The impact of human factors on agile projects

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***Abstract*—This research aims to provide more evidences about the impact of human factors in agile software projects. In this light we have conducted a systematic literature review (SLR) to investigate which human factors impact agile projects and conducted a survey in software companies in order to verify their perceptions. Considering the SLR, we found 48 resulting studies where most cited human factors were: Communication (23 papers), Collaboration (6 papers) and Trust (8 papers). The survey was answered for 186 companies that consider communication the most important factor. So we conclude that Communication, Trust and Collaboration are important factors in projects using agile methods but others factors need to be more investigated due the perception of its value to the industry.**

Keywords—— Human Factors; Agile Software Development; Systematic Literature Review.

I. INTRODUCTION

The nature of software development activity is centered on people and their relationships, interactions and collaboration. It means that activities performed by stakeholders depend, not only of technical aspects, but also how individuals' connections will work along the product development [1]. Pirzadeh [1] states human factors are related to different aspects of the human being and it could impact in the final software product. These factors are defined in three categories: (i) **individual** factors are related to human characteristics of team members such as personality; (ii) **interpersonal** factors are related to human factors among individuals who affect or are affected by engineering or software development process, such as cooperation, group learning and work in teams; (iii) **organizational** factors are related to company issues such as decision making. Vidgan and Wang [2] consider software development activity as a complex adaptive system (CAS) since the complex system (software development context) can be adaptive to its environment and how innovative properties of a system emerge from the interaction of its lower level components (people).

Considering agile software development, the value of interaction between people is made explicit in agile manifest in the first "individuals and interactions over processes and tools" and third statements "customer collaboration over contract negotiation" and in the sixty principle: "The most efficient and effective method of conveying information to and within a development team is face-to-face conversation" [3]. Cockburn [4] states that human factors can be described as any human issue caused by a team when people work together. Specifically in agile software development, this concept is related to any human aspect involved in the formation of teams to build software, since this kind of activity is focused on people interaction. Sharp [5] defines human factor as some types of social factors that arise from various interactions and need occur to allow the flow of software development process.

Cockburn and Highsmith [6] emphasize some human factors for agile development methods such as: cordiality, talent, skills and communication. These factors can emerge when a group of individuals is working together in teams. Sharp [5], Dybå and Dingsøyr [7] and Pirzadeh [1] reported that human and/or social factors, on different perspectives, are observed in traditional software development and agile environments especially in eXtreme Programming (XP). Pirzadeh [1] states that researches considering human factors in software development are scarce. It is still for necessary further researches to measure the impact of human factors in the software development process as a whole including agile environments. This is our motivation to conduct the research about the impact of human factors in agile projects. We performed a secondary study (systematic literature review - SLR) and a survey aiming to investigate which human factors are perceived as important in agile projects.

Besides this introductory section, this paper presents another four. In Section two, the related works are presented. In Section three we present the research methodology. Section four describes the analysis and discussion of the results. And in Section five we present the conclusions.

II. RELATED WORKS

Pirzadeh [1] conducted a systematic review to identify and characterize human factors that influence the process of software development. The research covered all software projects environments considering both: (i) people working in all development lifecycle and (ii) project managers. She proposed the following categories to human factors: (i) organizational, (ii) interpersonal and (iii) individual. According the author, the individual factor was the one that presents most influence in software projects specially activities related to requirements elicitation. Livermore [8] conducted an online survey to investigate which "factors" were related to successful implementation of agile methods in organizations. The author listed factors such as: (i) training, (ii) management involvement, (iii) external resources access and (iv) corporation size. These results only considered technical and organizational aspects not addressing human factors.

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Law and Charron [9] published an experience report presenting the effects of agile practices in social factors. The authors did not described how they selected the following social factors: (i) sharing of knowledge, (ii) motivation and (iii) customer collaboration. Based on the data collected from two software projects, the authors have succeeded in identifying the relevance of these three social factors in software projects. Gandomani *et al*. [10] conducted a qualitative study in order to investigate how human factors impact the adoption or transition to agile. Semi-structured interviews were conducted and data analysis was performed using grounded theory. They suggested that some human factors facilitate, while others prevent, changes from traditional approaches to agile. The enabling factors were: (i) team involvement, (ii) management commitment, (iii) competent technical leaders and (iv) team work. The challenging factors were: (i) resistance to change, (ii) cultural differences, (iii) lack of collaboration and (vi) lack of agile behavior. In addition, the authors provided some insights about how changes affect people involved in agile projects. The observed statements were: (i) enthusiasm for change, (ii) concern for change, (iii) indifferent to change, (iv) need for change and (v) unrealistic expectations on agile adoption. Finally, they added that providing incentives and motivation are important facilitators for the transition to agile.

