of these ‘problems’ could also be no such thing, some stakeholders could also be flawlessly overconfident of the established order and their ‘problem’ is that a substituted system is being forced on them due to the needs of other stakeholders. STSD methods have recognized that recognizing ‘the problem’ that the system is meant to solve is one among the keys to the success of the system, which is why many STSD approaches are oriented towards analysis and problem comprehension. Using an STSD method will thereof support the stakeholders to specialize on the character of the issues and are readily accessible to some agreements on what these really are. It also helps systems engineers to know the most important problems instead of what they believe as being the ‘problem their system is meant to unravel.  
  
The association of the systems development and organizational alter the processes during problem definition is necessitated by presenting, organizing and analyzing the method and environmental issues using a coherent model. The result therefore ought to be an outline of the work context that has been granted by the stakeholders, amid groups of corresponding requirements supported work performed in the context. These requirements, however, in theory a minimum of, will define: the objective of the system within the broader organizational context; the practicalities of its implementation in its operational environment; and definitely the functionality it provides to system stakeholders. Achieving a fitting balance between these various requirements form the idea for the development of a system which will be acceptable to, and used by the top system users, also as delivering the anticipated benefits to the stakeholders. However, in practice, expressing what is actually required by system users as groups of the requirements mean losing a number of the prosperity that is typical of socio-technical system analysis. Requirements can, however, state broad responsibilities, but the way that functionality is achieved and therefore the ways in which the system presents information to users cannot be lucidly explained using statements of the requirements. Everybody else knows that HCI design, for instance, depends solely on system prototyping and experimentation; other issues of STSD like support for cooperation and collaboration are inevitably explored and realized instead of predetermined.

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