Eliciting Strategies for the GQM+Strategies Approach in IT Service Measurement Initiatives

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***Abstract* – GQM+Strategies is a goal-oriented measurement approach that supports organizations in identifying goals, strategies to achieve goals, and measures to monitor strategies and goals. However, identifying proper strategies is not an easy task. This paper presents two studies performed to investigate how strategies can be established to achieve IT service goals. First, we carried out a qualitative study involving three IT service-related departments of a large company to find out how they have been defining strategies and problems faced. We noted that strategies were defined by leaders, in a top-down approach, or by teams, in a bottom-up approach, and causal analysis techniques have been used to investigate aspects which can impact goals achievement. We also found the relation between the IT service strategies and goals was not clear for the teams. Considering these findings, we performed an empirical study in another IT-service related department applying an approach combining GQM+Strategies plus some instruments (checklists, templates and examples) and causal analysis to support IT strategies identification. As a result, we noticed that by using that approach the team was able to derive IT strategies based on goals, define measures to monitor goals and strategies, and better understand the alignment between the goals to be achieved and the strategies to be performed. Moreover, results showed that causal analysis is useful to define strategies and that supporting instruments facilitate using the approach and building GQM+Strategies grid.**

Keywords – GQM+Strategies, IT services, Measurement, Qualitative Study

I. INTRODUCTION

A *service* delivers value to customers by facilitating results they want to achieve, without requiring them to own specific costs and risks. IT service management is a set of specialized organizational capabilities for providing value to customers through services. Its practice has been increasing as companies adopt an IT management service-oriented approach to support applications, infrastructure and processes [1] [2].

Guidance on how to develop and improve IT service practices is a key factor to improve service performance and customer satisfaction [3]. The literature includes models and standards devoted to IT service practices, such as CMMI-SVC [3], ITIL [2], and ISO/IEC 20000 [1]. These proposals require identifying appropriate measures to monitor processes performed to deliver service to customers. According to these proposals, measurement should be aligned to organizational goals in order to be able to provide relevant information for decision-making and business support. However, many organizations are not aware of how (or whether) the measures used to support decision-making are related to their goals [4].

In order to help organizations to define measurement programs aligned to organizational goals, as well as strategies to achieve the established goals, the GQM+Strategies approach [4] supports deriving, linking and disseminating goals and strategies across several organizational levels. It uses a measurement system to monitor and control strategies and goals success or failure. In GQM+Strategies, *strategies* refer to projects, actions or initiatives performed in order to achieve goals. They represent a planned and goal-oriented line of actions to be executed to achieve the goals defined at the respective organizational level. By applying GQM+Strategies in the IT service context, it is possible to establish IT service-related goals and strategies, as well as measures to monitor them and provide useful information for decision-making. However, although GQM+Strategies helps define related sequences of goals, strategies and measures, there is still a lack of support to make the approach more practical and usable [5] [6], and there is no information on how to identify strategies. For instance, there is no information about how to identify the aspects to be addressed by the strategies.

Studies investigating how IT service departments define strategies to achieve established goals could provide useful knowledge to address the above issue. Thus, we decided to perform a qualitative study involving three IT service-related departments of the Vale S/A Company, in order to understand how strategies have been defined and associated difficulties. By using coding techniques based on Grounded Theory procedures [7] to analyze information obtained through interviews, we found that strategies were defined through causal analysis either by managers, in a top-down approach, or by teams, in a bottom-up approach. In addition, we found that lack of processes, lack of strategy monitoring and lack of resources were difficulties encountered during strategies definition. The IT service-related departments spend a lot of effort to achieve the established business goals, which are defined once a year and transformed into cascaded measurable goals to be achieved at year-end. However, teams reported that it is hard to understand how the projects and actions they work on relate to goals achievement, or how to align the produced results with measurable goals. Thus, it was not clear for the

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team how strategies are defined based on business goals and related to measurable goals supporting those business goals.

Considering these findings and aiming to address some of the identified difficulties, we performed an empirical study in a fourth IT-service related department (IT Security) where we used GQM+Strategies plus some supporting instruments (templates, checklists and examples) and causal analysis to define IT service strategies and indicators, resulting in a GQM+Strategies grid presenting IT service goals, strategies and indicators to monitor goals and strategies. As a result, the IT Security team was able to derive goals into strategies, define indicators and better understand the alignment between the goals to be achieved and the strategies to be performed.

This paper presents the performed studies and their main findings. It is organized as follows: Section 2 provides a background for the paper, Section 3 regards the qualitative study, Section 4 concerns the empirical study, and Section 5 presents some final considerations.

II. BACKGROUND

2.1 IT Service Quality and Measurement

Service quality is an abstract concept due to the nature of the term "service", which is intangible, non-homogeneous and its consumption and production are inseparable. Service quality can be understood as a measure of how well a service level meets customers' requirements and expectations. The intangibility of services makes it difficult to understand how customers perceive and evaluate service quality [1].

In order to be able to offer quality services, providers must continually assess how services are being delivered and what customers expect in the future. Customers will be dissatisfied with IT service providers who at times overshoot expectations, and at other times undershoot. Providing consistent quality is one of the most difficult aspects of the service industry [3]. To assess and improve service quality, providers need to evaluate service-related processes and monitor goals achievement. Measurement plays an important role in this context. The basic element for measurement is measure, which quantifies aspects of entities to characterize them. When information provided by a measure can be used to monitor goals achievement, the measure plays the role of indicator [8].