Melo *et al*. [11] conducted a study part primary and part secondary that exposes factors that motivate or discourage developers in agile software projects. The authors conclude that the main motivations were: (i) autonomy, (ii) learning, (iii) feedback and (iv) team work. The demotivators were: (i) changes, (ii) work more than 8 hours frequently, and (iii) no identification with the work. The research conducted by Melo *et al*. was not intended to determine the impact of these motivators in agile projects. These related works were classified in four categories: (i) investigation of influence of human factors in software development in traditional and agile environments; (ii) general factors that contribute to successful adoption of agile, (iii) primary studies suggesting human factors related to agile development and finally (iv) the what (de)motives agile developers. This research is part primary and part secondary, because in the secondary study we aiming to find which human factors, recognized by researchers, are noticed in agile projects. The primary study, based on a survey, was carried out to corroborate (or not) with the secondary study. The main goal of the survey was to identify the perception of companies, which adopts agile methods, in which human factors are most evident in agile projects and how they impacts agile projects.

III. Research Methodology

We performed a systematic literature review and a survey to identify the influence of human factors in agile projects. In the survey all the data collection was performed by questionnaires showed on appendix B available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0).

A. Systematic Literature Review

This SLR is based on the protocol established by Kitchenham *et al.* [12]. The first step was to identify others secondary studies related to human factors in agile development. We found only one secondary study by Livermore [8], which was not related to agile development.

1) Research Questions:

After finding the unique candidate secondary study that would satisfy our curiosity, we need to determine the research questions that should be answered in order to attend our research goals. We elaborate two research questions (RQ), related to the secondary study, which are listed above:

RQ1: Which human factors affect the use of agile methods?

RQ2: What is the impact of human factors in projects supported by agile methods?

RQ3: Which human factors are highlighted by industry in agile projects?

2) Search Strategy:

The *search strategy* is available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0).

3) Extraction and Analysis:

Our extraction was performed on the 48 final selected papers. Initially, we copied the excerpts of the papers presenting the evidence in one Excel spreadsheet. After this step we conduct a thematic analysis to identify the human factors and the main categories related to them.

A. Survey

Our survey was based questionnaires based on two sources: (i) an online questionnaire and questionnaires applied in Agile Brazil 2015 conference. The surveys were conducted in order to clarify the perception of human factors in agile software development projects. We had proposed another research question (RQ3) related to the industry that is: RQ3: Which human factors are highlighted by industry in agile projects?

The online survey was the faster, broader and easier way to obtain a large quantity of answers. The questionnaire was prepared using Survey Monkey tool. The questionnaires applied on Agile Brazil 2015 conference was intended to collect more answers. The data collection happened from 20 October 2014 to 20 November 2014. It was available online through a link on the Survey Monkey and disseminated to experts in agile methods through e-mail and Agile Brazil 2014. The questionnaire event can be viewed in Appendix B available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0). We received 186 responses of different companies.

IV. Results Analysis

This section presents a summary of the results found on this research aiming to answer the research questions that were proposed.

A. RQ1: Which human factors affect in the use of agile methods?

In the SLR, we noticed that human factor is related to every interaction or human capacity exercised during the software development. We could address and encompass social, cognitive, human, personal and sociological aspects

extrapolating Cockburn [4] and Sharp [5] definitions to human factor. In the 48 studies selected, we found 12 human factors, presented in Table II available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0), that were considered relevant. Besides human factors, we also suggest seven (7) major categories: (i) team, (ii) project success, (iii) software development, (iv) requirements, (v) agile practices, (vi) decision-making and (vii) client involvement. We also want to identify which human factors were related to these categories. If a human factor is present in that environment, how it affects (positive or negative)? And if the human factor is absent, there will be any influence?

