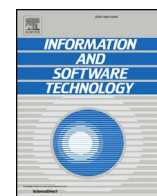




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A systematic mapping study about socio-technical congruence

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ABSTRACT

Context: Lack of coordination may create significant problems between work teams, this problem is even most critical when team workers are geographically distributed as it results in cost increases and delays in the projects. There exists a technique called Socio-Technical Congruence (STC) that aims at helping to measure and control the coordination level existing in an organization at their different levels.

Objective: The objective of this paper is to carry out a systematic mapping of the field of socio-technical congruence. The aspects of particular interest for this article are: Socio-Technical Congruence definition, different ways to measure it, available tools to measure or that can help to measure it, the areas of application, its benefits and the case studies that analyze the effects Socio-Technical Congruence has on the organization as regards the products quality and the improvements in performance in the long term development, in an attempt to characterize the state of the art of this field identifying gaps and opportunities for further research. Therefore, companies could use this work as a starting point to apply STC measures in their work teams.

Results: This paper presents the results of a systematic mapping of Literature about Socio-Technical Congruence (STC) in order to investigate and classify the existing articles and conferences about the subject, as well as summarizing the most important aspects in regards to provide a general overview about the existing studies.

Conclusions: After analyzing the 40 papers found, we can conclude that there is no one standard measure of socio-technical congruence, although most take the proposal by Kwan et al. applying adaptations and improvements on it as regards the environment that it will be focused on. In general, most case studies talk about the benefits of STC control in organizations. However, only one paper focus on global software development where the problems of communication, coordination and control are an important risk. Moreover, there are only a few papers that explore the risks of excessively overloading users with coordination iterations when controlling STC. In fact, no case study to examine these risks and their effect on developers' productivity has been found. The small number of studies found on STC, together with the research gaps we have pointed out, suggest that further investigation on socio-technical congruence is required.

1. Introduction

It is becoming increasingly common for development teams of software organizations to find themselves distributed and geographically separated. Distribution and modularity of software development have as their main objective to reduce labour costs, but this does imply implicit risks connected with coordination gaps [1]. Lack of coordination may create significant problems between work teams, all of which results in increases in costs and delays in the projects, and these effects could counteract the modularity and task externalization [2]. This issue is even more problematic in both distributed development and global software development; interest has thus grown in organizations as regards measuring, assessing and correcting the level of coordination reached among their work teams [1].

There exists a technique called Socio-Technical Congruence (STC)

that aims to help measure and control the level of coordination existing in an organization at its own different levels [3]. This is the concept of Socio-technical congruence, defined in [3](page 1) as follows:

“A technique to measure task dependencies among people, and the ‘fit’ between these task dependencies and the coordination activities performed by individuals”.

With the help of the right mechanisms, an organization can correct the coordination gaps early, thus avoiding possible misunderstandings caused by a lack of information that ends up delaying the work, or in the worst-case scenario, leading to the failure of the project [1].

Aware of the importance of this topic, the software factory (name is omitted by privacy) with which we are working on the LPS-BIGGER project (<http://www.cienlpsbigger.es/pt4-bigdata-en-el-software.html>) asked us to design and implement a tool that could be used to measure

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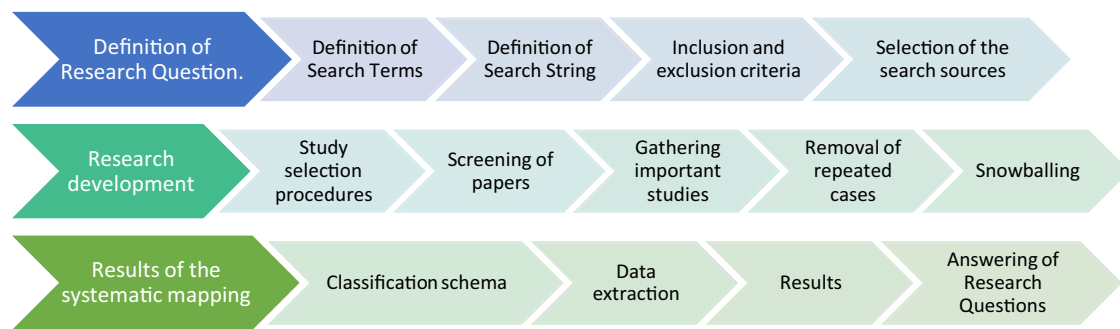