Measurement must be aligned to organizational goals. In the literature there are some approaches that deal with this issue, such as COBIT Goals Cascade [10], Balanced Scorecard [9], and GQM+Strategies [4]. COBIT Goals Cascade [10] provides a catalog with 17 enterprise goals and IT-related goals and more than 100 indicators that can be used to monitor goals. Balanced Scorecard (BSC) [9], in turn, applies measurement to verify if activities performed by an organization meet its goals with respect to its vision and strategy, addressing perspectives to derive measures from higher levels of an organization. BSC does not provide a list of measures and it should be used to facilitate translating strategies into actions [12][11]. GQM+Strategies is introduced in the following.

2.2 GQM+Strategies

The GQM+Strategies approach [4] is an extension of the Goal-Question-Metric paradigm [13] for goal-oriented measurement. It supports deriving, linking and disseminating goals and strategies across several organizational levels, and helps control success or failure of strategies and goals using a measurement system.

GQM+Strategies provides a model that relates goals and strategies at several organizational levels. One or more strategies can accomplish the same goal. Context factors and assumptions influence goals and strategies. Context factors represent known organizational environment variables. Assumptions are predicted, estimated or guessed unknowns, which can impact interpretation of measurement data, associated goals and strategies [4].

GQM+Strategies provides a mechanism not only to identify goals and strategies at several organizational levels, but also to consistently define measurement aligned to organizational goals and to interpret and compile measurement data at each level [4]. Goal-Question-Metric [13] is used with a measurement goal, associated questions, measures, and supplementary interpretation models. At each level, for each goal, a Goal-Question-Metric model measures goal achievement considering the related strategy [4].

A GQM+Strategies element includes an organizational goal, the strategies related to it, and the context and assumptions that influence them [4]. GQM+Strategies elements and related GQM models are organized in the GQM+Strategies Grid, making goals and strategies explicit, as well as the related measures, providing a clear correlation between goals, strategies and measurement initiatives [4].

2.3 Causal Analysis

Root-cause is the process of identifying causal factors and represents the most basic reason for an unwanted condition, issue, or problem, which, if eliminated or solved, can prevent it from happening [14]. It includes various techniques to support finding root causes of problems, defects, difficulties, issues or undesired events that are preventing the achievement of a better or a desired performance. In general, root-cause methods encompass guidelines for meetings and interviews with domain experts and relevant stakeholders, and also for organizing data gathered during those meetings and interviews [15].

Symptoms, apparent causes and root-causes are different. While symptoms represent actual evidence indicating an episode of something wrong and apparent cause is usually the immediate reason for that issue being happening, root-cause is the real basic reason for problem and needs to be solved in order for it not happen again [14]. After removing root-cause, symptoms can be monitored to help ensure that problem will not happen again [16].

Many tools and techniques can be used to support the process of identifying root-cause for a problem, and there is not a specific order to be followed. Documents and records analysis, interviews, brainstorms, flowcharts, Five Whys, cause-effect

and Pareto analysis are the most used [17]. A certain method (or a combination of methods) can be more or less suitable depending on the situation. Documents can be used to understand process requirements, while records can help verify the requirements outputs. Interviews can be used to have process owners explaining about documented and not documented practices. Brainstorming, in turn, is a common team builder technique used as a creative way to get ideas flooding. Five Whys is an informal way to track back the sequence of events that led the issue. Both, brainstorming and Five Whys, can uncover causes that could be missed. Flowcharting, cause-and-effect and Pareto analysis can be used to provide an easy view picture about a process. Flowcharting is used to understand how the process flows and help focus on linkage between other processes. Cause-and-effect and Pareto analysis graphically represent contributors to an issue [17].

Pareto Analysis principle affirms that highest effects, usually 80 percent, are the consequence of a few number of causes, often only 20 percent. It considers, then, that an efficient approach for root-cause analysis is to focus on those 20 percent [16]. Pareto diagrams are tools that graphically provide a quantitative way to represent problems and respective causes, by degree of gravity. Assuming the problem being handled has multiple known causes, it would be appropriate to address the ones that are most contributing to the problem [17]. Cause-and-effect diagrams are also called as fishbone diagrams because of their appearance, or Ishikawa diagrams, because of their developer (Kaoru Ishikawa). They support identification of processes and factors that are contributing to goal not being achieved and characterize the relation between not achieving and its causes, which can be split into causal and contribution factors [17]. Causal factors are issues that, if solved, can prevent negative event from happening again in future. Contributing factors are issues that increase chances of negative events happening. In process analysis context, a negative event can be a recurrent issue or an unsatisfactory performance level [16].

III. A QUALITATIVE STUDY ON HOW TO DEFINE IT SERVICE STRATEGIES

As previously discussed, there is a lack of knowledge on how to define IT service strategies to achieve IT service goals. The use of GQM+Strategies alone is not enough, because although GQM+Strategies guides about elements to be defined in order to build the GQM+Strategies grid, it does not detail how to establish the strategies. Therefore, we conducted a qualitative study to understand how organizations have defined strategies to achieve business goals in the context of IT services.

