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Self-organizing Six Sigma Program: as-is model and need for changes

Programa Seis Sigma Auto-organizado: modelo da situação atual e necessidades de mudanças

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Abstract: The formation of collaborative networks is an important way for organizations to stimulate innovation, reduce costs and transfer knowledge. A particular form of collaborative network - the self-organizing network - has shown great capability to promote the learning of those involved, systematize knowledge and lead to innovation. The Six Sigma programs, adopted by several organizations, have as their main objective the reduction in process variability, thus resulting in lower costs and quality improvement. The literature on self-organizing networks has little on the formation of these types of networks and the literature on Six Sigma is focused on statistical methods. Therefor, the aim of this article is to verify the needs for change in a Six Sigma program that enables the development of a self-organizing network. The case studied was carried out with a large organization, manufacturer of capital goods, where the Six Sigma program modeling was performed. From the generated models, as a result, it was have identified a set of changes needed so that the Six Sigma program can create a self-organizing network.
Keywords: Self-organizing network; Six Sigma; EKD; Enterprise modeling.

Resumo: *A formação de redes colaborativas é uma importante forma das organizações estimularem a inovação, reduzirem custos e transferir conhecimentos. Uma forma particular de rede colaborativa, as redes auto-organizadas, demonstram grande capacidade de promover o aprendizado dos envolvidos, sistematizar o conhecimento e promover a inovação. Já os programas Seis Sigma, adotados por diversas organizações, possuem como objetivo principal a redução da variabilidade de um processo, resultando na redução de custos e melhoria da qualidade. A literatura sobre redes auto-organizadas pouco apresenta sobre a formação destas redes e a literatura sobre Seis Sigma é voltada a métodos estatísticos. Desta forma, o objetivo deste artigo é verificar as mudanças necessárias em um programa Seis Sigma que viabilize o desenvolvimento de uma rede auto-organizada. Como objeto de análise, apresenta-se um estudo de caso junto a uma empresa de grande porte, fabricante de bens de capital agrícolas, na qual se realizou a modelagem do programa Seis Sigma. A partir dos modelos gerados, como resultado, identificou-se um conjunto de mudanças necessárias para que o programa Seis Sigma viabilize uma rede auto-organizada.*
Palavras-chave: *Rede auto-organizada; Seis Sigma; EKD; Modelagem organizacional.*

1 Introduction

The networks between different organizations and the networks formed within organizations are recognized as organizational forms capable of promoting collaboration, reducing costs and increasing the knowledge of their participants. Among the various types of collaborative networks, self-organizing networks stand out for their no centralized management, the intense participation of those involved, their ability to keep their development without significant external interference and the ability to promote the learning of all those involved in the network through the systematization and availability of the knowledge generated (Kash & Rycoft, 2000; Rycroft & Kash, 2004; Dutta et al., 2005; Wagner & Leydesdorff, 2005; Schuh et al., 2008).

Gutiérrez et al. (2012) claim that the Six Sigma program of an organization can be considered as a learning network, providing an organizational structure composed of a network of professionals who work together oriented towards projects. However,

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the analysis of the Six Sigma program as a network should not limit itself to the learning, thus covering the other benefits provided by the formation of a collaborative network, in particular a self-organizing network. The Six Sigma methodology promotes the improvement of processes, products, quality and especially cost reduction. At Motorola, approximately US$ 16 billion are documented in cost reductions and costs avoided. Because of its benefits, the Six Sigma methodology increasingly draws the attention of business managers, despite academic research still being under developed (Schroeder et al., 2008).

In this way, the purpose of this article is to examine, through a case study, the Six Sigma program of an organization and present an as-is model of this structure. Based on theoretical review, we will identify the changes needed to ensure that the Six Sigma program can enable the development of a self-organizing network, incorporating the features already identified in the literature.

2 Literature review

This topic provides a brief review on collaborative networks, self-organizing networks, Six Sigma methodology and EKD (Enterprise Knowledge Development).

2.1 Collaborative networks

Despite the wide use of the term cooperative networks, there is no consensus on their definition, and the term 'cooperation networks' is not always used among researchers, with variations such as partnerships, coalitions, cooperative arrangements, collaborative agreements, among others (Provan et al., 2007). The terminological variants follow the diverse perspectives taken by researchers, and thus we have studies focused on a wide range of adjacent subjects and with the use of various theories for analysis (Camarinha-Matos & Abreu, 2007). Such terminological differences, along with the use of various theories in the analysis of networks (since there is no general theory), result in the fragmentation of the field, with studies that are scattered, little connected, difficult to be compared and without accumulation of the knowledge produced (Bell et al., 2006).

In a collaborative network, each element must contribute with a specific set of capabilities, which depend on the capabilities of the other elements to generate meaning to the network (Andersson et al., 2008). The integration of these specific sets of capabilities offered by each network element allows the development of new products, processes or services that are performed in a shorter time and with fewer resources (Eschenbächer et al., 2011). This integration implies the sharing of knowledge and information, thus requiring the construction of mutual trust among members of the network. Self-organizing networks are a definition of the concept of collaborative networks and are characterized by project orientation, intentionality of the players in the definition of projects and symmetry in the relations among members (Rycroft & Kash, 2004).

2.2 Self-organizing networks

Self-organization refers to systems that develop structures and processes that primarily respond to their internal logic, not merely responding to external inputs (Rycroft & Kash, 2004), which occurs through nonlinear interactions that are outside of the control of a single player (Jarratt & Ceric, 2015). The use of the term is not limited to administrative studies, but it involves subjects such as biology (ecology studies), social sciences (studies on urban concentrations) and economics (the invisible hand) (Corning, 1995). The diversity in the use of the term makes it all the more necessary the explanation of this concept, which permeates the entire article.

The basis for the formation of self-organizing innovation networks is the ability to learn and use, productively, information noise that accompany this learning (Vany, 1996). As that learning requires the exchange of information and knowledge, it is essential the existence of trust and reciprocity, leading the network to collaborative behavior patterns, thus increasing the productivity of knowledge (Kash & Rycoft, 2000; Jarratt & Ceric, 2015). Other important mechanisms of self-organization of a network are the feedbacks and the coevolution of the network (Espinosa & Porter, 2011). This means that those involved in a self-organizing network have the ability to provide and receive responses to each other and evolve together as an individual and as a network. This again reinforces the importance of trust and reciprocity.

