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Abstract

Purpose – This paper focuses on organizational change through the business process management approach. While "business process modeling" permits understanding process activities and their activities with other participants, "current reality tree (CRT)" technique promotes the identification of process constraints. The purpose of this study is to compare the results from applying both diagnostic techniques, process modeling, using the business process modeling notation, and root cause analysis, using the CRT.

Design/methodology/approach – The comparison is made using a pre-experiment in which two teams conducted diagnoses concomitantly in the information technology management (ITM) process of one unit of the biggest and prestigious higher education institution (HEI) in Brazil.

Findings – The modeling technique and the CRT should be considered complementary techniques, since applying one does not diminish or exclude the importance of using the other. Results were compared analyzing which dimensions of the process each technique highlighted: strategy, organization, activity/information and resources.

Research limitations/implications – A possible limitation of this research is that the experiment was conducted in a single process and the result cannot be generalized to other processes.

Practical implications – It may be noted that the main contribution of this study is the presentation of the steps of two techniques for process diagnosis. It is expected that with the reports on diagnoses outcomes, team's assessment and the perception of the managers presented here other improvement teams may use the results of this research as an inspiration to perform process diagnosis, and as basis for decision making to define which technique to use according to the specific needs of process improvement.

Originality/value – The paper stands out the comparison of the technique application's outcomes. This study offers valuable insights to the organizations that are interested in restructuring their processes. It delineates many important benefits of such a diagnosis techniques. It also identifies possible pitfalls and recommends guidelines for the successful conduction of process diagnoses initiatives.

Keywords Comparative method, Organizational change, Change management, Business analysis, Modeling, Organizational processes

Paper type Research paper

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1. Introduction

Due to the highly competitive environment and the growing consumer demands, organizations use several tools and methods of management aimed at achieving truly competitive advantages. Many management approaches emerge in the attempt to have companies survive and stand out in this scenario. There is a tendency for organizations to opt for a management approach focused on processes rather than a functional approach due to factors like: increase in product development frequency, need for rapid transfer of information, quick decision making, need to adapt to changes in demand and a growing number of international competitors (Seethamraju and Marjanovic, 2009).

Neubauer (2009) underscores some challenges organizations are currently facing, such as the constant changes in business requirements, the reduction in product and service life cycles, international competition and growing cost pressure. Ponsignon *et al.* (2011) emphasize the importance of contingency studies and characteristics of processes related to service providing. In this context, there is a growing number of organizations implementing the business process management (BPM) approach, since this approach allows organizations to quickly adjust (Kujansivu and Lönnqvist, 2008; Neubauer, 2009) and focuses on generating value for the client (McComack *et al.*, 2009). Furthermore, managers shall develop greater understanding and awareness of their business process and obtain a more in-depth understanding of their immediate area of responsibility (Bititci *et al.*, 2011) for dealing with challenges.

According to Association of Business Process Management Professionals (ABPMP, 2009), BPM is a method for identifying, designing, executing, documenting, measuring, monitoring, controlling and improving automated or non-automated business processes to achieve results more aligned to organization strategies. This approach demands a permanent and continuous organizational commitment, conducted through the implementation and management of a continuous life cycle model, which has well defined and replenished phases that establish managerial guidelines for the organization which is the basis for it to always be in a continuous improvement process and, consequently, its processes aligned with its strategic objectives. The BPM life cycle involves the following gradual and interactive phases:

- planning;
- diagnostic;
- design and modeling;
- implementation;
- monitoring and control; and
- refinement (ABPMP, 2009).

In general, BPM approaches propose an improvement cycle encompassing the strategy definition, modeling and diagnostic of the current situation, definition of the change project portfolio, and project development phases (Burlton, 2001; Smith and Fingar, 2003; Jeston and Nelis, 2006). For the diagnostic phase, literature emphasizes the use of process modeling techniques (as-is modeling) (Weske *et al.*, 2004; ABPMP, 2009) with few authors suggesting other techniques for conducting the diagnosis. Most especially, Costa and Rozenfeld (2007) suggest the current reality tree (CRT) technique for more ample diagnosis of the business processes.

This paper focuses on organizational change through the BPM approach, especially in the diagnostic phase, since during a BPM cycle it is advisable to conduct diagnoses before carrying out any organizational change (ABPMP, 2009). Two gaps in the academic literature were found. The first is related to process modeling. Studies are lacking on the characteristics of information collected by this type of technique to check whether it exhausts the raising of several types of information, or whether it could be complemented (or even replaced) by another technique, meeting the different objectives of each diagnosis. While process modeling permits understanding the activities of processes and their interactions with other participants, the CRT identifies process constraints. The second gap is the lack of studies that compare process modeling with other diagnostic techniques, especially with the CRT construction technique. It is in these two gaps the paper aims to contribute with academic literature, trying to respond the following research questions:

RQ1. Do business process modeling and the CRT complement each other when conducting a diagnosis?

RQ2. In which situations should the improvement team opt for applying each or both techniques?

The objective of this study is to compare the results from applying these two diagnostic techniques, process modeling, using business process modeling notation (BPMN), and root cause analysis, using the CRT. This comparison is made using a pre-experiment in which two teams conducted two diagnoses concomitantly in the information technology management (ITM) of one academic unit of the biggest and most prestigious higher education institution (HEI) in Brazil. The results of the diagnostics were compared and team and sponsor satisfaction were evaluated.

In the next section, the literature review is presented focusing on the BPM life cycle, process modeling and the CRT technique. The research methodology is then discussed, and finally, the results. After that, discussions are conducted and in conclusion, the final remarks, indicating future studies.

2. Literature review

2.1 BPM lifecycle

A process-oriented organization seeks to achieve organizational strategic goals through improvement, management and control of critical processes (Jeston and Nelis, 2006). This management form implies the need to change how the organization works, requiring an enormous effort, creating the need for new management methods and tools implementation (Kohlbacher, 2010). The continuous improvement of business processes is relevant to BPM efforts typically achieved by a BPM lifecycle (Houy *et al.*, 2010).

The lifecycle and several of its phase descriptions vary depending on the authors (Harrington *et al.*, 1997; Burlton, 2001; Smith and Fingar, 2003; Khan, 2003; van der Aalst, 2004; Weske *et al.,* 2004; Muehlen and Ho, 2005; Havey, 2006; Jeston and Nelis, 2006; Kirchmer, 2006; ABPMP, 2009). The BPM lifecycle proposals differ in regards to the order and time of the execution of the phases (Houy *et al.*, 2010). The nomenclature and phases of these cycles may also vary. There are cycle proposals by authors in which there is a predominance of cycles with four or five steps, however, what remains is a cycle similar to the model proposed by ABPMP (2009) (Table I) to be used in this study for being the result of one of the main practice communities for the integration of the available subject knowledge.

