RESEARCH PAPER

Scrum method assessment in Federal Universities in Brazil: multiple case studies

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ABSTRACT

Goal: Assess the Agile Methodology Scrum in a software development project at Federal universities in the Southeast Brazil.

Design / Methodology / Approach: The method in this paper is multiple case studies and a qualitative approach. The data collection was performed using a questionnaire with open and closed questions based on the constructs of the literature review. Six Federal universities were selected in two states in the Southeast Region, based on previous contacts with institutions, and the analysis unit was the Information of Technology Centers or the Superintendent of Information Technology.

Results: It was noticed a low level of maturity in the use of agile methods in a great part of the universities and a high turnover of the team components, due to the scholarship students who participated in the research. In the open questions, it was noticed a very strong relationship between a set of subattributes: improvement in response time, cost and time reduction, increased of equipment performance and increase in added value. In the closed questions, it was noticed that Scrum had a better performance in the following sub-attribute samples: communication, collaboration, productivity, and time reduction.

Limitations of the investigation: The number of interviewers in the universities, to provide deeper analysis for the case studies.

Practical implications: The subattributes can be indicators to measure the performance of Scrum in corporations.

Originality/Value: While previous studies focus on the application in large companies and in classes of Graduation Programs at universities, this paper focuses on administrative operations in the universities.

Keywords: Assessment, Agile method, Scrum, Software development, Higher Education.

1. INTRODUCTION

Information technology (IT) allows connectivity and visibility (Diaz-Pinzón et al., 2019), but in order the IT companies become faster and stand-out in the market it is necessary to refine its competence to manage projects. The rapid rise of information technology was driven by the need to process the ever-increasing amount of faster data (Nicolas, Thomé, and Hellingrath, 2021). In this context, we can highlight agile methods of project management, which depend on the client involvement in the process of development or maintenance of the software (Singh et al., 2019).

Among agile methods, Scrum is one of the most used in software development sectors in which the marketing dynamics and the interactions with the clients require constant changes in the demand of goods, services and projects, especially in IT, that impair the promptness of the product deliveries (Dingsøyr et al., 2019; Petter and McLean, 2009). Scrum is also used as a methodology in project management (De Souza et al., 2017).

Although in the last years the number of agile methods in software development has steadily increased, this increasing is not accompanied by its assessment (Singh et al., 2019; Dybä and Dingsoyr, 2008; Stavru, 2014). It can be noticed that the absence of an analysis or assessment of the IT, agile methods and, more specifically Scrum, can affect the decision process of the software development of an organization. The consequences can limit the access to the technologies, compromise the relevance, the quality, the promptness and the reliability of the information that are generated, stored and released for several users of the organization (Haes and Van, 2009; Dechow et al., 2007).

In the public sector, the application of an agile method such as Scrum for software project management reduces costs and time, rework, improves the engagement of the project teams and the performance in products/services delivery according to the needs of their users, optimizing project developed by the public organization to serve the society (Constâncio and Souza Neto, 2016). Based on the above, the present paper has as research question: How to assess the Agile Methodology Scrum in project of software development in federal universities in the Southeast Region of Brazil? To answer this question, the paper was structured in four sections, this first one, introductory, the second section, the methodology; the third section, analysis and discussion; the fourth section, conclusion; and, finally, the acknowledgments and references.

2. LITERATURE REVIEW

2.1 Scrum Method to software development

Information System (IS) or Information Technology (IT) has the potential to support and create new business strategies. Besides, with today's lifestyle, ITs are part of people's lives, facilitating the interconnection between users and organizations, making information more flexible to convey the business message to its consumers (Cruz Estrada and Miranda Zavala, 2019). According to Correa Ospina and Diaz-Pinzón (2018), IT impacts the organization's performance indirectly, but it is directly related to customer management, which changes the company's competitiveness.

In recent years, software development methods have been created and disseminated. Among them, agile methods manage changes in the business better than classical models and scenarios where deadlines and costs are critical factors for the success of the project (Ambler, 2003; Harvie and Agah, 2016; Fitzgerald, Hartnett and Conboy, 2006).

The main contributions of agile methods over traditional are handling unstable requirements, delivering high-quality results, and it is a short-term software (Abrahamsson, Salo, Ronkainen and Warsta, 2002; Jyothi and Rao, 2011). Being agile means being able to adapt quickly to change flexibly (Schwaber et al., 2013). However, all these benefits can be evaluated through attributes that reflect their main characteristics, such as flexibility, speed, lightness, learning, and response to change.

There are several agile methods, such as Extreme Programming (XP), Feature Driven Development (FDD), Dynamic Systems Development Method, Adaptive Software Development, Crystal, Pragmatic Programming, and Test-Driven Development.

In 2009, Hossain, Alibabar, and Verner introduced a conceptual framework based on the research literature to address the challenges of combining Global Software Development (GSD) and agile methods. In their framework, the authors expected project managers to decide which agile strategies would be effective for a given GSD configuration, considering contextual information. Taromirad and Ramsin (2009) introduced the Comprehensive Assessment Framework for Agile Methodologies, aiming to cover all the different aspects of agile methodologies.

Among all agile methods, Scrum has some peculiar characteristics, its development process occurs through Sprints (Schwaber et al., 2013). In Scrum, product requirements are organized into a list of items called the Product Backlog and, through interaction cycles, the team focuses on a specific goal. At the end of this cycle, a functional version (increment) of the system is delivered to the customer. Faced with a scenario of agility, IS and IT have been generating competitive advantage in companies, through more agile and frequent software deliveries that meet the needs of the business.

Scrum is an agile project management method easy to understand, although it has a level of difficulty for the user. Therefore, people can address and solve complex problems while delivering products with greater added value, in a productive and creative manner (Schwaber et al., 2013). Added to this advantage, Abrahamsson et al. (2002) identified and evaluated the importance of the main agile methods to the entire academic community in providing faster responses to changes in the software development process compared to traditional ones. In these methods, requirements that support business demands are under changes often during the product development cycle to meet customer needs (Rising and Janoff, 2000). This fact makes software development more flexible, leading to a set of advantages, such as:

- acceleration of response time;
- increasing in quality and productivity;
- improvement in the alignment of Information Technology (IT) with the business;
- easiness to make changes;
- management of priorities reorganization in software development methods (Qumer and Sellers, 2006; Jyothi and Rao, 2011; Deemer et al., 2012; Nishijima and Santos, 2013; One, 2017).