3.1 Study Planning

The study involved three IT service-related departments (ommited by confidentially) of Vale S/A, a global mining company operating in over 30 countries, with offices, operations, exploration and joint ventures across five continents. Vale S/A encourages all departments on defining their own strategies to achieve measurable goals derived from business goals. Measurable goals must be achieved by the teams from the strategies they work on. However, defining strategies and measuring results of actions performed by teams is not a trivial task. Sometimes it is not clear for teams the relation between the strategies they work on and the business goals which motivated the definition of those strategies. Besides, it is not explicit how the results they produced relate to the measurable goals to be achieved. Measurable goals are expressed by means of targets established for indicators (e.g., based on the IT service goal "Improve problem-solving efficacy", the measurable goal "The rate of non-solved problems must not exceed 5%" could be derived).

Considering the needs reported by the IT service-related departments teams and managers, the study goal was to investigate how strategies can be defined to achieve IT service goals and measurable goals, as well as the difficulties faced when defining strategies.

Aligned to this goal, following research questions were established:

- RQ1: How are strategies defined to achieve IT service goals and measurable goals?
- RQ2: What difficulties are faced when defining strategies?

Characteristics of selected participants are shown in Table 1.

TABLE 1 – SUMMARY OF CHARACTERISTICS OF THE PARTICIPANTS

Characteristic	Participant 1	Participant 2	Participant 3
Number of managed employees	60	15	60
Experience as a manager	7 years	6 years	15 years
Technical background	Graduated in Computer Science	Graduated in Computer Science and Networks, and Master of Business Administration in Management	Graduated in Computer Science

IT Services department is composed of six areas, omitted here by confidentially purposes. Three areas were included in interviews of this study and another one was used in the case study described in Section 4. Two areas were not included in interviews because managers were not available.

3.2 Study Execution: Data Collection and Analysis Procedures

Research questions RQ1 and RQ2 were used as the basis for interviews. Interviewees were told to feel free to talk as much they wanted to. Each manager was interviewed individually, taking from 30 to 60 minutes each interview. The interviews were recorded and transcribed. Transcripts were validated with each participant by email.

After validating transcripts, data was structured and analyzed using Grounded Theory procedures [7], identifying relevant codes to answer research questions, categories to group the identified codes, and relationships between codes. One researcher did the open coding, analyzing transcripts from

interviews and defining codes to label parts of the text. After codes were created, categories were defined to group similar data. All collected data were analyzed along with another researcher, who reviewed and analyzed quotes, codes and categories, and obtained results were validated with the participants. ATLAS.ti[1] workbench was used as a support tool.

3.3 Study Results

The findings related to each research question are presented below, showing quotes from the participants accompanied by our observations.

RQ1: How are strategies defined aiming to achieve IT service goals and measurable goals?

Since IT services department members reported that they have encountered difficulties to understand the alignment between the business goals and the strategies defined to achieve them, we attempted to identify whether and how the teams are involved in strategies definition. We observed two different behaviors in terms of from whom the strategies arise Data extracted from the interviews showed that strategies can be defined by team leaders and cascaded to team members (here called a *top-down approach*), but team members can also actively participate in strategies definition suggesting them to the team leaders (here called a *bottom-up approach*). Participants 1 and 3 provided information that helped us to identify the top-down behavior. Participant 1 said "*strategies derivation is done by coordinators of my department*". Participant 3 said "*I select actions by myself to achieve goals*"

On the other hand, Participant 2 gave information that revealed a bottom-up behavior, mentioning "*it starts from bottom to up*" and "*I collect suggestions from the team.*" He also said "*manager reviews and selects strategies he considers more relevant.*"

We considered that reviewing strategies suggested by teams and selecting the ones considered more relevant is a bottom-up behavior, since the strategies arise from the teams. Participant 2 also provided information related to a top-down behavior when he stated "*upper manager also includes strategies he considers relevant, or that he received from director.*" This is a top-down behavior because extra strategies directly defined by upper-level management are included in the set of strategies to be performed.

Part of coding procedure is presented in Figure 1. Transcripts from interviews were extracted as quotations, open codes were created to represent their meaning, and categories were defined to represent codes relationships.

For example, when Participant 3 said "*I select actions by myself to achieve goals",* we transcribed this quotation and coded as *"Manager select actions"*. When Participant 2 said *"upper manager also includes strategies he considers relevant, or that he received from director"* we transcribed this quotation and coded as *"Manager includes actions by his own"*. When Participant 1 said *"strategies derivation is done by coordinators of my department"* we transcribed this quotation and coded as *"Coordinators start deriving actions"*. All those three codes were categorized as top-down behaviors.

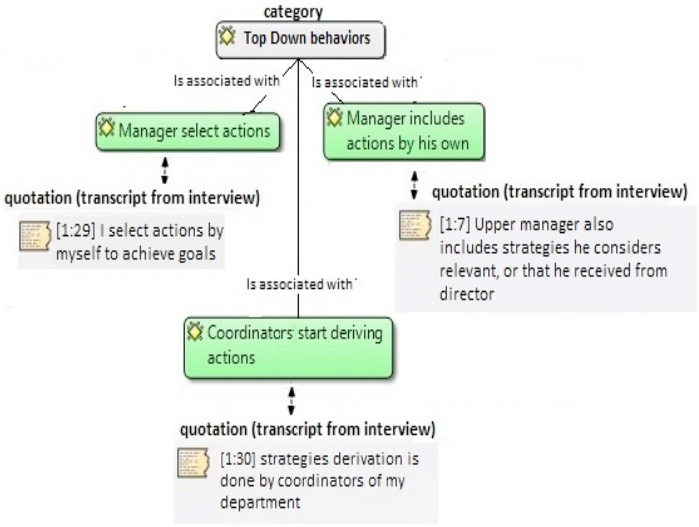

Figure 1 – Example of Coding Procedures

We also aimed to investigate which method, technique or procedure have been used to define strategies. Thus, in the context of RQ1, we asked the participants to tell us how they identify aspects to be addressed by the strategies.