Table I.
BPM lifecycle adapted from ABPMP (2009)

Phase	Description
Planning	Plan and strategy development toward processes. Understanding strategies and goals of the organization, offering structure and guidance for continuous process management centered on the client
Diagnostic	Understanding the organizational processes in the context of goals and desired objectives. Assimilates strategic planning information, process models, performance evaluations, and environmental change to understand the business processes within the organizational scope. Understanding the process involves process modeling and evaluation of environmental factors that have influence
Design	The design involves the creation of new specifications for new or modified processes. The design defines what is expected in the process defining appropriate metrics and managerial controls. Document the process as it should occur, with improvements
Implementation	Practical realization of defined activities, adapting the way to the players act
Monitoring/control	Providing information so that managers adjust resources to the processes' objectives, generating performance information with metrics related to goals and value
Refining	Implementation of the iterative analysis result and drawing cycle

Most of the cycles can be summarized by:

- planning;
- diagnostics;
- design/modeling;
- implementation;
- monitoring/control; and
- refinement (Table I).

The process "diagnostic" is important for a common understanding of the current status of a process and for verifying whether the process is aligned to the organization's strategic objectives (ABPMP, 2009). This phase is the focal point for this study. Several diagnostic techniques can be used during the process diagnostic; the two diagnostic techniques used in this study are detailed below.

2.2 Process modeling

ABPMP (2009) defines process modeling as a simplified representation of a set of end-to-end activities (processes). The models are traditionally comprised of diagrams and include information about the activities of the processes, about the interrelations between these activities, about the relations of the activities with the environment, and about the behavior and performance of these processes. In order to model the process, it is necessary to detail it in its constitutive activities. Using business process modeling the information is processed and represented in process models (Eikebrokk *et al.*, 2011).

Process modeling, among other techniques, contributes toward validation of a process improvement project. It enables the consolidation of knowledge, the identification and formulation of changes, in accordance with the future objective and needs of the current situation. That is why it is necessary to choose proper methods and techniques for the context of each situation. The modeling can be applied to analyze how the process is ("as is situation"), to support the design of how the process should be

(Harmon, 2007) and to propose the best option of changes to be implemented, given the organization's real conditions (ABPMP, 2009). For this study, process modeling is used during the analysis of the process ("as is situation").

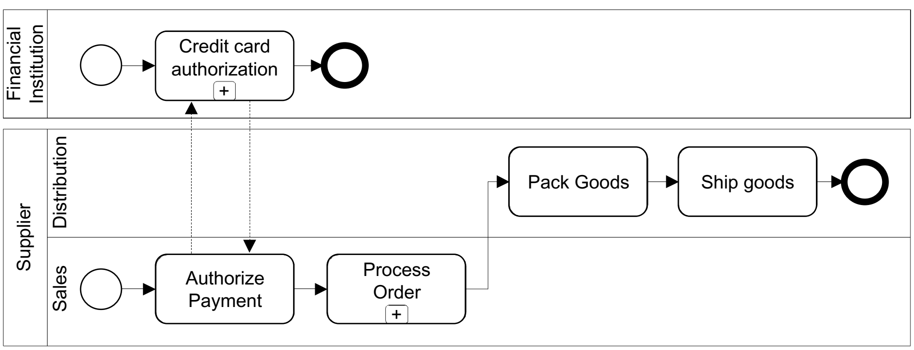
According to ABPMP (2009), there are two approaches for modeling the processes: top-down or bottom-up. Choice of the approach shall depend on the objective and the scope of the process modeling. The bottom-up approach can be indicated when there is no documentation of organizational processes and it is necessary to understand what the process is and how it occurs. If the intention is to improve end-to-end inter-functional processes, encompassing the entire organization and promoting better alignment between processes and strategy, the indicated approach is top-down (ABPMP, 2009). This study uses the top-down approach.

There are several forms of notation that can be used in process modeling, such as flowcharts, lanes, event-driven process chain (EPC), value chain, BPMN, among others (ABPMP, 2009). This study used BPMN, because it is standardized, used in the design and modeling of processes that also attempt to facilitate the implementation of process management (OMG, 2008).

Although it is a relatively new notation standard (officially launched in 2006, by OMG and Business Process Management Initiative (BPMI)), no other notation has become so widely used in such a short time and with such ample support by commercial and educational organizations, even influencing other forms of previously existing notation (Recker, 2010). Among the advantages of BPMN indicated by Ko *et al.* (2009) improved dialogue between management and information technology areas and greater ease in developing process execution codes called Business Process Execution Language (BPEL) stand out.

According to Rozman *et al.* (2008) BPMN is a graphic notation that permits process modeling of all important process concepts, such as, process, activity, event, routing, fusion, synchronization, messages, roles and others. The BPMN permits focusing on the informational perspective of a process, for example, in the tasks and information flows involved (Cull and Eldabi, 2010). Figure 1 shows part of a process modeled with BPMN.

Muehlen and Indulska (2010) claim that like other modeling languages, the use of BPMN is not sufficient to represent the business rules adequately. However, it is noteworthy the usability of this notation. Rozman *et al.* (2008) conducted a survey with



Source: OMG (2008)

Figure 1. Modeled process with BPMN

39 students that revealed a positive attitude by users concerning the usability of BPMN and its support tools. Thus, despite BPMN models still need to be better developed (Bi, 2010), one cannot argue about the benefits previous mentioned.

2.3 Current reality tree

The CRT consists of a theory of constraints (TOC) tool (Goldratt, 1994). This theory is based on a thinking process and has tools that provide subsidies for describing the current reality of an organization or a process. The TOC provides the focus for the continuous improvement process. It provides tools for answering three basic questions: what to change? Why change? How to cause this change? (Rahman, 2002).

CRT is one of the tools of this theory, used in the description phase of the reality of a process experienced in an organization. Through this tool, it is possible to obtain a general view of the current situation of the company and organization, that is, the CRT helps answer the question "what to change?". The CRT is constructed to help the organization identify constraints in a process, called undesirable effects (UEs) or problems. The term "tree" is used because father and son type cause and effect relationships are created among the UEs, "reality" due to the UEs are the perception of people about reality; and "current" because it is the perception of people of a specific situation in a specific period of time (Scoggin *et al.*, 2003). Therefore, CRT can be concluded as a root cause analysis diagnosis technique.

As illustrated in Figure 2, UEs are logically linked by means of causal relations. The UEs connected by arrows represent the effect caused by UEs from the tails of the arrow, thus, reading the CRT from top to bottom it is possible to notice that the main effect 1 is caused by UEs 2-4, and so on.