Fig. 1. Research protocol.

the STC in this company as it is very interested in monitoring the coordination among employees, projects and the different factories that this company has in order to detect a lack of coordination and prevent possible problems in advance. Before starting, we decided to analyse the related literature in order to discover which the best STC measure was and whether there was a tool that would fulfil the company's needs, in which case the company could perhaps buy it. After doing so, we realised that we had found no information about a standard measure for STC, best practices for designing tools to support STC or a tool that would fulfil our needs. In order to discover whether we had overlooked an important paper about the topic we therefore decided to perform a systematic mapping review. To the best of our knowledge, there is no previous systematic study in the field of socio-technical congruence. In our study we focus on a definition of socio-technical congruence, along with different ways in which to measure it, and discover the tools available to measure it, or that can help to do so, along with the areas of application. We also seek to look at the benefits and risks of measuring STC, along with the case studies that analyze the effects that socio-technical congruence has on the organization as regards product quality and improvements in performance in long-term development. We have thus attempted to characterise the state of the art of this field, identifying gaps and opportunities for further research.

This paper, then, presents the results of a systematic mapping of literature about socio-technical congruence, aiming to investigate and classify the existing papers and conferences about the subject, as well as to summarize the most important parts, so as to provide a general overview of the existing studies. The paper is organized as follows: [Section 2](#) presents the related work, and [Section 3](#) describes how the systematic mapping was planned. In [Section 4](#) a description of the search conducted in the study is set out. The scheme used to classify the papers obtained in the search is presented in [Section 5](#), while in [Section 6](#) we present the results we obtained during the study. The research questions are answered in [Section 7](#). Finally, [Section 8](#) summarizes the conclusions of the paper and outlines challenges that may lead to future research.

2. Related work

To the best of our knowledge, in the relevant literature there are no systematic literature reviews (SLR) or systematic mapping studies (SMS) which deal with all the issues that have to do with socio-technical congruence. It is true, however, that there is a partial systematic review by Betz et al. [4] that examines empirical research related to Conway's law and its application for cross-site coordination. Conway's law is therefore the starting point of socio-technical congruence. The research presented in [4] summarizes findings from a systematic review of empirical studies. These studies validate the importance of socio-technical congruence by looking at the pros and cons of congruent and incongruent scenarios, studying the evolution of socio-technical congruence over time.

There is also a piece of research from Portillo [1] that allows the state of the art to be established, giving a brief review of the different

metrics established for socio-technical congruence, as well as of their possible applications. The different metrics presented in this paper can be divided into two well-differentiated groups: metrics based on matrices and metrics based on social networks. Similarly, two main application areas for socio-technical congruence can be highlighted:

- Socio-technical congruence control oriented toward management: to help in decision-making processes.
- Socio-technical congruence control oriented toward the user: to raise awareness regarding changes in the work artefacts.

These data make it clear that a complete systematic review or a systematic mapping study are needed if we are to gain a thorough understanding of the state in which research into socio-technical congruence finds itself. Furthermore, in addition to the shortcomings that can be noted in the studies [1,4], it must be observed that they include only studies published until 2012 and 2011, respectively.

3. Search process

The purpose of this study is to determine and characterize the state of the art of socio-technical congruence in software engineering, analyzing the existing proposals and research work, thus identifying potential gaps, risks and opportunities for future research.

To carry out this systematic mapping, we followed the recommendations in [5,6]. In this section we present the planning of each step of the study: research questions, data sources and search strategy, along with the classification. We have based on in order to carry out the research protocol that has been produced to conduct the Systematic Mapping Study, as presented in Fig. 1.

3.1. Definition of research questions

The Systematic Mapping Study conducted helps to answer the following research question that was proposed in (RQ), and at the same time, this question has been divided into more questions (RQ1-8, see [Table 1](#)):

Table 1
Research questions.

Ref.	Questions
RQ1	How has socio-technical congruence been defined in literature?
RQ2	What are the properties of socio-technical congruence?
RQ3	What benefits and risks can socio-technical congruence provide to the organizations?
RQ4	What ways of measuring socio-technical congruence have been proposed?
RQ5	What are the pros and cons of different ways of measuring socio-technical congruence?
RQ6	In what areas can socio-technical congruence be applied?
RQ7	What kind of available tools help to measure Socio-technical congruence?
RQ8	What case studies have been published about Socio-technical congruence?

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