Self-organization is a characteristic of a complex system (Anderson, 1999), composed of a large number of interdependent parts with strong interaction, being difficult to predict its behavior (Anderson, 1999). Complex organizations are able to create, acquire and integrate a wide range of knowledge and abilities needed to innovate in technologies that are also complex (Kash & Rycoft, 2000). This assumes that a self-organizing network comes from organizations that have complex environments.

Scherrer-Rathje et al. (2009) have performed a comparison between self-organizing networks and what they have called "guided networks", being the latter ones not self-organizing networks. The main differences mentioned are: the management in a self-organizing network is implicit and the interactions in a self-organizing network are not configured and planned in an advanced way for the development of the activities.

A self-organizing network is characterized by the absence of an explicit coordinating leadership (Wagner & Leydesdorff, 2005), the ability to develop without significant direct external interference (Rycroft & Kash, 2004), the intense inter-relationship and communication between network participants (Anderson, 1999), the coevolution of the participants and the network (Kash & Rycoft, 2000), the learning capacity and use of this learning (Vany, 1996), the knowledge of the capabilities of all participants and access to these capabilities (Kash & Rycroft, 2002), the existence of mutual trust and aid (Kash & Rycroft, 2002), the ability to meet quickly a team to solve a problem and then dissolve it right after (Quinn et al., 1996) and the use of information systems to systematize the knowledge developed and accumulated by the network (Crowston et al., 2007).

Self-organizing networks can be observed in various contexts, but they are more evident in the relations of inter-organizational collaborations than in the relations presented in a particular company, university or government agency (Rycroft & Kash, 2004). Among the various works already carried out, we can find examples related to academic and scientific research networks (Bennett & Kidwell, 2001; Wagner & Leydesdorff, 2005), development networks of free software (Crowston et al., 2007), research and development networks in the automotive industry (Rycroft & Kash, 2004), networks of companies to improve sustainability (Espinosa & Porter, 2011), local public administration networks for economic policy development (Lee et al., 2012), networks of farmers (Dutta et al., 2005), networks of fashion industries (Schuh et al., 2008; Scherrer-Rathje et al., 2009), team management (Parker et al., 2015), among others. In all the literature reviewed, self-organizing networks were not addressed in the scope of Six Sigma programs, although there are common characteristics.

2.3 Six Sigma Methodology

The Six Sigma methodology is aimed at improving strategic processes and developing new products and services. It is based on statistical and scientific methods for drastic reductions in the default rates defined by the client (Linderman et al., 2003; Dora & Gellynck, 2015). The Six Sigma methodology was created by Motorola in the 1980s to face the Japanese threat in the electronics industry (Banuelas et al., 2005). The Six Sigma methodology means 3.4 defects per million opportunities (DPMO), and the term "sigma" represents the variation of the process in relation to the average. Not all processes can achieve the level of 3.4 DPMO, but this is the goal of Six Sigma programs.

Directed at the realization of projects in teams (Easton & Rosenzweig, 2015), the Six Sigma methodology is divided between the 'Define, Measure, Analyze, Improve, Control' (DMAIC), which are applied in existing processes when the causes of the problems are unknown or are not clear (Banuelas et al., 2005), and the 'Design for Six Sigma' (DFSS), applied to the development of new concepts of existing products (Koziolek & Derlukiewicz, 2012), being DMAIC more popular, applied and studied than DFSS. The literature imposes certain rigor in using these steps, defending the rigidity of the method and its application (Hahn et al., 1999; Banuelas et al., 2005; Patterson et al., 2005; Kwak & Anbari, 2006; Siakas et al., 2006). However, Chakravorty (2009) argues that the rigidity in the implementation of the method in cases where the problem to be solved is not clear must be decreased, and the "Define" phase should be finished along with the "Measure" phase or even the "Analyze" phase, being these three phases completed simultaneously.

The matrix structure of the Six Sigma methodology (structure of the program and organizational structure of the company) presents two variations in the literature. The first variation is composed of Champions, Master Black Belts (MBB), Black Belts (BB) and Green Belts (GB) (Hahn, 2005; Buch & Tolentino, 2006; Gutiérrez et al., 2012). The second one has the following formation: Champions, Black Belts (BB) and Green Belts (GB) (Schroeder et al., 2008; Calia et al., 2009; Laux et al., 2014), with the difference regarding the non-use of MBB. Each member has a different function, with their own responsibility and acting levels, interacting with each other for the development of projects.

Considering that a Six Sigma program has features of a collaborative network, this paper presents the changes needed in a Six Sigma program to enable the formation of a self-organizing network.

2.4 Enterprise Knowledge Development (EKD) Methodology

Enterprise modeling is used both as a technique to represent and understand the structure and behavior of organizations and to analyze business processes and, in many cases, as technical support for business process reengineering (Mertins & Jochem, 2005).

The Enterprise Knowledge Development (EKD) methodology offers a systematic and controlled way to analyze, understand, develop and document an organization, using the enterprise modeling (Rolland et al., 2000; Bubenko et al., 2001), from the preparation of six sub-models that are interdependent, as shown in Figure 1. The model of goals is used to describe the objectives of the company, as well as the issues related to reaching this objective. The model of business rules is used to define and clarify the rules around the objectives, and they can be limiting or not. The model of players and resources describes how players and resources involved in the organization are related to each other and among other models. The model of business processes is used to design and analyze the processes of the company, as well as flows of information and materials. The model of technical requirements and components is used to capture the requirements of information systems. The model of concepts is used to define and clarify terms and phenomena presented in other models (Bubenko et al., 2001).

Nurcan & Rolland (2003) have developed an adaptation of EKD called Enterprise Knowledge development - Change Management Method (EKD-CMM). This method is based on four main phases, schematically represented in Figure 2. The "reverse analysis" features a model with the current reality of the company, named "As-Is Model". The "definition of change" presents a model that seeks to identify the changes needed in the company, called "Model of Need for Change". The "implementation of change" presents a model that seeks to represent the future situation of the company, after the changes are implemented, named "To-Be Model". The "historical integration" considers the existing context during the implementation of change.