One disadvantage observed by McAvoy and Butler (2007) is related to team learning, which may not be effective in agile methodologies, possibly due to the social pressure on an individual to accept the 'group view' (a phenomenon known as the Abilene Paradox). Besides, it is necessary to maintain a certain level of conflict in the team to produce better communication, contestation, and, ultimately, learning.

2.2 Scrum Method: subattributes assessment

To submit the attributes and subattributes of the Scrum Method assessment in the universities, it was used the articles of Delone and McLean (1992), Ribeiro et al. (2010) and Ribeiro et al. (2018) due to their contributions to the assessment method and its subattributes and to the sources used in the assessment models recommended by these authors. Hence, the study collected the attributes and subattributes to: (1) assess the ITs; (2) assess the agility of the agile method; (3) assess the agile methods and the IT/IS; (4) assess Scrum. As a matter of research focus, this article will show the authors who contributed to the last step.

At the end of all the literature review, the attributes and their respective subattributes were compiled in sets by area that they belong to, as well as their respective authors who advocate their applications: Human Resources, Process, and Organization.

In the Process set of subattributes, the attributes selected in the literature were: Communication, Collaboration, Productivity, Effort Reduction, Team Learning, Introduction of New Technologies. Regarding to the Communication attribute, Loftus and Ratcliffe (2005) used the agile methods to promote the learning of new Technologies and the result was the faster acquisition of learning and the convenience in the introduction of new technologies. Besides, it was noticed that the group discussion led to a certain level of team conflict, which benefited a higher communication, contestation and, finally, learning. Jeong et al. (2018) evaluated the adoption of Scrum in the development of a software focused on the financial market, in which reduced the risk and promoted a higher productivity, Effort reduction, Communication and learning between client and developer.

The subattribute Collaboration among the company members (clients and developers) is a highly positive result of the agile methods implementation, where it can generate productivity gain in relation to the traditional methods (Svensson and Höst, 2005; Jeong et al., 2018).

The increasing of productivity was noticed by some authors in different studies and years, from 8% to 41.23%, (Jeong et al., 2018; Ilieva et al., 2004, p. 107). Vallon et al. (2018) analyzed the well-succeeded use of the agile methods in the software development with teams remotely distributed, identifying Time reduction and increasing the Productivity. The Effort Reduction is a consequence of the agile methods implementation and may reduce the use of man/hour in up to 11.45% (Jeong et al., 2018; Ilieva et al., 2004, p. 107).

Loftus and Ratcliffe (2005) noticed how the agile methods can foster the learning of new Technologies. The authors noticed that the introduction of new technologies is stimulated using agile technologies in companies and universities (post-graduate courses).

In the Process set of subattributes selected in the literatures were: Error Reduction, Risk Reduction and Cost Reduction. The Error Reduction was noticed by Ilieva et al. (2004, p. 107) when implementing the agile methods, leading to a reduction of defects in 13.33%. Andrat and Jaswal (2015) contributed with the study where the Agile Methodology Scrum is used as an alternative approach for managing and Cost reduction. In the public sector, the application of an agile method such as Scrum for management of software projects can have as a consequence the reduction of costs and time, rework, improving the engagement of the project teams and the performance in the delivery of product/services according to the needs of their users, thereby optimizing the services developed by the public organization to serve society (Constâncio and Souza Neto, 2016).

According to Mann and Maurer (2005) and Campanelli (2014), the Cost reduction and the delay in projects are mitigated by the reduction of the deadline. The Cost reduction becomes one of the main advantages noticed in different scenarios of application, because of the ease of Scrum Agile Methodology in dealing with unexpected process changes in companies in a more agile way, with leaner teams and development processes (Izza et al., 2008; Imache et al., 2012; Campanelli, 2014; Mitre-Hernandez, 2014; Sommmerville, 2015; Constâncio and Souza Neto, 2016).

In the Organization set of subattributes selected in the literature were: Time Reduction, Scope of the Project and Location of the Team (remote work). The time reduction was noticed by some authors with the implementation of agile methods (Ilieva et al. 2004, p. 107; Constâncio and Souza Neto, 2016; Vallon et al., 2018). Regarding the scope of the project, Boehm and Turner (2004) identified that the size of the project, the criticality of the project, the dynamism of the environment, the people and culture are crucial factors for agile development. For Jalali and Wholin (2010) and Vallon et al. (2018), the location of the team is a success factor for the development of the software in certain scenarios in order to generate higher productivity and performance in their activities. Table 1 summarizes these attributes and subattributes with their sources. It is important to highlight that the division into categories of attributes and subattributes was based on Ribeiro et al. (2018), when the authors grouped the subattributes according to the literature review and to the meaning of each one. Because the subattributes support the IT evaluation and were joined in the same attribute, they are related, but this does not mean that they influenced each other, as we present in the Results and Discussion section. Table 1 presents the subattributes with their sources from the literature review and the union of them in attributes.

Table 1 - Attributes and Subattributes to assess the Scrum impact

Attributes	Subattributes	Authors
Human Resources	Communication between clients and developers	Jeong et al. (2018); Loftus and Ratcliffe (2005)
	Collaboration between the members of the team	Jeong et al. (2018); Sommerville (2015); Svensson and Höst (2005)
	Productivity increase	Ilieva et al. (2004); Jeong et al. (2018); Vallon et al. (2018)
	Effort reduction	Ilieva et al. (2004); Jeong et al. (2018)
	Team learning	Jeong et al. (2018); Loftus and Ratcliffe (2005)
	Introduction of new technologies	Loftus and Ratcliffe (2005)
Process	Effort reduction	Ilieva et al. (2004)
	Risks reduction	Andrat and Jaswal (2015)
	Cost reduction	Constâncio and Souza Neto (2016); Campanelli (2014); Imache et al. (2012); Izza et al. (2008); Mitre-Hernandez (2014); Mann and Maurer (2005); Sommmerville (2015)
Organization	Time reduction	Constâncio and Souza Neto (2016); Ilieva et al. (2004); Vallon et al. (2018)
	Scope of the project	Boehm and Turner (2004)
	Team location (remote work)	Jalali and Wholin (2010); Vallon et al. (2018)

Source: Done by authors (2022).

