Scrum team self-organization: an understanding in the light of the systemic-complex paradigm

Scrum team self-organization: uma compreensão à luz do paradigma sistêmico-complexo

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ABSTRACT
Self-Organization of project teams is one of the six characteristics identified by Takeuchi; Nonaka (1986) that provide companies with flexibility and speed in the development of products and solutions. Schwaber (1997) incorporated this feature by creating a new approach to software development process which he called Scrum, one of the most used agile methods in the world. So, the objective of this research was to understand the self-organization in a Scrum Team (ST), in the light of the Systemic-Complex Paradigm (SCP), from the principles of Recursiveness, Dialogic and Hologrammaticity. This research involved the understanding of self-organization in a ST in light of the SCP in a large Information Technology (IT) company. A qualitative methodological approach was used through an action research. As a result, people's relationships were analyzed and the influence of the Environment (external to the team), the Whole (team), and the Parts (team people) were understood, where 31 factors were found that influence and promote self-organization on a ST. From this, the Scrum relationship with the SCP was established and management contributions were suggested for companies that have self-organizing ST or that wish to implement them.

Keywords: self-organization, scrum, agile team, team skills, systemic-complex paradigm.

RESUMO
A auto-organização das equipes de projeto é uma das seis características identificadas por Takeuchi; Nonaka (1986) que proporcionam às empresas flexibilidade e rapidez no desenvolvimento de produtos e soluções. Schwaber (1997) incorporou esta característica criando uma nova abordagem ao processo de desenvolvimento de software que ele chamou de Scrum, um dos métodos ágeis mais usados no mundo. Assim, o objetivo desta pesquisa foi entender a auto-organização em uma Equipe Scrum (ST), à luz do Paradigma Sistêmico-Complexo (SCP), a partir dos princípios de Recursividade, Dialogia e Hologrammaticidade. Esta pesquisa envolveu a compreensão da auto-organização em um ST à luz do SCP em uma grande empresa de Tecnologia da Informação (TI). Foi utilizada uma abordagem metodológica qualitativa através de uma investigação de ação. Como resultado, foram analisadas as relações das pessoas e compreendida a influência do Meio Ambiente (externa à equipe), do Todo (equipe) e das Partes (equipe), onde foram encontrados 31 fatores que influenciam e promovem a auto-organização em uma ST. A partir disso, a relação da Scrum com o SCP foi estabelecida e as contribuições de gestão foram sugeridas para empresas que têm ST auto-organizável ou que desejam implementá-las.

Palavras-chave: autoorganização, scrum, equipe ágil, habilidades de equipe, paradigma sistêmico-complexo.

1 INTRODUCTION
In the 1980s, Takeuchi and Nonaka (1986) published the article “The New Product Development Game” where they researched American and Japanese companies
such as Fuji-Xerox, Canon, Honda, NEC, Epson, Brother, 3M, Xerox and Hewlett-Packard in order to understand how to take more speed and flexibility in the development of new products. Inspired by the findings of this research, Schwaber (1997) created “Scrum” by publishing “SCRUM Development Process”, a new way of developing software (SW) products that has gradually been adopted by many companies.

In the annual report CollabNet VersionOne (2019) Scrum appears with 54% of the preference in organizations that, added to 10% of the hybrid use of Scrum with XP (Extreme Programming), named in the report as “Scrum/XP Hybrid”, take Scrum as the market reference, being the most used agile method in 2018, with a 64% market share. Over time, the Scrum development process/method was renamed Framework Scrum (Schwaber & Sutherland, 2020), gaining more adherents each day, according to the reports cited.

For Mahanti (2006), agile methodologies are an efficient way to produce SW with significant advantages in production costs, time-to-market reduction, resolution of complexities and quality improvement when compared to traditional methodologies. According to Reifer (2002), through the use of agile methods the production cost is 5 to 7% lower, and the time-to-market is 25 to 50% faster when compared to market benchmarks.

Going back in time, where this whole transformation movement started, Takeuchi and Nonaka (1986) signaled in the article that gave rise to the Scrum Framework that companies in Japan and the United States are using a holistic method - as in Rugby, where the ball is passed within the team as it moves as a unit in the field (Takeuchi & Nonaka, 1986, p. 1). Team Self-Organization is for Takeuchi and Nonaka (1986), one of the characteristics of this “holistic method” that proposed to bring speed and flexibility to organizations. Schwaber (1997) incorporated the concept of Self-Organization into Scrum, where Mahanti (2006) points out advantages of its use in SW development projects: (a) better return on investment (ROI), (b) early detection and cancellation of failed projects; (c) higher quality in SW; (d) better control over the project; (e) reduced dependence on people and greater flexibility.

As with the Scrum Framework, self-organization is one of the elements of Complex Thinking. Edgar Morin, one of the exponents of this thought, highlights that
self-organization creates forms that, as it evolves, recursively develops more self-organization of its parts, which reinforce the whole, in a continuous movement in the same way that it should be in a project team (Takeuchi & Nonaka, 1986). A self-organized assimilates to a living organism in constant change due to its ability to adapt to the environment to overcome the complexities involved towards the fulfillment of its objectives. In this sense, the Scrum Team (ST) through itself, experiences the understanding of the customer's need, develops solutions, seeks alternatives, destroys and builds understandings and establishes its own ways for all this to occur during the SW development process.

