COMPLEMENTARIST APPROACH TO CATEGORIZE DIFFERENT STAKEHOLDERS WITHIN SOCIO-TECHNICAL SYSTEMS

Chinmay Narwankar
Oregon State University, Corvallis, OR; narwankc@oregonstate.edu
Siqi Wang
Oregon State University, Corvallis, OR; wangsiq@oregonstate.edu
Rime Elatlassi
Oregon State University, Corvallis, OR; elatlasr@oregonstate.edu
Javier Calvo-Amodio, Ph.D.
Oregon State University, Corvallis, OR; Javier.Calvo@oregonstate.edu

ABSTRACT

Socio-technical systems is a systems approach to understanding complex systems when interactions between humans and technology are dominant. Thus, the term socio-technical relates to the relationship between complex human activity systems and the technical infrastructure that governs the nature of the system. Socio-technical systems typically have multiple stakeholders, either in charge of systemic development, governing the system, or being affected (directly or indirectly) by it. Thus, in order to understand a socio-technical system, it is important to understand the different roles the stakeholders have within the system of interest. This research contributes in providing a complementarist and pluralist approach in recognizing the roles of stakeholders within socio-technical systems and categorizing them by introducing a formative taxonomy flexible for any socio-technical system, dependent on its context and purpose. Critical systems thinking and boundary critique are utilized as a foundation for categorizing stakeholders, while the onion model along with soft system methodology are used to delineate the stratified spheres of influence each stakeholder category has on the system. Even though, the obligations vary across the different systems context and purposes, the proposed flexible approach is expected to be beneficial to system thinkers and analysts in realization, recognition and categorization of stakeholders within socio-technical systems.

Keywords: Solar system model, Systems engineering, Socio-technical system, Stakeholder Categorization.

INTRODUCTION

Socio-technical systems is a systems practice that diagnoses a complex system as the result of interactions among the human activity systems and technical environment which governs the system as a whole. In systems engineering, the group of interested individuals within human activity systems are broadly addressed as stakeholders. The most conventional definition of stakeholder is "any group or individual who can affect or is affected by the achievement of the organization's objectives" (Freeman, 1984; Fontaine, Haarman & Schmid, 2006). But the function, nature and role of stakeholder is still ambiguous and arguable and has changed over the years. So far as even the "fore-bearer of the concept of stakeholders", Freeman (2004) refined the definition of stakeholders during the course of time. One of his current definitions of stakeholders states them as "those groups who are vital to the survival and success of the corporation" (Freeman, 2004; Fontaine, Haarman & Schmid, 2006). Hence, Rabinowitz (2015) strongly believed the involvement of stakeholders leads to better processes, higher mutual understandings and less conflicts of social values. But, for gaining maximum advantage from the involvement of stakeholders, it is necessary to figure out the following questions:

- Who are the stakeholders in a particular system?
- Which of them are involved and affected by the system?
- At what level are they involved?
- What are the issues they might bring with them?

Also, based on Rabinowitz (2015), identifying the stakeholders and their interests proves advantageous because: 1) a group of like-minded as well as different stakeholders contributing in the development and application of the system helps in adding more ideas which might be missed by the stakeholder due to a relatively small weltanschauung. Thus, the actors will not be blindsided of the concerns they had not addressed before, 2) including various perspectives of different stakeholders from different sectors, provides with a rich picture of the stakeholders' consents and issues and ideas about which stakeholders would be the assets or pitfalls for the system, and 3) the involvement of various stakeholders creates a base for an equal, civil, courteous, ethical and clear approach towards the system development and implementation; thus, establishing a sound system.

Hence, a capable and effective consultation and classification of important stakeholders is of utmost importance in the evaluation of socio-technical system.