Regardless of who defines the strategies, or whether they are defined in a top-down or bottom-up approach, we observed that causal analysis techniques have been used to investigate aspects (causes), which can impact goals achievement and should be handled in the strategies. In the IT service departments involved in this study, causal analysis results have been used to establish the focus of the strategies, considering that strategies should overcome the identified obstacles.

We got this information from statements such as "*we try to find patterns for issues that are happening*", "*I investigate root cause*", "*we try to understand why is the issue happening*", "*I applied Pareto technique and found that most incidents were happening due to password issues,*" and "*analysis is based on root cause.*"

Figure 2 shows RQ1 and categories created from collected data.

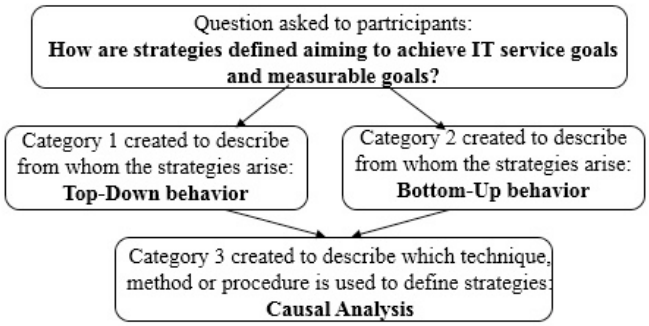

Figure 2 – Question asked and categories related to RQ1

[1] ATLAS.ti (http://atlasti.com/)

RQ2: What difficulties are faced when defining strategies?

Since IT service managers reported that strategies definition is not a trivial task, we tried to identify challenges which should be handled when defining strategies.

We categorized the findings in three categories, namely: *lack of processes,* when process to support defining strategies, *lack of resources,* when personnel or tool needed to strategies definition is missing, and *lack of strategy monitoring*, when strategies in progress are not monitored and this can influence to decide whether new strategies need to be defined.

Participant 3 reported difficulties when he says is hard to improve something that is not performing well, when he stated "*there is a need to adjust the processes already running in production*" and "*there is a need to change process to be used in new cases*". According to Participant 3, his department is the first point of contact for users to report incidents or requests. The attendant needs to understand what the user says and search for a document about the issue to verify how to solve it, or escalate it to the next support level. The team's success is measured by indicators regarding the percentage of incidents solved at the first level (which should be high), and the percentage of redirected incidents (which should be low).

Participant 3 also stated that strategies usually focus on changing the documents content or any part of the process which is not performing well. However, he does not have enough people to work on those changes and it is not easy to find out what needs to be changed. We categorized this difficulty as lack of resources as he explained the reason of reported difficulties is that he does not have enough personnel for working on necessary changes. Participant 1 reported a difficulty related to lack of processes when he mentioned "*lack of formal documentation for the strategies,*" and also a difficulty related to lack of strategy monitoring when he mentioned "*lack of a monitoring tool*" and "*difficulty of monitoring the achievement of budget target by account billing date.*" Participant 2 reported a difficulty about lack of processes when he mentioned "*lack of discipline to measure and report,*" saying that people do not have a documented process to follow, which causes lack of discipline. He also reported lack of resources when he stated "*we do not have dedicated people for measuring activities*" and lack of strategy monitoring when he mentioned "*difficulty in monitoring the strategies.*". Figure 3 shows the question participants were asked for RQ2 and categories created from collected data.

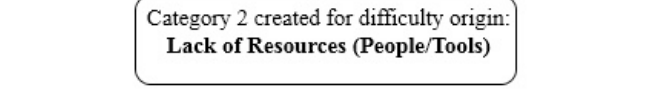

Figure 3 – Question asked and categories related to RQ2

3.4 Discussion

The results obtained in the study showed us that IT service strategies can be defined by leaders using a top-down approach, or by teams using a bottom-up approach. In both approaches, causal analysis techniques can be used to identify aspects that may prevent goals to be achieved and should be focused by the strategies. We also found out that some problems faced when defining the strategies are related to lack of process, lack of resources, and lack of strategy monitoring.

Concerning the identified problems, lack of resources is an organizational constraint. Thus, solving it depends on the organization to provide new resources to help strategies definition. As for lack of process and lack of strategy monitoring, we believe that the use of an approach based on the GQM+Strategies can help deal with these issues.

GQM+Strategies can be used to establish a set of steps to guide IT service departments in deriving IT service strategies from business goals. This can help to treat the lack of process problem. Moreover, GQM+Strategies includes the definition of measures to monitor goals and strategies, helping to treat the lack of strategy monitoring problem. Additionally, GQM+Strategies suggests that goals, strategies and measures are represented in the GQM+Strategies grid, which can help communicate the IT service goals and related strategies and measures to the team. This can contribute to solve the problem reported by the IT service teams at the beginning of this study, when they said the relation between the strategies they work on and the business goals is not clear, neither how the results they produce relate to the measurable goals.