From the above, a complex issue related to people is created, as it is expected that the ST, from the beginning of the work, make decisions, seek solutions, manage conflicts and fulfill their goals, relying only on themselves. This is all in the face of external pressure from the client and from the company where the ST works so that the delivery of the SW project takes place using as a reference of excellence the cost reduction, productivity and time-to-market indicators practiced in the market (Reifer, 2002).

Faced with this problematization regarding self-organization in agile teams present in Scrum, this research was guided by the following question: "How is Scrum Team Self-Organization in the light of the Systemic-Complex Paradigm (SCP)?".

From this, the general objective of this research was to understand the self-organization in a ST, in the light of the SCP, from the principles of Recursiveness, Dialogic and Hologrammaticity (Morin, 2015). The results found throughout all phases of this action research, indicate that there is a deep relationship between the Scrum Framework and the Systemic-Complex Paradigm, and through this paradigm it becomes possible to understand the property of self-organization of people who are part of the ST and their relations with the other Parts, the Whole and the Environment to which they coexist. This research was carried out in a large IT company in Brazil and lasted 9 months considering its initial conception and problematization.

2 THEORETICAL FOUNDATION

This chapter presents the references of the discussion of self-organization through the theoretical foundation of the Systemic-Complex Paradigm and the Scrum Framework.
2.1 SYSTEMIC-COMPLEX PARADIGM

In view of the use of concepts of Systemic Thinking and Complex Thinking, we characterize in this research as a way to simplify the understanding (when using the two theories together), the term Systemic-Complex Paradigm, or the acronym SCP as already mentioned.

2.1.1 The Systemic Thinking

Systems Thinking was based on the ideas of organismic biologists during the first half of the century (Capra, 2006). For Andrade et al., (2006), Systems Thinking contemplates and involves the work of numerous fields of investigation such as, for example, biology, cybernetics, systems engineering, management sciences, economics, sociology, neurosciences, cognitive theories, learning, psychology, mathematics, sciences of complexity and computational simulation.

Understanding Systems Thinking requires a shift from the perception of material objects and structures (which is the basis of mechanistic-Cartesian thinking) to non-material relationships, processes and organizational patterns, representing the essence of life (Capra & Luisi, 2014). The eight characteristics and concepts of Systems Thinking according to Capra and Luisi (2014) are: (1) change of perspective from the parts to the whole; (2) inherent multidisciplinarity; (3) from objects to relationships; (4) from measurement to mapping; (5) from quantities to qualities; (6) from structures to processes; (7) from objective science to epistemic science and (8) from Cartesian certainty to approximate knowledge.

Regarding characteristic (7), scientific descriptions are objective and independent of the human observer, that is, of the knowledge process. The systemic epistemic science, on the other hand, contemplates the understanding of the knowledge process and this needs to be included in the description of natural phenomena. "What we observe is not nature itself, but nature exposed to our method of investigation." (Heisenberg, 1958, p. 58).
2.1.2 The Complex Thinking

Complex Thinking or Complexity is a set of facts, actions, events, interactions, chances, retroactions, determinations that constitute our world of phenomena. It is a tissue of inseparably associated heterogeneous constituents that poses the paradox of one and multiple (Morin, 2015).

Edgar Morin throughout his works, has been trying to understand concepts and add knowledge, however, trying to somehow synthesize definitions in an attempt to propose a summarized understanding of Complex Thought, a theme where self-organization is present. Fagundes (2007), studying Morin's works, points out that throughout his works the author goes “deepening principles of intelligibility that are complementary and interdependent and that, when articulated, constitute the paradigm of complexity”. In 2001 Morin formulates in three principles in the work “Introduction to Complex Thinking” (Morin, 2015), which were used as beacons to understand how Self-Organization takes place in a ST in the light of the SCP:

a) Dialogic: It is what allows maintaining the duality within the unit and at the same time associates complementary and antagonistic terms. For example, order and disorder, which establish tension with each other, but can also collaborate, producing new organizations and complexities. (Morin, 2015, p. 63)

b) Recursiveness: "The recursive idea is [...] an idea in rupture with the linear idea of cause and effect, product/producer, structure/superstructure, since everything that is produced comes back to what it produced in a cycle itself self-constituting, self-organizing and self-producing". (Morin, 2015, p. 74).

c) Hologrammaticity: Pervades the idea that not only the part is in the whole, but the whole is in the part. It immobilizes the linear spirit, as the knowledge-producing movement is enriched through the knowledge of the parts for the whole and of the whole for the parts (anthroposocial relationship). Each point has almost all the information of the whole and, in a way, the whole, as the whole of which we are a part, is present in our mind. (Morin, 2015, p. 88).