PRIMARY CLASSIFICATION OF STAKEHOLDERS

Ulrich (1983), established the concept of Boundary critique for primary classification of stakeholders. For Ulrich (2003), boundaries of a system are entrenched depending upon the "the involved" and "the affected" (*Figure* 1). Hence, according to the perspectives of Ulrich (1983), boundaries are conditioned on the basis of different stakeholders (Castiblanco, 2012).

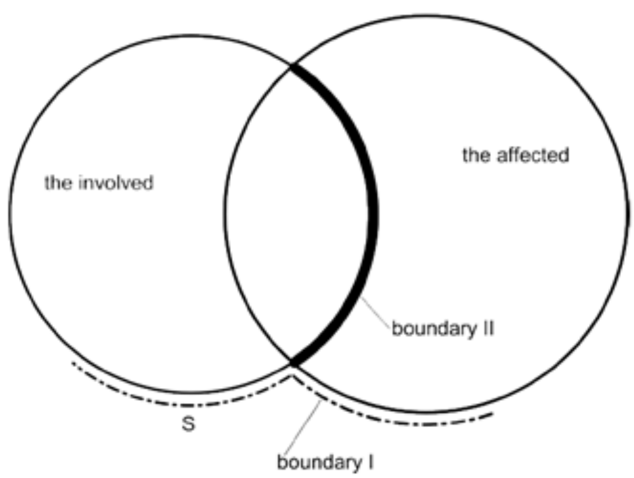

Figure 1: The System S with Boundary as a function of The Involved and The Affected (Ulrich, 1983; Castiblanco, 2012)

From Ulrich (1983), we draw the general categorization of stakeholders within two main groups defined as follows: (*Table* 1)

Table 1: Primary Classification of Stakeholders

The Affected	The Involved
These are the stakeholders which stand affected directly by the system, in a positive or negative manner. Some systems stand to affect the stakeholders on both sides of the equation: a system that is beneficiary for one may negatively affect the other (Rabinowitz, 2015). For example, inclusion of automated machineries and robots in the industrial sector has positive effect on the end customers and owners, while it badly affected the workers, who get discharged from the industry.	These category includes the individuals and organizations whose involvement is highly relevant in positively or negatively affecting the affected, by their efforts or actions on the system (Rabinowitz, 2015). For example. The policy maker, project champions, directors of the organization are responsible for the inclusion of automated machineries and robots in the industries.

According to Rabinowitz (2015), there is another classification of stakeholders that is inclusive with either or both of the earlier classifications. These stakeholders are called *key stakeholders*, who can have a positive or negative effect on the system they engage in. They include the government official, policy makers, federal agencies, directors of the organizations and more. Realization and recognition of various roles of stakeholders that land within the primary classifications of stakeholders in a socio-technical system is vital for a successful development and implementation of the system. Thus, in this research, a model is proposed for classification of stakeholders with crucial roles within any socio-technical system. Furthermore, these roles are then grouped as “the involved” and “the affected”, for a better understanding.

THE SOLAR SYSTEM MODEL FOR STAKEHOLDERS’ CLASSIFICATION

Proposed Model: The Solar System Model (*Figure* 2) is the influence bound system, where influence behaves like gravity, comprising of technical infrastructure as the Sun and the stakeholders influenced directly or indirectly by it as the objects orbiting it. Stakeholders in close proximity of the technical infrastructure are highly influenced by it. In the real solar system, more the distance between the sun and the Object, lesser the gravitational influence of the sun on that object. Similarly, the wider the orbits of the stakeholders, lesser is the influence of technical infrastructure on them. Also, as the technical influence begins to decrease upon the stakeholders, social influence of the system becomes more prominent among them.

The Orbits: Orbit is a gravitationally curved path drawn around a point in space (Morrison & Wolff, 1987). Hence, the technical infrastructure being the point in space, technical influence works as gravity that draws the curved path for the orbit in the socio-technical solar system model. The model initially has three default orbits. But, since each system is different, multiple orbits can be included as per the necessity. The three main orbits are:-

Technical Orbit: Highly influenced by the technical infrastructure of the system, hence the name. It includes the current technical infrastructure of the system, for example, as simple as software programs, electronic devices to as complex as military status equipment. The stakeholders that influence or are most influenced by the technical system, standard operational conducts and rules controlling the operations (Alexander, 2005) are included within this orbit.