As seen in Figure 2, a significant majority of the UEs is caused by other UEs. Therefore, it is essential to classify the UEs in order to achieve a better understanding of which UE should be prioritized to be eliminated or minimized. The UE at the top of the tree is called main effect because it does not cause another effect; and these are the

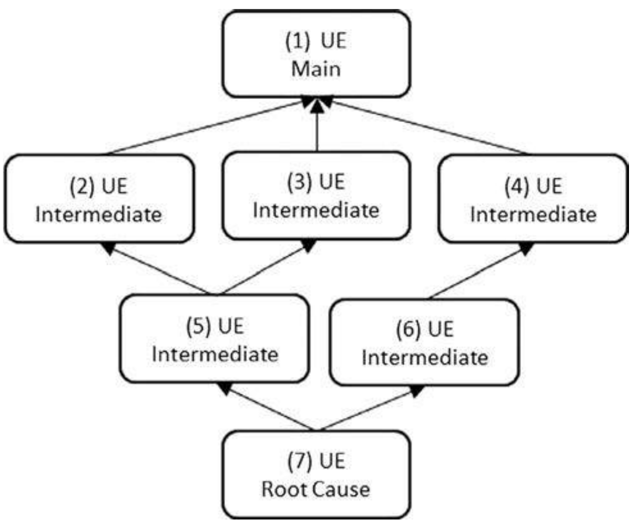


Figure 2.
CRT example

UEs that people are more conscious about and are more noticeable. The UEs located in the middle of the tree are called intermediate effects; some of these effects cause various other effects, therefore, when they are identified, it is important to make an effort to seek its elimination. Finally, at the base of the tree, are the root causes. These are the effects that originate all other UEs. The importance of the root causes is not generally perceived on a daily basis by those involved in the process and, therefore, its identification is the main goal when creating the CRTs. The improvement projects should aim at eliminating the greatest number of UEs and this can be achieved in an efficient manner when treating root causes (Goldratt, 1994).

In dealing with a CRT construction technique, several authors have customized the classic technique proposed by Goldratt (1994) (Rahman, 2002; Reid and Cormier, 2003; Scoggin *et al.*, 2003; Patwardhan *et al.*, 2006; Taylor *et al.,* 2006; Walker and Cox, 2006; Costa *et al.*, 2011). Table II presents a comparison between these techniques. In general, five activities are proposed: know the object of study, conduct interviews, formulate UEs, associate UEs, and validate CRT. Costa *et al.* (2011) proposes tree new activities, which are, plan diagnostic, prepare interview guide and identify improvement opportunities. For this study was selected the Costa *et al.* (2011) technique, once it highlights and deeply details the activities regarding the improvement opportunities identification.

Although a CRT construction is simple, it requires sophisticated reasoning, as UEs are the perceptions of people about something that bothers their system/process. For this reason, the CRT construction team should be careful to avoid the inclusion of only its own perceptions in the tree, because this could result in a tree that reflects a personal view rather than a common organization reality view accepted by the team. This risk can be eliminated through interviews with as many people as possible and by creating a team composed of members from different areas of the company for the validation of the CRT.

3. Research methodology

The aim of this study, as previously mentioned, is to compare the results from applying two techniques of process diagnosis: process modeling using the BPMN standard, and the cause and effect tree, using the CRT technique. To achieve this goal, we performed a pre-experiment to observe the different results produced by

	Authors					
Activities	Reid and Cormier (2003)	Rahman (2002)	Walker and Cox (2006)	Scoggin *et al.* (2003)	Taylor *et al.* (2006)	Costa *et al.* (2011)
Plan diagnostic						x
Know the object of study	x		x			x
Prepare interview guide						x
Conduct interviews	x		x		x	x
Formulate UEs	x	x	x	x	x	x
Associate UEs	x	x	x	x	x	x
Validate CRT		x		x	x	x
Identify improvement opportunities						x

Table II. Comparison of CRT construction methods both techniques. It is noteworthy that accordingly to Malhorta (2004), an experiment is a study in which an intervention is deliberately introduced to observe its effects. The experiment conducted in this study should be classified as a pre-experiment, because it was performed with two units of comparison (Malhorta, 2004). However, in this study it will be mentioned only as experiment. The research protocol is presented in Table III. To guide the comparison of the techniques' results, a deployment of the main objective of the experiment was performed as shown in Table IV.

The diagnoses were carried out in the ITM process at one of the largest and most recognized HEI in Brazil. The unit mentioned offers five undergraduate courses, as well as postgraduate courses and Master's or Doctorate degrees, covering more than 3,000 students. This unit has over 90 professors and more than 60 employees in their organizational structure. It is inserted into an internationally recognized institution that offers undergraduate courses in all areas of knowledge, with 240 courses in total, spread over seven campuses and two centers for specialized research. The institution as a whole has a more than 6,000 faculty members, with more than 1,800 research centers.

Table III.
Research protocol

Research questions	Do business process modeling and the CRT complement each other when applied for process diagnosis? In which situations should the improvement team elect for applying each or both techniques?
Unit of analysis	ITM process in one of unit of the biggest HEI in Brazil
Time frame	March 2011 to December 2011
Application site	One unit of the biggest HEI in Brazil
Validity of the constructs	Theory-and-practice contraposition, based on the state-of-the-art of the theme
Internal validity	Evaluation of the improvement opportunities identified in each diagnosis Interview with team members and the manager of the target process as a source of evidence
Elementary questions to compare the results of each diagnostic technique	What are the problems and improvement opportunities identified? What is the team satisfaction regarding the use of each technique? What is the organization satisfaction regarding the use of each technique?

Table IV.
Deployment of experiment objectives

Main objective	Specific objectives	Deployment of objectives
Compare CRT and modeling methods results with BPMN	Analyze the problems (Doggett, 2005; Mahto and Kumar, 2008) and opportunities of improvement identified (Elzinga *et al.*, 1995) Assess team satisfaction (Doggett, 2005; Mahto and Kumar, 2008) Assess organizational satisfaction (Jeston and Nelis, 2006; Trkman, 2010)	Dimension analysis of the process diagnosed (problems) Analysis of process dimensions that need to be improved (opportunities) Analyze execution difficulties Team motivation analysis Necessary knowledge analysis Satisfaction analysis with the obtained results

The experiment was conducted with the voluntary participation of a group of 11 postgraduate students during the BPM class from the postgraduate administration/management program from the same educational institution. Students were randomly divided into two teams (Table V). Both teams carried out the diagnoses concurrently investigating the same case and interviewed the same people. The team that performed the process modeling was called the BPMN team and the one that applied the CRT diagnosis was called the CRT team.

Scholars and employees from the mentioned academic unit participated in the experiment. The selected team to be interviewed in the experiment consisted of six employees, with various responsibilities related to computing and media. The objective of the ITM process, before starting this project was to manage, provide and maintain technology-based solutions and information systems for the academic and the financial-administrative area of the HEI. In order to achieve this goal, ITM offered five services:

(1) software development;
(2) loans and management of audiovisual equipment;
(3) hardware maintenance;
(4) server maintenance; and
(5) network infrastructure management.

Following the experiment results are described.