In this context of understanding the reality to which we are inserted, changing the view of objects (Mechanistic-Cartesian) to the view of relationships (Systemic-Complex), enters the principle of self-organization.
2.1.3 The Self-Organization

The concept of Self-Organization was initially proposed by cyberneticist W. Ross Ashby in the 40's where until the 70's it was widely studied by physicists and chemists to understand the spontaneous behavior of molecules and particles (Heylighen, 2008). In this research, we sought to understand how such elements were able to continuously self-organize in the face of the environment and complexities involved to the point of seeking balance. Ross Ashby (1962) with the theory of self-organizing systems made fundamental contributions to the theme.

This property allows the organism to modify its internal structure to better interact with its environment. So, a structure that is not organized by external forces is called a living or self-organized organization (Morin, 2015). For Heylighen (2008), self-organization is the spontaneous emergence of the global structure from local interactions. “Spontaneous” means that no internal or external agent is in control of the process.

Regarding the application of Self-Organization of teams in the business environment such as operational models or agile SW development projects, Balkema and Molleman (1999) highlight barriers or possible impacts that require attention from companies given the influence that self-organization produces in: (a) managerial aspects; (b) behavioral and psychological aspects; (c) people's skills and knowledge and (d) the need itself for the application of Self-Organization. Such aspects cannot be left out and need to be evaluated by organizations before using them.

2.1.4 The Middle (Environment), the Whole and the Parts

From the theoretical review of Systemic Thinking (Capra & Luisi, 2014) and the dialogic, recursive and hologrammatic principles of Complex Thinking (Morin, 2015), the light of problem analysis goes through understanding the relationships of the Middle, the Whole and the Parts:

a) MIDDLE: environment that influences the Whole and the Parts and which, in a dialogical and recursive manner, influences the Environment cyclically.

b) WHOLE: unit of action or organization, it is formed by smaller Parts that when added together make up the Whole, however, they do not explain the Whole. The Whole influences the Parts, which in turn influence and form the Whole.
c) PARTS: individuations that together form the Whole, but which, when analyzed separately, do not explain the Whole. Also, regarding the Parts, according to the principle of Hologrammaticity, these can contain the Whole and are also a Whole.

Having the preliminary definition of the theoretical foundations of the SCP and the understanding of the Middle, the Whole and the Parts, it is important to have a vision of what the Scrum Framework is.

2.2 SCRUM FRAMEWORK

“The New New Product Development Game” is the name of the article published in the Harvard Business Review in 1986 by Hirotaka Takeuchi and Ikujiro Nonaka, which gave rise to a revolution regarding the development of products and SWs. Takeuchi and Nonaka (1986) state that in the competitive world of new product development, speed and flexibility are essential and that the sequential approach no longer serves companies.

Researching companies like Fuji-Xerox, Canon, Honda, NEC, Epson, Brother, 3M, Xerox and Hewlett-Packard, Takeuchi and Nonaka (1986) identify a new approach, according to them holistic, which has six characteristics, including the self-organization of teams (teams). According to the authors, the team starts operating as if it were a start-up, taking initiatives, taking risks and developing their own agendas. At some point, the team has its own concept, creating its own identity and effectively becoming an organization. The self-organization referred to by Takeuchi and Nonaka (1986) is therefore something that is developed by the team, initially based on the relationships of its different components.

Takeuchi and Nonaka (1986) compare this new team approach to the sport of Rugby as being an organization (a system), where the ball is passed “within the team” as it “moves as a unit within the field”. In 1997, based on Takeuchi's research findings; Nonaka (1986), Ken Schwaber publishes the article entitled “SCRUM Development Process” (Schwaber, 1997) which proposes a new SW development process relating it to Complexity Theory, with the objective of establishing a method to be able to deal with the enormous complexity of a set of variables that change significantly during the SW
development project. According to Schwaber (1997), the systems development process is “complicated and complex”.

The Scrum proposed by Schwaber (1997) is a huge change in relation to the Waterfall model, arising from the mechanistic-Cartesian model where: “to know it is enough to disassemble” (Andrade et al., 2006). The Scrum Framework enables teams to work as teams adaptively in a complex environment of change given that the basis of its process is empiricism (Schwaber & Sutherland, 2020), where the product is built from experimentation, representing the evolutionary feedback principle of Recursiveness (Morin, 2015). Another striking feature in Scrum is the lack of a manager telling people what they need to do, that is, the team has autonomy and therefore, they need to continually adapt and self-organize. According to Schwaber and Sutherland (2020) adaptation becomes more difficult when the people involved are not empowered or self-managed, that is, when the team is not self-organized.

In this sense, a role foreseen in Scrum is the Scrum Master (SM), leader-server of the team (Schwaber & Sutherland, 2020). The SM does not take autonomy from the team, on the contrary, it is seen as another member of the ST, helping to remove any impediment to fulfilling the team’s goals. The SM does not say what people need to do and organizes the different rites provided for in the Scrum Framework.

In 2009 Ken Schwaber founded Scrum.org, a global organization that maintains and evolves Scrum. For this, Schwaber and Jeff Sutherland (one of the 17 professionals who created Fowler's Agile Manifesto), maintain “The Scrum Guide™” (Schwaber & Sutherland, 2020), a guide that contains the practices on how the Scrum works and how it should be implemented. As it is an empirical process, where knowledge comes from experience and decisions are based on what is known so far (Schwaber & Sutherland, 2020), three are its pillars: (a) transparency, (b) inspection and (c) adaptation.

