From Unknown to Known Impacts of Organizational Changes on Socio-technical Systems

Marília Guterres Ferreira[1, 2], Neil Maiden[2,] Julio Cesar Sampaio do Prado Leite[1]

[1]Pontifícia Universidade Católica do Rio de Janeiro (PUC-Rio), Rio de Janeiro, Brasil
{mferreira, jcspl}@inf.puc-rio.br
[2]City University London, London, United Kingdom
n.a.m.maiden@city.ac.uk

Abstract. Keeping organizations and their Socio-technical System (STS) aligned over time is a complex endeavour. We believe understanding the organizational dynamics of changes, and of the impacts these changes will have, can support the evolution of STSs. Reasoning on the organizational changes in advance also supports the development of an STS more likely to be aligned to the dynamics of the organization. This work presents the design and the application of a Dynamic Organizational Framework (DOF), constituted of a dynamic organizational model (DOM) on which to base the reasoning, a database of questions (DBQ) to explore possible organizational impacts, and a method to reason on changes and impacts within goal models. We apply this framework to analyse the impacts of the introduction of a system into the customers' attendance process in a Post Office in London. First results show contributions towards to the awareness about the organization, and to the quality and accuracy of requirements.

Keywords: Socio-technical systems, Software Evolution, Requirements Engineering, Organizational Model, Organizational Alignment, Goal Modelling, Goal Analysis.

1 Introduction

In order to enhance their performance in a rapidly changing environment, organizations continuously change, frequently, guided by strategic management plans. In this setting, organizational change creates new requirements for the deployed socio-technical system (STS), which, in turn, may also change the organization [1]. Over time, an STS presents inconsistencies and lack of compliance with new environmental requirements in which it was deployed, i.e. activities and business processes through which the organization intends to generate value; in other words, its business strategy. This lack of compliance is due to unforeseen impacts and demands the evolution of the STS which is a difficult, complex, costly, and time-consuming process. Our research aims to support stakeholders and organizational analysts in understanding likely organizational impacts of proposed organizational changes, as strategic changes, and then gain insights and reasoning on the impacts of these changes on the

STS' requirements evolution. Therefore we propose a Dynamic Organizational Framework (DOF) constituted of a sequence of procedures supported by a Dynamic Organizational Model (DOM), to understand organizational flow of impacts, and by a Database of Questions (DBQ), to elicit knowledge from organizational analysts. These techniques are meant to be used on information acquisition within the context of *goal* and *scenario modelling.* We use goal-oriented requirements engineering, specifically the i* framework, because it is suitable for modelling and analysis in requirements engineering, then we can model and understand stakeholders' underlying motivations for systems, identify the relation between the system and the organizational and business context, clarify and capture organizational changes, impacts and requirements from the analysis [2].

In order to augment our knowledge, we also apply scenario walkthroughs into the organizational impacts to analyse and capture requirements. The idea behind these impact scenarios walkthroughs is that people are better at identifying facts of commission rather than omission. From this, impact scenario walkthroughs offer stakeholders support to think about most likely impacts of organizational changes. If the identified impact is relevant to the system being specified but not yet handled in the specification, then a potential requirement change has been identified, and it is suggested to the developers to acquire and document the relevant requirements [3].

2 The Dynamic Organizational Framework

A project introduces a new STS (the designed thing) into the organization (the environment) and this introduction generates impact on the organization. Thus, the Dynamic Organizational Framework aims to support the elicitation of organizational changes and reasoning about potential impacts on and from both the organizational and the STS. Hence, it is constituted of a sequence of activities assisted by a Dynamic Organizational Model (DOM) and by a Database of Questions (DBQ). These support tools were developed through extensive literature review, application in real cases and recurrent refinements, summarized as follows. First, to understand the flow of changes and impacts in organizations, we initially must understand the organization itself. Hence, we based our model on Jay Galbraith's Star Model, the most widely-used and accepted organizational design framework [4]. This model relies on the following five *dimensions* of an organization: *Strategy:* determines the direction of the organization; *Structure:* defines the placement of power and authority in the organization, the location of decision-making power; *Processes:* outlines the flow of information, cut across an organization structure and determines its functioning; *Rewards:* influences the motivation of people to perform and address organizational goals; *People:* defines and influences the employees' mind-sets and skills to implement the company's chosen direction. Through exploratory literature review and applications in real experiences, we identified *elements* for each of the five ends of the Star Model. The resulting first version of the organizational model, then formed by organizational *dimensions* and respective *elements*, was used as a base in a workshop to discuss organizational changes brought up by a Learning Management System in a University.