IV. USING CAUSAL ANALYSIS AND GQM+STRATEGIES TO ESTABLISH IT SERVICE STRATEGIES: A CASE STUDY

As previously discussed, in the qualitative study performed in three IT service departments at Vale S/A we found out that causal analysis can be used to help identify aspects to be considered in IT service strategies. We also noticed some problems that we believe it could be addressed by using the GQM+Strategies approach.

The manager of the IT Security department of the Vale S/A reported that the department members were aware of the organizational business goals, but did not know how to cascade these goals to specific IT Security goals, neither how to define indicators to measure goals achievement and the strategies to get there. As the GQM+Strategies approach supports multi-level definition of goals and strategies in a measurement context [3][4], we decided to conduct an empirical study at the IT Security department to evaluate whether the use of causal analysis plus GQM+Strategies can help IT service departments to establish IT service strategies.

In order to facilitate the use of GQM+Strategies, we defined a step-by-step process combining GQM+Strategies and causal analysis. It comprises the following activities: *Elicit Context Factors and Assumptions*, when context factors and assumptions that can influence on goals and strategies are identified; *Define IT Service Goals*, which consists in defining the IT service goals to be achieved; *Define Measurement Plans for IT Service Goals*, when indicators and interpretation models

are defined to monitor goals achievement; *Define IT Service Strategies*, which involves defining the strategies to be performed aiming at goals achievement (in this process, the strategies must be defined with the support of causal analysis techniques); *Define Measurement Plans for IT Service Strategies*, when indicators and interpretation models are defined to monitor the strategies; and *Build the GQM+Strategies Grid*, when the results produced in the previous activities are represented in a grid. Additionally, to support the activities execution, we developed some instruments such as checklists, templates and examples suitable for the IT Service domain (e.g., we developed a template to be filled in when defining a measurement plan to IT service indicators and we provided some examples of measurement plans created by using the template). In this paper we present only some templates. All the developed instruments can be found at our technical report [18].

By defining a process and instruments to help performing its activities, we intended to address the lack of processes problem identified in the qualitative study. Moreover, the use of GQM+Strategies also intended to address the lack of strategy monitoring problem, since by using GQM+Strategies indicators to monitor the strategies are defined.

4.1 Study Planning

The purpose of this study was to verify whether an approach using causal analysis and GQM+Strategies is useful to support defining IT service strategies. In the context of this work, we use the term "strategy" as it is used in GQM+Strategies. Thus, when talking about strategies, we are talking about actions, projects or other initiatives established or performed to achieve goals. The process and additional instruments mentioned above were used in the study.

Aligned to the study goal, the following research question was defined:

- RQ: Does the use of an approach combining GQM+Strategies and causal analysis help to define IT service strategies?

The organization where the study was performed was also Vale S/A, but now at the IT Security department. This department was not involved in the qualitative study. Similar to the teams of the three departments involved in the qualitative study, the IT Security team reported that the relation between goals and strategies was not clear. The IT Security manager, in turn, informed that he wanted the team to be able to define the strategies needed to achieve goals.

The study participants were the IT Security coordinator, the IT Security manager and the IT Security team. The study procedure consisted of executing the defined GQM+Strategies process and using the supporting instruments to establish IT service goals, strategies and indicators. Causal analysis was applied to cascade IT Service goals in operational goals and then direct the strategies definition. A bottom-up approach was used (i.e., the strategies were defined by the team) because the IT Security manager wanted the team to be able to define strategies. The activities were conducted by one of the researchers and performed together with the study participants.

4.2 Study Execution

By following the defined GQM+Strategies process, the study execution comprised seven activities.

The first activity was to *Elicit Context Factors and Assumptions*. Relevant context factors and assumptions were identified based on organizational goals and other information about the organization. Several processes critical for Vale S/A business are based on IT applications, which are hosted in an infrastructure and supported by IT service teams. Availability of critical applications is monitored by software. When any application becomes unavailable, a crisis room involving all technical teams responsible by that application is opened and all teams remain in the call until the application is available again. The main organizational goal was to reduce costs, but IT service teams should also increase end user experience, which includes reducing critical applications unavailability due to security issues. In the view of the above, the first context factor identified was "Organization main goal is to reduce cost but also improve end user experience" and the related assumption was "the IT Security department should not increase costs".

The second activity was to *Define IT Service Goals*. Considering information provided by the IT service coordinator and by the IT service manager, ten IT service goals were defined. In the context of this paper, we will explore one of them: (G1) "Decrease critical applications unavailability due to security issues".

The third activity was to *Define Measurement Plans for IT Service Goals*. IT Security team defined the indicator "Amount of hours that critical applications were unavailable due to security issues", which indicates how many hours applications considered critical to business were unavailable due to security issues. Considering that unavailability of critical applications is measured by software, we should be able to get data for this indicator from the monitoring software. However, monitoring reports provided by the monitoring software do not provide the reason for unavailability. Vale S/A has a ITIL-based [8][2] process that includes creating a new problem record to investigate root cause for every unavailability event that happens in critical applications. However, at the moment the study was performed, information needed to collect data for the defined indicator was not being provided yet. Thus, in order to gather data for this indicator, a new report was needed, unifying the number of hours that each application was unavailable and the root-cause for that event.