According to Schwaber and Sutherland (2020), the Sprint is the heart of the Scrum Framework, it is where “ideas are turned into value”. It is a time-box of at most 1 (one) month in which the ST creates an increase in the value of the product, that is, a delivery based on the requirements that were prioritized by the Product Owner (PO), that is, the Sprint Goal. Four are Scrum rites conceived by Schwaber (1997) and enhanced by Schwaber and Sutherland (2020): (a) Sprint Planning, (b) Daily Scrum, (c) Sprint Review and
(d) Sprint Retrospective. It is through these events that teams plan, execute, inspect and adapt in an evolutionary way, promoting their self-organization. Sprints, therefore, are iterative and recursive cycles that start in the rite of Sprint Planning and end in the Sprint Retrospective. When a sprint ends, another one starts automatically. It is within this environment and context that the ST is expected to be able to self-organize.

3 METHODOLOGY

The research used an exploratory model with a qualitative methodological approach, adopting the Action Research strategy (Thiollent, 1947). The choice was made by the possibility of the researcher being able to participate immersed in the ST, being able to better understand the self-organization following an adaptive recursive flow, according to elements also present in the SCP, bringing synergy of the methodology with the research object.

3.1 RESEARCH CONTEXT AND PARTICIPANTS

The analysis unit of this research was a SW development team that uses the Scrum Framework, the ST. The participating team was selected from within a large Brazilian IT company, with national and international operations, with over 29 years of providing SW development and digital transformation services. Professionals who were part of the ST participated in the research, which contributed to the understanding of the Whole and the Parts, and, additionally, other professionals who had a relationship with the ST for a correct understanding of the Middle (environment) in which they were involved. From this, the research participants who worked within the ST were: P1 Test Analyst; P2 Functional SAP Consultant; P3 Back-End SW Developer; P4 SW Front-End Developer; P5 ABAP SW Developer; P6 User Experience/User Interface and P7 Scrum Master (SM). The other participating professionals involved in the environment were: P8 Business Partner (BP); P9 Account Executive (EC), P10 Operations Manager (GO), P11 Service Manager (GS), P12 Human Resources Manager (HR) and P13 Agility Head (HA).

In addition to the participants listed above, some meetings were attended by other professionals such as a SW Architect, Client Project Manager and PO. Even with
involvement in the research weaving their views and opinions in group meetings, these professionals were not listed as direct participants due to the unavailability of an agenda for individual conversation.

3.2 METHODOLOGICAL PROCEDURES

The researcher chose to create a logical sequence of phases and cycles that were conducted during the action research to better organize the study, creating the right moments for the necessary understandings in order to answer the research question. Three phases were carried out by the researcher: (a) Exploratory Phase: study the chosen company, understand the use of the Scrum Framework in the company, observe the organizational structure in which the ST is inserted, identify how the company defines the SW development teams and to present how the specific ST studied was chosen, as well as the work that this ST would be doing to serve a client; (b) Action Phase: contains 4 distinct Cycles where for each one the following steps of (1) Plan, (2) Act, (3) Describe and (4) Evaluate were followed as recommended by Tripp (2005). At each end of the cycle, the next one started, and (c) External Disclosure Phase: presentation of the research results to the participants.

Within the Action Phase, each of the 4 Cycles had clear and defined objectives: (Cycle 1) to understand the MIDDLE in which the ST was inserted; (Cycle 2) understand the WHOLE, that is, an initial view of the ST through observation as a team, without even focusing on individualities; (Cycle 3) understand the PARTS, that is, people themselves who are part of the ST with a focus on individual views and (Cycle 4) come back to understanding the WHOLE, making a consolidated relationship with the three principles of the SCP.

3.3 DATA ANALYSIS

Considering that this study is based on the assumptions of the SCP, the Textual Discursive Analysis (TDA) was chosen as a data analysis process, as it adheres to self-organization. According to Moraes (2003), the movement from disorder towards a new order, the emergence of the new from chaos, is a self-organized and intuitive process.
As TDA is more open and has more freedom to categorize information, it is not tied to the mutual exclusion rule, commonly present in traditional content analysis approaches. In this research, a priori categorizations were chosen due to the existence of theoretical references on human factors categorization in SW agile teams according to Sudhakar et al. (2011) and Lalsing et al. (2012). Once the categories were established, the data were entered into NVIVO tool, which supported the data analysis process.

4 FINDINGS AND RESULTS

This chapter presents the findings and results of this research with the ST.

4.1 EXPLORATORY PHASE

The company that served as the “research environment” has more than 120 agilists (SMs, POs and Agile Coaches) distributed in more than 30 clients having Scrum as the most used SW development framework. It was noticed that the company has a clearly defined organizational structure with the involvement of different profiles with the ST (participants P8 to P13). This understanding made it clear that the ST does not act in isolation, that is, it is an open system that is influenced by its environment, and it is in this context that self-organization occurs.

