

# Challenges in Assessing Parameters of a Socio-Technical System

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**Abstract.** The paper is an investigation of challenges in assessing parameters of a socio-technical system. The investigation is carried out using an augmented socio-technical matrix the quadrants of which represent culture, type of structure, methods/technique and type of technology. Investigation concerns a specific kind of matrixes developed for the purpose of achieving the right level of flexibility for a business process. The paper lists the challenges that need to be addressed when assessing parameters of a socio-technical system and suggests ways of dealing with them. Conclusion includes some generalization and plans for the future.

**Keywords:** socio-technical system, metric, assessment, organizational culture

## 1 Introduction

### 1.1 The goal of the paper

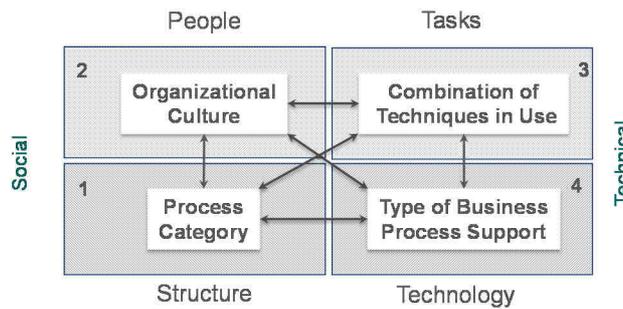
In this paper, we assume that a work system can be viewed as consisting of two parts - *social* and *technical* - each of which is split into two parts on its own: the *social* part consists of *people* and (social) *structure*, and the *technical* part consists of *tasks* and *technology*. As the result, the system can be represented as a 2x2 matrix as suggested in [1]. Moreover, we assume that a work system can be analyzed based on an augmented matrix [2] (in the same proceedings as this paper) where the level of abstraction in each quadrant is increased: specific people are substituted by the concept of organizational culture, mindset of a team, etc.; specific tasks are substituted by techniques, methods, etc. used in the tasks; specific structure is substituted by the type of structure; specific technology is substituted by the type of technology.

On a general level, the goal of this paper is to investigate the challenges of assessing a particular work system based on abstract concepts in the augmented matrix, for example, assessing organizational culture. The meaning of abstract concepts in the augmented matrix depends on the type of work systems, and the purpose of analysis. Therefore, assessment methods may differ from system to system, and from purpose to purpose. Still, there might be commonality that, in the end, can be generalized. This paper is not aimed at producing generalization; it discusses the challenges based on a concrete example of a specific type of work system.

**1.2 An example to be considered**

The work system example is taken from [3], but see also [2], that proposes a framework for achieving right level of flexibility/standardization of a business process in relation to the environment in which the process operates. For example, starting a new company, developing and launching a new product, or launching an existing product in a new market requires flexible (less standardized) processes, while operating in an established market with hard competition requires less flexible (more standardized) processes to beat the competitors.

The framework from [3] includes two types of rules. The first type establishes the level of flexibility of the process based on its environment (e.g., see the examples above). The second type of rules defines the internal rules of alignment between the socio-technical system's components to ensure that the needed level of process flexibility is maintained. For example, a flexible process requires a different type of business process support systems than the rigid one. In this paper we will be concerned only with the second type of rules using an augmented matrix presented in Fig. 1.



**Fig. 1.** An augmented STS-matrix from [3].

Fig. 1 represents a high level model of a work system related to a Business Process (BP) understood as a sub-system (of an organization) responsible for starting and finishing process instances (cases) of the given type, which are created as a response on certain kind of internal or external situations, e.g., a request for quote from a potential customer. Such work system, denoted as BPWS (Business Process Work System), is regarded as a socio-technical system that includes all people participating in the process instances of the given process type, rules regulating their behavior, tasks completed in the frame of process instances, IT systems that support running process instances, etc.

The framework in [3] is aimed at detecting misalignment between the environment of the BPWS and the inside of BPWS. The misalignment concerns only one aspect of business processes managed by BPWS - flexibility. The word flexibility in relation to BP has different meanings; in this paper, flexibility refers to BP instance flexibility, i.e., flexibility of people driving a particular process instance (case) to make decisions on "what", "how" and "who" based on the state of the instance and their intuition, knowledge and experience, rather than follow fixed and rigid rules. As has been mentioned above, for some situations/contexts (e.g. a startup), the flexibility is much

needed, in others (e.g. a stable market with hard competition), it should be greatly limited to achieve the high level of efficiency.

