



## **IMPACT OF SYSTEMIC MANAGEMENT ON PROJECT DEVELOPMENT: A STUDY IN A SOFTWARE HOUSE**

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### **ABSTRACT**

The 21st century market demands of companies the ability to self-manage in order to efficiently and effectively meet the needs of each customer; Thus, to achieve these results, it is important to minimize efforts and eliminate rework. In this context, a comprehensive view that reflects the globalized scenario and technological revolution is fundamental. An example of such is the General Theory of Systems, which emerged, at the beginning of the 20th century, as a form of integration between the different areas of knowledge, generating resources for a management model that provides to the manager a holistic view of the business, focusing on the interrelationships between the organization's elements. Based on the above, this study aims to analyze the application of Systemic Theory in a Software House company in the region of Bragança Paulista. We used the case study method and bibliographic research to develop the work and participant observation in the data collection, with the development of company projects as object of study. From the analysis of the case it is possible to verify, as a benefit of the systemic management model, a tendency towards greater effectiveness in the resolution of conflicts, as well as opportunities for productivity gains, due to the holistic perception of the processes.

**Keywords:** Systemic Management; Systems; Project development; Software House.

### **1. INTRODUCTION**

The complexity of an organization is the result of the forces and pressures it suffers from its environment (Donaires, 2006). Therefore, the current scenario requires managers to take into account the problem of globalization in decision making.

Globalization means combining the behavior of great civilizations and dissolving their boundaries in a historically unprecedented way (Shimizu, 2011). The result of this process is the creation of complex problems that require a specific way of thinking. And this because, according to Senge et Sterman (1994) apud Andrade (1997), a new way of thinking should help to map, challenge and improve mental models, aiming for more effective actions in the organizational reality. However, there is an expectation that reality will follow

an orderly model, which presents regularity and repetitiveness, such as those typical of a machine. This expectation is a consequence of the Cartesian education of professionals and the legacy of the classical administration that permeates managerial thinking (Donaires, 2009). A comprehensive vision that generates resources for a management model which allows a holistic view of the business is required in this context.

But where can we find such a paradigm that allows us to deal with the professional problems of the complex and dynamic environment of today's market? According to Martinelli (2002), pragmatic managers often face challenges that require new ways of thinking and ask the academic world to provide them with a 'pair of systemic lenses', with an overall



perspective that is generic, comprehensive, holistic and concrete, capable of describing the administrative performance. So, the systemic vision (or systemic perspective), based on the General Theory of Systems which emerged at the beginning of the 20th century as a form of integration between the different areas of knowledge, began to characterize different researches in the field of administration, especially in the search for guidelines and methodologies for the so-called integrated, holistic systemic-evolutionary administration (Martinelli, 2006).

In order to present this reality in software development, it is important to note that the complexity of the software is the result of the complexity of the process that generated it, which in turn is a reflection of the complexity of the organization. Organizations that aim to develop software in a globalized, varied or fragmented market are themselves complex organizations. This means that such organizations cannot be understood through the mechanism simplifying view (Donaires, 2006). Thus, based on the above, this study aims to analyze the application of the systemic theory in the development of Software House projects in the Bragança Region. The tool used in the case study for the implementation of systemic management was the Scrum Agile Method.

This study aims to demonstrate the consequences derived from the practice of systemic thinking, describing its theoretical principles and contextualizing them, from the analysis of the case, to the reality of the company-object of study. Such consequences include benefits, such as greater effectiveness in conflict resolution, and as incentives for productivity gains from the holistic perception of processes.

## 2. LITERATURE REVIEW

This section presents the literature review through the analysis of theoretical references published in articles, books, websites and theses, with the purpose of verifying the state of the art on the subject of work.

### 2.1. System definition

There are many definitions for 'system' in the literature. Ribeiro (2004) states that it is a set of elements, interacting and interdependent, each with its specific function, that works in harmony to reach a certain common objective; Faria (1980) defines a system as an integrator of the various sectoral flows that result in the activities of the specialized organs responsible for the performance of the typical functions of an organism. A large system coordinates the general flow and the subsystems carry specific flows. The system is, in short, an organization in action. He states that this concept is subtended as a result of the following properties:

- a) Aspects: a system is a set of elements in interaction; A set of objects and relations between objects and between their attributes; and finally, a system is also an organized whole composed of many parts, a set of attributes;
- b) Criteria and characteristics: a system must be definable in the sense that it can be located with certain precision in time and space; A system is considered as such, in cases where a variety of operations performed preferably by various disciplines (organ) leads to the conclusion that there is a specific system; A system must manifest significant differences in scales of structure and process; and,
- c) Existing fundamentals in the concept of system: the general goals of the system, and more specifically, the performance measurements of the whole system; the system environment and fixed constraints; the resources and components of the system, its activities, purposes and measures of income and also its administration.