It was observed that it is very rare for a team to organize itself only with collaborators. Thus, the ST studied was a hybrid (employees and hirings), with a diversity of people and profiles in the group, the called cross-fertilization (Takeuchi & Nonaka, 1986). The business objective of the ST was to develop a SW for a large customer in the food sector in Brazil. This SW was a mobile application for sellers directly linked to the commercial director, being referred by respondents as a highly strategic project for the customer and with great visibility in the customer’s board.

4.2 ACTION PHASE

The Action Phase, according to the planning developed by the researcher, comprised four iterative and recursive Cycles where the information collected in one cycle “fed” the next cycle, providing a reflection on the information observed in previous cycles. Understanding the ST's self-organization, in the light of the SCP, based on the
principles of: Recursiveness, Dialogic and Hologrammaticity, requires a systemic observation of the team’s relationships. In this sense, Capra and Luisi (2014) place as fundamental the understanding of the Middle, the Whole and the Parts to develop the systemic look of these relationships as illustrated in Figure 1. From this, through this systemic look of the researcher-observer, the results collected in the different meetings held demonstrate the complexity of the SW development context in which the participants are inserted. When the company decides as a work method to use the Scrum Framework, it is expected that it is able to provide, through its dynamics and meeting rites, an environment where the self-organization of the ST emerges, day after day, improving (as time passes), the synergy of people to deliver the result.

Figure 1 - Relationships between the Middle, the Whole and the Parts in the context of Scrum

4.2.1 Cycle 1: Understanding the MIDDLE (environment)

To understand the Middle, 5 (five) meetings were held, involving a total of 7 (seven) participants, where the researcher conducted semi-structured interviews, took note of the observations and made audio recordings with the prior authorization of the participants.

At the end of the meetings and from the analysis of the data collected, the researcher inserted a Systemic Thinking tool as referenced by Andrade et al. (2006), called Systemic Map (SMP), which prepared an SMP for each of the key professional profiles participating in each area of the company (P8 to P13), which have a relationship with the
team in order to understand its influence on the studied ST. Additionally, an SMP of the Scrum Master's performance (P7) was also designed due to its relevance in the interactions with the environment in which the Team is involved.

According to the SMP and contributions from the HA (P13), the company's agility area makes a relationship with the ST researched at the beginning of the project to give initial guidance to the team, performing the agility and on-demand Setup when deemed necessary. HA influences the Whole (team) and the Parts (people who are part of the team), where people (Parts) and the team (Whole) systemically and recursively reinforce HA again, promoting, for example, learning in which one takes to the other Scrum teams (ST) of the company. HA also develops ST people on the Scrum Framework and supports the team's Team Building. Such actions increase the probability of project success, leaving the customer more satisfied, repurchasing new projects and services, generating new team building needs, increasing the HA experience in agility, sharing this experience with the people and thus, in a systemic and recursive way, it has a positive influence on the ST. “[...] the first thing is to generate the team's empathy.” (P13). "[...] for me, every team needs to have a Team Building at the start.” (P13).

BP (P8), when working with the Parts (ST people), creates emotional support with the ST (Whole) that systemically and recursively reinforces BP’s work. The GO (P10) and GS (P11) representatives of the service delivery area, on the other hand, promote a safe environment for the ST to develop self-organization, with the SM as the team's servant leader (Schwaber & Sutherland, 2020). The work of managers is more linked to administrative aspects and their engagement in the company:

"[...] it is administrative support for the teams [...] to communicate something that is happening in the company, follow up on hours, approve bulletins, financial follow-up, generate a report to the Account Executive and to the client itself. (P11).

Managing the expectations of the EC (P9), which plays the role of the commercial area, is fundamental for the service delivery area and the ST. Their biggest concerns are the progress of the service and also managing customer expectations. “[...] we have 4 months to convince that this team that is running understands value and delivers value.” (P9). “[...] if you don't show any evolution, you start creating a question mark.” (P9). In
the systemic map of the EC, the search for the “successfully delivered project” was clearly seen in order to gain credibility with the client, get to know them in greater depth and foster new sales.

In understanding the Middle, it was also realized that the SM (P7) has the responsibility to defend the interests of the team in the role of a leader, working the negotiations with the client regarding the need for the ST to understand what needs to be done, it guarantees the prioritizations with the client’s PO, helps the ST to remove its impediments and must have the keen perception of evaluating what may or may not impact the team during the work. Two fundamental reinforcing (R) ties appeared in the SM systemic map:

a) Reinforcer Tie 1: from the moment the SM encourages the ST’s autonomy to define how to develop their activities and do their work, they develop a favorable environment for the emergence of the team’s self-organization. Consequently, the more the ST promotes self-organization and delivers the proposed results, the more the SM understands that autonomy is essential in order to reinforce the dialectic relationship.

b) Reinforcer Tie 2: Considering Reinforcer Tie 1, the more self-organization the ST has, the more people on the team learn with practice, that is, with the experience of performing the work with the other team members. As a result, team members develop, learn and grow as professionals and people. When people learn in an experiential way, they are better able to organize themselves as a team to deliver the project, further reinforcing the trust on the part of the SM that gives the ST more autonomy.