For each quadrant, [3] introduces metrics for assessment of a BPWS from the point of view of the concept defined for the quadrant. Thereafter, rules of alignment are introduced based on measurements made for the quadrants in Fig.1. The rules of alignment are defined for each two quadrants at a time, and they are expressed via the metrics for assessment for these two quadrants. To give a clue on how rules of alignment work, here is an example: a Business Process Support (BPS) system that uses shared spaces (technology) is considered to be aligned with the collaborative internal environment (culture). Introducing such a system in the culture with internal competition will fail (people will not use the system properly), unless the culture is also changed.

Metrics themselves are introduced for the sake of having the rules related to flexibility and may not be universal, i.e., not suitable for other tasks than detecting misalignment regarding flexibility. Other tasks may require different, or extended metrics. In addition, the metrics and rules are preliminary, and have not been tested in practice.

Each metric is defined as a vector that includes several components. A component could be either a value of a parameter (a variable that can take values from a predefined range) or show the relative frequency of a certain type (category) of events or internal business rules. Parameters are used in quadrant 2 and 4, while relative frequencies are used for quadrant 1 and 3.

The metrics and the rules of alignment were developed at the same time based, partly, on literature, and, partly, on own practical experience. Due to the lack of space, we cannot elaborate on the rules of alignment and metrics more, but refer the reader to [3]. For the framework to be applied in practice, there is a need to have methods of assessment of work systems according to the abstract concepts and metrics introduced for them. Such methods have not been developed yet, and the goal of this paper is to investigate challenges and suggest some ideas on how the assessment could be done. In Section 2, we give an overview of the metrics introduced in [3], and in Section 3, we discuss challenges and suggestions on meeting them.

## 2 Metrics for assessment

**Quadrant 1.** *Process Category* serves as a connection between the external environment and internals of the BPWS. Four process categories are identified for this concept: *Loose*, *Guiding*, *Restrictive* and *Stringent*, which represent different levels of process flexibility. A metric we introduced to identify to which category a certain process belongs is based on classification of internal business rules according to which instances of the given business process type are run. Such rules define which action to take, who should complete them, etc. Four types of rules are defined based on their *modality*:

1. *Obligations* – what must be done, independent of the will or judgment of the process participants (e.g. prescribed by law).

2. *Recommendations* – what is normally recommended, but could be overridden by process participants in a particular process instance.
3. *Negative recommendations* – what is not recommended, but could be employed by process participants in a particular process instance.
4. *Prohibitions* - what must never be done, independent of the will or judgment of the process participants (e.g. prescribed by law).

Using the rules types/modalities, a metric for assessing flexibility of the processes can be defined as a four component vector, each component representing the relative number of internal business rules of the corresponding type (see the list above) on the scale: *None, Some, Many*. The correspondence between flexibility categories and the metric can be roughly defined as *Loose* =  $\langle \text{Some}, \text{None}, \text{None}, \text{Some} \rangle$ , *Guiding* =  $\langle \text{Some}, \text{Many}, \text{Many}, \text{Some} \rangle$ , *Restrictive* =  $\langle \text{Many}, \text{Some}, \text{Some}, \text{Many} \rangle$  and *Stringent* =  $\langle \text{Many}, \text{None}, \text{None}, \text{Many} \rangle$ .

**Quadrant 2.** *Organizational Culture* is a predominant (shared by the majority) mental model that affects the behavior of process participants. In our case, it is defined as a vector of values for the following three parameters (each parameter is regarded as a variable with the fix number of values that can be assigned to it):

1. *World view* – is the degree in which process participants consider internal environment as *competitive* vs. *cooperative*.
2. *Resourcefulness* – is the degree to which the process participants are able and willing to find and complete tasks by themselves rather than waiting for instructions on what to do and how to do it: *low/medium/high*.
3. *Scope* – is the breadth of context that process participants are interested in and willing to take into consideration when completing tasks in the frame of process instances: *narrow/medium/wide*. *Narrow* corresponds to the immediate surroundings like inputs provided for a particular task. *Medium* corresponds to the process instance in the frame of which the current activity is taking place, e.g., the goal to be reached in this process instance. *Wide* corresponds to all process instances under execution, e.g. considering importance of a particular customer even when the customer order is of lesser magnitude.