Data from the workshop showed a *flow of changes and impacts* within organizational dimensions and the consequent need to incorporate organizational dynamics in the model.

Therefore, we conflated our model to the Configuration Model of Organizational Culture (CMOC) [5], making the necessary amendments. Besides dynamic relationships, the CMOC also maps interactions from the organization with the external environment, which demanded more research on their respective elements. Our final DOM is depicted in Fig. 1. Now, each organizational dimension is connected by *flow of impacts* (arrows left-to-right) and *flow of adjustments* (arrows right-to-left).

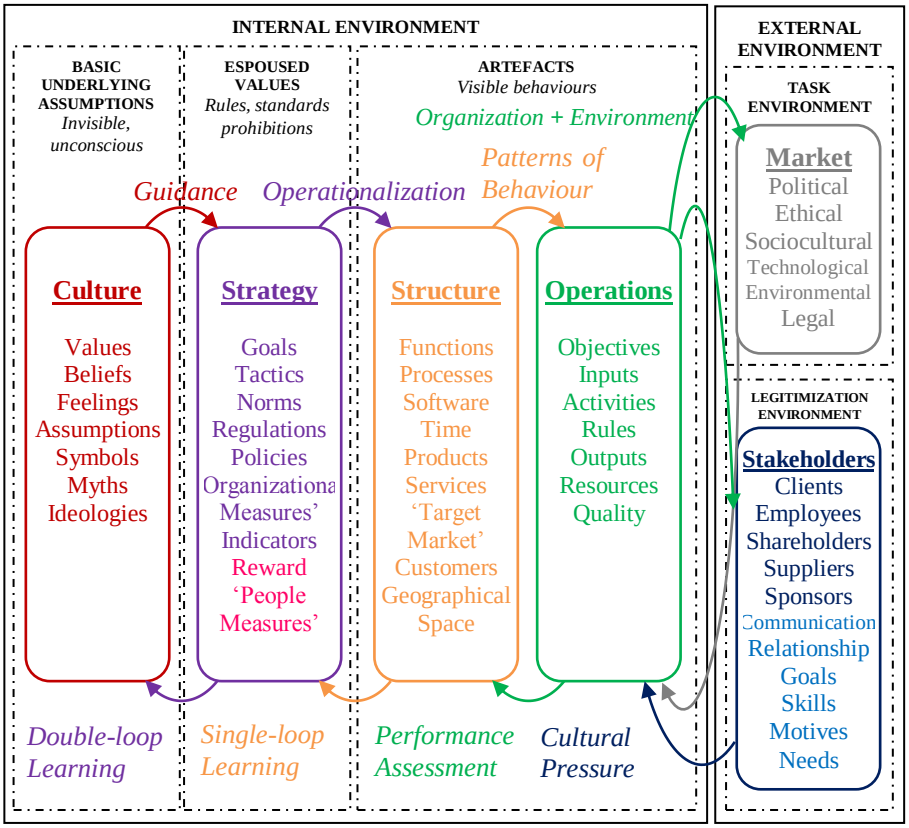

Fig. 1. Dynamic Organizational Model (DOM)

In order to elicit knowledge from the stakeholders about organizational changes and impacts, we constructed a database consisting of *88 questions* (DBQ). These questions are grounded on the organizational *elements* and organized in *10 sets*, corresponding to the *5 flows of impacts* (arrows left-to-right in Fig. 1) and to the *5 flows of adjustments* (arrows right-to-left in Fig. 1) within the organizational *dimensions*. For example, consider the generic organizational change *"Sell new product X"*. First we identify the organizational *dimension* which better fits it: this is a new *Strategy* and by it, we start our *flow of reasoning* according to the flow of impacts on the dimension

Structure. For that, we apply questions from the set: *Operationalization*. One of the questions is: "*What new processes are needed to implement this new strategy?*". Possible answer: "*Sell product X*". Then, flow of impacts on *Operations*, set *Patterns of Behaviours*: "*What are the activities needed to this new process?*", answer: definition of specific activities. Following, flow of impacts on *Stakeholders*, set *Legitimacy Management*: "*What skills are needed from the employees closer to the change?*", identification of necessary skills. Now, we can start a flow of adjustments, regarding the findings. Set: *Cultural Pressure*: "*What operational adjustments are needed to satisfy employees' goals?*". Flow of adjustment, set *Performance Assessment*: "*How does the new functions relate to existing functions?*". And so on.