Finally, Faria (2002) conceptualizes the system as being complex, and to understand it, we must know its characteristics, types, parameters, as well as other aspects.

### 2.2. General Systems Theory

The administration is one of the sciences that uses the Systemic Theory approach (Faria, 2002). The author clarifies that the General Theory of Systems has established a reciprocal dependency and the need for its integration, and that since then, all branches of knowledge have come to treat their studies – of any areas – as systems.

From the use of this theory in the articles by Ludwig von Bertalanffy, Faria (2002) mentions that he presented the theory and concepts, with establishments of real and current conditions, as follows:

- a) Foundations established: there are subsystems; Systems are open, and there are many outside interferences; Functions depend on the structure of these systems;
- b) Main characteristics: organized and complex set; Set of interrelated units; Every system has a goal; Every system affected in one of its parts will be affected in the others; There is a balance between the parts of a system.

Faria (2002) shows that systems are characterized by their parameters, according to Figure 1. These parameters



are Input; Throughput; Output; Feedback; Environment. It is also important to recognize the existing types of system, which can be as below:

- a) Concrete - the physical structure of the company, being able to quantitatively measure its performance;
- b) Abstract – based on concepts, hypotheses;
- c) Open - characterized by the great interaction with the environment; and,
- d) Closed - characterized by processes limited to one input.



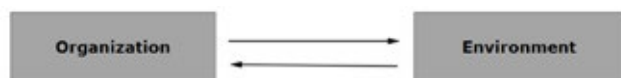
**Figure 1.** System Parameters.

Source: Faria (2002, p.127).

As for applicability, Ribeiro (2004) concluded that systems theory plays a decisive role in the science of our time, since it allows the integration of knowledge of the physics, biology and human sciences. Specifically in administration, Bouding (1956) apud Wetherbe (1987) state that:

The systemic approach is the way to think about the work of managing. It provides a framework for visualizing internal and external environmental factors as an integrated whole. It allows the recognition of the function of the subsystems as well as of the complex supra-systems in which the organizations have to operate. Systemic concepts create a way of thinking which, on the one hand, helps the manager to recognize the nature of complex problems and, through this, to operate within the perceived environment.

Ribeiro (2004) states that the systemic theory had the benefit of presenting the organization functioning in parts and at the same time in interaction with the environment, as shown in Figure 2 below.



**Figure 2.** Organization/environment interaction.

Source: Ribeiro (2004, p. 108).

Finally, Wetherbe (1987) concludes that:

The systemic approach is a way of thinking when analyzing or managing systems. It does not con-

sider only parts of a system; on the contrary, it takes into account the total effect created when the parts work as a whole - the system itself. Systems design consists of establishing the goals of the systems, selecting for inclusion those entities that have attributes that can contribute to the goals of the systems and properly structure the entities included in it.

This way, in the last 50 years, a broad set of systemic methodologies have been developed aiming to solve poorly structured problems, some of which can be used to address common problems in administration, especially in the issues related to daily dealings of people inside organizations (Martinelli, 2006).

### 2.3. Project Management

Terribili Filho (2011, 40) defines a project as any effort to create a product or service, with beginning and end, using deadlines to complete its stages and involving budgets related to human and logistic resources. With the completion of all steps, which are based on pre-established requirements, you have the deliverable “outcome”, lacking only final approval from your sponsor or client. This definition reinforces the characteristics of project management, presented by Svejvig and Andersen (2015), which are: executability, simplicity, temporality, linearity, controllability and instrumentality.

Through projects, it is possible to build the combination of the necessary organizational resources in order to provide a high performance capacity in the creation and execution of organizational strategies (Cleland et Ireland, 2007).

In turn, project management is based on delivering of planned outcomes with quality and in the expected time and into the budget (Terribili Filho, 2011). Its implementation is done through procedures that consist of the fundamental functions of administration, using resources to achieve the goals of the project (Cleland et Ireland, 2007).

According to Faria (1980), it is possible to build a project based on the systemic approach, rationally verifying the organizational structure and resources available to achieve a goal. To do this we must:

- a) Prescribe a system that brings functionality to the organization of a process for the general solution of problems;
- b) Define a system of parameters that provides the necessary format for the solution of the problems; and
- c) Describe models and properties that provide the



necessary means for the iteration of alternative outputs in the problem solving process.