Socio-technical Orbit: The area between technical orbit and socio-technical orbit includes the stakeholders influenced by both, the technical aspects as well as social complexity of the system. Hence, the primary stakeholders within this orbit are the "human beneficiaries" (Alexander, 2005) of the system, irrelevant of their involvement in the systemic operations.

Socio-Technical System, S (Solar System Model)

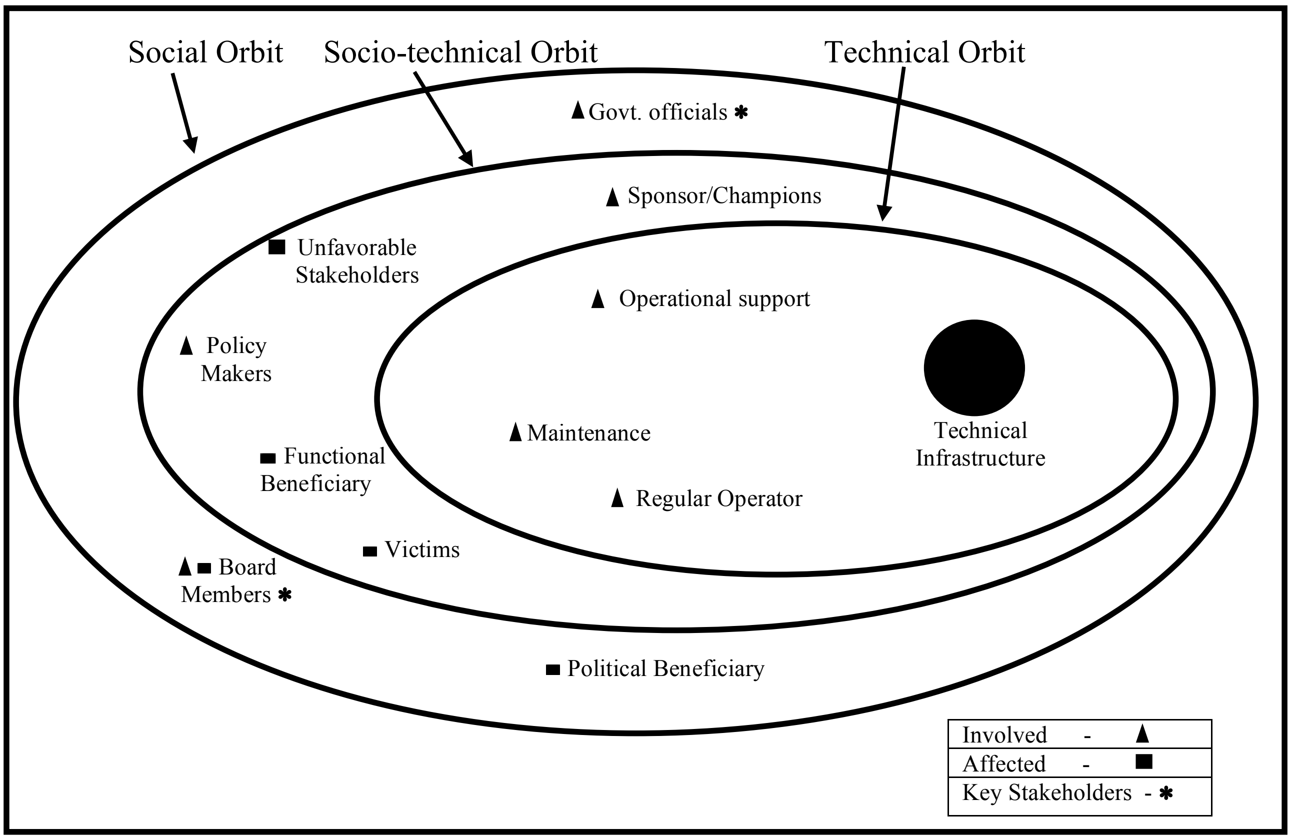

Figure 2: The Solar System Model for stakeholders' classification in socio-technical system