4. Results

4.1 Modeling application

The process modeling activities were conducted in five phases:

(1) planning of the diagnostic;
(2) interviews;
(3) process modeling;
(4) proposition of improvement projects; and
(5) final discussion (Figure 3).

Team	Education		Previous diagnostic knowledge level	Previous participation in process diagnosis
	Under-graduation	Post-graduation		
CRT	Administration	Master's program	Medium	No
	Administration	Master's program	Poor	No
	Administration	PhD program	Poor	No
	Environmental engineering	Master's program	Poor	No
	Administration	PhD program	Poor	No
	Administration	PhD program	Poor	Yes
BPMN	Information systems	Master's program	High	Yes
	Administration	Master's program	Medium	Yes
	Environmental engineering	PhD program	Poor	No
	Administration	PhD program	Medium	No
	Information systems	PhD program	Medium	Yes

Table V. Description of participants

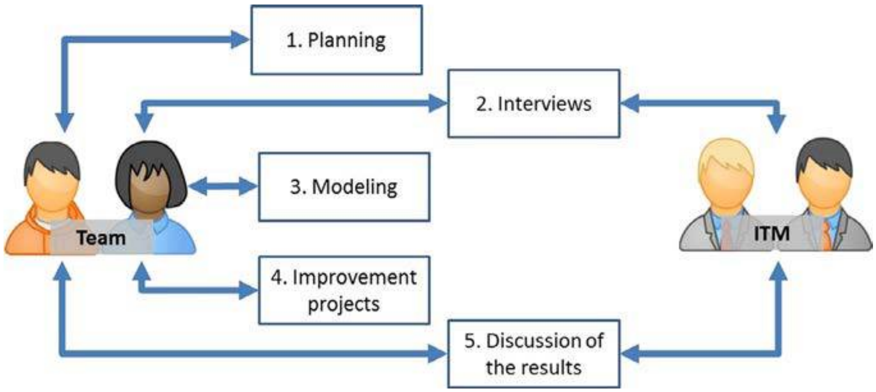


Figure 3.
Phases followed during the process modeling

During phase 1 "planning the diagnostic", the responsibilities were assigned to each team member, a guide was developed to conduct interviews and interviews were scheduled with the ITM personnel. The team determined that the interviews would always be conducted by two team members to guarantee the effectiveness of the search and registry of information.

In the second phase, interviews were conducted in two stages: first, general interviews were conducted with members of the ITM personnel, in order to understand the overall purpose of the processes, their main responsibilities and the macro-process; and in the second phase, specific interviews were conducted with members of ITM personnel, for detailed information about the activities and information flow, besides the control transmissions and relationships with other processes and participants (customers, for example). In all, six participants from ITM were interviewed: manager, audiovisual and computer technicians, and programmers. The involvement of the ITM personnel was partial, since, although initially motivated, collaborator's availability and motivation were reduced throughout the project, making the interview stage more difficult.

From the interviews, the third stage, process modeling, has been initiated. The team held internal discussions in order to organize all the information collected and understand the current situation of the processes (as is). For the process modeling, free software was used called the Intalio Designer[1]. It is noteworthy that the current situation of the processes was partly modeled, since the participants in the ITM had difficulty in reporting their activities related to each process and defining the responsibilities of each member. A second important point to modeling was the transition period of coordination in which ITM was at that time. Several changes in the activities were taking place at the same time. The current situation was understood from the reports and observations, in which the collaborators often included aspects that should happen, but that did not occur at the time of the interviews, or aspects that were in the initial phase of implementation.

Six sub-processes were modeled for the future situation (to be): user support, hardware, development, audiovisual, servers, and infrastructure (Appendix 1). There was also the suggestion of including a management profile sub-process in order to perform more managerial activities, such as team monitoring, project management, people management, among others. However, this sub-process was not modeled due to the focus of the study which is directed to the key activities of ITM.

Phase 4, identifying opportunities for improvement, was partly together with the process modeling (should be). For each process, it was discussed which aspects should be improved or radically changed, in addition to management techniques that could contribute to the process effectiveness. From the process analysis it was possible to identify the following gaps (problems) in the processes:

(1) Service request for some activities only, missing records of some works performed.
(2) Informal control of audiovisual material without periodic backup.
(3) Absence of register (history) about server incidents.
(4) There are various contact points with the user, thus making control difficult.
(5) Developing non standardized software among developers.
(6) Absence of developed software documentation.
(7) Difficulty in prioritizing projects.
(8) Inability to estimate delivery time of services/products to the user.
(9) Little control over time destined for each activity of collaborators.
(10) Absence of performance measurement.
(11) Absences of history about effective life and equipment maintenance (infrastructure).
(12) Informal control of borrowed equipment.
(13) Informal resource management, making capacity planning impossible.

The desirable and feasible changes to be implemented were defined taking into account the constraints of the ITM personnel and bureaucratic issues. Some suggested improvements were already about to be implemented due to the transition phase ITM was going through and the new personnel that joined ITM. The team was concerned about aligning the process objectives with larger goals of the institution in which the ITM was inserted, consequently, were added to the modeled processes the proposals for improvements. A set of performance indicators were suggested to follow-up and monitor the process activities. Nine improvement opportunities were identified, each related to one or more process constraints, characterized as focused and specific suggestions for each situation:

(14) Create a procedure for opening a user internal service request.
(15) Create a procedure for backing up audiovisual material.
(16) Create a procedure for detailing incidents with servers.
(17) Create a procedure for registering work performed by the team.
(18) Adopt software development methodology.
(19) Define and implement best project management practices for software development.
(20) Define and implement best portfolio management practices for software development projects.
(21) Create procedures for management and control of loaned and donated equipment from the unit.
(22) Create a performance indicators chart for continuous improvement.

Finally, in phase 5, discussion of results, the team presented the process models and the improvement opportunities suggested to the professor of the discipline and ITM coordination, which analyzed the process models and suggested some changes for better understanding of concurrent activities. Small corrections were made in the process models including greater separation between current and future situation modeling. In a concise manner, the ITM process manager considered the results of modeling consonant with the current situation and reported that the result did not present a high degree of novelty for those involved in the process. Despite the lack of clarity perceived during the interviews, the manager underscored the process models were predictable since, in the opinion of coordination, the processes were well known and internalized by the team.

4.2 CRT application

For the diagnosis of the CRT, it was used the procedure proposed by Costa *et al.* (2011) (Figure 4). The diagnosis was performed following the first eight steps:

(1) plan diagnostic;
(2) understand the process;
(3) prepare an interview guide;
(4) conduct interviews;
(5) formulate effects;
(6) associate effects;
(7) identify opportunities for improvement;
(8) evaluate diagnostic and project portfolio; and
(9) The last step, prioritize opportunities, was not performed by time constraints of the participants.