Thus, Faria (1980) states that the systemic conception of organization differs from classical methods because it seeks global solutions, establishing functional interaction between the specialized organs and aims to nullify the tendency of compartmentalization of organ microstructures, which tend to function in order to preserve the sector goals to the detriment of the final ones. According to Castro (2000), the success of the organizational system depends on the coordinated optimization of its social, economic and technological dimensions, according to Figure 3 below.

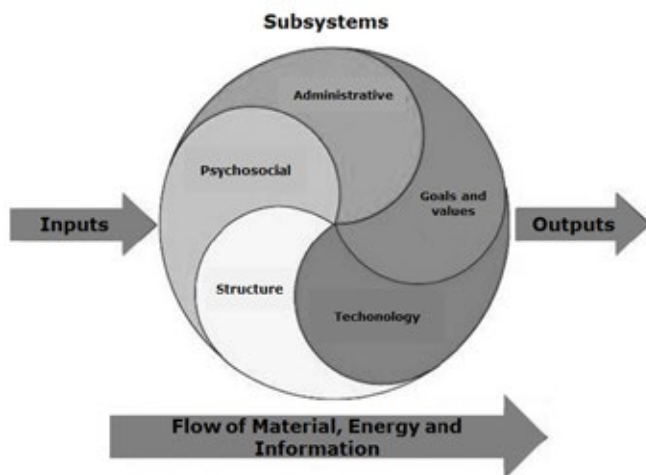


Figure 3. The company as a sociotechnical system.

Source: Castro (2000, p. 37).

## 2.4. Scrum

Scrum is an agile model of project management software. It is based on the incremental development of the applications, centered in the team, allowing a greater control of the process by having very short iteration cycles. Its processes are based on agile development methodologies, characterized as a “non-traditional” way of developing software, in which the highest priority is centered on customer satisfaction through the early and continuous delivery of software to be evaluated (Ferreira et al. Sabbagh, 2014; Prikladnicki, Willi, Milani, 2014).

In order to standardize software development practices, in February 2001 a group of representatives of agile development methodologies created the Agile Manifesto, with the following twelve principles, according to Beck et al. (2001):

- a) The highest priority is to satisfy the customer through the continuous and in-advance delivery of value-added software;

- b) Changes in requirements are welcome, even late in development;
- c) Agile processes take advantage of the changes aiming at competitive advantage for the client;
- d) Frequently deliver working software, from a few weeks to a few months basis, preferably on the smaller timeframe possible;
- e) Businessmen and developers must work together on a daily basis throughout the project;
- f) It is preferable to build projects involving motivated individuals;
- g) It is necessary to give employees the required environment and support and trust them to do the work;
- h) The most efficient and effective method of transmitting information to and between a development team is through face-to-face conversation;
- i) Software running is the primary measure of progress;
- j) Agile processes promote sustainable development. Sponsors, developers and users should be able to maintain a steady pace indefinitely;
- k) Continuous attention to technical excellence and good design increase agility;
- l) Simplicity - the art of maximizing the amount of unfulfilled work - is essential;
- m) The best architectures, requirements and designs emerge from self-organizing teams; and,
- n) At regular intervals, the team reflects on how to become more effective and refines and adjusts their behavior accordingly.

Although the manifesto defines new values for software development, its old guidelines have not been discarded. However, it focuses now in meeting new needs observed within development. So, as listed below, according to Beck et al. (2001), it is possible to value:

- a) Individuals and interactions rather than processes and tools;
- b) Working software rather than comprehensive documentation;



- c) Collaboration with the client rather than contract negotiation; and,
- d) Respond to changes rather than following a plan.

Initially focused only on software development, this methodology extended to project management and organizational culture. As a result, Scrum techniques have brought assertiveness and integration to companies, a fact that corroborates Santos Filho's (2012) studies.

And also, according to Serrador et Pinto (2015), agile methods are designed to use a minimum of documentation in order to facilitate flexibility and responsiveness to changes, which implies less planning and more flexibility in agile projects compared to traditional management projects.

### 3. METHOD AND OBJECT OF STUDY

We adopted the case study as the methodological procedure to conduct this article. At first, we carried out a bibliographical research with the purpose to base and contextualize the theme. According to Cervo et al. (2007):

The bibliographical research aims to explain a problem from theoretical references published in articles, books, dissertations and theses. It can be performed independently or as part of descriptive or experimental research. In both cases, we seek to know and analyze the cultural or scientific contributions of the past on certain subjects, themes or problems.