Social Orbit: Beyond the socio-technical orbit, the influence of the technical infrastructure is low, and hence the stakeholders included within this region are mainly influenced by the social aspect of the system. Hence, the primary stakeholders within this orbit are mainly the political and financial beneficiaries of the socio-technical system.

In the Solar system Model, the Stakeholders are simplified as either involved or affected for a better understanding of the system: (*Table* 2)

Table 2: Dividing stakeholder in the Solar System Model in terms of "the involved" and "the affected"

The Involved -▲	The Affected - ■
Regular Operators Champion Policy makers Board members of the organization ✱ Government officials ✱ Maintenance Operators Operational Support	Victims Functional Beneficiary Political Beneficiary Board members of the organization ✱ Unfavorable Stakeholders

✱ Key Stakeholders

Stakeholder roles in a socio-technical system: The Solar System model exhibits numerous stakeholder roles within the recognized orbits. The framework of identifying the "baseline stakeholders" (Sharp, Finkelstein & Galal, 1999) and Onion Model (Stucliffe, 2002; Alexander, 2005) makes following case for including the following stakeholders and the nature of their roles in a socio-technical system:

Technical Orbit: According to Alexander (2005), the category of operators contain three sub categories that explains their different roles in the system.
Regular Operator: This role involves the tasks of commanding or governing the input and outputs of the technology, through a human-technical interaction or otherwise. The main interactions of a regular operator in terms of stakeholders (Alexander, 2005) are with the other operators and functional beneficiaries of the system, giving refined information and receiving instructions. In a socio-technical environment, an operator plays a relevant role in all the aspects and development of the system. Even so, the requirement of an operator is highly influential in a control system environment, where safety is the main concern.

Maintenance: These operators are responsible for maintaining the technical systems, for example, servicing the machinery, troubleshooting the problems within the technical infrastructure, performing safety checks on the system and fixing the defects (Alexander, 2005). The main interactions of a maintenance operator are with the system and the regular operators. Maintenance services are rarely required while establishing the system. Their use occur only during the processing end. However, maintenance support must be in place during the development phase of the system, if in terms of diagnostics, safety checks, calibrating the technical system, monitoring the system or maintain activity accounts.

Operational support: This is the advising panel for regular operators and maintenance operators of the system. They interact mainly with the regular operator and maintenance operators. These stakeholders focus on supporting the operations rather than performing control or productive activities on the technical system. A good support boost the effectiveness and efficiency of the operations, thus increasing the system value (Alexander, 2005).

Socio-Technical Orbit:

Functional Beneficiary: These stakeholders are the primary beneficiaries of the system. Thus, they are the group of stakeholders that benefit from the development and outputs produced by the system (Alexander, 2005). For example, a performance manager benefits from the performance data accumulated by the regular and maintenance operators, even though they cannot operate the technical infrastructure directly. Functional beneficiaries interact with the regular and maintenance operators in order to give them instructions and receiving data or any other benefits of the system (Alexander, 2005).

Champion/Sponsor: Champions are the group of stakeholders authorized for utilizing the resources within or outside the system for the development of the system. So, they are responsible for raising funds, deal with political pressures, monitor changes and help avoiding obstacles by "conducting a risk assessment" for the system (McDonough, 2012). Champion ensures complete supervision of the development, from initiation to execution (McDonough, 2012). These stakeholders play a very important role in the system, in terms capability to effectively handle the beneficiaries and victims of the system within and outside the system (Alexander, 2005). Thus, the actions of Champions are mainly involved at a political level than a technical level (Alexander, 2005).