**Quadrant 3.** *Combination of techniques in use* is defined with the help of classifying all tasks completed in the process in three categories defined as follows:

1. *Follow instructions* – a task is completed according to predefined instructions.
2. *Tactical decision making* – task completion is guided by information on the development of a particular process instance, including the instance goal, and history.
3. *Strategic decision making* – task completion is guided by a situation in the whole work-system, e.g., prioritizing some process instances against others.

A metric for *Combination of techniques* is defined as a vector that identifies the relative frequencies of usage of each category of tasks on scale *Low/High*. For example,  $\langle \text{High}, \text{Low}, \text{Low} \rangle$  corresponds to the situation when most tasks completed in the process instances are predefined, which means little room for creativity and innovation.

**Quadrant 4.** *Type of Business Process Support (BPS)* characterizes systems/tools that assist process participants in running process instances with the help of a vector that includes values of the following three parameters:

1. *Structuredness* defines the degree of structuredness of data (information) introduced by BPS: *Low/High*. A low level of structuredness means that the exchange is done informally in a natural language. A high level of structuredness means that the exchange is done through formalized documents, e.g., a form that include numbers, check lists, or selections from a fixed number of alternatives.
2. *Orderliness* characterizes to what extent the order of the tasks completion in process instances is imposed by BPS for the given process type: *Low/High*. In a process with high degree of *Orderliness*, the order of tasks execution is usually depicted as a flowchart interpreted by a BPS system at runtime. In a process with a low degree of *Orderliness*, the order is established on the fly by participants.
3. *Information Logistics* defines the way information is delivered to process participants: *Messaging/Shared space*. *Messaging* means that information is sent to a person who needs it, while *Shared space* means that the relevant information is placed in a shared space accessible to other participants.

As an example, using word processor plus email for communication can be characterized by a vector  $\langle \text{Low}, \text{Low}, \text{Messaging} \rangle$ . A traditional workflow-based system with form support has the following characteristics:  $\langle \text{High}, \text{High}, \text{Messaging} \rangle$ .

### 3 Challenges to overcome

#### 3.1 Process category

As has been mentioned in the Section 2, the categories of flexibility are defined based on classification of internal business rules that guide the process instances according to their modality: *obligations*, *recommendations*, *negative recommendations* and *prohibitions*. To assess the relative size of each class of rules, there is a need to have a list of rules in which each rule is tagged with its modality. However, an idea that an organization has a full list of rules related to the given process type cannot be taken for granted. Some organizations can have a fully defined process description, others may have very little or none documentation, the process description being hold on a tacit level, i.e. in the heads of process participants. Another challenge is that even if the business rules are described, e.g. in a work manual, they are not properly tagged with their modalities. It may lead to that obligations and recommendations is impossible to differentiate; the same goes to negative recommendations and prohibitions.

From the deliberation above follows that to assess the flexibility level some kind of a process mapping project may be required to obtain a set of tagged rules. Such a project will consume organizational resources, e.g. hiring a facilitator and engaging the process participants in the project. On the positive side, a process description produced could

be useful for other purposes than just assessment of flexibility, e.g. designing a BPS system, or process improvement.

Even when a list tagged business rules exist, they need to be checked against the actual behavior. For example, if a recommendation is never broken – it should be upgraded to an obligation. In the same spirit, if a rule that is formally considered as an obligation

often broken, it should be degraded to a recommendation. This can be done by interviewing process participants, or setting a questionnaire with a list of suspicious rules and asking the participants to mark whether they sometimes break them or not.

There could be a better opportunity to check the modality of various rules if the process is supported by an elaborated BPS system that creates traces of process instances. In this case, the factual modality of various rules could be figured out by process mining. Note, however, that the success of mining depends on process participants actually using the system when handling process instances, and not going around it.