2. MATERIAL AND METHODS

The bibliographic and field research used in this article, with a qualitative research approach (Gray, 2012; Bryman, 2003) and the research strategy chosen was the study of

multiple cases in six federal universities in the Southeast region of Brazil (Yin, 2015).

Focused on the attributes to assess Agile Methods and Scrum, it was performed a bibliometric survey, following the steps of Gomes et al. (2018) and Oliveira et al. (2019). The survey was performed in the Web of Science and Scopus databases.

For the data collection, it was prepared a questionnaire with open and closed questions based on the literature review. For the closed questions it was adopted the 5-point Likert scale (where 1 = very low; 2 = low; 3 = average; 4 = high; 5 = very high) used to reflect the perception level of each participant about this assessment. The closed questions were based on the subattributes shown in Table 1.

This set of subattributes can be replicated for other sectors and adapted to other ITs.

The questionnaire was sent by internet, through a Form for the analysis sites, that is, the Superintendents of Information Technology (SITs) and Information of Technology Centers (ITCs) of the six universities. The snowball sampling strategy was applied, considering that the authors identified cases of interest from people (respondents) who know what cases are information-rich (Miles and Huberman, 1994). It took approximately 45 minutes to answer all questions, and it was sent to six respondents.

The six studied universities, among 53 Universities in Brazil (MEC, 2018), were: Universidade Federal Fluminense (UFF), Campus Niterói, in Rio de Janeiro State (STI), identified as University A (UA); Universidade Federal de Ouro Preto (UFOP), Campus Ouro Preto, in Minas Gerais State (NTI), identified as University B (UB); Universidade Federal Rural do Rio de Janeiro (UFRRJ), Campus Seropédica, in Rio de Janeiro State (NTI), identified as University C (UC); Universidade Federal do Estado do Rio de Janeiro (UNIRIO), Campus Urca, in Rio de Janeiro State (NTI), identified as University D (UD); Universidade Federal de Juiz de Fora (UFJF), in Minas Gerais State (NTI), identified as University E (UE); CEFET-Rio, Campus São Cristóvão, in Rio de Janeiro State (NTI), identified as University F (UF). Each university had its respondent numbered from one to six, all of them post-graduated, working at university between 6 and 25 years at the time of the research performance, all of them in the function of IT Manager and with an experience period in software development between 6 and 25 years. All of these universities have the software development as one of their activities and use the Scrum Method.

After the collection in theses universities, the answers were reproduced and organized for the data analysis, in which the divergence between the theory and the findings in this field were sought. For the open questions, the answers were analyzed after by QDA Miner software analysis and closed answers were analyzed by the literature review and the scores given by the respondents.

3. RESULTS AND DISCUSSION

4.1 Profile of respondents

The profiles of respondents are presented in Table 2, each one has a letter and number related to his/her identity (respondent 1 = R1, respondent 2 = R2 and etc.).

Table 2 – Respondents' profiles

Data	UA	UB	UC	UD	UE	UF
	R1	R2	R3	R4	R5	R6
Academic formation	Master	Master	Master	Master	Master	Master
Time working at the University	15 years	13 years	8 years	6 years	25 years	7 years
Position	IT management	IT management	IT management	IT management	IT management	IT management
Time in the position	7 years	5 years	5 years	3 years	13 years	3 years
Experience in Software Development	15 years	13 years	8 years	6 years	25 years	10 years

Source: Done by authors (2022).

4.2 Analysis of the open questions

In the six case studies it was possible to check that the advantages of the Agile Methodology Scrum previously raised in the literature (Schwaber et al., 2013; Abrahamsson et al., 2002; Qumer and Sellers, 2006; Jyothi and Rao, 2011; Deemer et al., 2012; Nishijima and Santos, 2013) were confirmed in the universities, which have made little progress with the obstacles of the traditional methods.

In relation to the disadvantages, some authors showed the difficulty in having and keeping a team qualified with all the processes that the method advocate for the development of the software, as noticed by McAvoy and Butler (2007). Due to the budget limitation of the public organizations, there is a certain difficulty in promoting private courses and lectures. Thus, some respondents solve the learning and training obstacle through cycles of internal courses, in which the most experienced member of the team is responsible for keeping the other members trained in relation to the processes. Therefore, we could notice many benefits, as besides spreading the expertise among the team in a constant way, there is a reduction in the impact on a possible turnover of the team.

The difficult in meeting with the clients, an important item to notice the constant and necessary changes in the demands of goods and services and in the Project, especially in IT, that compromise the promptness in the products delivery, as noticed by Dingsøyr et al. (2019) and Petter and McLean (2009) were also considered a disadvantage of the method in most of the cases. It can impair the performance of the planning, and the validation of the results generated by the team was another disadvantage highlighted in the case study. Then, it was necessary a general meeting with all people involved in the project to raise the awareness of the importance in following all the steps of the development process that dictate the Agile Methodology Scrum and to emphasize the advantages and benefits that the Methodology offers to the organization. It was noticed two additional difficulties in the case studies, which were not found in the literature review, the technical maturity and the high turnover of the team.

A crucial point raised is related to Reliability – gained by the success of the projects developed when using the Methodology – by the ITs sectors of the universities. It happened, mostly, because of the speed in delivery and the dynamism achieved in the application of the Methodology, as seen in Constâncio and Souza Neto (2016), Ilieva et al. (2004) and Vallon et al. (2018), when these authors analyzed in their studies the time reductions. However, it was also noticed an increase of the demands for software solutions from several business areas of the universities to these IT sectors.