We summarized the procedure steps of the DOF as follows:

1. **Stimulating Organizational Awareness:** to boost organizational awareness, requirements engineers and organizational analysts model the *As Is* and start modelling the *To Be* contexts using i*.
2. **Identification of organizational changes:** From the comparisons between the models, the participants identify the organizational changes (new elements in the To Be models) between the two contexts.

For each organizational change (new element):

3. **Identification of the type of change:** (i) Participants decide on one change (new element); (ii) Using the DOM, participants chose one *organizational dimension* that better represents the change (strategic, structural, operational, related to people, related to market, or cultural);
4. **Identification of the flow of reasoning to follow:** in order to stimulate a natural flow of reasoning, for each change participants can choose from either the *flow of impacts* or the *flow of adjustment*, according to their own insights regarding the DOM.
5. **Identification of impacts:** (i) According to the type of change and to the chosen flow of reasoning, participants use the *questions* from the matching set in the DBQ to identify the likely organizational impacts. (ii) When necessary, to facilitate the reasoning of the participants, they construct *As Is* and *To Be scenarios* of key use cases of the future system corresponding to the previously identified organizational change. (iii) By (vertically) *walking through the scenarios*, once identified changes between them, participants (horizontally) apply the questions, annotate the organizational changes (the answers of the questions) and the organizational impacts following the flow of reasoning they came up.
6. **Identification of requirements changes:** then, from the identification of likely organizational impacts, participants analyse the possible *impacts on the STS'* requirements.

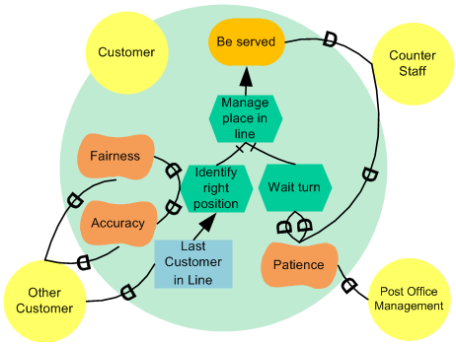

Fig. 2: SR of Post Office (*As Is*)

The procedure ends when analysts are satisfied with the exploration of likely impacts. The flow of reasoning can follow