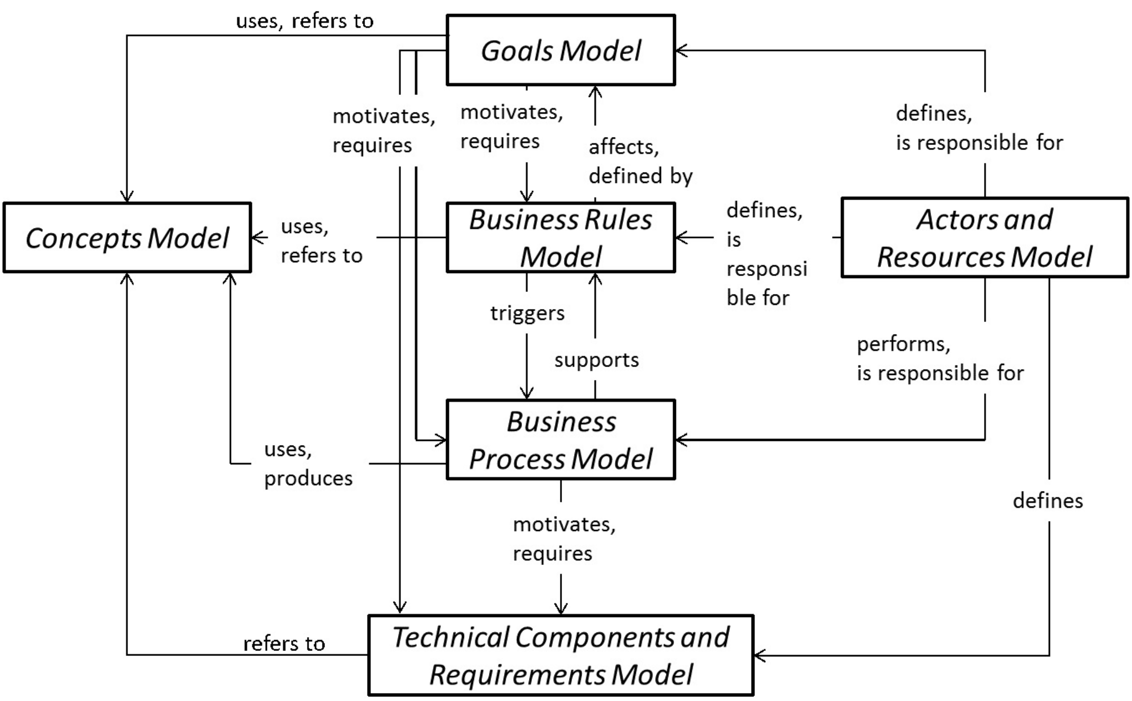

Figure 1. Sub-models of EKD. Source: Adapted from Bubenko et al. (2001).

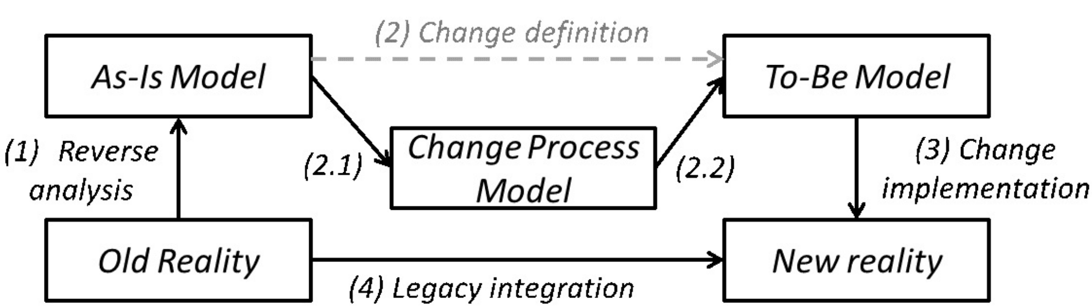

Figure 2. EKD-CMM Model. Source: Adapted from Nurcan & Rolland (2003).

2.5 Considerations on the literature review

The theoretical framework addresses the concepts used during the development of this research. Figure 3 shows the relationship between the concepts and how they make up the research result.

It is known that the use of the Six Sigma methodology provides positive results for the company that uses it. As we have not seen in the literature studies that analyze the Six Sigma program as a self-organizing innovation network, we hope to integrate the concepts presented in a set of need for change.

3 Research method

The research is based on a qualitative approach of the Six Sigma program of a single organization using the case study. The research is exploratory, and we sought to look for more information on the subject of the research being it, however, possible to get a new perception on the phenomenon (Marconi & Lakatos, 2000). According to Yin (2010), a case study seeks to answer questions such as "how" and/or "why", inserted in the real world and not controlled by the researcher, being in this way aligned to the objectives of the research. Data collection was based on a semi-structured interview, whose script included questions that allowed the modeling of the Six Sigma program in the company and the identification of the existence or not of features of a self-organizing network in the Six Sigma program of the company.

The case study was conducted in a Brazilian multinational company, with more than sixty years in business, several business units, and whose main unit is the production of agricultural machinery. The company has approximately 4,000 employees, of which 1,700 work in the unit studied. The annual revenue is approximately R$ 1 billion, and 75% of this value corresponds to the unit studied. The interview was conducted with the Black Belt responsible for monitoring the Six Sigma projects, who have reported annual earnings of more than R$ 1 million with the Six Sigma projects developed.

The pieces of information verified through the semi-structured interview and the documentation were initially systematized with the EKD methodology. Early versions of the models were submitted to the respondent to verify possible divergences and validated by the respondent as being representative of the Six Sigma program. After analysis and suitability of the models, they were again analyzed by the researcher, in the light of the theoretical framework on self-organizing innovation networks to identify common features between the Six Sigma program and the self-organizing innovation networks, resulting in a set of need for change in the management of the Six Sigma program.

4 Results

The research has presented as result the systematization of the Six Sigma program of the company, allowing an assessment both by the researcher and the BB interviewed. The modeling has enabled the communication of the operation and the analysis of changes needed.