Table III available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0) presents our findings to all these questions. We divided the results throughout seven categories and which, and how (positively or negatively), human factors affects aspects related to those categories. We seek the perception of presence or absence of the human factor, e.g. if collaboration is present or declaredly absent in teams aspects, and, if the presence or absence is positive (+) or negative (-) in that environment. These aspects are presented in next research question. The most observed human factors were: (i) communication, (ii) collaboration and (iii) trust corroborating with following principles of the agile manifesto: **(Principle 4)** – "Business people and developer must work together daily throughout the project". (Collaboration). **(Principle 5)** – "Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done". (Trust). **(Principle 6)** – "The most efficient and effective method of conveying information to and within a development team is face- to-face conversation". (Communication). To this research question we were just interested in "which" human factors affects agile software projects, but we also want to know "how" this human factors influences agile projects. To discover it we still have one more research question to answer.

B. *RQ2: What is the impact of human factors in projects supported by agile methods?*

Based on results of RQ1, we analyzed the impact of these human factors in agile projects. The collected evidences showed how these human factors influence agile projects. The absence or presence of human factor was inserted into a column called status and the impact can be positive (+) or negative (-) due this presence or absence. The impact of human factors can be viewed in Table III available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0). Considering the results shown in Table III, we could notice that almost every time when a factor was present, the impact was positive and when a factor was absent the impact would be negative. But, some exceptions were observed:

(i) Team autonomy. Two studies, [s1462] [s0203]; suggested that team autonomy could be negative in agile projects: "When members of highly autonomous teams stayed together for a long time, those teams gradually turned into silos." [s1462] and "The high individual autonomy resulted in developers focusing on their own module; and not knowing what others were doing." [s0203]**. (ii) Software Development Communication:** One study [s0906] suggests that high communication is a negative aspect: "Our results indicate that an increased reliance on less informative communication channels results in higher defect rates." [s0906], it suggests. **(iii) Requirements Client Involvement:** The involvement of the client could negative when managing requirements. According Hoda [s4011]: "Getting customer representatives to clarify requirements is also a problem because of their unavailability.". **(iv) Decision Making Autonomy:** Ghanam et al. [s1462] suggested that autonomy is a negative aspect considering the process of decision-making: "in some teams, high autonomy had an impact on decision-making, where the team considered certain issues internal without paying much attention to the consequences of their decisions on the underlying platform." [s1462]. These exceptions lead us to reflect about the importance of presence or absence of a specific human factor without understand de context.

RQ3: *Which human factors are highlighted by industry in Agile projects?* We collected data through a questionnaire containing nine questions related to human factors in the context of agile methods. The questions 1 to 3, are referred that the population of the respondents. The profile of the people can be seen in the Figure 1 to 3.

