Is People-Structure-Tasks-Technology Matrix Outdated?

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Abstract. The paper investigates whether the classical socio-technical matrix that differentiate 4 quadrants of social-technical system: people, structure, tasks and technology can still be useful for practical purposes. The paper gives a positive answer on the question, provided that the level of abstraction in defining these four quadrants is increased to deal with culture, type of structure, methods (techniques) and type of technology, as well as the idea of joint optimization is substituted with the idea of alignment. The paper presents some examples where the concept of the augment matrix has been used.

Keywords: socio-technical system, STS-matrix, alignment

1 Introduction

This position paper is devoted to the question of usefulness of a socio-technical matrix suggested in [1], which is depicted in Fig. 1, and will be referred to as an STS-matrix in this paper. The matrix presents a work system as consisting of two parts social and technical each of which is split into two parts of its own; *Social* part consists of *People* and (social) *Structure*, while *Technical* part consists of *Tasks* and *Technology*.

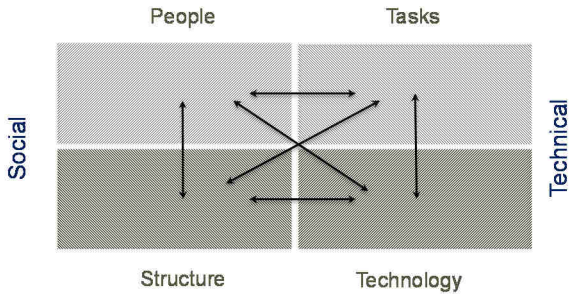

Fig. 1. Socio-technical matrix adapted from [1]

At STPIS 2015, Steven Alter presented his critical view on the usefulness of this matrix [2]. His critique concerns several issues:

1. Conceptual I. It is difficult, if ever possible, to separate social from technical, e.g. a task from the agent, when deciding what to place in the respective quadrants.

2. Conceptual II. It is difficult to understand what joint optimization of the four parts mean.
3. Practical. The methodology of how to analyze a concrete work system using the matrix is too complicated.

We agree with some of the above critique, particularly point 2 and 3 in the list. However, instead of regarding STS-matrix outdated, we are looking for new areas of application of the concept beyond using STS-matrix in its original form for detailed analysis of a specific system. The search led us to augmenting the STS matrix by increasing the level of abstraction in its quadrants. More concrete, instead of looking at specific people, we investigate organizational culture, mindset of a team, etc.; instead of investigating specific tasks, we look on techniques, methods, etc. used in this tasks; instead of looking at a specific structure, we investigate a type of structure; instead of looking at specific technology used, we investigate a type of technology. As the result, we get an augmented and generalized STS-matrix depicted in Fig. 2. Note that the idea of changing the level of abstraction comes from Stewart Kowalski who used it in the area of security [3].

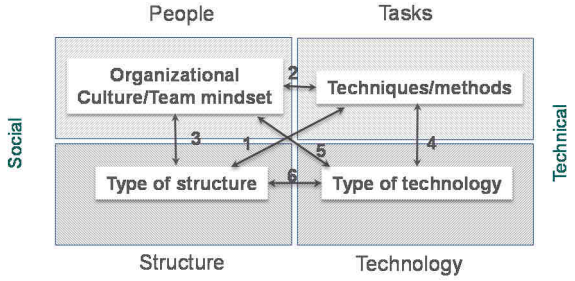

Fig. 2. Increasing the level of abstraction in STS-matrix

Besides increasing the level of abstraction, we substitute the concept of joint optimization with the concept of alignment depicted with arrows in Fig 2. All components of the socio-technical system should be aligned with each other for the system to work properly, which gives us 6 different kinds of alignments to analyze or achieve. Note that alignment is considered on the level of abstract categories, not specific people, tasks, etc. For example, using technology intended for cooperation, e.g., groupware, wiki, or a system based on shared spaces, will be aligned with organizational culture where people consider the internal environment to be collaborative, and misaligned with organizational culture where people consider the internal environment to be competitive. Introducing such a system in the competitive culture will fail (people will not use the system properly), unless the culture is also changed.