4.1 Goals model

Figure 4 presents the goals model of the Six Sigma program in the organization studied. The increase in the competitiveness of the Organization (Goal 1) can be reached from cost reduction (Goal 1.1), reduction in the variability of processes (Goal 1.2) or the improvement of the quality of the products (Goal 1.3). The persons involved in the Six Sigma program have partial dedication, which is considered a problem (Problem 1) which can be solved by the establishment of a minimum structure dedicated entirely to the Six Sigma methodology. The ensuring of the use of the methodology for the development of projects (Goal 2) supports Goal 1, as the increase in competitiveness is reached through the correct application of the methodology. There are periodic meetings to ensure the correct application of the methodology. There is the opportunity to create a bank with best practices

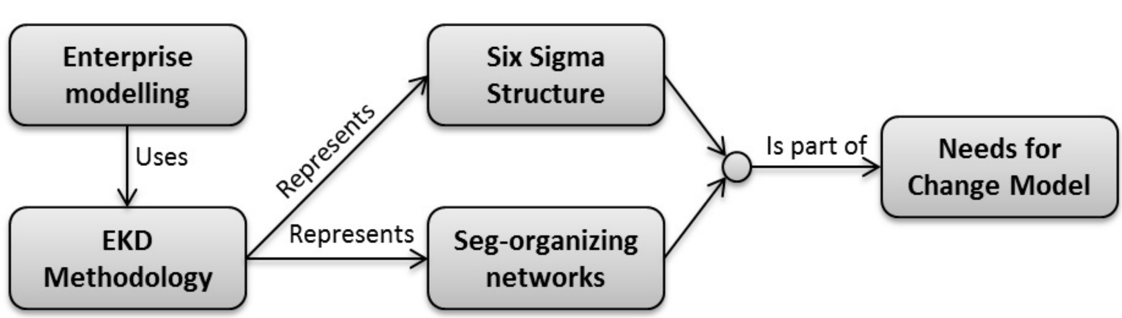

Figure 3. Relationship between the concepts of the research.

in Six Sigma (Opportunity 1), useful as a reference of successful and unsuccessful previous projects, in this way avoiding the repetition of failures and enabling the repetition of successes. When using the bank with the best practices, participants can verify if their projects are adequate to the methodology, thereby avoiding deviations that only would be detected in follow-up meetings.

4.2 Business rules model

Figure 5 presents the business rules model, responsible for enabling the objectives, and every objective should have at least one rule associated to it. By using pre-established project selection criteria (Rule 1), there is an attempt to ensure that only projects with potential to increase competitiveness (Goal 1) in the organization should be developed. These criteria are available in an electronic spreadsheet where the projects are assessed by the Black Belt or Master Black Belt before being developed. By performing periodic follow-up meetings (Rule 2), those responsible seek to keep developing projects according to what is planned to increase competitiveness (Goal 1). The deviations identified in these meetings are addressed and reviewed at the next follow-up meeting. By using the support of the project office (Rule 3), it is ensured the use of the methodology

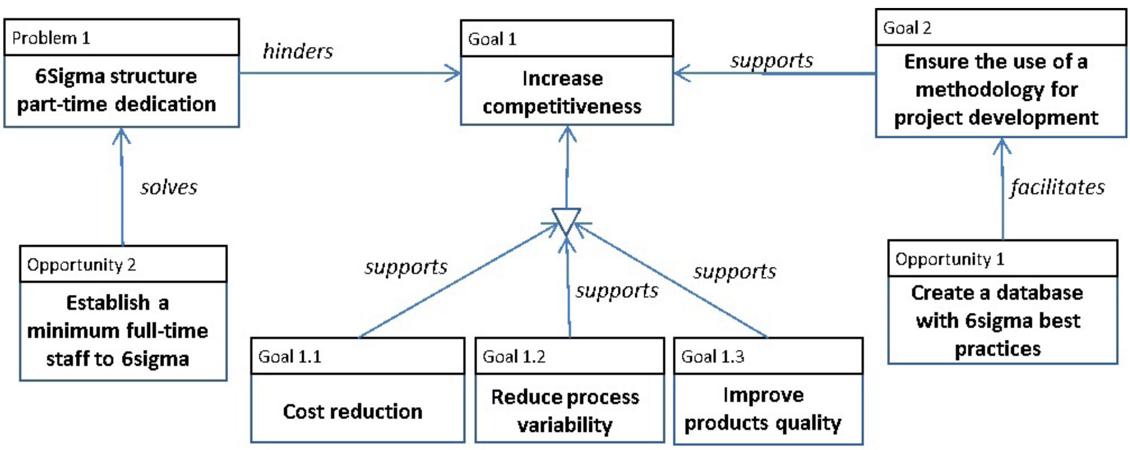

Figure 4. Goals Model of the Six Sigma program.