After this, the present work observed, recorded, analyzed and correlated facts, discovering their relationships and connections, their nature and their characteristics (Cervo et al., 2007). The intention was to obtain an empirical evaluation of the subjects covered in the bibliographic review, and also to provide resources for inferences about the subject.

We conducted the case study in a Software House that has been operating in market for five years, located in the city of Bragança Paulista, state of São Paulo, which works on the production of customized applications for Web, Desktop and Mobile platforms. The object of study was the development of the company's own projects.

This Software House has grown a lot over the past year. Its staff of only three employees has grown to seven, a chief executive officer, a chief financial officer, a project manager, a customer service developer, and three programmers. With this rapid growth, the company did not have the time to adapt to the new organizational structure. Since ongoing projects can not be paralyzed and programmers are busy,

it has not been possible to implement a proven, market-approved development methodology capable of managing the project, development team, and customer service, and also of providing information for the project director and the CEO to make decisions more accurately and in a shorter time frame.

Given these conditions, the company needed a dynamic perspective that would allow it to deal with the changes. In this way, the use of the systemic approach meets the current needs of the company. The tool used in the case study for the implementation of systemic management was the Scrum Agile Method, which is quite objective, with well-defined roles, is easy to adapt and presents a relatively low learning curve. This method allows its practitioners to know exactly what is happening throughout the project and make the necessary adjustments to keep the project moving over time in order to achieve its goals (Schwaber, 2004 apud Pereira et al., 2007).

We made use of intensive direct observation for collecting data, as participant observation specifically in this case. According to Marconi et Lakatos (2010), participatory observation consists of the real participation of the researcher into the community or group, becoming a part of them and participating in their normal activities. In this case, the form of participant observation used was natural, since the observer belongs to the same community or group investigated.

The project director was the responsible for monitoring the software development process. He is also in charge of elaborating the project based on the data collected by the general manager; defining the structure of the application modules; monitoring project execution; and of defining the adjustments to be made after customer feedback.

Weekly reports were carried out on the activities carried out in the project, in order to document the whole process of data collection. It should be noted that, since it is not possible to monitor the entire project, due to the development time being longer than the deadline for delivery of this article, the conclusions are based only on a project excerpt.

### 4. DATA ANALYSIS

In order to reach the proposed goals, here is how we structured the data analysis, as follows: first, it presents the observation of the current situation of the company object of study, with respect to its structure and the administrative model. The following is a review of possible failures in the software creation process and, finally, the proposal of the application of Scrum as a management method, as well as the first results of the application of this proposal in the company-object of study.



#### 4.1. Software House Current Situation

After a growth in its staff, the company finds it difficult to carry on with its projects. One year earlier, it operated with only one developer - who executed one project at a time - and the company director; with a 300% increase in its staff, the Software House needs to adapt to the new reality and begin to implement defined rules and methods to control its processes in order to avoid delays, reworking, poorly-designed Projects and customer service failure, generating losses that the company could not afford.

In that scenario, the company used its own methodology to manage its projects, which no longer meets the needs expected by the project director and the CEO. They currently intend to use the experience gained in each project as learning to enhance their processes in future projects. Another observed need is to carry out a cost estimate of the project with precision, since the current management model used by the company does not provide resources for estimating the cost in a correct way and also if deadlines are accurately stipulated.

The project development methodology used by Software House is developed according to the following steps:

- a) A meeting is held between the general manager and the client for data collection, focusing on business needs. In this meeting, the company gather data and business rules of the client;
- b) After collecting this information, the project director prepares a pre-project divided into modules, according to the specifications given;
- c) This document is issued to the client, whose approval will occur after the evaluation of conformity to the business rules required for the application informed in the meeting;
- d) With the approval of the client, the project director defines the structure of the application and delegates the execution to the programmers;
- e) Periodically, the project director meets up with the programmers and checks the progress of the project;
- f) With the project finished, company begins the stage of tests, in which the programmers test the functionalities of the application;
- g) With the conclusion of internal tests, comes the approval stage, when the application becomes available to the client for a given period, so that the business rules are validated. In this period, developers will adjust the program code if necessary;

- h) When client approval stage ends, the application is made fully available, so that the clients can use it in their business;
- i) From this date onwards, the company's customer service department is responsible for maintaining contact with the client in order to receive and transfer requests for new tools and adjustments to the project, starting a new development cycle; and,
- j) With the project completed, the project manager meets with the general manager to evaluate the work done.