According to Morin (2016) every open being acts and retroacts with its environment. Through the study of the environment (Middle) in which the ST is inserted, it was realized that this open being is necessary for the team’s existence. For Morin (2019), the idea of self-production or self-organization does not exclude dependence on the external world: on the contrary, it implies it, being a self-eco-organization.

4.2.2 Cycle 2: Understanding the WHOLE (team)

During this cycle, the researcher focused his observations on understanding how the team (as a group) performs its activities seeking self-organization. Eleven (11)
meetings were held, where in 9 (nine) the researcher participated inserted as part of the researched ST. The interactions carried out by the researcher with the ST involved understanding the work process defined by the ST, knowing the SWs and work tools used by the ST (for communication and support for Scrum) as support in the direction of self-organization and understanding self-organization of the ST in the Scrum rites. From this, Figure 2 below sheds light on how the ST operates and what the Whole is where self-organization emerges, and which seeks to be achieved:

Under the light of the Recursivity principle (Morin, 2015), visually, the figure shows the non-linearity of the ST as a result of the different interactions between its members. The three reinforcing ties (R) demonstrate the Recursivity and feedback of forces that self-develop and reinforce the result of the dynamics established in the team at each 15-day Sprint worked by the group. Recursiveness is present, therefore, both in activities within the Sprint, as well as in continuous recursive flows, one Sprint after another, with learning as one of the main foundations for continuous improvement in each cycle performed.
From the point of view of the Dialogic principle (Morin, 2015), there is a great diversity of roles involved in ST which Takeuchi and Nonaka (1986) call it cross-fertilization. The different roles of the people on the team shown in Figure 2 become complementary but also antagonistic. These antagonisms occur in different dyads: (a) Developers □ Testers; (b) Front End Developer □ Back End Developer; (c) SM □ Project Manager and (d) Customer □ Company, among others.

On the principle of Hologrammaticity, in the Scrum Framework, the last meeting (Retrospective), which closes each Sprint, aims to learn and adapt through lessons learned so that the ST is better in the next Sprint, a point that can be seen in Figure 2 Sprint after Sprint, delivery after delivery, learning after learning, the team begins to establish its own identity as a group, emerging properties present between the parts (such as self-organization), which do not exist when analyzing the whole separately. In this sense, Recursivity and Dialogic present enhance the development of the Whole (team) that produce the Parts (people of the team), which consequently produce the Whole (team). In this knowledge-producing movement (Morin, 2015), these properties of the Whole that emerge from the Parts hologrammatically bring to each relationship between the Parts, a Whole that recursively becomes its producer.

4.2.3 Cycle 3: Understanding the PARTS (people)

At the end of Cycle 1, where the researcher understood the Middle, that is, the environment that involves and influences the ST, and Cycle 2, where the Whole (the ST itself) was understood, this Cycle 3 is characterized by the moment when the researcher he studied people in their individuality, that is, the Parts that make up the Whole. “[...] it is not about abandoning the knowledge of the parts for the knowledge of the totalities, nor of the analysis for the synthesis; it is necessary to combine them”. (Morin, 2011, p. 31).

In this cycle, the researcher conducted 7 (seven) individual semi-structured interviews with people who are directly part of the ST in order to understand how they individually visualized the team's self-organization process.

From the individual interviews carried out with the ST, and after data collection in Cycles 1, 2 and 3, the researcher was “submerged, involved and impregnated with the
investigated content” (Moraes, 2003), as foreseen by the Focus 1 of TDA, the data collected in Cycle 2 were “loaded” into the NVIVO tool for the analysis of this cycle.

According to Lalsing et al. (2012), through which the People Factors in agile SW development were analyzed, the teams are based on: self-organization, intense collaboration and continuous improvement. In this sense and through the studies by Sudhakar et al. (2011) also related to people factors in SW projects, we chose, as indicated in the methodology, to understand the self-organization of the ST with analysis categories defined a priori based on these studies considering that the Scrum Framework is an agile directed method to SW development. The 6 (six) categories used by Sudhakar et al. (2011) and proposed by Lalsing et al. (2012) that were used by the researcher for TDA were: (a) Team Climate, (b) Team Diversity, (c) Team Innovation, (d) Team Member Skills and Characteristics, (e) Team Leadership Behavior and (f) DE.

As a result of this Cycle 3 (Parts), 31 (thirty-one) factors were identified that influence the self-organization of a ST and that were grouped into 6 highlighted categories and numbered from 1 to 6 as can be seen in Figure 3. For better identification and reference, each factor also received a numbering within its category.

From the coverage analysis in NVIVO, it was observed that the most relevant factors for the development of self-organization in ST are: (1st) team collaboration and cooperation (factor 1.2), (2nd) group engagement and unity (factor 1.8), (3rd) the autonomy they have (factor 4.3), (4th) the focus on goals (factor 1.4), (5th) learning (factor 1.1), (6th) close communication between those involved (factor 1.6), (7th) having and being in a safe environment to develop their activities (factor 6.1) and (8th) having the leadership confidence in the work they do (factor 5EV.2).