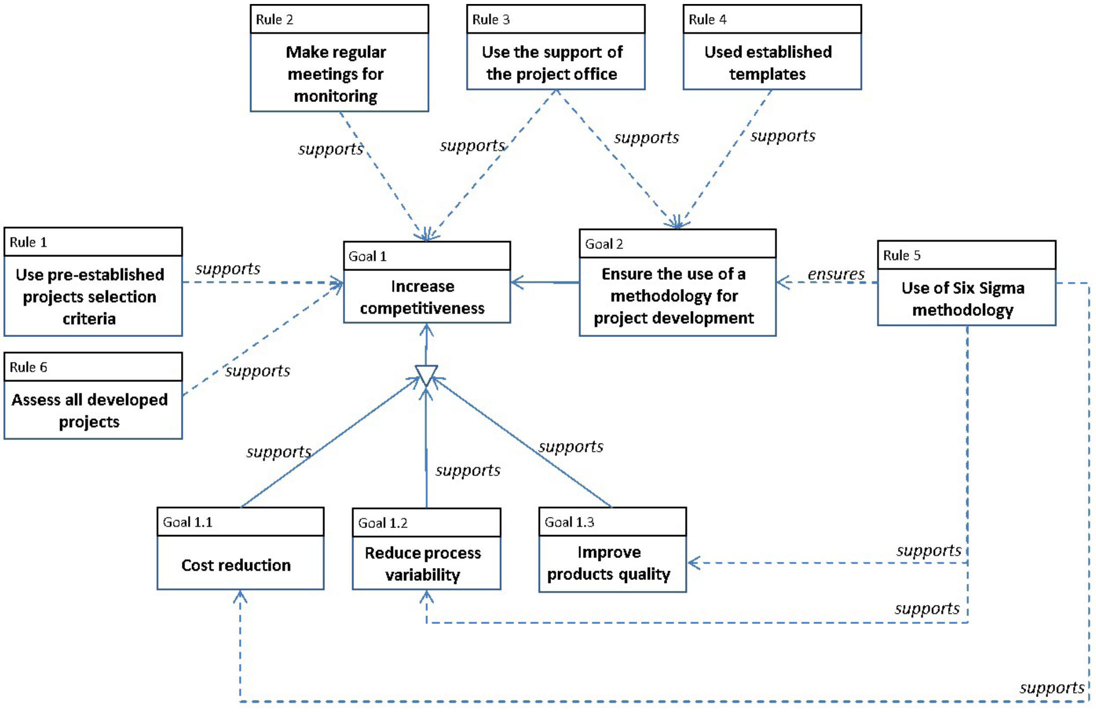

Figure 5. Business rules model of the Six Sigma program.

for the development of projects (Goal 2) and it is kept on schedule for the project, in order to increase competitiveness (Goal 1). The project office supports the development of projects regarding the application of the methodology, meeting of deadlines and budget and communication between the various levels of management involved. The use of templates (Rule 4) ensures the use of the methodology in the development of projects (Goal 2) and (Rule 5). The use of templates minimizes the occurrence of deviations. The Six Sigma methodology (Rule 5) allows cost reduction (Goal 1.1), reduction in the variability of processes (Goal 1.2) and the improvement of the product quality (Goal 1.3). The projects must be assessed (Rule 6) to increase competitiveness (Goal 1). Financial gain, compliance with schedule and budget and the correct use of the methodology are important. It is the responsibility of the Master Black Belt to ponder when a project is considered successful.

4.3 Actors and resources model

Figure 6 presents the actor and resources model. The management of operations (Organizational Unit 1) is composed of the project office (Organizational Unit 1.4), validation management (Organizational Unit 1.3), factory management (Organizational Unit 1.2) and the various managements of the other processes of the company (Organizational Unit 1.1). A Black Belt (Individual Unit 2) can be part of both the project office and some management of a specific process. The Black Belt can carry out the control of projects (Role 5), is the leader of Six Sigma projects (Role 2) and participates in project teams (Role 6). By exercising the role of control of projects, the Black Belt is responsible for the ERP (Resource 6), in which the data on the development costs of the projects are released. The Black Belt also verifies the monitoring and control spreadsheets (Resource 1) to achieve the goals and the correct use of the Six Sigma methodology.

The Six Sigma project leader is responsible for the monitoring and control spreadsheets regarding their correct filling, in addition to using the Six Sigma methodology (Resource 2) and developing the Six Sigma project (Resource 4). The Master Black Belt (Individual Unit 3) is a Six Sigma expert (Role 3) and an Six Sigma instructor (Role 7), in addition to approving and guiding the Six Sigma projects and supporting the Black Belt in the application of the methodology. Being the Master Black Belt an expert in the methodology, it is up to them to train those entering the Six Sigma structure, assisting in the application of the methodology, assisting in the use of statistical tools and remedying any doubts of the leaders of projects that may arise during the project development.

The manager of a given process (Individual Unit 1) is the Owner of the process (Role 1), where the project will be developed, and indicates possible Six

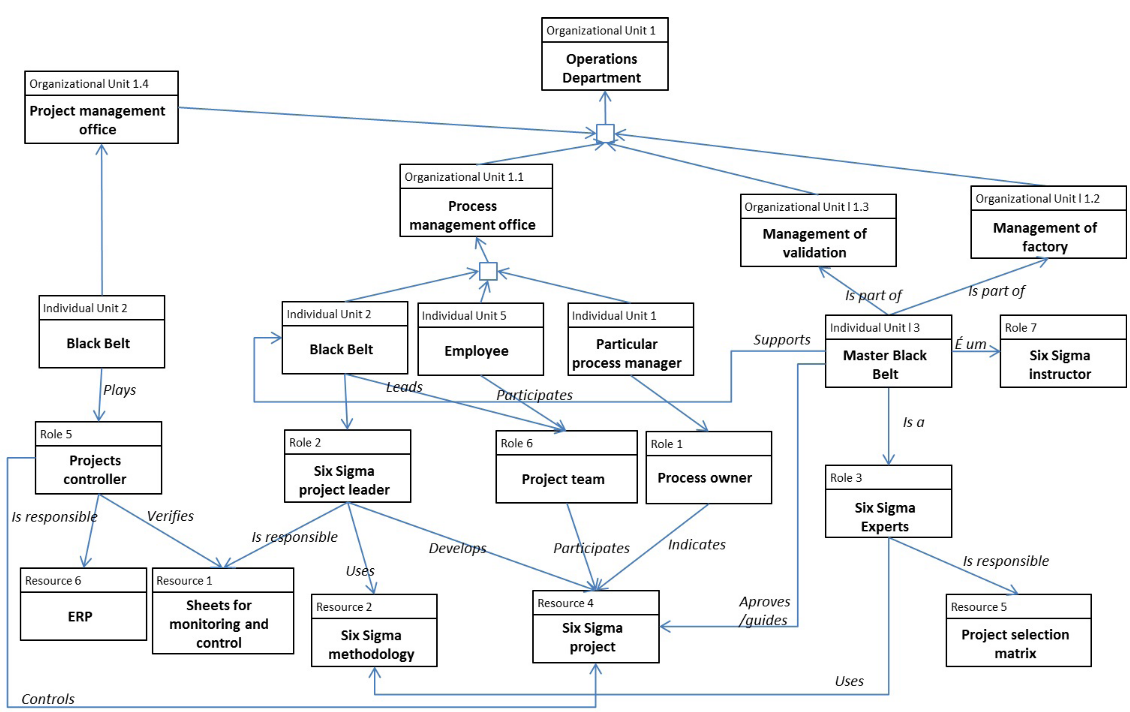

Figure 6. Actors and resources model of the Six Sigma program.

Sigma projects. The projects can be developed in any process of the organization but always by indication of the managers. The other employees (Individual Unit 5) participate in project teams (Role 6), where they receive brief training taught by the Master Black Belt to know the methodology.