Through the analysis of the steps described we can observe a linear and sequential model, focused on the temporal chain between the project activities. According to Jaeger et al. (2010, p. 2-3):

Sequential methods applied to engineering projects put greater emphasis on the initial stages of projects, that is, in planning before construction. One of the most prominent models is the Cascade, which organizes software projects in four major steps, to be carried out sequentially, which are: analysis, design, coding and testing. In the Cascade process, each stage of the cycle must be fully completed before starting the next one, thus it presents long cycles for the execution of each stage and development products are delivered only after the completion of all these steps. Even today, this is the most widely known and used model in software development.

Any failures perceived in the process are pointed out later, so that it is possible to select which variables must be manipulated in order to achieve the desired result.

#### 4.2. Problems found

Due to the situation described in the previous item, we observed existing flaws in the software creation process that can result in the failure of the project, which are as follows:

- a) Client Feedback occurs at the end of the project. If the information collected at the beginning of the project is not accurate, the result will turn into a big rework for the developer company;
- b) Project progress monitoring fails. Because even though the project is divided in modules, and even if there is a stipulated deadline for the programmers to deliver the project, it is still not possible, after project completion, to measure the time taken to conclude each activity. This impairs the judgment of the project manager regarding the performance of the



team; for example, it is difficult to determine which collaborators perform the work more efficiently and effectively;

- c) Integration among the project participants could be better. Even with regular meetings, the company lacks a greater participation of the team, a fact that impairs the progress of the project;
- d) General Manager Feedback fails. A status meeting is held only after project conclusion, therefore, the general manager has no control over the actual situation of the ongoing projects in the company;
- e) Project budget control is deficient. In current conditions, the company has difficulties calculating the projects' actual costs. This is because it has no control of worked time, which is important because the workforce of the employees is the element that generates the greatest cost.

In view of these shortcomings, we must highlight that they are not caused only due to the correct fulfillment of activities and good practices, and the success of a project does not only stem from these factors. For this reason, stands out the importance of the systemic perspective, which aims to apprehend software engineering without fragmenting it in any dualities, since any company is constituted by inseparable technical, social, historical, economic, ethics and politics aspects inextricably articulated to form a single and indivisible "fabric" (Santos and Júnior, 2009).

### 4.3. Scrum as systemic solution

We can establish a relationship between Scrum and the concepts of the General Theory of Systems, as the constituent elements of Scrum, namely, the ceremonies, artifacts and roles, allow the visualization of a systemic model endowed with elements dynamically interrelated to perform functions with the following common objectives:

- a) Product Backlogs: a particular activity or function that is specific and important to the system as a whole in order to achieve a common goal. This is the list of all activities to be developed. They are characterized in the systemic theory as resources and information to the system (inputs);
- b) Sprint Backlogs: a subsystem that processes or converts its inputs through its specialties. This is the list of all the functionalities to be developed during the complete project, which must be well defined and detailed at the beginning of the work - it should be listed and ordered by execution priority;

- c) Sprint Review / Retrospective: At the end of each Sprint, a Sprint Review Meeting is held. During this meeting, the Scrum Team presents what was done during the Sprint. Typically, this presentation is done as a demonstration of the product's new features. In systemic theory, this would be the processing;
- d) Potentially Shippable Product Increment: In Scrum requires that a potential product increment is delivered in each Sprint. This increment must consist of an executable file, generated from thoroughly tested code, and documentation of the operational procedures of the functionalities, either in the form of "Help" or "User Documentation". These are the outputs.

In the application of Scrum as a systemic solution to the problems listed above, we can highlight the following factors as the main characteristics of this process.

The steps of the development process are based on small cycles called Sprints, which predefines a set of functionalities. At the conclusion of each cycle, customer deliveries are made at regular intervals, an idea that corroborates with reports by Inayata et al. (2015).

The teams work together to achieve the desired result. As a way of monitoring the progress of the project, and in order to reflect on the work of the team and the progress of the project, the conclusion of the stages is monitored at the end of each development cycle through the use of a Kanban board.

Everyone involved in the process is part of the project and thus the client becomes also a team member who receives constant feedback on the progress of the system.

The Scrum method provides the cost control based on activity completion reports, to know the exact time spent on each task. With this, the company can calculate the cost through the variables 'payroll' vs. 'time spent', and it is also possible to measure the final cost of the project.