Besides internal alignment of the social-technical system, it should be aligned to the external environment. Any change in the environment as well as a change inside the system, e.g. changing the type of technology may require realignment of the whole socio-technical system.

The question that naturally arises from the suggestions above is which categories to choose when increasing the level of abstraction. We believe that there is no universal

answer to this question, the categories are chosen based on the purpose of using the STS-matrix. Thus, the matrix in Fig. 2 represents an architype that needs to be instantiated for a particular category of tasks, or a particular task.

We envision that the augmented STS-matrix can be used for (1) detecting and remedying misalignments in work systems, and (2) planning and completing interventions. In both cases, first an assessment of all four components of the system is done based on the abstract concepts in the matrix. This will give a model of the currents state of the system – as-is model. Secondly, an STS-matrix that depicts a desired state is drawn – to-be model. In case (1), this will be a matrix with misalignments removed. In case (2) this will be a matrix expected after intervention, e.g. introducing a new kind of technology, a new method of organizing work (e.g. going agile for a software development company), etc. Thirdly a plan of going from as-is to to-be is drawn based on comparing the as-is model with to-be model.

In the sections that follow, we will give some examples of how an augmented STS-matrix could be used.

2 Developing a framework

A version of augmented STS-matrix of the type in Fig. 2 has been introduced in a framework [4] for defining and achieving the right level of flexibility/standardization in Business Processes (BP) dependent on the process context. 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.

The framework introduces four different categories of contexts called Marketing Positions (MP) in which instances of a given business process are run, see Fig. 3:

MP1: **Exploration**: Entering a new market, e.g. with a new product, or with an old product but in a new geographical location
MP2: **Standardization**: Growing with an expanding market.
MP3: **Optimization**: Functioning in an existing competitive market.
MP4: **Freezing**: Control exit from a declining market

According to [4] the required level of flexibility/standardization of a business process depends on the type of context. In the exploration context, the process should be flexible, i.e. least standardize to allow to find a way to adjust to an emergent market. Standardization starts with the MP2 context to ensure efficiency needed to cope with problems of growth. MP3 requires even more standardization to create optimized processes in order to be able to compete in a stable market. Still, in this context, some flexibility is required to deal with deviating customer needs. In the MP4 context, such flexibility is not required and the process can be quite stringent.

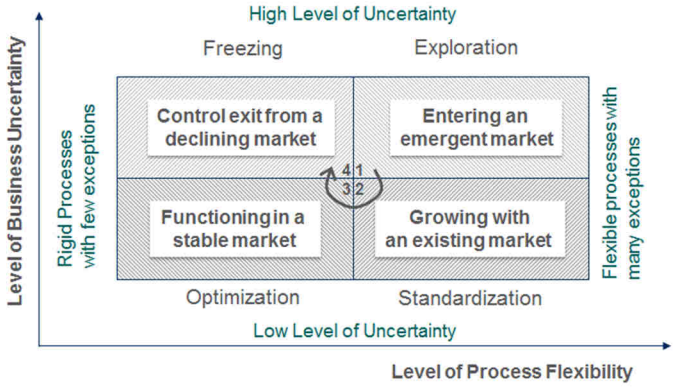

Fig. 3. Marketing positions that defines a type of context for a business process [4].

Four categories of process flexibility were introduced and defined in the framework and their correspondence to marketing positions was established. This four types were labeled as Loose (MP1), Guiding (MP2), Restrictive (MP3) and Stringent (MP4).

Establishing the needs for a certain level of flexibility/standardization is not enough for ensuring it. The next question would be how to establish whether the right level for a given business process type, e.g. sales, is achieved or not, and what to do if it is not achieved. For this end, the framework in [4] considers a work system related to a given business process as a sub-system (of an organization) responsible for starting and finishing process instances of the given type. Such 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.