### 3.2 Organizational culture

Organizational culture is assessed based on three parameters: *World view*, *Resourcefulness* and *Scope*. Assessing *World view* consists of establishing whether the internal environment is collaborative or competitive. This can be done by establishing the level of collaborativeness in the given work system. Here, the frequency of the following events could be taken into consideration: (a) sharing information with colleagues; (b) knowing what tasks their colleagues are currently working on; (c) asking for help; (d) providing help. The frequency of this kind of events can be established by interviewing process participants in line with suggestions from [4]. Another possibility could be investigating a BPS system logs, provided that the events listed above are logged and the process participants actually use the system for the purpose of collaboration.

The investigation like the described above could reveal the degree of collaboration that actually happen. However, low degree of actual collaboration does not automatically lead to the conclusion, that *World view* is *competitive*. It can very well be that the participants want to collaborate, but there are no means provided for this end, especially if the team is virtual. An additional investigation should be launched to assess the attitude of participants to collaboration, e.g. whether they will be willing/unwilling to collaborate if some means facilitating collaboration are provided.

Assessing *Resourcefulness* requires investigating the ratio of self-assignments of tasks to tasks assignments from a manager plus automatically assigned tasks based on the work description and some fixed algorithm, e.g. scheduling. Some ways of measuring this type of parameters are suggested in [4]. If a BPS system supports assignments and self-assignments and is actually used by process participants, *Resourcefulness* can be established by investigating logs, otherwise interviews or a questionnaire could be used. In the same way as with *World view*, lack of self-assignment does not automatically lead to *Resourcefulness* being *low*. The distribution of responsibilities and a rigid BPS system could prevent resourcefulness of process participants to reveal itself. An investigation whether the participants would be resourceful in another environment needs to be conducted via interviews or a questionnaire.

Assessing *Scope* requires investigation of the breadth of context the participant take into consideration when completing their tasks, i.e. whether they are satisfied with the minimum information needed to complete a task or look at a wider picture. The latter could be the context of the given process instance or all process instances currently running. As with the previous parameters, this can be done via interviews, or analyzing a BPS system's logs if the latter traces the information a user access while completing a task. Again, beside actual breads of context used, it might be needed to investigate the attitude, in case the wider context is not easily available to the process participants.

### 3.3 Combination of techniques in use

Parameter *Combination of techniques in use* correlates with parameter *Scope* introduced for *Organizational culture*. To assess this parameter, we need to investigate the number of tasks that are completed taking into consideration the wider context, more exactly we need to know how many task are completed (a) without considering a wider context (b) considering the context of the given process instance, and (c) considering the context of all currently running process instances. Relating these number to the total number of tasks completed in a process instance and taking an average will give us data for establishing the combination of techniques. Note that in difference from *Scope*, we do not need to investigate the participants' attitudes here, just actual state of affairs.

### 3.4 Type of BPS

Assessing type of BPS consists of two parts:

1. Assessing IT systems/tools employed in BPS
2. Assessing how they are configured.

The first part is needed to understand the capability of a system/tool as such, for example, whether the tool provides shared spaces, allows to defined structured forms, has a capability to strictly define the order of tasks, has means to limit access to certain information, or to certain tasks, etc. Here, a framework drafted in [5] could be useful. The second part concerns how a system/tool is actually put in use. For example, assume that formally shared spaces exist, but access to them is limited in a way so that each participant has access only to his/her own shared space. Then, we cannot consider that information is transferred through shared spaces. Both 1 and 2 above requires some investigation, but this investigation is more of technical nature and could be easier to complete than investigation of parameters introduced for other quadrants.

## 4 Concluding remarks and plans for the future

The goal of this paper is to understand the challenges when assessing the four components of a socio-technical system. Though the discussion is strongly connected to a specific case, we believe that some generalization can be made based on this case, e.g.:

- Quadrant 1: A structure may not be documented, and even if documented may not reflect the reality. There may be a need to uncover the structure in order to assess it.
- Quadrant 2: It is not enough to investigate what actually happens, as the actual behavior might be enforced by other components, e.g., structure or technology. The attitude of people manning a given work system needs to be investigated as well.
- Quadrant 3: Here, it is enough to understand what is actually happening.
- Quadrant 4: It is not enough to look only on technology in use, its configuration needs to be investigated.

Our investigation in the problem of assessing parameters of a socio-technical system presented here is a preliminary one. The next step is developing and testing a detailed assessment methodology for the particular case presented in this paper.

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