In the category view, also from the coverage analysis in NVIVO, the ones that were most relevant in order were: (1st) Team Climate, (2nd) Team Member Skills and

Figure 3 - Mind Map of Factors Influencing People's Relationships for the Development of Self-Organization in the Light of Complexity

Source: Created by the Author through the MindNode tool.

4.2.4 Cycle 4: Return to Understanding the WHOLE (team)

Having a diversity of data collected during the first three Cycles of the action research that helped the researcher-observer to understand: the Middle (environment), the Whole (team) and the Parts (members of the ST), the researcher returned to integrate the understanding of the self-organization of the Whole, observing the team in the light of the three principles of complexity (Morin, 2015), being the designer of the understandings and relations of the observed reality.

(A) Recursivity Principle:

According to the researcher's immersion in ST, it was verified that the Scrum Framework is by nature recursive, retroactive, systemic and circular. The final result produced by the ST is the product of the different Sprints (or cycles) that work like a circuit where the end of one Sprint meets the beginning of the next. According to Morin (2016), a recursive process is any process whose final states or effects produce initial states or initial causes.
As noted in this action research, at the end of a Sprint its members hold a Sprint Review Meeting where they observe the result, learn from the process and prepare to start a new cycle, where gradually the result (SW) and self-organization emerge through people. With regard to the relationships of the ST members, the researcher took part, together with the other members of the team, in a recursive reinforcing relationship that is fundamental to the process of self-organization. When people exert one or more factors linked to the category "Team Member Skills and Characteristics" presented in Cycle 2 (Understanding the Parts), the factors in the category "Team Climate" are improved as an effect of their generating cause. These factors, therefore, become the cause, because, by improving these factors (from the “Team Climate” category), individuals self-produce and self-develop, improving factors of the “Team Member Skills and Characteristics”. As a consequence, self-organization takes shape emerging and being produced as a property of the Whole, where the more self-organization retroacts on the people on the team as a cause, the more self-organization retroacts as an effect and so on recursively. “ [...] society is produced by the interactions between individuals, but society, once produced, retroacts on individuals and produces them”. (Morin, 2015, p. 74).

(B) Dialogic Principle:

As observed in the different cycles of this action research with the ST, the dialogic is present in different themes related to the implementation of the Scrum Framework. According to Morin (2016), the organization of a system is the organization of difference. "It (difference) establishes complementary relationships between different and diverse parts, as well as between the parts and the whole.” (Morin, 2016, p. 148).

Diversity, that is Cross-Functionality for Takeuchi and Nonaka (1986) (factor 2.1 of the Team Diversity category in the study of the parts carried out in Cycle 3), is absolutely present in the composition of the roles (people) of the ST, in the individual differences (parts) that complement each other to form the unit, the whole, the team, where dialogical relationships establish the necessary self-organization to deliver the goals established by the group.

Antagonistic positions of people make the dialogic of Divergence and Convergence (factor 2.3) where, for Morin (2006), any system whose organization is active is a system in which antagonisms are active. In the studied ST, different people are dependent
on each other as can be seen in Figure 2 and in factor 2.2 (Interdependence), where these generate risk to the project because one member is interdependent on the other, but at the same time lead to Collaboration and Cooperation (factor 1.2), Engagement and Union (factor 1.8), Learning (factor 1.1) and Mutual Trust (factor 1.3).

Because ST is an open system, the environment (Middle) intends the team (Whole), where Expectation Management (factor 5.3) needs to be constantly aligned with top management as a way for ST people to demonstrate their results and earn more and more Autonomy (factor 4.3). The dialogic between “autonomy” and "control" coexist in a context in which, as noted, one of the determining aspects for the loss of autonomy is the team failing to gradually and recurrently deliver the Sprint goals pre-established by the group itself, that is, Focus on Objectives (factor 1.7). Top management, therefore, opens up, gives autonomy to the ST, but can fail to provide it when necessary, making a closing/enclosure movement of the system (Closed System), where this top management temporarily exerts more direction within what is the responsibility of the their role in order to, for example: carry out a closer follow-up to help ensure delivery or participate in meetings provided for in Scrum even though they are not part of the ST without this being able to harm or take away the self-organization developed by the team. According to Morin (2019), the concept of autonomy can only be conceived from a systems theory that is both open and closed.

The Dialogic Principle is therefore fundamental for the development of the ST's self-organization. It is it that self-produces the balance between the different dualities existing between the relationships of the people on the team (Parts), between the relationships of people with the team (Whole) and people with the environment (Middle).

(C) Hologrammaticity Principle:

According to Morin (2015), the Hologrammatic idea itself is linked to the Recursive idea (A), which is linked, in part, to the Dialogic idea (B). Due to the fact that the ST is interacting in a complex environment (Middle) using an agile non-linear method (Scrum), where knowledge and learning are constant and this self-produce and reinforce the system to which they are part, order and disorder balance this system causing properties that do not exist a priori to emerge as properties of the Whole (self-organization, for example). These properties of the Whole that emerge from the Parts hologrammatically
bring to each relationship between the Parts, a Whole that recursively becomes the producer of the Parts. The Whole produces the Parts that produce the Whole. “[...] we can enrich the knowledge of the parts by the whole and of the whole by the parts, in the same knowledge-producing movement” (Morin, 2015, p. 75).