To analyze a BPWS from the flexibility point of view, a variant of augmented STS-matrix was built, see the right hand side of Fig. 4. In the matrix, the concrete elements of the system are substituted by abstract concepts. In particular, a specific structure of the system – rules regulating process participants behavior – is replaced by process category; the latter is defined as one of the categories identified above for process flexibility – *Loose*, *Guiding*, *Restrictive* and *Stringent*. The substitution allows to connect external environment - context of the business process - with the internal one as shown in the left bottom corner of Fig. 4.

The development of the framework proceeded with defining other abstract concepts and rules of alignment between them. The concept of culture, for example, is defined via three parameters/variables: Worldview (competitive/collaborative), Resourcefulness (low/medium/high) and Scope – the size of context taken into consideration when completing tasks in the frame of process instances. The concept of Type of Business Process Support is defined via there parameters: Structuredness of data (low/medium/high), Orderliness of task flow (low/medium/high) and Information Logistics (Messaging, Shared spaces). The rules of alignment connect parameters of one abstract

concept, to the parameters of another; for example, a support system that uses *Shared spaces* (a technological parameter) is aligned with *Collaborative* world view (a cultural parameter).

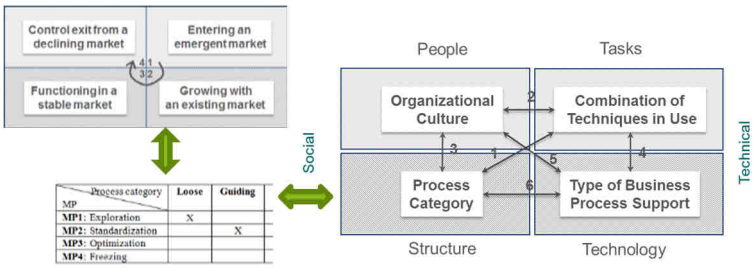

Fig. 4. Aligning socio-technical system to the external context.

The STS matrix in Fig. 4 and rules of alignment are envisioned as a tool for determining where the alignment is lacking and what should be changed to restore it. To apply the rules, each part of the social technical system should be analyzed to establish its nature according to the parameters of the corresponding abstract concept, more details see in [5]. Note that the STS-matrix in Fig. 4, though a specialization of the matrix in Fig. 2, remains on the metalevel. Substituting each concept with an assessment according to the parameters introduced for this concept produces a model of a specific BPWS that can be analyzed according to the rules of alignment.

3 Presenting a detected situation

The next example is related to the project presented at STPIS 2016 [6]. The project was a case study that concerned organizational transformation connected to the transition from manufacturing "dumb" products to "intelligent" ones. The case organization was an international automobile manufacture implementing the concept of "connected car" that converted a car from a "dumb" product to an intelligent one capable of communicating with the driver, other cars, a service station, etc. To implement the concept, the manufacturer created a special department CC (Connected Car) entrusted to provide all software for the connected car concept. The incorporation of CC in the organizational structure was not painless though, and the project goal was to analyze and diagnose the situation.

The analysis and diagnostics was perform using Viable Systems Model (VSM) of Beer [7] and pathological archetypes of Patrick Hoverstadt [8]. The analysis led to a describing a situation with the help of the "Stray lamb" pathological archetype. This archetype refers to a generic situation when a new and important department is not given a proper position in the formal and informal organizational structure. More concrete, CC department was seen and treated as a subcontractor to other departments involved in new car development, such as R&D, Services, etc. As the result, CC was

involved too late in the projects, and thus put in a difficult situation to design software against hardware that might not support the functionality requested in the software.

Based on the analysis, suggestions were made on restructuring the work around new car development so that CC was included in the organizational structure on the same footing as other departments participating in the development. However, such change would solve only part of the problem – organizational structure. A deeper problem lies in the fact that the traditional car development uses a different approach to managing projects than that used in CC. More exactly, while traditional development uses top-down planned development, the CC needs to use agile development to be in synch with changes happening in the highly dynamic area of Internet of Things (IoT). This difference means that integrating CC in the car development organizational structure goes far beyond making organizational changes; the whole socio-technical system should be changed.