The fourth activity was to *Define IT Service Strategies*. Thus, in this activity, based on the findings of the qualitative study, we applied causal analysis to investigate aspects the strategies should focus on. The IT Security operations specialist (a member of the IT Security team) informed that applications unavailability due to security issues could be mainly caused by unpatched or unprotected machines, unresolved threats[2], antivirus software operational issues, and other security threats like new or unknown vulnerabilities. Based on this

[2] Unresolved threats refer to threats that could not be cleaned by antivirus software and require a manual clean.

information, the cause-and-effect diagram shown in Figure 4 was built. Threats are automatically detected by antivirus software. The causal analysis was performed by using cause-and-effect diagram because it is a technique the team was familiar with, as it usually applies them to solve technical issues.

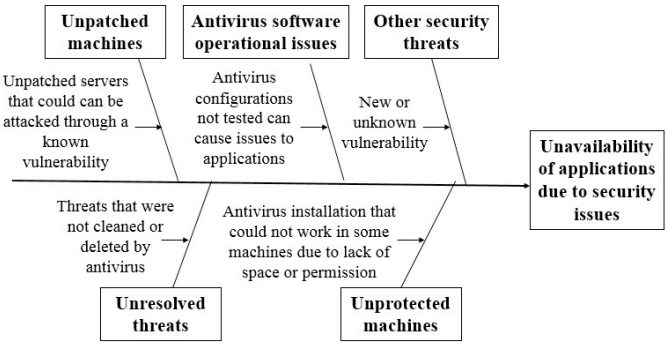

Figure 4- Cause-and-Effect diagram

The IT Security operations specialist informed that, among the identified causes, Unpatched Machines, Unprotected Machines and Unresolved Threats were the three most critical. Considering that, strategies for dealing with each one of these causes were defined. Concerning Unpatched Machines, we were informed that applications teams were avoiding to install patches because they were afraid to impact applications' functionalities. Therefore, the strategy defined to deal with Unpatched Machines cause was to (S1) run a vulnerability assessment and report each application team about missing patches, including a classification to show if the patch is related to operational system or application.

As for the Unprotected Machines cause, we found out that one of the reasons for not install antivirus was related to lack of available space or permission, causing installation to fail. Also, the software could be corrupted for any reason. As users were not available to manually install antivirus with the support team, a strategy created was to (S2) block unprotected machines to access network until they have antivirus installed.

Regarding the Unresolved Threats cause, we found out that that they were occuring in a single location (that we call here "local X" for confidentially purposes) and were always originated in removable medias. Therefore, the strategy created was to (S3) block USB ports on machines of local X, in servers and users´ machines.

Table 2 shows the strategies documented by using the suggested template. Table 2 shows the documentation of three strategies in the same table (due to space limitation). The strategies can also be defined in separated tables (one table to each strategy).

Similar to the strategies related to Unpatched Machines, Unprotected Machines, and Unresolved Threats, other strategies were defined based on the causal analysis results. In this paper, for sake of data confidentiality, we explore only the strategies presented in Table 2.

TABLE 2 – STRATEGIES CREATED AFTER CAUSAL ANALYSIS

Strategies Names	(S1) Run a vulnerability assessment and report each application team about missing patches (S2) Block unprotected machines to access network (S3) Block USB ports on machines of local X
IT Service Goal to be achieved by strategies	(G1)Decrease critical applications unavailability of due to security issues.
Strategies Description	(S1) Every month, run a vulnerability assessment and report to application teams the missing patches by server. Application team should apply the patches in pre-production environments and test. Infrastructure team should receive validation communication and apply patches in production environments. (S2) Prepare and send communication to business partners and end users. Then, apply configuration to block unprotected machines to access network. (S3) Prepare and send communication to business partners and end users. Then block USB ports on machines of local X.
Strategies Owner	(S1) IT Security outsourcing team to run and report. Application teams to perform validation tests. Infrastructure team to apply patches. (S2) and (S3) IT Security
Strategies Sponsor	IT Security Manager
Strategies Complexity	Low
Strategies Risk	Low
Strategies Cost	(S1) Cost only for application teams to test applications for patching, infrastructure team can apply the patches by using operational teams, with no additional costs. (S2) and (S3) No additional costs (use internal teams).

The sixth activity was to *Define Measurement Plans for IT Service Strategies*. The following indicators were defined: (I-S1) Percentage of updated patches, for S1; (I-S2) Percentage of unprotected machines, for S2; and (I-S3) Percentage of unresolved threats, for S3.

Table 3 shows the measurement plans defined for the strategies S1, S2 and S3 and documented by using the suggested template. Similar to strategies, Table 3 shows the documentation of three measurement plans in the same table. However, measurement plans can also be defined individually, i.e., in separated tables (one table to each measurement plan).