4.4 Business process model

Figure 7 presents the business process model of the Six Sigma program. Business processes are started by the owner of a process (Role 1) of the organization, that is, the manager of any process. They make the suggestion to the Master Black Belt of a new project of interest in their area (Process 1) through a project nomination form (Infoset 1). This nomination form is assessed (Process 2) and, of the criteria used for the assessment, we can highlight the deadline for the development of the project, the measurable financial return, the ignorance of the causes of the problems and the development costs of the project. The project can be not selected (Infoset 2), and the manager is told that the project is not suitable, or selected (Infoset 3) for development. If the project is selected, the charter of the project is elaborated (Process 3), containing information such as development team, goals, budget, schedule and scope (Infoset 4). The charter is developed jointly by the owner of the process, the project leader and the Master Black Belt. With these pieces of information, the development of the project is started (Process 4).

During development, statistical and non-statistical tools and techniques are applied for the solution of the problem. This process also includes the follow-up by the Black Belt of the indicators of the project (Process 4.1), such as budget, schedule and financial gain, and the guidance during the implementation of the project (Process 4.2), which is carried out by the Master Black Belt. After the project is finished, its results are assessed (Process 5) jointly by the project leader, owner of the process, Master Black Belt and Black Belt, thus resulting in a final report of the project (Infoset 5).

There is also a process of training the employees in the Six Sigma methodology (Process 6), which is performed by a Six Sigma Instructor (Role 7). The trained employee (Infoset 6) starts their participation from the preparation of the charter of the project (Process 3), in addition to being responsible for the development of projects (Process 4). The first project led by the employee is developed close to the Master Black Belt, as the first project is the "final exam" of the training in the Six Sigma methodology.

4.5 Technical requirements and components model

Figure 8 presents the technical requirements and components model of the Six Sigma program of company A. This model was developed from the expectation of the respondent regarding an information system that would meet his needs, as the organization studied did

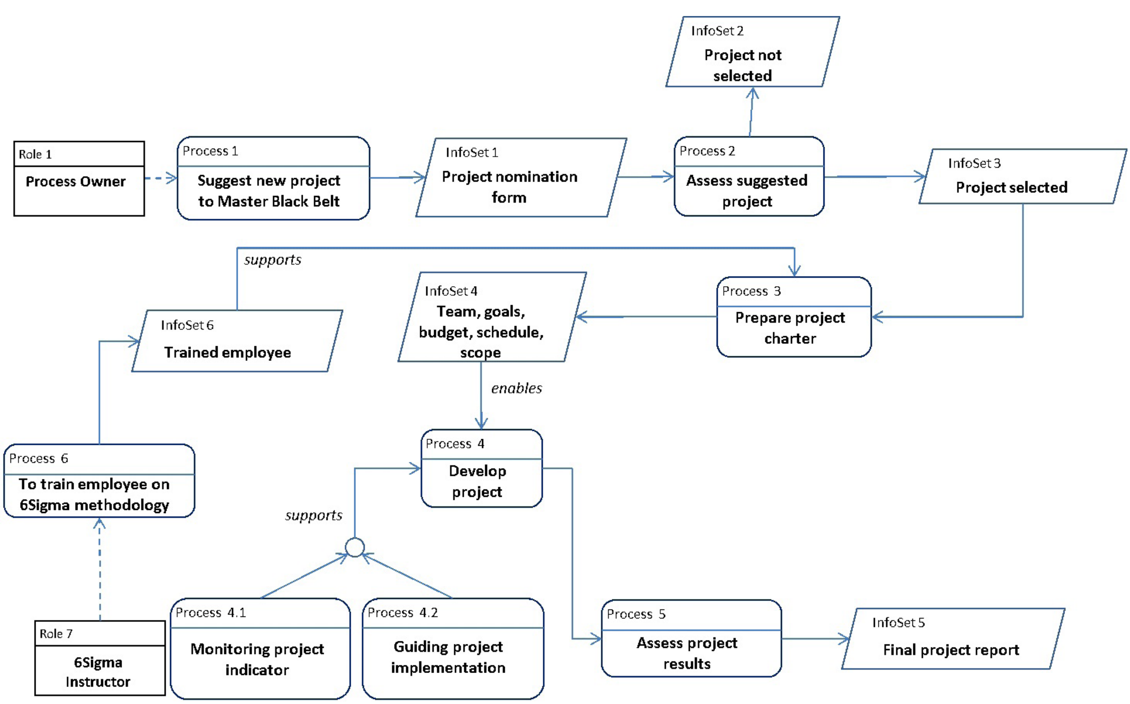

Figure 7. Business processes model of the Six Sigma program.