During the first diagnosis step the team planned activities to be performed and assigned responsibilities to each team member. Along with ITM, the team has set people to be interviewed and schedule the interviews to be conducted with ITM personnel, as well as the initial visit for prior knowledge of the processes. It was determined by the team that interviews would always be conducted by two team members in order to facilitate discussions during the construction of the CRT.

During the second step the team visited the organization's Information Technology department to get an overview of the process target, where it was presented the main

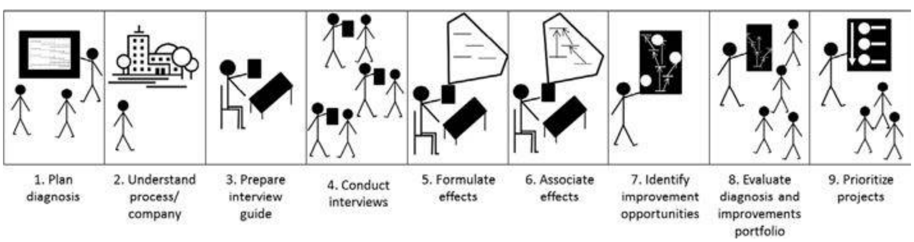


Figure 4.
CRT construction phases

services offered by the sector. The main service flow has been exposed and responsible for each of these services was introduced. Finally, the internal call system was presented by the sector.

In the next step, the team developed the interview guide that was used as a guide in all the interviews, in order to standardize the information collected for each ITM respondent. Through the interview guide, it was possible to obtain information about:

- the services offered by the section;
- the overall relationship with customers;
- the activities/information and organization structure;
- the resources (tools, equipment and facilities); and
- about their strategies (development and operational) (Appendix 2).

In the fourth step, six interviews were performed with those involved in the process, averaging 2 hours each. The interviews were conducted individually with each ITM process personnel, always by two team members, so that one person was responsible for conducting the interview, and the other to document the testimony of the respondent. The interviews were not recorded so that the interviewees were free to express themselves more openly.

The fifth step, formulate effects, was initiated after completion of all interviews. The team ended up with a list containing 47 UEs (process failures/problems).

During the sixth step, the team associated the effects with each other, resulting in the initial CRT version, presented in Appendix 3. The students identified 51 UEs, among them five root causes and 89 causal relationships.

In the seventh step, through the analysis of UEs and their causal relationships, the team identified nine opportunities for improvement:

(23) Hiring trainees for procedural activity development.

(24) Create an internal communication board of the ITM activities (personalized by sectors and with colors meaning).

(25) Create requirement management procedures (gathering and management).

(26) Improve new software solicitation procedure.

(27) Create a visible complaints channel for users.

(28) Define and manage process performance indicators.

(29) Map and disseminate ITM processes.

(30) Promote workshops for sharing experiences and for disseminating services and products among the several HEI units.

(31) Create procedures for the register and sharing of lessons learned.

Finally, in step 8, evaluate the diagnosis and project portfolio, the team presented the tree to the ITM coordination and to the professor in charge, which reported that CRT presented the majority of their day to day problems. It was only asked that a few terms and expressions were altered for a better diagnosis understanding by the process collaborators.

5. Research results

The comparison of diagnosis techniques was performed taking into account three aspects:

(1) the problems and the identified improvement opportunities;

(2) the satisfaction of the team; and

(3) the organization's outcome satisfaction.

5.1 Analysis of problems and opportunities for improvement identified

The problems and the identified improvement opportunities in both diagnoses were classified accordingly to the process dimensions proposed by Silva and Rozenfeld (2007): strategy, organization, activity/information, and resources. This classification was selected for two reasons: first because it is a way to compare the diagnosis results through analysis of which process dimension favors each technique, and second, because it is understood that it is in line with the definition of business process proposed by Vernadat (1996): "a business process comprises a structured set of activities associated with the information it handles, using the company's resources and organization." Accordingly to this classification, in the organizational dimension, aspects of the organizational structure, leadership, teamwork and learning are represented. Whereas in the activities/information dimension is grouped the aspects related to the process operation itself. The strategic dimension is macro-level decision-making, which influences and is influenced by aspects of the dimension organization. The physical and human resources utilized as support so the previous dimensions work, especially the activities/information, are grouped in the dimension resources.

Regarding the problems/undesirables effects identified by the teams (Figure 5) it is possible to observe that, from the process modeling technique, there was a concentration of identification of the failures related to the scope of activities/information (86 percent). This can be explained because the focus of BPMN is on the informational perspective of a process (Cull and Eldabi, 2010). It is important to note that, with this technique, no organizational failure was identified, such as teamwork, motivation and training. Whereas in the CRT it can be perceived that problems were identified in the four dimensions of the process. Despite the large concentration of failures in the activities/information dimension (54 percent), the presence of problems related to the organizational dimension (30 percent) is notable. Especially problems related to lack of incentives for training and the absence of knowledge sharing within the team.

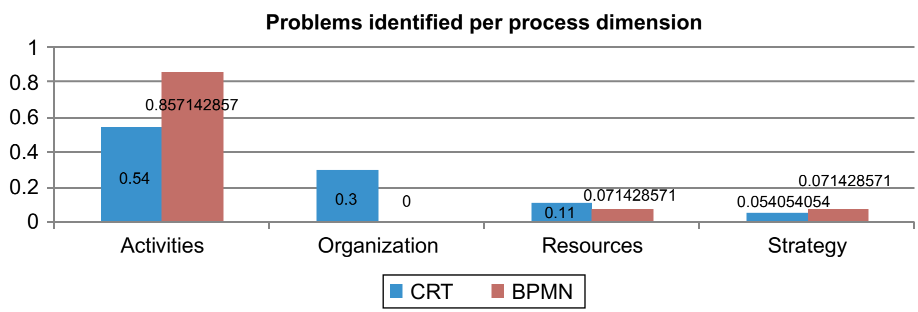


Figure 5.
Points for improvement identified with BPMN and CRT modeling techniques

Regarding the improvement opportunities identified by the teams (Figure 6), both teams identified the same number of opportunities. The BPM team proposed the great parcel of improvements related to the activities/information dimension (86 percent). It was predictable since 86 percent of the problems identified by them were from the same dimension. It is possible to observe that the projects suggested from the process modeling technique have more specific focus for more technical and detailed activities.

The CRT team, in turn, was able to identify opportunities for improvement related to the four process areas. It is noteworthy that 33 percent of the improvement opportunities identified are related to the organization dimension, in particular, related to knowledge management of the team and between teams from other organization units.

Importantly, the CRT team found that it would be appropriate to perform the modeling and dissemination of the ITM processes. Only two opportunities for improvement were identified by both teams. The first relates to the creation of a performance indicator system for the process, and the second one focused on the improvement of management of ITM activities.

5.2 Assess team satisfaction

To compare the results of the diagnosis, the team satisfaction was also evaluated in terms of:

- difficulty in performing the diagnosis by the teams;
- motivation; and
- level of knowledge required of each technique.