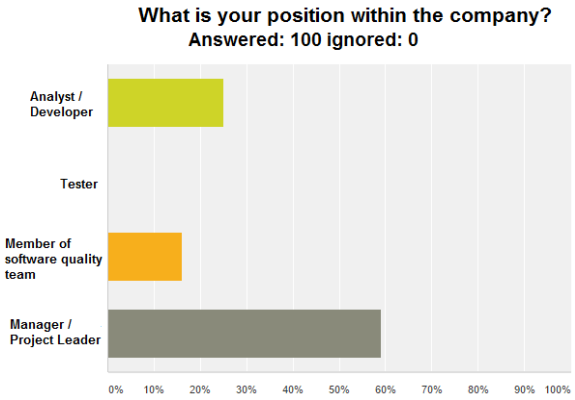

Fig. 1. The profile of the people

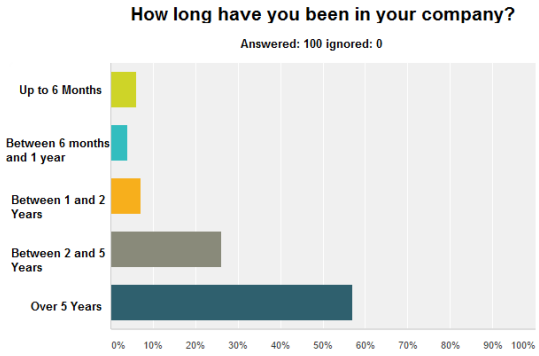

Fig. 2. Time in the company

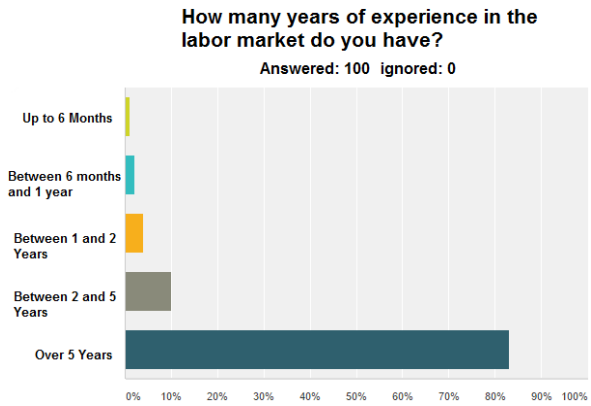

Fig. 3. Years of experience

The questions 4 and 5 were designed to understand which agile methods were most used. We found that the most widely used agile method is Scrum and time of use of agile methods cover the range 2-5 years.

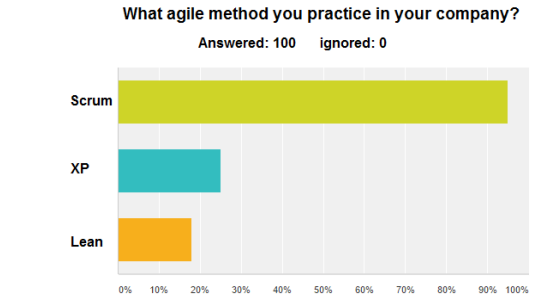

Fig. 4. Agile methods most used

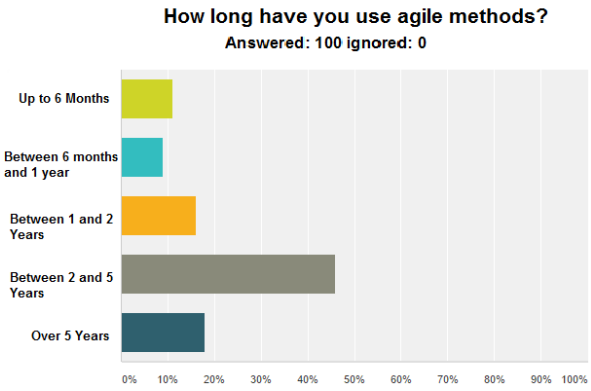

Fig. 5. Time using agile methods

From questions 6-9, we used twelve factors found in SLR related to four categories: (i) development of agile projects, (ii) team interaction, (iii) success of projects and (iv) decision making. In this survey, we did not considered the categories (a) requirements, (b) client involvement and (c) agile practices because they emerged in a late stage of the thematic analysis and the questionnaire were already launched and the number of answers was considerable large. We prefer to present our most accurate result even it being different of that used on survey. The questions 6 to 9 are: **Q6** -Which of these human factors is highlighted during the development of agile projects? **Q7** - Which of the following factors do you consider that positively impact the interaction of an agile development team of software? **Q8** - Which of the following factors do you consider that positively impact the success of agile projects? **Q9** - Which of the following factors do you consider that positively impact on decision making within an agile project?

The scores were represented by percentage. The results as a whole can be viewed at the Table IV available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0).

Comparison between SLR and Survey

Based on results found in the SLR and Survey, it was possible to establish a comparison of "quantitative data" between the categories and human factors, which were found in the SLR and also highlighted in the survey as shown in Table V available on-line (https://www.dropbox.com/sh/d4bpcpv1ubvc826/AADziFdKRPsRo17guJArpyo4a?dl=0). The idea of this comparison is just to observe the % of citations in SLR and % of companies that recognizes the importance of a human factor in that context. The comparison showed in Table V suggests that communication factor is mentioned, among other factors, in the categories time, success of projects, software development and decision-making. IT was corroborated in survey data where communication factor is emphasized in all categories questioned in the survey. Besides communication, we need to emphasize other factors perceived in a positive way:

(I) Considering the survey, most of the respondents, when asked about team category pointed the value of communication, collaboration and trust. These factors are also the most cited in SLR but, Leadership and Knowledge, which had the same number citations than collaboration, factors were less recognized as important in the survey. (ii) Back to the survey, in the category "success of the projects" the factor customer engagement had almost the same importance communication what is far of the results in SLR. (iii) Considering the category development of projects the survey just highlight the perception of the importance of communication when compared with knowledge and client involvement. (iv) and, in decision-making category, the survey and SLR presented similar data.