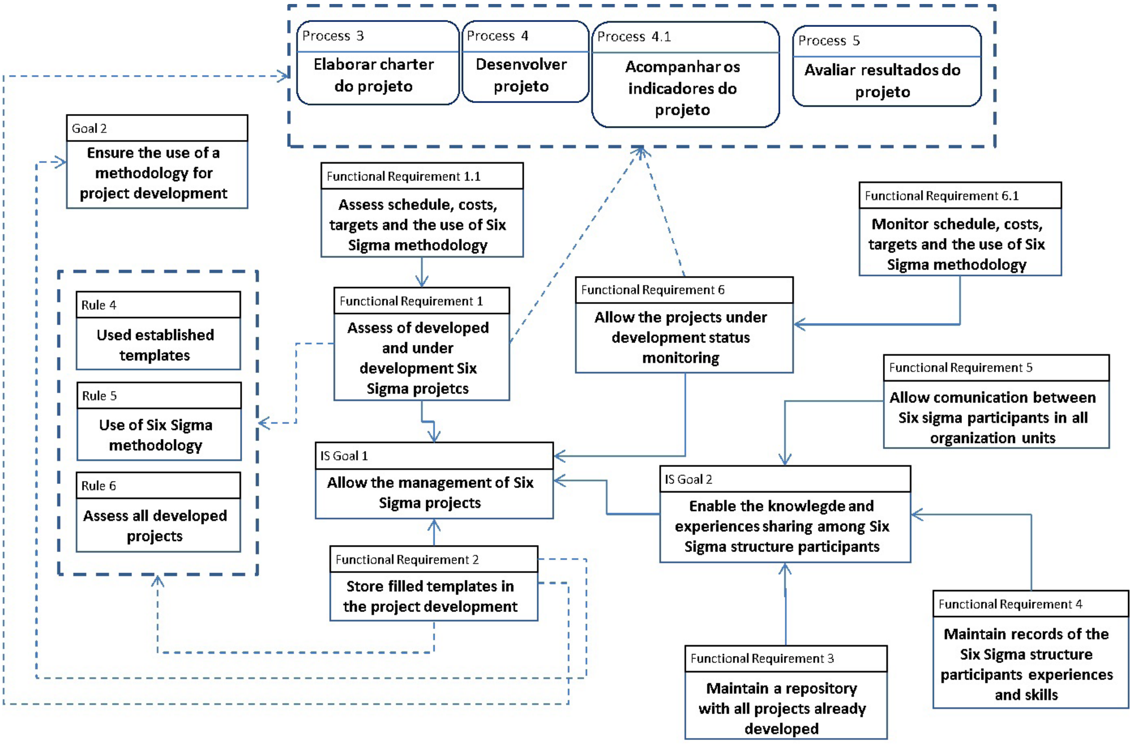

Figure 8. Technical requirements and components model of the Six Sigma program.

not have any information system that supported the management of the Six Sigma program in the period when the case study was developed. In this model, the requirements that the information system (IS) must fulfill to achieve its objective of enabling the management of Six Sigma projects (IS Goal 1) are defined. To achieve this objective, the IS must store the templates filled in the development of projects (Functional Requirement IS 2).

The IS must also allow the monitoring of the status of projects in development (Functional Requirement 6) with the monitoring of the schedule, costs, goals and implementation of the Six Sigma methodology (Functional Requirement 6.1), which is made by the Black Belt, and the assessment of projects in development and developed (Functional Requirement 1) with the assessment of the schedule, costs, goals and implementation of Six Sigma methodology (Functional Requirement 1.1), which is made by the Master Black Belt. Such requirements support some processes (Processes 3, 4, 4.1 and 5), implement some rules (Rules 4, 5 and 6) and allow the achievement of the objective of ensuring the use of methodology for the development of the process (Goal 1).

To facilitate the establishment of a bank with best practices in Six Sigma (Opportunity 1), the IS also has the objective of enabling the sharing of knowledge and experiences among the participants of the Six Sigma program (IS Goal 2). This objective of the IS achieved through the meeting of the requirements to maintain repositories with all projects already developed (Functional Requirement 3), so that new projects can use the knowledge produced in previous projects, keep a record of the participants in the Six Sigma program with their experiences and capabilities (Functional Requirement 4) and allow the communication between those involved in the Six Sigma program in all units of the organization (Functional Requirement 5).

4.6 Concepts model

Figure 9 presents the model of concepts of the Six Sigma program in the organization studied. The central concept which permeates all models is the management of the Six Sigma program (Concept 1). The selection of Six Sigma projects (Concept 1.1), the development of projects (Concept 1.2), the monitoring of projects (Concept 1.3) and assessment of projects (Concept 1.4) are part of the management of the Six Sigma program. To perform the selection of projects, selection criteria (Concept 1.1.1) are used, of which we can mention: the solution of the problem should be unknown (Concept 1.1.1.1), the project must be performed in the short term (Concept 1.1.1.3) and

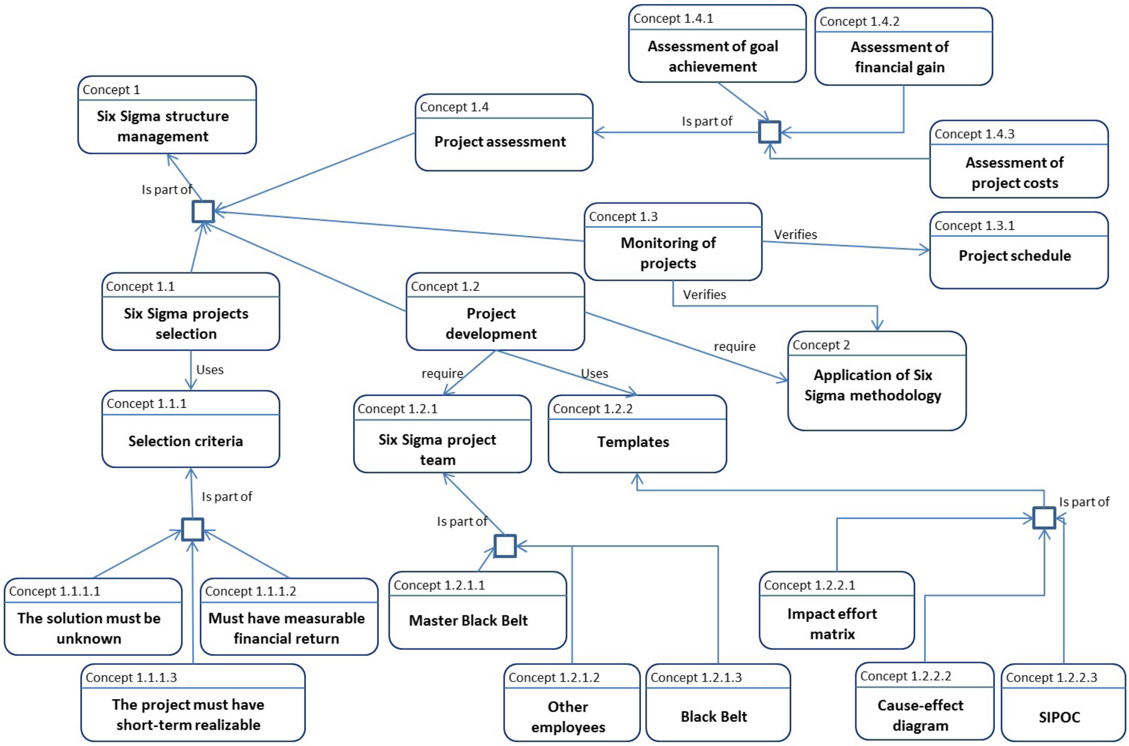

Figure 9. Concepts model of the Six Sigma program.

the project must have measurable financial return (Concept 1.1.1.2).