The adoption of the Agile Methodology Scrum was reinforced in the case studies due to the benefits generated by the method, such as the increased value of the ITs sectors, but it is necessary an alignment of the methodology with the strategic planning of the organization, according to Jeong et al. (2018).

Other important data that contributes for the success of Scrum was the support offered by the board of directors of the Colleges and the Rectory. Because of the strategic alignment of the ITs with the organization, the support of the senior management is determining for the success of Scrum. A project manager's figure in the organization who provides the communication between the technical part of the project management and the other departments of the organization is crucial. The manager was the associate who understood what Scrum can do for the organization and, thus, is able to assess if the methodology was in line with the expectation of the top management. Besides helping in the decision-making regarding the implementation of the method, the manager also follows its use, assuring that the designed objectives were achieved.

It was also noticed that, in most cases, the initiative to use the Agile Methodology Scrum was done autonomously by the IT Managers and, so, in most of the answers, the respondents signaled that the use of the method is still considerably incipient in their sectors, but they had already noticed that the process of software development has achieved a higher agility, communication, learning and knowledge of the whole team (Svensson and Höst, 2005; Loftus and Ratcliffe, 2005; Jeong et al., 2018). The answers are summarized in Table 3.

Table 3 – Summary of answers from open questions

Theme		Sources	Confirmation/refutation	Suggestions (what was done/observed)
Advantages of Scrum		Schwaber et al. (2013); Abrahamsson et al. (2002); Qumer and Sellers (2006); Jyothi and Rao (2011); Deemer et al. (2012); Nishijima and Santos (2013); One (2017)	confirm	
Disadvantages	Difficulties in keeping the team trained	McAvoy and Butler (2007)	confirm	Cycles of internal courses, in which a more experienced team member is responsible for keeping the others trained in the processes
	Difficulties in promoting meetings with clients	Dingsøyr et al. (2019); Petter and McLean (2009)	confirm	A general meeting with all those involved in the project to raise awareness of the importance of following all the stages of the development process, which dictates the agile Scrum method, and to highlight the advantages and benefits that the methodology offers to the organization
	-	-	-	It was noticed, in the field research, two more difficulties, the technical experience and the high employee turnover
Project reliability		Constâncio and Souza Neto (2016); Ilieva et al. (2004); Vallon et al. (2018)	confirm	There was also an increase in demands for software solutions from several business areas in the university to IT sectors
Method adoption		Jeong et al. (2018)	confirm	Despite the adoption, it is still necessary an alignment of Scrum with the organization's strategic planning
Support from top management (directors and dean)		Vallon et al. (2018); Svensson and Höst (2005); Loftus and Ratcliffe (2005); Jeong, Park and Kim (2018)	confirm	There was a support, but the initiative, in most cases, came from the NTI/STI managers
Assessment of Scrum		(All sources from Table 1)	96% of the answers were positive	The implementation carried out in each of the six universities was successful

Source: Done by authors (2022).

4.3 Analysis of the closed questions

This section starts with the records of the collected data, the analysis of these data by the contraposition between the theory and the field. Table 4 shows the answers of the closed questions, organized by university, based on the attributes and subattributes raised in the literature review and identified in Table 1, using the scale informed in the methodology section.

Table 4 – Scores for each sub-attribute from interviewers

Attributes	Subattributes	UA	UB	UC	UD	UE	UF
		R1	R2	R3	R4	R5	R6
Human Resources	Communication	5	3	5	5	4	4
	Collaboration	5	3	5	5	3	5
	Productivity	4	3	4	4	4	4
	Effort reduction	3	4	3	4	2	4
	Team learning	5	4	3	4	3	4
	Introduction of New Technologies	4	3	3	3	4	4
Process	Error reduction	4	3	3	3	4	4
	Risk reduction	4	3	4	3	3	4
	Cost reduction	3	3	3	3	2	4
Organization	Time reduction	3	4	4	4	4	4
	Scope of the project	5	3	2	3	3	4
	Team location (remote work)	5	4	3	4	4	3

Source: Done by authors (2022).

In Table 4, according to the criterion defined in the Material and Methods item, it is noticed that among the interviewees from the universities, there were two divergences between the respondents' answers. The first, in the Human Resources attribute, was in Team Learning sub-attribute. This sub-attribute deals with the degree of knowledge of each developer in relation to the technology used and the level of maturity in relation to the practices adopted by the Method (SIDKY, 2007). This depends on the level of maturity in the use of the Agile Method, as interviewees R3 and R5 see collaboration and communication between the team as more important, while R6 only signals collaboration. Besides, the last interviewee score can be justified because the agile method would "blame" the success or failure of deliveries to the entire team and not to the member (SCHWABER et al., 2013). Finally, it can also be explained by the easy adaptation of the method to new development tools and configuration management by the entire team (SCHWABER et al., 2013; CRISTAL et al., 2008; MANN; MAURER, 2005; CAMPANELLI, 2014; BOEHM; TURNER, 2004; ANDRAT; JASWAL, 2015; JEONG; PARK; KIM, 2018).

As for the sub-attribute Introduction of new technologies, it is observed that only R1, R5 and R6 considered it something feasible to occur in the project, observing a small difference in relation to the score given by the others (R2, R3 and R4). This small difference may be related to the investment potential of each NTI/STI in research and innovation of new technologies in the entire software development process. Still based on the analysis, it is noticed the importance given by R1, R3, R4 and R6 when scoring Communication, as 5. This happens because this is one of the pillars of the advantages of using the Scrum method, whose rate promotes the communication and dialogue between team and client, instead of excessive and unnecessary document generation.