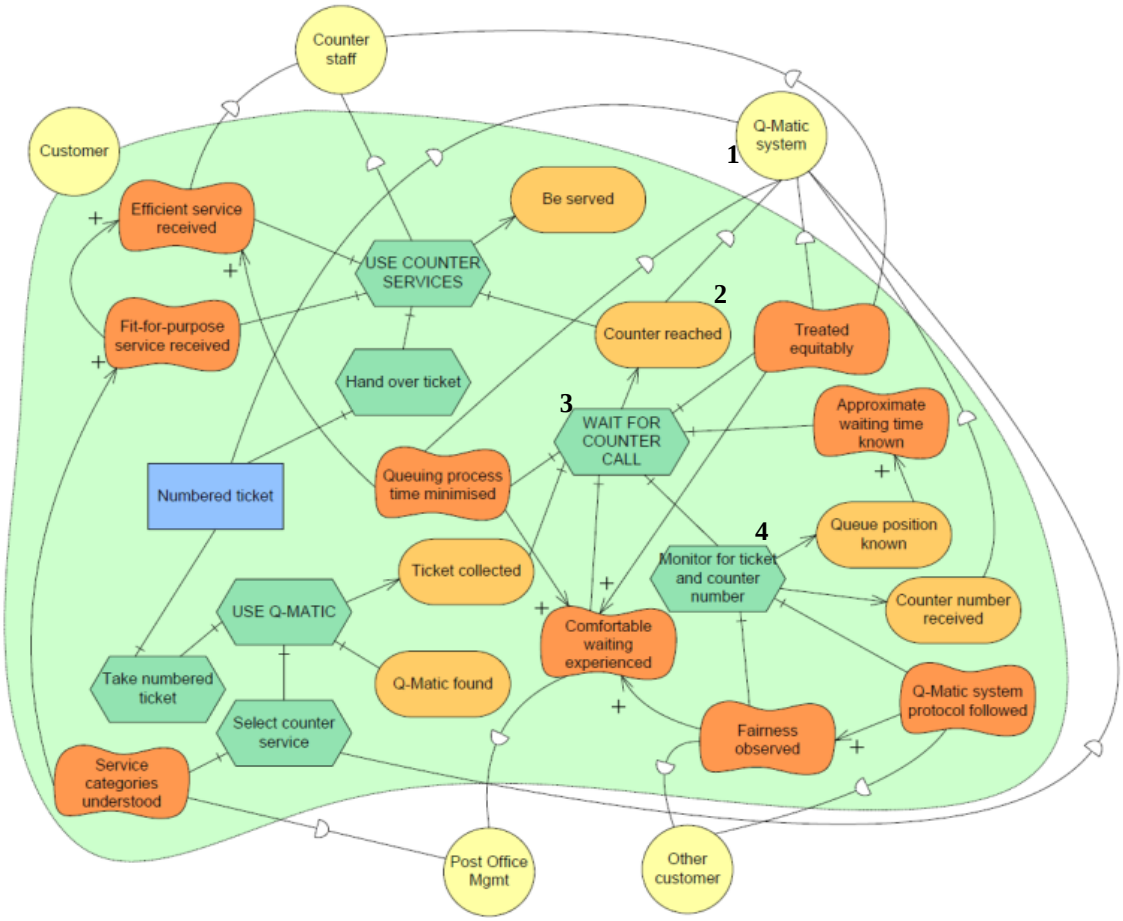

Fig. 3: Strategic Rationale of Post Office (To Be) (with IDs presented in Table 1)

unlimited flows of impacts and flow of adjustments since one change may bring infinite impacts in different organizational dimensions. The last version of the DOF was applied in a real case of organizational change occurred in a Post Office in London, and the method of application is as follows: we present the As Is SR model in Fig. 2 and the To Be in Fig. 3. A summarized flow of reasoning is illustrated in Table 1.

By the end of the study of the Post Office case, the authors identified 18 main changes, explored 6 different flows of impacts, and identified 51 possible organizational changes and consequent 40 STS' requirements changes, which if implemented correctly, will minimise undesirable effects of the impacts. The abstraction level of the requirements varied, for example, we found a need for entire software to support new services, as "Post and Go", and we pointed 10 different specific indicators to be extracted from data gathered by the STS. As the DOF is based on the participant's reasoning, the results and flows of impacts diverse from participant to participant, since it is a representation of the perceptions of the person to whom the DOF is being applied.

3 Conclusion

In this paper we presented our Dynamic Organizational Framework (DOF) to elicit and reason about organizational changes and impacts within goal models and scenario

walkthroughs so that stakeholders can analyse the consequent impacts on STS requirements. First results show contributions towards requirements quality and accuracy; it brings a better understanding of organizational dimensions, elements and impacts of organizational changes, contributes to organizational learning and consequently enables the development of more powerful STS. In the future, we are going to validate this proposal in other cases; make a thorough comparison with related researches [6]; extend the model to address impacts on external organizations; develop a tool to support the DOF; study creative techniques to boost thinking about impacts; and apply the DOF to analyse the relationship between Software Transparency and Power Dynamics in Organizations.

Table 1. Summarized rationale of the application of DOF

ID	Type of change	Direction of Flow	Question	Organizational Answer	Impact	Requirement
	i*					
1	**New system** (Structural)	Patterns of Behaviour	How does this structure relate to the *objectives* of the system?	Controls attendance of customers by counter staff (Be served || counter reached)	New goal (2)	N. A.
2	**New Goal** (Operational)	Patterns of Behaviour	Is any *activity* needed?	The customer should wait for counter call	New task (3)	STS shall call the customer by number.
3	**New Task** (Operational)	Patterns of Behaviour	Is any *activity* needed?	The customer should monitor for ticket and counter number	New task (4)	STS shall print the ticket with the queue number accurately.
Impact Scenarios Walkthrough (continuation)						
Scenario	**New Quality** = *Transparency of the Queue*	Single-loop learning	Does this new structure bring new *organizational measures*?	Total amount of customers: .[day|month|year]. .served on counter .using services. .buying products.	Now it is possible to control the flow of the queue.	STS shall calculate the total amount of customers: .[day|month|year]. .served on counter .using services. .buying products.

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