Regarding the analysis of the difficulties faced by the team four items were investigated: obtaining the process information, compiling the process information, using the support tools, and identifying improvement opportunities (Figure 7). For all four items the respondents were asked to give their opinion using a discrete scale of 1-10, meaning 1 "slightly difficult" and 10 "extremely difficult". The item of compiling the process information presented a higher degree of difficulty for the CRT team (average 8.00) compared with the BPMN team (average 4.80). The CRT team reported that interpreting the results obtained in the interviews and turning them into "UEs" were challenging, as well as identifying the causal relationships between the UEs. According to team members this difficulty is due to the inexperience of the team with the technique itself and the lack of knowledge of the process target (information technology). The modeling team presented a lower difficulty (average 4.80) for this item may be because there were

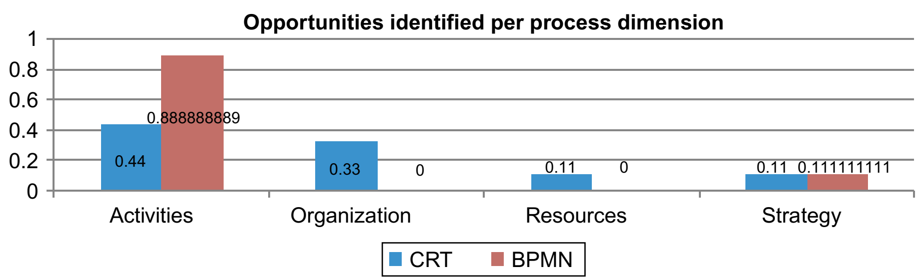


Figure 6.
Suggested improvement opportunities with BPMN and CRT modeling techniques

two team members with information system background. This result confirms the positive attitude by users concerning the usability of BPMN, as Rozman *et al.* (2008) suggested. Members of this team reported that there was difficulty in determining the sequence of process activities, since interviewers were not clear about the sequence of activities and share of responsibilities of the sector.

A second item that differentiated the assessment of the teams was the difficulty in using the support tool. The modeling team considered that this was the biggest challenge (average 7.00) unlike the CRT team (average 3.83). It is assumed that the difficulty in using the tool to support process modeling (Intalio) is due to two factors: first, the challenges of the notation itself on how processes should be modeled according to BPMN, and second the specific difficulty in exporting and importing process models. The team reported that in general the tool is intuitive enough to model the processes, pointing out that there is no difficulty in creating the objects for activities and connecting them with each other, but on what the tool allows you to perform, for example, the impossibility of putting two people in charge of the same activity. But as previously mentioned, this should not be considered as a restriction of the tool, but as a standard notation in the BPMN case.

The analysis of the team motivation compared the motivation of team members before and after diagnosis and the satisfaction with the results obtained. Regarding the motivation before and after the diagnosis, the respondents were able to score their motivation using a discrete scale of 1-10, meaning 1 "slightly motivated" and 10 "extremely motivated", and the satisfaction were scored using a discrete scale of 1-10, meaning 1 "not at all satisfied" and 10 "extremely satisfied". As shown in Figure 7, the average of the CRT team motivation increased after the end of the diagnosis (6.67-8.83), which should be a consequence of the high level of satisfaction with the results obtained. The team reported that it was helpful to identify the root causes of the process and investigate their impacts to obtain the best results from improvement efforts. The high satisfaction of this team, according to its members, is related to the actual usefulness of the results obtained for the ITM personnel. Concerning the modeling team there was a small decrease in motivation believed to be a result of team consensus about the high degree of commitment and availability required by this technique. It is believed that the level of team satisfaction with the results (average 6.60) lower than the CRT team is due to less involvement of ITM members in model validation and expectations not met by the team in shaping the future.

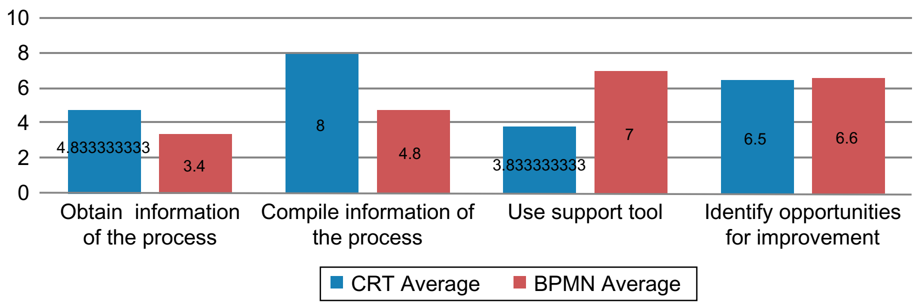


Figure 7.
Analysis of the difficulty in performing diagnosis

Finally, it was compared the degree of knowledge about the target process required to perform both diagnosis (Figure 8). The respondents used a discrete scale of 1-10, meaning 1 "none" and 10 "substantial knowledge". As shown in Figure 8, there was no significant difference between the two techniques. The two teams deemed it is necessary to have some prior knowledge of the diagnosed process, in the case of this case study, the ITM, as related to the diagnosis technique. It is noteworthy mention that, possibly, the BPMN team assigned a lower degree of knowledge of the process (average 4.60) than the CRT team (average 5.67) since, as previously mentioned, on its team there were two members trained in information system, which contributed to better understanding of the target process.

Regarding the knowledge of the diagnosis technique (Figure 9), the respondents were asked about the degree of previous knowledge required to apply the diagnosis technique using a discrete scale of 1-10, meaning 1 "none" and 10 "substantial knowledge". CRT team mentioned the difficulty in using logical reasoning required by the technique, in other words, the abstraction of cause and effect relationships between process problems. Whereas the BPMN team mentioned the difficulty in applying modeling notation best practices.

5.3 Analysis of the organization satisfaction

To assess the satisfaction of the organization diagnosed about the techniques outcomes, the ITM process manager was interviewed. He differentiated the two techniques highlighting strengths and weaknesses of both. In his opinion, the CRT diagnosis:

> [. . .] was useful to highlight structural problems and the lack of sponsorship by management. In addition, it led to the identification of more subtle features that impact people's performance in accomplishing tasks, in their personal and professional point of view regarding activities and ITM services, and the their impact on the process and vice versa.