In addition, analyzing Figure 1 we can observe the benefits achieved with the adoption of the Agile Method, such as Effort reduction, Productivity related to the projects, and favoring the introduction of new development technologies. As for the reduction of effort, for respondents R2, R4 and R6, the Agile Scrum Method greatly influences the reduction of effort of the entire team (ILIEVA, IVANOV; STEFANOVA, 2004). This is due to the tool's efficiency in managing changes in an integrated team cadenced by objective and realistic planning with the client's interests (JEONG; PARK; KIM, 2018).
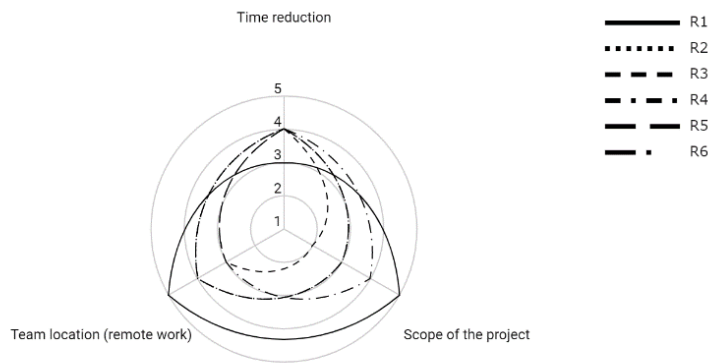
Figure 1 – Human Resources subattributes scores
Source: Done by authors (2022).

In Figure 2, related to the Process attribute, Risk Reduction sub-attribute, only R1, R3 and R6 considered that the Methodology has a strong influence on the Risk reduction, which affects the development project, while R2, R4 and R5 scored it on average. This difference may be related to the size of the project, the criticality of the project, the dynamism of the environment, people and culture, as they are crucial variables for the agile management of the risks inherent to the project (BOEHM; TURNER, 2004; ANDRAT; JASWAL, 2015).

In the Defects reduction sub-attribute, an advantage was observed by R1, R5 and R6 but less significant for the other interviewees. This difference in the answers may be related to the maturity level of the agile software development process. This happens from the very end of each cycle of the agile Scrum method some artifacts are generated and need to be validated by the technical team and representatives of the business areas (DANTAS, 2003, p.37). Finally, although R6 has signaled Cost Reduction as an advantage perceived by the agile Scrum method, interviewees R1, R2, R3 and R4 perceived it as on average and R5 as low. This discrepancy and little relevance were observed because the universities surveyed are public entities, their purpose is focused on the quality of public service provision, rather than profit or financial gains. However, for the literature review, Cost reduction is one of the main perceived advantages (IZZA et al., 2008; IMACHE et al., 2012; SOMMMERVILLE, 2015; CAMPANELLI, 2014; MITRE-HERNANDEZ, 2014).
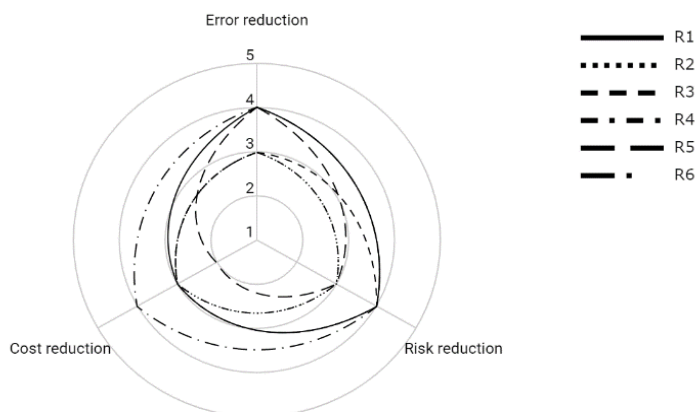

Figure 2 – Process subattributes' scores
Source: Done by authors (2022).

In Figure 3, where we can see the Organization attributes scores, sub-attribute Reduction of deadlines, except for R1, all respondents considered that the Agile Methodology Scrum has a high degree of influence on reducing the deadlines of software development projects. This difference is related to the maturity level of each interviewee's use of the Method. In addition, for Mann and Maurer (2005) and Campanelli (2014), this difference may be related to the dynamism and flexibility of the Methodology in managing business changes that occur frequently in most institutions, to different degrees and in less time, generate innovation quickly and continuously to obtain better results and performance in projects (DENNING,

2013; SILVA; LOVATO, 2016).

In the Project Scope sub-attribute, the difference between the answers can be justified by the level of complexity of the project that each of the interviewees has developed. This occurs in some scenarios where deadlines, costs, project size, and the location of teams are key factors for success (VALLON et al., 2018; MITRE-HERNÁNDEZ, 2014). Among the scores for the Remote work sub-attribute, there was a disparity between the scores granted by R1 and the others. The team's location can justify these differences and be a success factor for software development in certain scenarios to generate greater productivity and performance in their activities (JALALI; WHOLIN, 2010; VALLON et al., 2018).
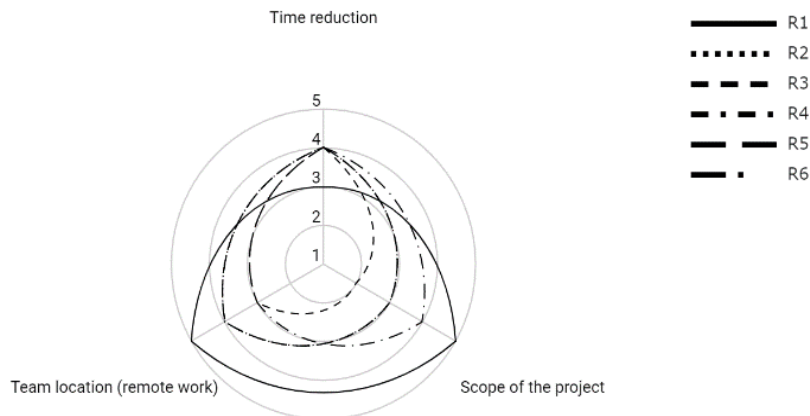

Figure 3 – Organization subattributes' scores
Source: Done by authors (2022).

When considering the offer of assessment attributes of the Agile Methodology Scrum described in Table 1, it is important to say that approximately 96% of the answers had a positive score, 3, 4 and 5. So, when analyzing the Agile Methodology Scrum by the presented scale, is reasonable to assume and to take into consideration that Scrum had a very good assessment in the universities researched.