TABLE 3 –MEASUREMENT PLANS FOR STRATEGIES

Related IT Service Goal	(G1) Decrease critical applications unavailability due to security issues
Measurement Goals	(I-S1) Increase n relation to the last month (I-S2) and (I-S3) Reduce in relation to the last month
Target	(I-S1) More than 90%, (I-S2) Less than 5%, (I-S3) Less than 2%
Information Needs	(I-S1) How many patches are missing to be installed? (I-S1) How many machines do not have antivirus running? (I-S3) How many threats were detected by antivirus, but could not be cleaned nor deleted?
Indicator	(I-S1) Percentage of updated patches (I-S2) Percentage of unprotected machines (I-S3) Percentage of unresolved threats
Measurable Entity	(I-S1): Patches installation process, (I-S2): Antivirus installation process, (I-S3): Threats
Base Measures	(I-S1) NM1 = Number of installed patches TN = Total number of missing patches (I-S2) NM2 = Number of machines without antivirus running TN = Total number of machines (I-S3) NM3 = Number of detected and unresolved threats TN = Total number of detected threats
Measure Calculation Formula	(I-S1) = (NM1 / TN) * 100 (I-S2) = (NM2 / TN) * 100 (I-S3) = (NM3 / TN) * 100
Measurement Procedure	(I-S1) Extract data from vulnerability scan reports (I-S2) Extract data from antivirus reports (I-S2) Extract data from antivirus reports
Measurement Responsible	(I-S1) (I-S2) (I-S3) IT Security outsourcing team
Measure Unit	(I-S1) (I-S2) (I-S3) Percentage
Measurement Moment	(I-S1) (I-S2) (I-S3) 5th working day of the month
Measurement Periodicity	(I-S1) (I-S2) (I-S3) Monthly
Interpretation Model	(I-S1) (I-S2) (I-S3) If value is until 5% over target, then investigate isolated cases that caused this behavior. If value is more than 5% over target, then investigate problems in the strategy execution or review the strategy.
Interpretation Responsible	(I-S1) (I-S2) (I-S3) IT security operations specialist
Interpretation Moment	(I-S1) (I-S2) (I-S3) At the beginning of each month, after indicators data are updated and starting one month after the strategy is implemented.
Interpretation Periodicity	(I-S1) (I-S2) (I-S3) Monthly

The seventh activity consisted in *Building the GQM+Strategies Grid* using information produced in the previous activities. The context factors, assumptions, goals, strategies and indicators were organized into a GQM+Strategies Grid and presented to the IT Security coordinator, the IT Security manager and the IT Security team to gather feedback. Figure 5 shows a fragment of the resulting grid, including the elements related to the strategies (S1) "Run vulnerability assessment and report each application team about missing patches"; (S2) "Block unprotected machines to access network"; and (S3) "Block USB ports on machines of local X. The action plans defined for each strategy are not detailed in the grid due to space limitation. As examples, actions for (S3) include: Find locations with larger amount of unresolved threats; Communicate respective managers of users' machines that USB port will be blocked, Test a configuration in antivirus software console; and Apply configuration to block USB port in the selected machines.

4.3 Study Results

At the moment this paper was written, the IT Security team has started to run the defined strategies. In this paper the research question is answered considering results obtained so far.

> *RQ: Does the use of an approach combining GQM+Strategies and causal analysis help define proper IT service strategies?*

After executing the steps of the process combining GQM+Strategies and causal analysis, we conducted an interview with the IT Security coordinator aiming to obtain his feedback. The coordinator said that by using GQM+Strategy and causal analysis, the IT Security team was able to properly define IT service goals aligned to business goals, create strategies to achieve the defined goals and indicators to monitor the strategies. Causal analysis was considered an intuitive and practical way to think about factors to be focused by strategies.

According to the coordinator, the approach also contributed to make clearer for the team the relation between goals, strategies and indicators. He stated that after the study, the IT Security team was more dedicated to measurement activities, because they understood the relationship between what they should measure, what they should do (i.e., the strategies) and the relation with the IT service goals. He also reported that documenting goals, strategies and indicators helped the team better understand what should be done, why it should be done and how it should be done.

Moreover, he informed that the team was motivated to keep using the approach and that he believes that the templates, checklists and examples provided will help them to use the approach without the researchers intervention. The coordinator expressed some concern with the amount of time required to perform the process. Since the IT Security department has defined strategies in an ad-hoc manner, not much time has been required to do so. On the other hand, following a step-by-step process that involves documenting all the produced results demands time. We argued that the benefits of using such process will probably be realized after some time using the process and the produced results.

The coordinator also said that although the relations between goals, strategies and indicators have become clearer, he felt that some members of the team were still not able to truly

understand the alignment between strategy results and goals achievement.

We believe that this issue is due to involvement and communication problems. Before using the process, the team was less involved in the definition of the strategies. Consequently, it did not see how strategies and goals were related and it was limited to work on the strategies designed to it. Thus, for most of the team members, defining strategies is a new task and some time can be necessary for growing their involvement in this task. We also believe that by being involved in defining strategies and getting to know the GQM+Strategies grid that communicates goals, strategies and indicators, the team will progressively better understand the relations between goals and strategies and also between the results produced and the measurable goals to be achieved.

As future works, the team is interested in defining goals related to reduce security risks on critical applications, not only regarding availability, but also with respect to missing data and other security concerns. The risk issue was not explored during this study because the team was not prepared to quantify risks. Thus, the team plan to identify and monitor risks related to critical applications and, then, establish strategies involving real time monitoring to decrease risks, as well as indicators to monitor the strategies.