The development of projects (Concept 1.2) requires a Six Sigma project team (Concept 1.2.1), uses some templates (Concept 1.2.2) and requires the application of the Six Sigma methodology (Concept 2). The Master Black Belt (Concept 1.2.1.1), the Black Belt (Concept 1.2.1.2) and the other employees (Concept 1.2.1.3) are part of the project team. The templates used for the development of projects are the effort X impact matrix (Concept 1.2.2.1), the cause-and-effect diagram (Concept 1.2.2.2) and the SIPOC (Concept 1.2.2.3). The monitoring of projects (Concept 1.3) verifies the application of the Six Sigma methodology (Concept 2) and the project schedule (Concept 1.3.1). The assessment of the project (Concept 1.4) consists of the assessment of the scope of the goal (Concept 1.4.1), assessment of the financial gain (Concept 1.4.2) and assessment of the cost of the project (Concept 1.4.3).

4.7 Discussion of results

The models have the current dynamics of the Six Sigma program. After analyzing the models from the literature, we can compare the characteristics of a self-organizing network with the characteristics in the Six Sigma program, resulting in a set of changes to create a self-organizing network from a Six Sigma program. Chart 1 presents the characteristics, the evidence of the case study and the need for change to enable the formation of a self-organizing network from a Six Sigma program.

It is worth mentioning that the suggested changes require the development of a culture of collaboration, because without this culture changes little affect the dynamics of the Six Sigma program, in this way not allowing the formation of a self-organizing innovation network.

The structure found in company A does not have GBs, thus hindering the spread of the Six Sigma methodology. As they work with partial dedication to Six Sigma projects, the GBs are diffusers of the methodology, inserting it in their daily work and increasing the interest of other employees. As shown in the literature, the GBs lead less complex projects in which an advanced knowledge in statistical methods is not necessary, what allows BBs to perform more complex projects, requiring deeper knowledge.

Of the suggested changes, we highlight the implementation of an IS that allows maintaining a repository with all projects already developed, being this repository accessible to all participants involved. The IS part of several of the proposed changes, as it: promotes learning and interaction of participants, makes available the capabilities of participants to everyone, and quickly forms teams. Another change needed is the sharing of responsibilities of the

Chart 1. Need for change for the viability of a self-organizing network.

Characteristic (Literature)	Evidence	Need for Change
Joint learning and development of the network (Vany, 1996)	Learning is only possible through conversations with the MBB	Promotion of the learning through interaction and consultation to IS and direct meetings
Quick formation of teams for troubleshooting (Quinn et al., 1996)	The teams are formed quickly, however centrally and conducted by the MBB	Arranging a mechanism for quickly grouping the skills needed and forming the team
Strong interaction and communication between the participants of the network (Anderson, 1999)	There is no relationship between the participants, except the monitoring meetings	Encouragement of the meeting of those involved and development of the IS for interaction.
Coevolution of the participants of the network and the network itself (Kash & Rycoft)	Participants do not develop jointly, only through external training	Promotion of the learning through interaction and consultation to IS and direct meetings
Extensive knowledge of the skills of participants and access to these capabilities (Kash & Rycroft, 2002)	Only the MBB know the capabilities of those involved	Make available the capabilities of those involved through IS and make them accessible
Existence of mutual trust and aid (Kash & Rycroft, 2002)	There is confidence, but only the MBB helps	Make available the capabilities of those involved through IS and make them accessible
Ability to be developed without significant direct external interference (Rycroft & Kash, 2004)	Projects are developed primarily from indications of the owners of processes	Method for generation and selection of ideas within the Six Sigma structure
Non-existence of an explicit centralized leadership (Wagner & Leydesdorff, 2005)	Leadership that is explicit and centralized in the MBB, who select the projects and have the knowledge	Modification of the performance of MBBs so that they can be supporters of the Six Sigma program.
Use of information systems to systematize the knowledge developed (Crowston et al., 2007)	The information system is only used for cost allocation	Use of IS to allow interaction between participants, exchange of experiences, placement of files and recovery of older projects.

MBB, allowing them to decentralize decisions and selection of projects, sharing responsibility with BBs. The development of a method for the generation of ideas and selection of projects within the Six Sigma structure also contributes to the formation of the self-organizing network, since it makes the program less susceptible to external interference. In addition to suggesting and selecting projects, the structure must be able to form teams quickly and with the right capabilities for the development of the project.

5 Conclusion

The characteristics and functions identified in a Six Sigma program have several variations among different organizations. In the company analyzed, we have identified points for improvement and need for change. The suggested changes seek to allow the creation of a self-organizing network from the Six Sigma program, bringing benefits to the company in the form of improvement of organizational learning, systematization of knowledge and greater autonomy of the BBs.

The management of the Six Sigma program as a self-organizing network provides the benefit of allowing the self-management of the structure, without relying on a single person, thus providing greater autonomy and authority to those involved, collectively suggesting and selecting projects and keeping its operation without significant interference that is external to the network. We highlight that a new analysis must be performed after the application of the changes suggested in order to validate whether they will lead to the formation of a self-organizing network.

This article contributes with the existing literature in two ways: first by analyzing the possibilities of the Six Sigma program becoming a self-organizing network by implementing the suggested changes; and second, by expanding the available knowledge on the management of Six Sigma programs. The changes must be accompanied by the development of a collaborative culture, which will allow the actual implementation and maintenance of the changes suggested.

It should be noted that the use of the EKD methodology has enabled the conversion of the implicit knowledge regarding the management of the Six

Sigma program into explicit knowledge, thus allowing the analysis and verification of the characteristics of self-organizing networks. The models developed will be used by the organization itself to understand and improve the Six Sigma program.

This research presents as limitation, and opportunity for future research, the modeling and analysis of a single case. Such limitation is due to the fact that the Six Sigma program can have different structures in different organizations. In this way, case studies should be carried out in the Six Sigma programs of other organizations, thus enabling the comparison between them and improving the consistency of the suggested changes. Another opportunity for study is the implementation of the necessary changes and the realization of a new modeling, thus confirming that the suggested changes enable the formation of self-organizing networks from the Six Sigma program.

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