It was noticed that in the set of Human Resources subattributes, the subattributes Communication, Collaboration, Productivity and Learning of the Team were the subattributes in which Scrum had the best assessments in the IT areas of universities, as noticed in the literature (Ilieva et al., 2004; Jeong et al., 2018; Vallon et al., 2018; Loftus and Ratcliffe, 2005; McAvoy and Butler, 2007), the flexibility and interactivity of the Agile Methodology Scrum increased such advantages in the relationship between team and client. However, in the subattributes Effort Reduction and Introduction of New Technologies, Scrum had a low score by the IT areas of universities. It can be explained by the level of maturity of the Agile Methodology Scrum use of each IT area, as well as the nature and purpose of each researched organization.

In the Process attribute, in the subattributes Error reduction and Risk reduction, Agile Methodology Scrum had the best assessment. It is due to the dynamism of the Methodology in the management of changes and reduction of the risk in the process of software development through their daily meetings. The sub-attribute Cost reduction, although such sub-attribute is well discussed in the literature as one of the advantages of the use of the Agile Methodology Scrum (Campanelli, 2014; Imache et al., 2012; Izza et al., 2008; Mitre-Hernandez, 2014; Mann and Maurer, 2005), received low scores by the respondents. Based on the studies, this discrepancy can be linked to the purpose of the researched organization, whose main purpose is the quality of the public service rendering and not the financial gain.

Finally, in the Organization attributes, the subattributes Time reduction (Constâncio and Souza Neto, 2016; Ilieva et al., 2004; Vallon et al., 2018) and Remote Work (Mitre-Hernández, 2014; Vallon et al., 2018), Scrum received a positive assessment by the IT areas from the respondents. It can be explained by the central purpose of the Agile Methodology Scrum, which is in the validation of communication and collaboration (Human Resource), instead of documentation excess of the traditional methods. However, when analyzing the sub-attribute Scope of the Project, besides noticing a low relevance by the IT areas, it was also noticed a variation in the perceptions of each respondent. This fact can be explained by the level of maturity in the use of Scrum, as well as the complexity of each project that each respondent

developed or had developed.

The interviewees' profiles can lead to divergences between some answers, as the level of maturity in the agile software development process, as well as the personal subattributes of each manager, can influence this evaluation (SIDKY, 2007; MITRE-HERNÁNDEZ, 2014; VALLON et al., 2018). It is observed that more than half of the IT managers have more than 10 years of experience in software development, but at a different time during their careers, as well as the time that they work at the university. Thus, although they all have the same training, as observed in Table 2, experiences in other institutions before those currently working may have made the set of respondents heterogeneous.

4. CONCLUSION

Based on what was analyzed in the cases, it is possible to confirm, considering the set of attributes and subattributes identified in the Literature Review, that Scrum succeeded its implementation in the universities. One of the reasons would be the low level of complexity of the methodology implementation, since the unities of analysis used to spend time answering demands for solution of low complexity software from several business areas from the universities. Despite some disadvantages, such as low level of technical maturity and high team turnover, 96% of the answers confirm positive experiences. Although the research obtains these answers, it was noticed in the unities of analysis the presence of assessment activity of the method.

In this study, through the survey of the main articles about IT and IS assessment, it was built an offer of attribute set to assess the Agile Methodology Scrum, with three different focus, that is, human resources, process and organization. This union of attributes contributes for the literature as it associates different articles published in journals and in different years, by authors from several public and private institutions, from different sectors (education, technology, government, etc.), which enable the structuring of a tool to be used by researchers in the assessment area of IT/IS and agile methods.

During the analysis, a strong relationship among the attributes researched appeared. Three subattributes from different sets received the lower scores (Effort reduction, Cost reduction, and Scope of the project). These low scores represent the investment that the universities must do in support of their employees, avoiding waste of time and cost, and focusing on the scope of the project. Hence, when the institution focuses on its project, time, cost, and efforts wasting are decreased because they are concentrated on one goal. On the other hand, two subattributes in the same set of attributes (Communication and Collaboration) received higher scores followed by Productivity, Team learning (in the same set) Time reduction, and Team location (remote work). These scores show that higher Productivity and better Team learning are consequences - even when the members are in different locations (or in remote work) - of efficient Communication and effective Collaboration between the members of a team.

The contribution for the companies (and not only universities) consists of the possibility of a company to use these attributes as indicators to the assessment of this IT or a similar one, in the three dimensions of the company (HR, process and organization), or only in one of them. Furthermore, if it is a company in the education area, the use of this set added to the study of multiple cases will allow the institution to use not only the theoretical set, but also the experiences of the six universities to a better understanding, planning and strategic planning and the action for improvements in its IT sector.

Since Scrum is a recognized agile methodology in the development of software, it assures more efficiency of the organization in the process of software development, which results in faster and leaner answers to the demands for software solutions in the ITs sectors of the universities studied. In this regard, the paper contributes to a decisive way to the public service rendering with more quality and efficiency, speeding the decision-making process of the organization with little improvement with the barriers of the traditional methods.

The work limitations are related to the reduced number of researched institutions, about 11% of the total of Brazilian universities, based on the use of case study method, which did not allow the generalization of the results in the study. When considering the fact that the superintendence and centers of universities' IT are sectors that have a reduced number of employees, and the staff consists of scholarship students, also, a further development with a higher number of respondents who use Scrum was not possible due to the short period that those scholarship students remain in the sector.

For future studies, it is suggested to perform a survey encompassing IT specialists, preferably managers who use agile methods in a higher number of universities in Brazil, using the questionnaire only for closed questions. So, the universities that have projects with a

higher level of maturity in the use of the Agile Methodology Scrum could enhance the study.

ACKNOWLEDGMENTS

REFERENCES

Abrahamsson P., Salo O., Ronkainen J. and Warsta, J. (2002), "Agile Software Development Methods: Review and Analysis", *VTT Technical Research Centre of Finland, VTT Publications*, 478. DOI: https://doi.org/10.3940/rina.efs.2012.10

Andrat, H. and Jaswal, S. (2015), "An alternative approach for risk assessment in Scrum", *International Conference on Computing and Network Communications*, IEEE Communcations Society, Trivandrum, Kerala, India, pp. 535-539. DOI: https://doi.org/10.1109/coconet.2015.7411239

Boehm B. and Turner R. (2004), *Equilibrando a agilidade e a disciplina*, 7 ed. Pearson Education, Boston. 266p.