Some exceptions were found when comparing the data from the SLR and the Survey because it was not possible to find the same factor highlighted by the industry and in the academy, as:

1 - In category success of the projects, the companies recognized the value of the factors collaboration (67.7%) and motivation (45.2%). But, there were no researches about this factor considering success of projects. 2 - In category software development we can notice the perception of the importance of leadership (54.3%) and motivation (59.7%) factors without any research considering them. 3 - In category decision making the experience factor (56.5%) was highlighted positively, but we want to emphasize the importance of experience that is the same of communication.

V. CONCLUSION

We found many evidences about the influence of human factor in agile software development either in individual, interpersonal and organizational sphere. We want to highlight the number of evidences found about (individual, interpersonal OR organizational) factors where 48 papers related to this category. This papers related to 12 factors found in this SLR suggest that important studies on human aspects have been conducted. Thus, our perception is that researches about human factor is incipient and only concepts and initial thoughts comprehends its impact when considering agile methods. The most cited human factors were: Communication (23 papers), collaboration (6 papers) and trust (8 papers). These factors were the most important in the SLR, because they are important to the principles of Agile Manifest when describing that communication is the most important means of information exchange. Collaboration in teams using agile methods as a key aspect to use information efficiently and Collaboration in teams using agile methods as a key aspect for use of information efficiently and mutual trust.

The four exceptions found in the study suggests that even if such aspects are extremely important for agile methods, some sharply may hinder the adoption of these methods as can be seen with respect to autonomy in self-organizing teams and result in decision making and customer engagement during the agile software development, in the requirements phase. Such exceptions need to further investigation to know if they occur in other contexts. Based on the primary studies we conclude that Communication, Trust and Collaboration are most cited factors when describing human factors on agile projects. It is worth mentioning that other factors have given importance as knowledge, leadership and motivation as results of SLR. Finally, we conclude that such exceptions found in the comparison of data between SLR and allow Survey suggest that larger studies still need to be performed.

A. Threats to Validity

Kitchenham [13] and Sjoberg et al. [14] point out that the main limitations and threats to validity of this type of study are: (1) inaccuracy in the data extraction; (2) classification errors; (3) select only studies in a specific period; (4) selection bias; (5) credibility; (6) results transferring.

In order to mitigate these limitations and threats, the following strategy was adopted: (1) The approach of synthesis and thematic analysis that included the data extraction of publication was used, context and evidence in a systematic and structured way, as process suggested by Cruzes and Dybå [15]. (2) The selection was made with two or more researchers at every stage of examination. The conflicts were resolved at a meeting between the researchers. (3) All studies published since the beginning of the agile manifesto in 2001 until 2012 were selected. (4) To avoid bias in the studies selection, meetings and guides were conducted at every stage of research. In the case of extraction phase, there was also a random extraction developed by another researcher, who served for comparison in relation to extraction by the research author. (5) To increase the credibility, multiple data sources as the main conference on agile area for manual search were used, as well the top four automatic search engines of software engineering cited by Kitchenham et al. [12] and Dybå and Dingsøyr [7]. (6) To increase the results transfer of this review, the protocol and its phases were described, including data extraction and synthesis process.

B. Future Works

Considering this results some future researches are suggested such as:

(1) A qualitative research supported based on interviews, in order to verify the results of this research and its perception of industry. Thus, with the findings of this SLR and the qualitative research is intended to develop a deep understanding of the influence of human factors in agile methods. (2) Others secondary studies could be conducted to find evidences of why, in what contexts these human factors affect agile teams. This research is only devoted to "map" what and how human factors affects agile projects, but we do not know why and in which contexts.

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