### 4.4. Project of a system with Scrum

We were not able to follow the entire development of the project in this case study because, according to the project manager, it takes about six months between project completion and homologation. Thus, we recorded the first results obtained, and a forecast for further results of the project.

The Software House began the first project using the Scrum methodology in June 2012, with no previous trai-



ning for team members, who relied only on knowledge gained from readings on how to use Scrum. As a result of this situation, even with correct standards stipulated, there were some mistaken processes in the implanted methodology, as follows:

- a) Daily meetings, which should be held every day and lasting 15 minutes according to the Scrum standard, were carried out two or three times a week, with an average duration of 40 minutes;
- b) Tasks defined in the sprint backlog were developed in a very different timeframe than indicated by team members. On certain occasions, the time set was too little to perform a task, while in others there was too much time;
- c) Additional tasks that were identified during development should be added by the members. Since this fail to occur, it generated a false result for task time scores; and,
- d) Team members did not update their sprint backlogs daily on the Kanban board as requested; they had waited a day or two to do so.

Although the first results were not so favorable, the project manager reported a change in the team, and pointed out the following changes in behavior and motivation of the members:

- a) Team members became motivated to participate in the development of the project and the creation of the tasks and with the speed with which these tasks were carried out;
- b) They adopted a program to control the time spent to perform the tasks;
- c) The team worked integrated in the same environment. This facilitated communication between them, speeding up the resolution of any urgent problems; and,
- d) The team was motivated by the challenge of learning and implementing a new development methodology.

According to the project manager's report, one point that added greater reliability to the team's work was the adoption of the Test Driven Development (TDD) methodology associated with Scrum. TDD is a method in which the programmer writes a test for the deployed solution. This methodology improves the final quality of the software delivered by the developer because, as Lewis (2004) states, quality can not be achieved by evaluating a product already made. The

aim, therefore, is to prevent quality defects or shortcomings in the first place by making products assessable through quality assurance measures.

As we observed, even with the clients being called and reminded to participate in the iterations, they still do not fully participate in the progress of the project and the activities carried out, since they are not yet comfortable and do not see importance in their participation in the project stages. Although this is not the desired result, it is important to note that with Scrum, the client has been more involved in the project than before when using another methodology, thus reducing the chances of project rework due to disparity in business requirements and rules.

Finally, it is noteworthy to add that the essence of an agile project is its ability to learn and adapt with this learning. For the Agile Methods, systematic corrections of small mistakes made by false assumptions are the key to the proper functioning of their cycles of speculation, collaboration and learning (Highsmith, 2002 apud Jaeger et al., 2010; Brhela et al., 2015).

## 5. CONCLUSIONS

As discussed, and corroborating with the findings of Faria (2002), the General Theory of Systems created a new perspective for business administration, in which the organization is configured as a complex system which interacts with its environment, and whose managers deal with problems influencing unpredictable variables. In this conception, a software development project requires an approach that considers all the issues involved in its life cycle as a whole and in an integrated way.

The solution adopted to solve this challenge was the use of the Scrum methodology as a systemic method, corroborating with the principles presented by Beck et al. (2001). Scrum is characterized as a development model that prioritizes communication, collective participation, and project organization in iteration cycles. This method has also provided artifacts that allow everyone to perform necessary adjustments and corrections to the development processes handled by the Software House.

Thus, this study aimed to present the consequences of the systemic thinking practice applied to the development of software projects in the Bragança Paulista Region. The method used was the participant observation, carried out by the company's project manager. The case study focused on the needs encountered in the company during this, which in general were problems with customer and managerial feedback, cost control and project progress.





In addition to the influence of technical factors on procedural failures, the Software House also had to adapt its organizational culture to Scrum, and so we could observe faults in this implementation, such as incorrect updating of important information, unproductive creation and division of tasks, and unnecessary time spent on daily meetings. However, after the implementation of Scrum there was a greater integration, i.e., the teams worked together to achieve the desired result; members were motivated by the speed in which the tasks were performed; and the customer participated more actively in the project.

We also expect that, through the individual and team learning of the participants, the adaptation can be better and better. Following the example of the company's development area, the Scrum methodology stands as a solution for other areas, such as the Design department, which presents the possibility of further research in this field of study.

Finally, it is relevant to note that there was a temporal limitation regarding the analysis of the process of development and application of the Scrum method in the project, this is due to the fact that the duration of the project was superior to the analysis interval spent on the case study in the Software House.

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