Bryman, A. (2003), *Research Methods and Organization Studies*, 1 ed. Routledge, Londres.

Campanelli, A.A., Camil, R.D. and Parreiras, F.S. (2018), "The impact of tailoring criteria on agile practices adoption: A survey with novice agile practitioners in Brazil", *Journal of Systems and Software*, Vol. 137, pp. 366-379. DOI: https://doi.org/10.1016/j.jss.2017.12.012

Campanelli, A. (2014), "A model for the agile method", *Projects and Dissertations in Information Systems and Knowledge Management*, Vol. 3, No. 2, pp. 36-42.

Constâncio, F. and Souza Neto, J. (2016), "Correlação entre o nível de engajamento das equipes de projeto e o desempenho em uma empresa pública estruturada por projetos", *Revista de Gestão e Projetos,* Vol. 7, No. 2, pp. 17-19. DOI: https://doi.org/10.5585/gep.v7i2.340

Cristal, M., Wildt, D. and Prikladnicki, R. (2008), "Usage of SCRUM: practices within a global company", In: International Conference on Global Software Engineering, 1, IEEE, Bangalore, pp. 222-226. DOI: https://doi.org/10.1109/icgse.2008.34

Dantas, V. (2003), "Uma metodologia para o desenvolvimento de aplicações Web num cenário global", 37 p. Thesis (Master in Computer Science). Centro de Ciências e Tecnologia, Universidade Federal de Campina Grande, Campina Grande, Paraíba, Brasil. DOI: https://doi.org/10.24873/j.rpemd.2021.10.846

Dechow, N., Granlund, M. and Mouritsen, J. (2007), "Interactions between modern information technology and management control", *Management Accounting*, Vol. 3, pp. 45-64. DOI: https://doi.org/10.1016/s1751-3243(06)02007-4

Deemer, P., Benefield, G., Larman, C. and Vodde, B. (2012), "The scrum primer".

Delone, W.H. and McLean, E.R. (1992), "Information Systems Success: the quest for the dependent variable", *Information Systems Research*, Vol. 3, No. 1, pp. 60-95. DOI: https://doi.org/10.1287/isre.3.1.60

Denning, S. (2013), "Why Agile can be a game changer for managing continuous innovation in many industries", *Strategy and Leadership*, Vol. 41, No. 2, pp. 5-11. DOI: https://doi.org/10.1108/10878571311318187

Souza Scotelano, L., Dalvo Pereira da Conceição, R., da Costa Leonídio, U. and Silva de Jesus, C. (2017), "Project management maturity model: the case in an automotive industry in Brazil", *Brazilian Journal of Operations & Production Management*, Vol. 14, No. 4, pp. 500–507. DOI: https://doi.org/10.14488/BJOPM.2017.v14.n4.a6

Dingsøyr, T., Falessi, D. and Power, K. (2019), "Agile development at scale: the next frontier", *IEEE Software*, Vol. 36, No. 2, pp. 30-38. DOI: https://doi.org/10.1109/ms.2018.2884884

Díaz-Pinzón, B.H., Rodríguez V.M.T. and Espinosa Moreno, J.C. (2019), "Modelo de capacidad en tecnologías de información en mipymes colombianas", *Innovar*, Vol. 29, No. 74, pp. 45-56. DOI: https://doi.org/10.15446/innovar.v29n74.82094

DYBÅ, T. and DINGSØYR, T. (2008), "Empirical studies of agile software development: a systematic review", *Information and Software Technology*, Vol. 50, No. 9-10, pp. 833-859. DOI: https://doi.org/10.1016/j.infsof.2008.01.006

Gomes, C.F.S., Ribeiro, P.C.C. and Freire, K.A.M. (2018), "Bibliometric research in Warehouse Management System from 2006 to 2016", in WMSCI 2019: World Multi-Conference on Systemics, Cybernetics and Informatics, International Institute of Informatics and Systemics, Orlando, Florida, USA, pp. 200-204. DOI:

https://doi.org/10.54808/wmsci2022.02

Gray, D. (2012), *Pesquisa no mundo real*. 2 ed., Porto Alegre: Penso.

Haes, S. and Van, G. (2009), "Exploratory Study into IT Governance Implementations and its Impact on Business/IT Alignment", *Information Systems Management*, Vol. 26, pp. 123-137. DOI: https://doi.org/10.1080/10580530902794786

Ilieva, S., Ivanov, P. and Stefanova, E. (2004), "Analyses of an agile methodology implementation", *Euromicro 2004*, IEEE Computer Society, Rennes, France, pp. 326-333. DOI: https://doi.org/10.1109/eurmic.2004.1333387

Imache, R., Izza, S. and Ahmed-Nacer, M. (2012), "An enterprise information system agility assessment model" *ComSIS*, Vol. 9, No. 1, pp. 108-133. DOI: https://doi.org/10.2298/csis101110041i

Izza, S., Imache, R., Vincent, L. and Lounis, Y. (2008), "An approach for the evaluation of the agility in the context of enterprise interoperability", *International Conference on Interoperability for Enterprise Software and Applications*, IESA, Berlin, Germany. DOI: https://doi.org/10.1007/978-1-84800-221-0_1

Jalali, S. and Wohlin, C. (2010), "Agile practices in global software engineering-a systematic map", *IEEE International Conference on Global Software Engineering*, IEEE Computer Society, Princenton, NJ, USA, pp. 1-11. DOI: https://doi.org/10.1109/icgse.2010.14

Jeong, Y., Park, K. and Kim, D. (2018), "Study on management alternatives on agile method based financial security software Project", *Journal of Theoretical and Applied Information Technology*, Vol. 96, No. 6, pp. 1690-1700.