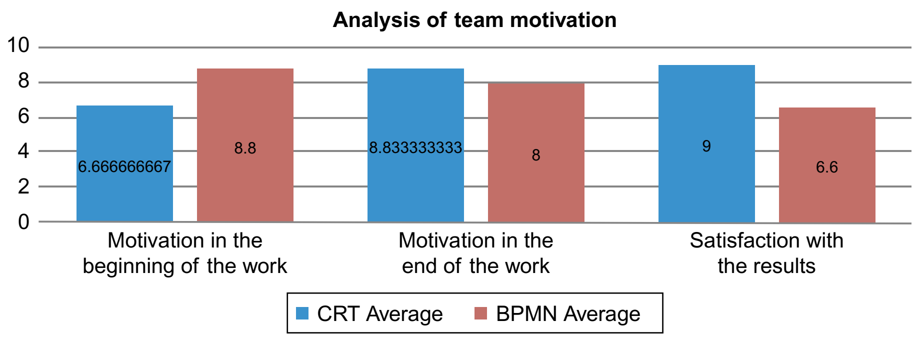


Figure 8.
Comparison of team satisfaction with the utilized method

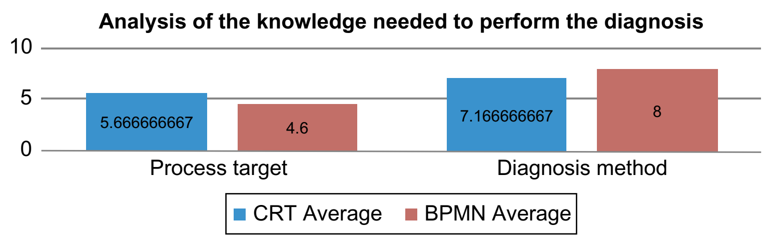


Figure 9.
Comparison of knowledge needed to perform the diagnosis

Meanwhile, the modeling diagnosis, in his opinion, is more aimed to the activities and information analysis, its outcomes could be more comprehensive and better utilized if its scope included other processes that, somehow, communicate or relate to the ITM processes. This limitation should be expected once modeling languages does not fully represent business rules (Muehlen and Indulska, 2010). The ITM process manager argues that the processes are well defined and internalized by the team, thus limiting the modeling contribution. According to his words "the contribution of this technique, in this case, was small compared to the CRT for the same scope."

The analysis of how much each diagnostic captured the reality of the organization demonstrated that in the case of process modeling the ITM process manager underscored that the processes were defined at a macro level, not observing several service executed by the team. CRT, in turn, was able to represent the undesired effects of the process but it did not evidence process structure. The results of modeling were not considered innovative, although they presented the process structure, contrary to CRT, whose logical relations were not known by the ITM team.

According to the ITM process manager, the CRT's result is dependent of support from superior hierarchical levels in the institution for correction of the determined root causes. In this sense, the manager underscores the need for proper disclosure of diagnoses for the various hierarchical levels in the institution since only some UEs could be eliminated or minimized with independent management actions. Regarding the improvement projects proposed by the teams, in his opinion, there are different levels of complexity for implementation, since in some cases, cultural change is required, while others depend on the availability of more financial resources and personnel. As for project satisfaction, the ITM process manager considered that all projects from both diagnoses are potentially effective, with a high degree of satisfaction, though they depend on the support of the institutional sponsors for implementation.

6. Final remarks

This work was conceived in order to compare the results from applying two techniques of process diagnosis: process modeling using BPMN and root causes analysis, using the CRT technique. It was conducted a pre-experiment in the ITM process in an academic unit of the largest and most recognized HEI in Brazil. This experiment provided a better comparison of the diagnoses outcomes as a single process has been diagnosed, as well as the same process collaborators were interviewed by both teams, thereby minimizing any variable that might distort the result comparisons.

By analyzing the results of the experiment the following research questions could be answered:

RQ3. Do business process modeling and the CRT technique complement each other when conducting a diagnosis?

RQ4. In what situations should the improvement team opt for one or both technique application?

To answer these questions it was compared the problems and improvement opportunities identified during the diagnoses, the team satisfaction, and the organization satisfaction with the results achieved.

As an academic contribution, it stands out the comparison of the technique application's outcomes. It is concluded that the techniques of modeling and CRT must not be considered supplementary, but complementary. It is possible to note that the activity/information dimension is privileged by the process modeling, while the CRT provides better identification of problems related to organizational aspects and resource management, not omitting aspects related with the activities/information dimension.

It is suggested in this study that the improvement team should opt for the use of the CRT technique when a broader process diagnosis is necessary, in other words, when it is aimed an overview of the process. As a result the team can expect the best understanding of structural problems of the process and the root causes identification that impact the efficiency and effectiveness of the process. The use of process modeling should be chosen when the team is already aware that the major dysfunctions of the process are related to how the process activities are organized and the flow of information established. Through the analysis of the modeling, the team is better able to focus on localized improvements such as improving and/or establishment of procedures, automation of activities and establishing metrics. Thus, it can be inferred that the CRT technique should be employed in a first cycle of BPM improvement and whenever appropriate, process modeling can be used immediately.

It may be noted that the main contribution of this study to society is the presentation of the steps of two techniques for process diagnosis. In addition, all diagnoses outcomes obtained were presented, and the team's assessment and the perception of the managers were here discussed. It is expected that with these reports other improvement teams may use the results of this research as an inspiration to perform process diagnosis, and as basis for decision making to define which technique to use according to the specific needs of process improvement.

A possible limitation of this research is that the experiment was conducted in a single process and the result cannot be generalized to other processes. In the case presented here, it was not possible to identify a large number of problems related to the strategic aspects of the process, raising the following research question:

RQ5. What are the diagnosis techniques that o better identify opportunities for improvement related to the process strategic management?

This study offers valuable insights to the organizations that are interested in restructuring their processes. It delineates many important benefits of such a diagnosis techniques. It also identifies possible pitfalls and recommends guidelines for the successful conduction of process diagnoses initiatives.