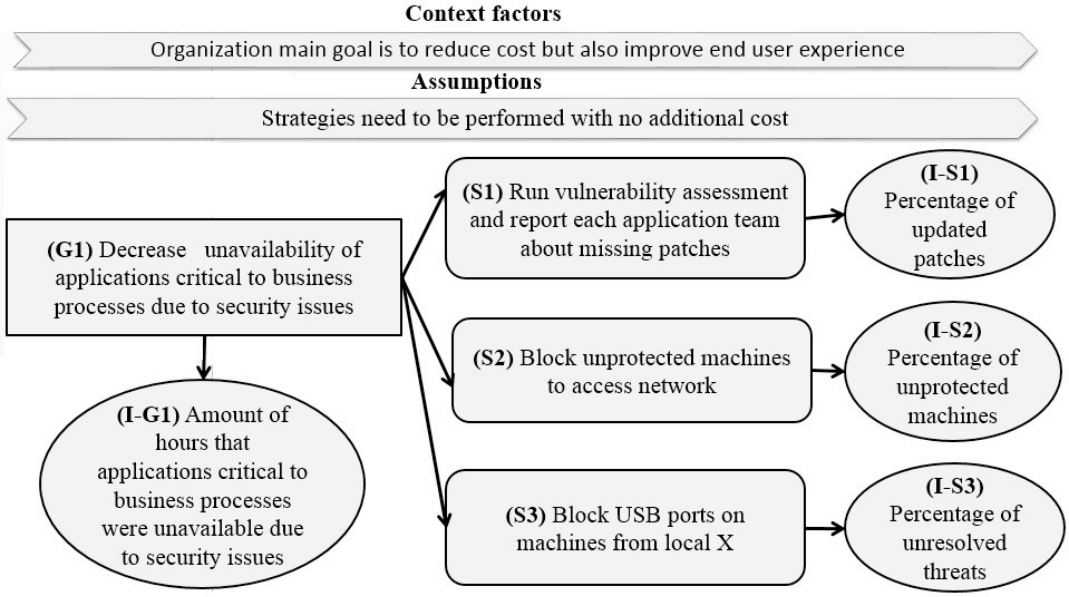

Figure 5 – Fragment of the GQM+Strategies grid

4.4 Discussion

The results obtained in the study showed us that the use of an approach combining GQM+Strategies and causal analysis helped the IT Security department to define IT service strategies aligned to the business goals. The approach adopted in the study consisted of a step-by-step process based on GQM+Strategies. In the process, causal analysis is applied to direct strategies definition. Some instruments to support the process execution were also provided.

By using a process to guide the strategies definition from business goals, and instruments to help perform the process, it was possible to address the lack of process problem identified in the qualitative study, since now the IT Security department has a step-by-step process plus supporting instruments to be used to define IT service strategies.

Moreover, defining measurement plans to monitor strategies contributed to treat the lack of strategy monitoring problem, because the IT Security department can now monitor the strategies by using the associated measurement plans, which can help verify if new strategies are necessary.

Every study presents threats to the validity of its results [18].

The main threat in this study concerns generalizing results to other organizations. We applied the approach combining GQM+Strategies and causal analysis in a single case.

Additionally, when the study was performed the team was running a tight schedule to deliver other results to the director. Thus, it was not possible to define strategies for some of the IT service goals initially identified, making the study scope more limited. In order to cover the scope initially established (i.e., defining strategies for all the identified IT service goals), we mentored the team and provided instruments [18] to help it in applying the approach without the researchers intervention.

Another threat to validity concerns the participation of the researcher who conducted the study. Although she worked in a department not involved in the studies, her knowledge of the organization policies, business goals and general IT service processes can have influenced on the use of the approach and on the identification of root causes.

In order to mitigate this threat, the researcher only guided activities execution and provided information to help in some doubts about concepts used in the templates, taking care to not interfere in identified goals, strategies and indicators.

V. FINAL CONSIDERATIONS

This paper presented studies performed to investigate how IT service strategies can be defined to achieve IT service goals. Two studies were performed.

First, in a qualitative study, we conducted interviews with managers of three IT service-related departments of the Vale S/A and, by applying Grounded Theory to qualitatively analyze the data, we found out that strategies were defined by leaders and communicated to team members, in a top-down approach, or defined by team members and validated by leaders, in a bottom-up approach.

We also found that causal analysis was used as means to identify aspects that strategies should focus on. The study also showed us main difficulties faced when defining strategies are related to lack of resources (people and tools), lack of processes and lack of strategy monitoring.

In the view of the obtained results, we performed an empirical study in another IT service department of the Vale S/A to verify if the use of an approach combining GQM+Strategies and causal analysis could help the department to define IT service strategies aligned to business goals, and address the lack of processes and lack of strategy monitoring problems identified in the qualitative study.

The results showed that causal analysis is useful to define IT service strategies, and that checklists, templates and examples are useful tools to facilitate using GQM+Strategies in the IT Service domain.

We also noted that the GQM+Strategies grid is a good communication tool to provide a clear view and help team members understand and monitor the relations between strategies and goals. IT Security team created a report to monthly present to IT Services director, showing measurement results of indicators aligned to goals, and now he is able to also present related strategies ongoing to achieve the indicators targets.

The team could better monitor results of actions being performed by measuring strategies indicators, which were aligned through GQM+Strategies grid to goals indicators. The team was motivated to keep using the approach because they could clearly understand alignment between their daily activities to goals.

It is important to point out that the studies presented in this paper are initial studies that aimed to investigate how IT service strategies can be defined. The obtained results can be understood as initial evidences that causal analysis is a feasible way to support defining strategies and that the use of a step-by-step process based on GQM+Strategies helps to establish a systematic way to derive IT service strategies from goals and communicate the results through the GQM+Strategies grid.

However, new studies are necessary. In this sense, as future works, we intend to get new feedback about the use of the approach in the IT Security department to gather information about the results obtained after a larger period of time than the one considered in the first feedback.

We also plan to perform new studies to get information about how IT service strategies can be defined. Based on knowledge obtained from these studies, we intend to define a systematic approach to help IT service organizations/departments identify strategies to achieve IT service goals.

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