Jyothi, V.E. and Rao, K.N. (2011), "Effective implementation of agile practices ingenious and organized theoretical framework", *International Journal of Advanced Computer Science and Applications*, Vol. 2, No. 3, pp. 41–48. DOI: https://doi.org/10.14569/ijacsa.2011.020308

Loftus, C. and Ratcliffe, M. (2005), "Extreme programming promotes extreme learning?" *ACM SIGCSE Bulletin,* Vol. 37, No. 3, pp. 311-315. DOI: https://doi.org/10.1145/1151954.1067531

Mann, C. and Maurer, F. (2005), "A Case study on the impact of Scrum on overtime and customer satisfaction", *The Agile Development Conference*, IEEE Computer Society, Washington DC, USA, pp. 70-79. DOI: https://doi.org/10.1109/adc.2005.1

McAvoy, J. and Butler, T. (2007), "The impact of the Abilene Paradox on double loop learning in an agile team", *Information and software technology*, Vol. 49, No. 6, pp. 552-563. DOI: https://doi.org/10.1016/j.infsof.2007.02.012

Miles, M. B. and Huberman, A. M. (1994), "Qualitative data analysis: an expanded sourcebook", 2 ed., SAGE, Los Angeles.

Mitre-Hernández, H. (2014), "Estimation and control in agile methods for software development: a case study", *Ingeniería investigación y tecnologia*, Vol. 15, No. 3, pp. 403-418.

Nicolas, F.N.P., Thomé, A.M.T. and Hellingrath, B. (2021), "Usage of information technology and business analytics within sales and operations planning: a systematic literature review", *Brazilian Journal of Operations & Production Management,* Vol. 18, No. 03, e20211152. DOI: https://doi.org/10.14488/BJOPM.2021.023

Nishijima, R. and Santos, J. (2013), "The challenge of implementing Scrum agile methodology in a traditional development environment", *International Journal of Computers & Technology*, Vol. 5, No. 2, pp. 98-108. DOI: https://doi.org/10.24297/ijct.v5i2.3529

Oliveira, A.O., Oliveira, H.L.S., Gomes, C.F.S. and Ribeiro, P.C.C. (2019), "Quantitative Analysis of RFID' Publications from 2006 to 2016", *International Journal of Information Management*, Vol. 48, pp. 185-192. DOI: https://doi.org/10.1016/j.ijinfomgt.2019.02.001

Petter, S. and McLean, E. (2009), "A meta-analytic assessment of the DeLone and McLean IS success model: An examination of IS success at the individual level", *Information and Management*, Vol. 46, No. 3, pp. 159-166. DOI: https://doi.org/10.1016/j.im.2008.12.006

Qumer, A, and Sellers, B. (2006), "Comparative evaluation of XP and scrum using the 4D analytical tool (4-DAT)" in Themistocleous, M., Papadaki, M. and Kamal, M.M. *European and Mediterranean Conference on Information Systems*, Institute for the Future, Costa Blanca, Alicante, Spain, pp. 6-7.

Ribeiro, P.C.C., Batalha, M.O., Chudoba, K.M., Bailey, D. and Scavarda, A.J. (2018), "Identification technologies evaluation method: an application in cattle chain", *Brazilian Journal of Operations & Production Management*, Vol. 15, No. 1, pp. 23-34. DOI: https://doi.org/10.14488/bjopm.2018.v15.n1.a3

Ribeiro, P.C.C., Batalha, M.O. and Scavarda, A.J. (2010), "Application of RFID in Brazilian harvest facilities: two case studies", *WMSCI 2010: World Multiconference on Systemics, Cybernetics and Informatics*, International Institute of Informatics and Systemics, Florida, USA, pp. 1-5. DOI: https://doi.org/10.54808/wmsci2022.02

Rising, L. and Janoff, N. (2000), "The Scrum software development process for small teams", *IEEE Software*, Vol. 17, No. 4, pp. 26-32. DOI: https://doi.org/10.1109/52.854065

Schwaber, K., Beedle, M. and Sutherland, J. (2013), *The Scrum Guide.*

Sidky, A. S. (2007), *A Structured Approach to Adopting Agile Practices: The Agile Adoption Framework*, Dissertation (Doctoral Computer Science) Virginia Polytechnic Institute and State University.

Silva, E. and Lovato, L. (2016), "Framework Scrum: Eficiência em Projetos de Software", *Revista de Gestão e Projetos - GeP*, Vol. 7, No. 2, pp. 1-15. DOI: https://doi.org/10.5585/gep.v7i2.330

Singh, R., Vijayan, S., Ilango, V., Rasheed, A.A. (2019), "Software development process models comparison and assessment of degree of agility based on agile practices and performance implementation on XP and Scrum", *International Journal of Scientific & Technology Research*, Vol. 12, No. 8, pp. 1008-1016.

Sommerville, I. (2015), "Engenharia de Software", 10 ed., Pearson Education, São Paulo.

Soundararajan, S. and Arthur, J.D. (2011), "A structured framework for assessing the "goodness" of agile methods", *IEEE International Conference and Workshops on Engineering of Computer-Based Systems*, IEEE Computer Society, Las Vegas, pp. 1-4. DOI: https://doi.org/10.1109/ecbs.2011.26

Stavru, S. (2014), "A critical examination of recent industrial surveys on agile method usage", *Journal of Systems and Software,* Vol. 94, No. 2, pp. 87-97. DOI: https://doi.org/10.1016/j.jss.2014.03.041

Svensson, H. and Höst, M. (2005), "Views from an organization on how agile development affects its collaboration with a software development team" in Bomarius F. and Komi-Sirviö S. editor. *Proceedings of International Conference on Product Focused Software Process Improvement, Association of Computing Machinery*, Oulu, Finland, pp. 487-501. DOI: https://doi.org/10.1007/11497455_38

Vallon, R., Silva, Estacio, B.J., Prikladnicki, R. and Grechenig, T. (2018), "Systematic literature review on agile practices in global software development", *Information and Software Technology*, Vol. 96, pp 161-180. DOI: https://doi.org/10.1016/j.infsof.2017.12.004

Yin, R.K. (2015), *Estudo de Caso: Planejamento e Métodos*, 5 ed., Bookman: São Paulo.