To show the depth and breadth of changes, two augmented STS-matrixes were built: one represents the traditional car development, see Fig. 5, the other represents the new development where the concept of connected car plays the major role, see Fig. 6. In both matrixes the quadrants are aligned, thus comparing the two matrixes helps to understand the scope of changes needed to be completed. Note that Fig. 5 and 6 are not included in [6] but were presented at the STPIS 2016.

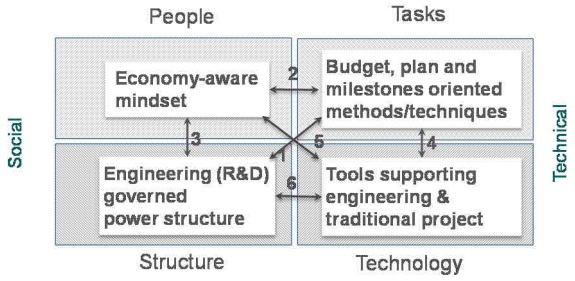

Fig. 5. An STS-matrix for traditional car development project

4 Concluding remarks

The goal of this paper is to discuss the practical usefulness of the "classical" STS matrix. Using examples from own practice, we have shown that the matrix could be of use, provided that the perspective on its content has been changed. The change consists of increasing the level of abstraction in each of the quadrants and focusing on alignment

between them and between the whole system and its environment (instead of joint optimization).

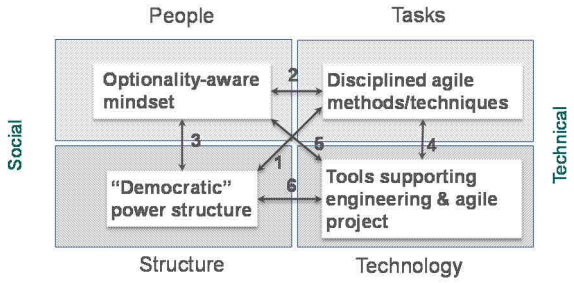

Fig. 6. An STS-matrix for new type of development

In the author's view, any method or tool has its right for existence when there is at least one person who can use it for some useful purpose. The classical STS-matrix has some area of application for some researchers and practitioners. However, as [2] shows, others have doubts regarding the usefulness of the classical matrix for their professional work, the author belonging to the rank of sceptics. Using the augmented matrix extends the area of applicability of the STS matrix in general and may attract even sceptics. Regarding three concerns from [2] (see Section 1 for the list), we believe they can be resolved when using the augmented matrix in the following manner:

1. *Difficulties in separation social and technical.* While it might be difficult to separate a task from a person who completes it, it might be easier to separate the social and technical on the level of abstract concepts, e.g. organizational culture vs techniques.
2. *Difficulties in understanding the concept of joint optimization.* Joint optimization is substituted by the concept of alignment, for example alignment between organizational culture and methods/techniques, which might be easier to understand, at least in each specific case. For example a culture, where each member of a team considers him-/herself as an expert in a narrow field could not be considered as aligned with the agile system development techniques [9].
3. *Too complicated methodology*. As our first example shows, instead of always using a general methodology, a specialized methodology for a particular class of tasks can be developed. Though development of a specialized methodology could be a formidable task on its own, when completed, it can be reused in many cases and by different analysts. As our second example shows, the augmented matrix can be useful, even when the investigation is completed using some other methods.

As it has been stated in the introduction, we envision two ways of using the augmented STS-matrix: (1) detecting and remedying misalignment, and (2) planning and completing an intervention (organizational change). The first example demonstrate the first type of usage, as the framework described aims at detecting misalignments, though it can also be used for intervention planning when the context of the process changes, which

would require changing the level of flexibility and aligning other parts of the socio-technical system to it. The second example demonstrates how the augmented matrix can be used for modeling a system of interest in as-is and to-be states in order to understand the scope of changes to be introduced during the intervention, and be able to plan them properly.

Note that as it has been mentioned in Section 2, to apply the rules of alignment when they are explicitly defined presumes that a system of interest has been assessed according to the abstract concepts introduced into the matrix. Such assessment, on its own, constitutes a challenging task, which is discussed in another paper that can be found in this proceedings volume [5].

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