A practical relationship of Hologrammaticity with the relationships of people in a ST that the researcher-observer-conceptor made, based on the results found in the immersion of this action research, was how the perceptions of the Middle, the Whole and the Parts are hologrammatically different from person to person. A member of team A can have a perception of what the Whole is and how the Middle influences this imagined Whole. A person B can be a completely opposite view of what is the Whole and how the Middle can influence this Whole but also the Part (the person himself). For example, for some a change in deadline (to gain 1 month more), to deliver the SW project can be very good for the team (Whole) but for others it can be bad, given that this Part (person) who didn't like it would start another project on the date following the original delivery date and will now be delayed. These two people create within themselves, positive or negative images of the Middle, good or bad images of the Whole. Each member, therefore, carries with him unique images and complexities of the context in which he is involved, in this way, hologrammatically both the Whole and the Middle are contained in the Parts.

4.3 EXTERNAL DISCLOSURE PHASE

In this phase, the analyzes resulting from the action research cycles were presented, emphasizing the elements that involved the understanding of the environment (Middle), the ST (Whole) and the study of the relationships of the members (Parts) regarding the understanding of self-organization.

The meeting was conducted in an open and participatory manner with those involved who made different positive comments about the results presented. During the meeting, new ideas emerged among the group, demonstrating that learning and evolution is continuous and recursive, where dialogic and complementarity became evident as a result of the group’s self-organizing work.
4.4 MANAGEMENT CONTRIBUTIONS

From the study carried out, pragmatically and in a synthetic way, the Management Contributions (MC) recommended for a company that uses the Scrum Framework for SW development, where it needs to implement or improve the self-organization of teams are:

a) Develop an Organizational Culture of Self-Organization in the company having as a starting point the mind map of Figure 3 considering the 31 factors that influence people's relationships for self-organization.

b) Develop SM skills, with greater emphasis on behavioral/soft skills than technical aspects.

c) Foster the development of the behavior of ST members regarding their individual and collective skills and characteristics, promoting Team Buildings and reinforcing the Team Climate aspects.

d) Align expectations about the delivery of the product that the ST will work with the project sponsor and other stakeholders. Everyone must be equalized on the Scrum dynamics, the role and responsibilities of those involved, expected metrics as well as how to communicate the progress of value delivery.

e) Having the leadership and senior management close to the ST, providing a safe environment for self-organization to emerge, with the ability to make the opening and closing movements at the right times, meeting the expectations of the stakeholders.

5 FINAL CONSIDERATIONS

The self-organization of the ST does not happen in a manner imposed by the company, it emerges naturally provided that "the seed is planted in the proper soil", that is, that the company promotes the appropriate environment ("soil"), having people ("seeds") open and with the proper mindset to flourish this new form of teamwork. I name it the Organizational Culture of Self-Organization. To develop this culture, MC were pointed out, as well as 31 factors that influence people's relationships for the self-organization of a ST. From this, organizations can better prepare themselves before launching a new ST, improve the delivery of value to customers throughout the Scrum rites, as well as train
teams in the factors of climate, competences, diversity and behavior identified in this action research.

Notably, the great "nutrient" observed for the birth of living ST self-organization is the development and improvement of human relationships as well as an organizational culture with compatible values, that is, the relationships of people who are part of the team and of relationships with people who are outside the team, but who interact with it. The Parts, the Whole and the Middle are open systems that promote constant exchanges, where in this case, human relationships develop a primordial role, being the link between different nodes of a large network (web) that constitute the life of the team. Without good relationships, that is, without good "nutrients" there is no "seed" that can resist.

About theoretical contributions, this study enables the advancement in the area of agile SW development because, in the light of the SCP, it built a bridge to understand the self-organization mentioned by Takeuchi and Nonaka (1986) and used as the foundation of Schwaber’s Scrum Framework. Under this foundation, looking at human relationships becomes fundamental for delivering results in a sustainable way. Dialogically, this study also opens space in the Systemic-Complex theory to encompass the relationship with agile SW development methods such as Scrum.

As limitations, it is highlighted that the team studied due to the COVID-19 worldwide pandemic had to act 100% remotely, that more than 80% of the team members had already worked with the Scrum Framework and that the ST had good professional seniority.

For future research, it is recommended that analyzes be carried out with more STs, mixing teams from different seniorities and varying people's disposition, that is, 100% face-to-face teams in the same place and teams mixed with people working locally and others remotely. It is also recommended that future research can be carried out adopting other methodological approaches and strategies, as well as expanding the scope of the concepts of self-organization and complexity studied here at the level of a ST, to organizational levels with scaled agility frameworks such as the Scaled Agile Framework (SAFe®) or models aimed at business agility (Business Agility).
REFERENCES