Note

1. More information about the tool can be found on Intalio web site (www.intalio.com/bpm).

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Appendix 1

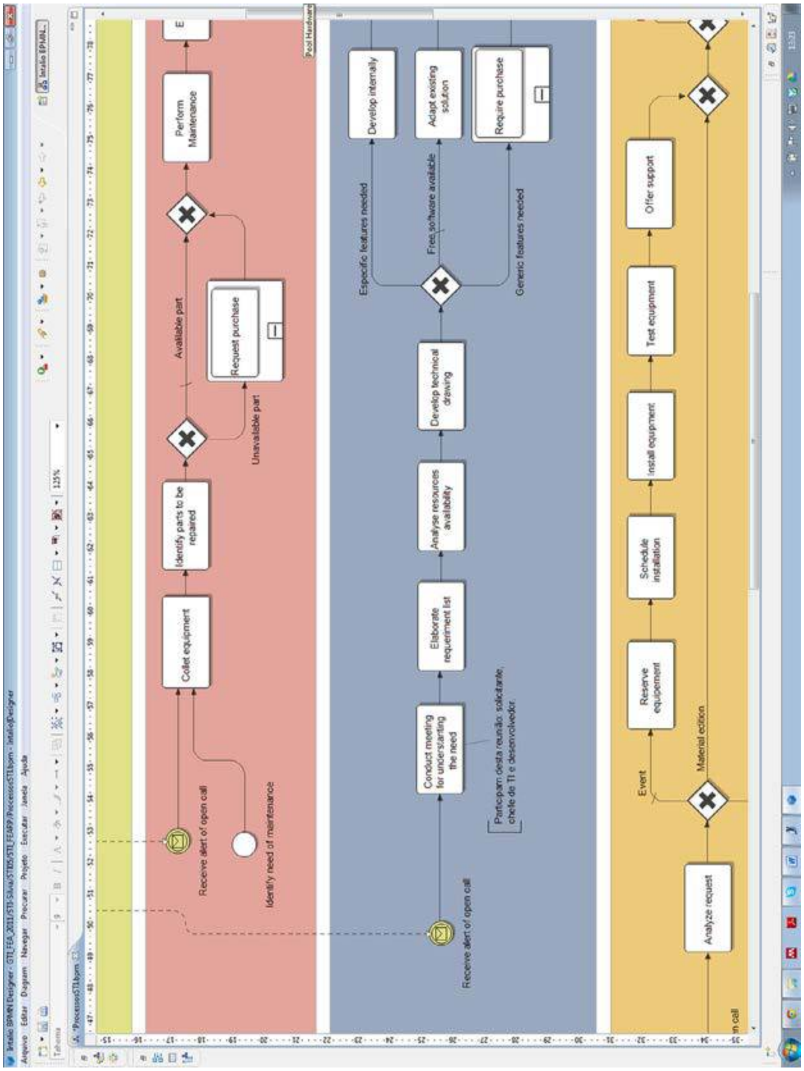

Figure A1.
Partial view of ITM modeling process

Appendix 2. Interview guide (CRT)

1. Product

1.1 Service mastery offered by the organization

- Service quality.
- Service lifecycle.
- Organization service differential versus other locations.

2. External relationship

2.1 Relationship with other locations

- Communication-coordination with competition.
- Organization of the relationship with competitor.

2.2 General relationship with clients

- Communication-coordination with clients.
- Organization of client relationships.
- Time management of client relationships.

3. Strategies

3.1 Elaboration and operationalization

- Existence of an organization strategy.
- Formulation process and strategy implementation.
- Strategy orientation (performance indicators?).
- Strategy operationalization means and agents.
- Monitoring of indicators.
- Managerial tools for internal strategic operationalization.
- Strategy information system.

4. Resources

4.1 Service system utilization

- Utilization of resource capacity.
- Interaction with personnel to learn the system features.
- Degree of transparency of the system operation parameter.
- Measurement of sales performance effectiveness (reports).
- Resource performance positioning in the face of possible alternatives.

5. Activities

5.1 Organizational structure

- Structure of the organization.
- Organization/structure for service delivery to client.

5.2 Work organization

- Rules and procedures.
- Allocation of workload.
- Versatility and autonomy at work.
- Absenteeism.

5.3 Activity definition

- Existence of a formal work description.
- Knowledge of work scope.

5.4 Information availability and circulation

- Knowledge of the information necessary to carry out the job.
- Degree of difficulty in accessing information.
- Information circulation procedures information system that supports availability and circulation.

5.5 Time management

- Individual and collective work scheduling.
- Operations that were poorly done or not carried out due to a lack of time.
- Disturbing time management factors at work.

5.6 Adequacy, training education-employment

- Workstation content.
- Personnel qualification.
- Training devices.
- Manifestation and expression of personnel training needs.

5.7 Work conditions

- Physical comfort at work.
- Adequacy of work schedule.
- Workplace atmosphere.

Appendix 3

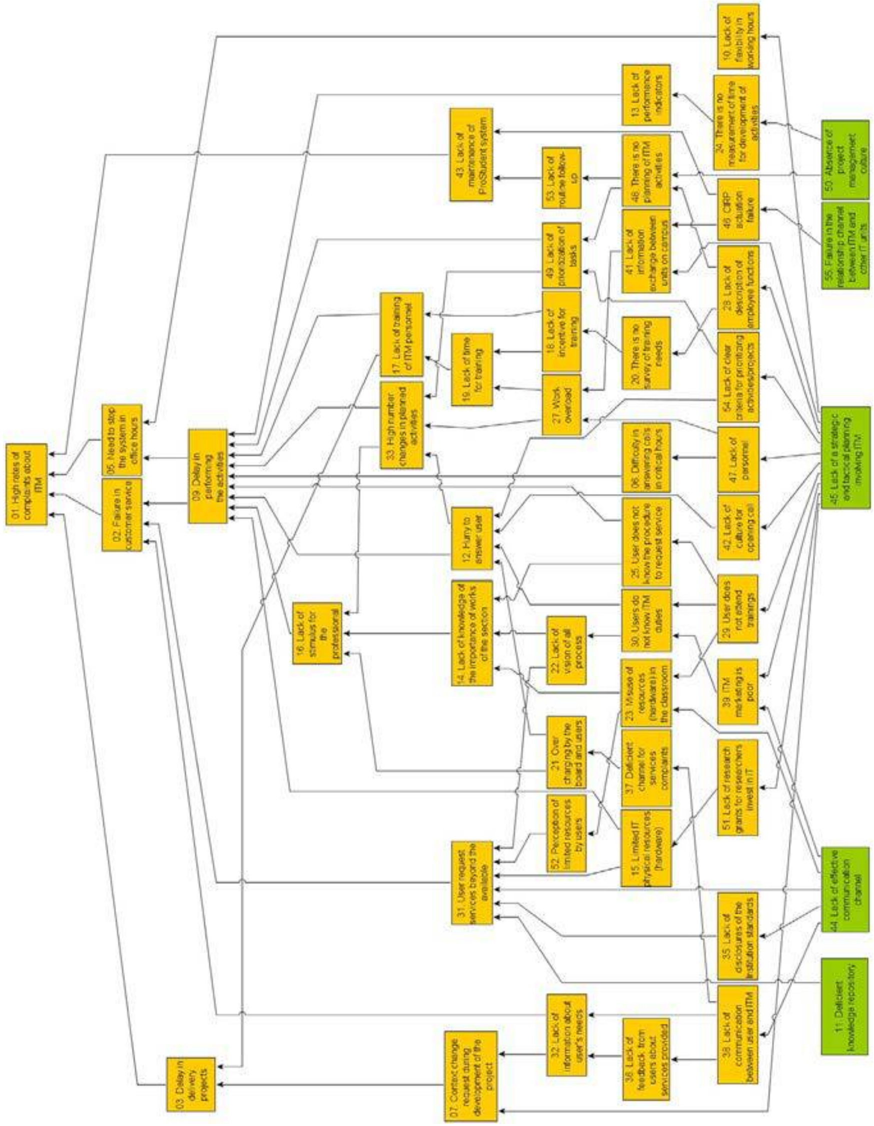

Figure A2.
Current reality tree

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