Policy Makers: The roles for this group of stakeholders are of "advisors" (Rabinowitz, 2015), to those in power to make the changes. Thus, the policy makers do not possess any "Official Power", but their judgements and proposals are followed and considered closely by the systems organizations. The decisions made by the policy maker, thereby affects the overall development of the system.

Victims: Any group of stakeholders negatively affected by the development and progress of the system are called the victims of the system. These damages can be mental, physical, financial or in many other ways to be found reasonable by the authorities. For example, the victims could be an agricultural community living in close proximity to a chemical factory, thus being exposed to radiations, pollutions, contaminated air and water and many other ways. Cultivations are affected due to the harmful chemicals that surround the lands, thus affecting the financial situations of the community. Hence, these stakeholders need to be given higher priority and their interests should be considered superlative while developing and maintaining the socio-technical system.

Unfavorable Stakeholders: These stakeholders maybe a group or activities which may cause interferences and interruptions, thus harming or sabotaging the development and progress of the system (Alexander, 2005). Examples of these stakeholders as described by Alexander (2005), include organization's competitors, military enemies, political and commercial spies, hackers, thieves, spammers and frauds. All these stakeholders causes negative impact on the system, trying to be right in their own terms.

Social Orbit:

Board members of the organization / Owners: These stakeholders are the financial backbone of the system as well as primary financial beneficiaries or victims of the system. They also enjoy the power to issue policies and regulations without consulting the policy makers, hence are crucial in development and progress of the system.

Government Officials: Government officials are of great importance in socio-technical systems in more than one ways. The federal or provincial representatives, legislators, etc. (Rabinowitz, 2015) introduces general laws and regulations and are responsible for public budget controls at federal, state or provincial level. The Governors, Mayors, Councilors, etc. are supported to practice laws, conduct and govern the budgets, and are socially responsible for the success or failure of the system.

Political Beneficiary: Group of stakeholders with roles in governmental organizations, political communities or "private businesses" (Alexander, 2005) that benefits from the development and success of the system are termed as political beneficiaries. These benefits may be with regards to power, impact, effect and reputation. For example, an electricity management organization could benefit politically from the installment of hydroelectric pumps and power plants. Certain political interactions within these organizations can also be negative, but these roles are critical across all the aspects of the system.

CONCLUSION AND FUTURE WORK

The approach in this research starts with technical infrastructure at the center, and moves outwards. In this manner, the model takes into consideration that all the crucial stakeholders are taken into consideration, avoiding those not germane to the system. For example, operators for machineries used in a machine shop are not considered as stakeholder for paint shop activities. Also, even though it's just a basic model, it is adjustable in terms of involving more stakeholders or adding multiple layers or orbits given the nature and complexity of the system. This may help in making the model highly flexible, with changes in the system over the period of time. Yet, there exists a risk of overdoing the analysis to an extent unnecessary for a simple system (Sharp et.al., 1999). For example, too much time is spent on realization and recognition of stakeholder roles and responsibilities, and the main issue of the system is overlooked. "Knowledge of where to stop is as important as to where to look" (Sharp et.al., 1999). Future work for the research will be to come up with protocols to answer this question.

The solar system model proposed in this research has not been validated yet. The next approach for this model would be of applying it to a real life systemic activity. Validation will provide a better picture on the proficiency of the model in realizing and recognizing the stakeholder roles and responsibilities. Also, tool support is always an extra asset for the model, saying that, this approach is applicable with nothing but hand drawn structures and a small brainstorming session on inclusion and exclusion of various stakeholders and their influential drive. This analysis does not presuppose any development approach, if the approach is implicated at a certain phase of the system, the inclusion and exclusion of the stakeholders should be taken into consideration. Hence, further study includes research on evolution of the influence of stakeholder roles and changes overtime.

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